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

A New Survey of Universal Knowledge

ENCYCLOPÆDIA BRITANNICA

Volume 20

SARSAPARILLA *TO* SORCERY

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SARSAPARILLA *TO* SORCERY

SARSAPARILLA, a drug prepared from the roots of several species of the genus *Smilax* (lily family). The origin of the name is Spanish. *zarza* meaning "bramble" and *parilla,* "little vine." The plants are indigenous to Central America from the southern and western coasts of Mexico to Peru. Only three species have been identified with certainty: *Smilax aristolochiifolia, S. regeli* and *S. febrifuga,* known in commerce, respectively, as Mexican, Honduras and Ecuadorian sarsaparillas. Other varieties, known commercially as Ecuadorian (or Guayaquil) and Central American (Jamaica or Guatemala), are derived from unidentified species of *Smilax.* The plants are large perennial climbing or trailing vines, growing from short, thick. underground stems from which rise numerous semiwoody flexuous angular stems, bearing large alternate-stalked leaves. The tendrils that provide support for the plants spring from the bases of the leaves. The roots are dried in the sun, then gathered loosely into bundles or bound tightly into cylinders, depending on the place of origin, and exported. Several sterols and a crystalline glycoside, sarsaponin, which yields sarsapogenin on hydrolysis, have been isolated from the root. Sarsapogenin is related to steroids such as progesterone and is used in their synthesis. Sarsaparilla is regarded popularly as a tonic, but in fact is inert and useless. A liquid extract in which it is combined with other flavouring agents is an ingredient of such carbonated drinks as the American root beer. (V. E.)

SARSFIELD, PATRICK (?–1693), titular earl of Lucan, Irish Jacobite and soldier. belonged to an Anglo-Norman family long settled in Ireland. He was born at Lucan, but the date is unknown. Patrick, nho was a younger son, entered Dongan's regiment of foot on Feb. 9. 1678. During the last years of Charles II he served in the English regiments which were attached to the army of Louis XIV of France. The accession of King James II led to his return home.

He took part in the suppression of the Western rebellion at the battle of Sedgemoor on July 6, 1685. In the following year he was promoted to a colonelcy. King James had adopted the dangerous policy of remodelling the Irish army so as to turn it from a Protestant to a Roman Catholic force, and Sarsfield whose family adhered to the church of Rome, was selected to assist in this reorganization. When the king brought over a few Irish soldiers to coerce the English, Sarsfield went in command of them. Sarsfield had a brush with some of the Scottish soldiers in the service of the prince of Orange at Wincanton. When King James fled to France, Sarsfield accompanied him.

In 1689 he returned to Ireland with the king. During the earlier part of the war he did good service by securing Connaught, and was promoted to brigadier, and then major general After the battle of the Boyne (July 1, 1690), and during the siege of Limerick, Sarsfield came prominently forward. His capture of a convoy of military stores at one of the two places called Ballyneety, between Limerick and Tipperary, delayed the siege of the town till the winter rains forced the English to retire. This achievement made him the popular hero of the war with the Irish. When the cause of King James was ruined in Ireland, Sarsfield arranged the capitulation of Limerick and sailed to France on Dec. 22, 1691. He received a commission as lieutenant general (maréchal de camp) from King Louis XIV and fought with distinction in Flanders till he was mortally wounded at the battle of Landen (Aug. 19, 1693). He died at Huy two or three days after the battle. In 1691 he had been created earl of Lucan by King James. He married Lady Honora de Burgh, by whom he had one son, James. nho died childless in 1718.

See J. Todhunter, *Life* of **Patrick** *Sarsfield* **(1895).**

SARTHE, a *dkpartement* of France, formed in 1790 out of the eastern part of Maine, and portions of Anjou and of Perche. Pop (1954) 420,393. Area 2,411 sq.mi. It is bounded north by the *département* of Orne. northeast by Eure-et-Loir, east by Loir-et-Cher, south by Indre-et-Loire and Maine-et-Loire and west by Mayenne. The *dkpartement* includes the greater part of the basin of the Sarthe, which drains the large bay in the southern flank of the hills of Normandy, and the city of Le Mans is at the focus of this bay, nhere the Sarthe from the northwest joins the Huisne from the northeast. It is floored largely by Jurassic and Cretaceous rocks succeeding one another eastuard, with the Armorican Palaeozoics on its western border. Southeast of the Huisne the Eocene deposits stand out, forming a relatively poor territory. The Loir flows through the southern edge of the department to join the Sarthe in Maine-et-Loire; along its chalky banks caves have been hollowed out which, like those along the Cher and the Loire, serve as dwelling houses and stores. The mean annual temperature is 51° to 52° F. The rainfall is between 25 and 26 in.

The *de'partement* is mainly agricultural. There are three distinct districts: — the corn lands to the north of the Sarthe and the Huisne; the region of barren land and moor: partly planted with pine, between those two streams and the Loir; and the wine-growing country to the south of the Loir. Sarthe produces much barley and hemp. The raising of cattle and of horses, notably those of the Perche breed, prospers, and fowls and geese are fattened in large numbers for the Paris market. Apples are largely grown for cider. The chief forests are those of Bercé in the south and Perseigne in the north; the fields in the department are divided by hedges planted with trees. Coal, marble and freestone are among the mineral products. The staple industry is the weaving of hemp and flax, and cotton and wool-weaving are also carried on. Paper is made in several localities. Iron-foundries, copper and bell foundries: factories for provision-preserving, marbleworks at Sablé, potteries, tileworks, glass-works and stained-glass manufactories, curriеries, machine factories, wire-gauze factories: flourmills are also important. The *département* is served by the Ouest-État, the Orléans and the State railways, and the Sarthe and Loir provide about 100 mi. of waterway, though the latter river carries little traffic.

The *de'partement* forms the diocese of Le Mans and part of the ecclesiastical province of Tours, has its court of appeal at Angers, and its académie (educational division) at Caen, and forms part of the territory of the IV army corps, with its headquarters at Le Mans. The *arrondissements* are named from Le Mans; the chief town, La Flèche and Mamers. There are *33* cantons and *386* communes. The chief towns are Le Xlans, La Fleche, La Ferté-Bernard, Solesmes (*qq.v.*) and Sablé.

SARTI, GIUSEPPE (1729–1802), Italian composer, was born in Faenza, Dec. *1, 1729*. He studied under the direction of Padre Martini at Bologna, and was organist at the cathedral in Faenza 1748–50. At the age of *22* he completed his first opera, *Pompeo in Armenia.* successfully produced in Faenza (*1752*). This success was followed by *Il Rè pastore,* in Venice (1753), which with others established his fame abroad.-

He mas called by Frederick V of Denmark to Copenhagen, where for several years he directed Italian opera and was made court conductor. He was then commissioned by the Danish king to engage singers in Italy for a new company. During his absence in Italy King Frederick died, and Sarti remained in Italy for three years. On his return to Copenhagen in 1768, he conducted the court opera until 1775, when he was dismissed for political reasons. During his stay in Denmark, he composed 20 Italian operas and many Danish Singspiele.

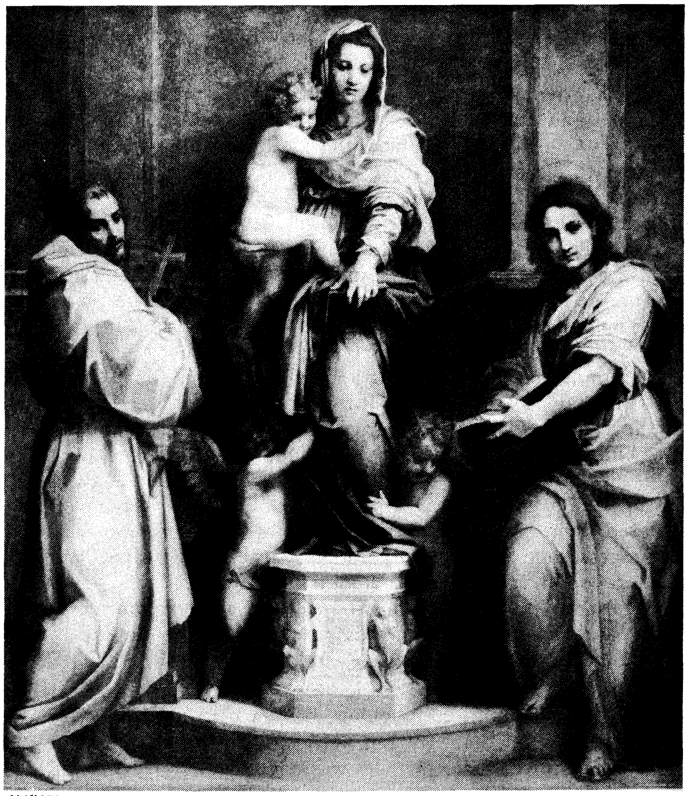
From Copenhagen he uent directly to Venice. where he was made director of the Ospedaletto conservatory. In 1779 he won the directorship of the cathedral in Milan, in competition with the leading musicians in Naples. This gave him the opportunity to write several masses, a Miserere *a 4,* and motets. It was during this period that he achieved his greatest dramatic success by writing some *1j* operas, among them *Giulio Sabino* (Venice, 1781) and *Fra i due litiganti il terzo gode (Le Nozze di Dorina)* (Milan, *1782*). This great success established his reputation and brought him many students of note, among them Cherubini, who became his assistant.

Sarti left Italy again upon invitation from Catherine II of Russia (1784) to go to St. Petersburg. On his way he stopped in Vienna, where he was received in court by the emperor, and met Mozart, who was then in his prime. In St. Petersburg, Sarti was welcomed with even greater favour in the court of Catherine II. Under his directorship, the Italian opera attained unparalleled success and perfection. The empress. uho showed great interest in his achievements, wrote the libretto for his opera *Olega.* Beside being a composer, Sarti was a skilled mathematician and physicist. He invented a device for counting tone vibrations for which he was made honorary member of the St. Petersburg Academy of Science. Among the works he composed for the Russian court is a Te Deum composed on the taking of Ochakov by Potemkin. In this composition Sarti used fireworks and cannon for accent and martial effect. He lost favour with the empress for a short time, and Prince Potemkin came to his aid by establishing a school in a village in Ukraine! and making Sarti director. The empress restored him to favour again, however, and made him head of a new conservatory planned after those of Italy.

Sarti was a prolific composer, and wrote 54 operas. They possess great character and charm, and Mozart wrote variations on an air from one of them. Among other compositions are a requiem, two Te Deums, two concertos, six sonatas for the harpsichord and many masses. Several of the masses are frequently performed. Very few of his compositions have been engraved. Most of his works were placed in the library of the conservatory in Paris, and that of Naples.

After the death of the empress of Russia, Sarti made plans to revisit Italy, and stopped on his way in Berlin, where he fell seriously ill and died July 28, *1802.*

SARTO, ANDREA DEL (1486–1530), one of the most popular Florentine painters of the early 16th century, was born in Florence on July *14, 1486.* His father. Xgnolo di Francesco, was a tailor *(sarto),* and from this fact the painter derived his name. In *1*508 Andrea was enrolled in the guild of the Medici e Speziali. According to G. Vasari, he was trained initially by a goldsmith, was later apprenticed for three years to a painter Gian Barile, and subsequently worked with Piero di Cosimo, traces of whose influence are found in his earliest authenticated works—five frescoes of scenes from the life of St. Philip Benizzi, executed in the entrance court of the Annunziata in Florence in *1 jog–10.* A sixth of the "Adoration of the Magi" dates from *1*511 and a



ALINARI

"MADONNA OF THE HARPIES" BY ANDREA DEL SARTO. IN THE UFFIZI GALLERY. FLORENCE

seventh of the "Birth of the Virgin" from 1514. Whereas the earlier of these frescoes are dry and somewhat academic in style, in the latest the scale of the figures is increased and the execution reveals the boldness and beauty of colouring of Andrea's mature work. At this time Andrea was closely associated with the painter Franciabigio, as well as with the sculptor Jacopo Sansovino. who exercised a deep influence on his figurative style. His relation to both artists can be traced in a celebrated cycle of grisaille frescoes of scenes from the life of St. John the Baptist in the Chiostro dello Scalzo. Florence. The Scalzo frescoes were interrupted in 1518 by a visit to France. where Andrea entered the employment of Francis I. The single relic of his activity in France is a painting of "Charity" dated 1518 in the Louvre. Paris. Returning to Florence in 1519 he resumed work in the Scalzo between 1522 and 1526. To this period belong his most ambitious frescoes, the "Tribute to Caesar" at Poggia a Cajano (1521), the great "Last Supper" at S. Salvi (about 1526) and the "Madonna del Sacco" in the cloister of the Annunziata (dated 1525). This last fresco, with its bold pyramidal design and delicate handling, is perhaps Andrea's finest work.

With a few exceptions. Andrea's most notable panel paintings are in the Uffizi and Pitti galleries in Florence. They include his best-known work, the "Madonna of the Harpies" (1517), the "Dispute about the Trinity" (1517–18), a magnificent "Lamentation over the Dead Christ" (1524) and three large altarpieces of the Assumption. In these he combines the compositional procedure of the Tuscan High Renaissance with a splendour of colour reminiscent of Venetian painting.

Andrea was also a distinguished portrait painter. His best work in this genre is the introspective "Portrait of a Sculptor" in the National gallery, London. A self-portrait is in the Uffizi gallery. As a draftsman, Andrea favoured the medium of red chalk, which he employed with exceptional directness and accomplishment. A large collection of his drawings is in the Uffizi gallery. Endowed with a less original talent than his great contemporaries Raphael and Leonardo da Vinci, and a more equable temperament than his disciples Rosso and Jacopo da Pontormo, Andrea del Sarto remains a central figure in Florentine High Renaissance art, whose work is marked by monumentality, sincerity and sensibility and by its disregard of external effect. The romantic story of his marriage to Lucrezia del Fede (probably 1517) is recounted by Vasari. Andrea del Sarto died of the plague at Florence on Sept. 29, 1530.

See I. Fraenckel, *Andrea del Sarto* (1935); B. Berenson, *The Drawings* of *the Florentine Painters,* 3 vol. (1938). (J. W. P.-H.)

SARTS. The Sarts are an Iranian Turkish tribe, numbering about 2,000,000, who live in Ferghana and Syr Daria territories. They are highly organized, living in permanent villages, with a developed Sufi system of education. They practise a system of agriculture, using irrigation canals, and growing fruit and cotton. They are also accomplished traders. In religion they are Sunnites, many of them belonging to the Sufi order. They have mixed considerably with the Tadjiks, the remnant of the old non-Turkic population, and physically are largely of the Alpine type. In culture they differ widely from most of the tribes speaking cognate languages. (L. H. D. B.)

SARZANA, a town and episcopal see of Liguria, Italy, in the province of La Spezia, 9 mi. E. of Spezia. Pop. (1957 est.) 16,846 (commune). The cathedral of white marble in the Gothic style, dating from 1204, was completed in 1471. The old citadel, built by the Pisans in 1263, was re-erected in 1388. Glass bottles and bricks are made there. Sarzana's position at the entrance to the valley of the Magra (anc. Macra), the boundary between Etruria and Liguria in Roman times. gave it military importance in the middle ages. The first mention of it is found in 983.

SASARAM, a town in Shahabad district. Bihar. India. on the Eastern railway, 90 mi. W.S.W. of Patna. Pop. (1951) 29.265. It is famous as containing the tomb of the emperor Sher Shah (1540–45). The tomb, the finest example of Pathan architecture in India. with a dome 101 ft. high, stands on an island in the middle of. an artificial lake. The town also contains the tomb of Sher Shah's father, another fine specimen of Pathan art; a building called the Kila, or fort. said to have been his palace; and the grave and unfinished tomb of Sher Shah's son. the emperor Salim Shah. Outside is the ruined tomb of Alawal Khan, the reputed architect of Sher Shah's and his father's tomb. A rock edict of Xsoka is inscribed on the Chandan Pir Shahid hill, close to the town.

SASEBO, a port town in Nagasaki prefecture. Kyushu, Jap. Pop. (1960) 262,484. Provided with a good natural harbour near the mouth of Ōmura bay, Sasebo was a naval base from 1896 until the end of World War II. It was a small village until the restoration (1868), but expanded rapidly after the wars with China and Russia. The town was partially destroyed in World War II, but because of facilities which years of experience had perfected, Sasebo revived as a commercial and fishing port. The harbour facilities are also used by the U.S. armed forces stationed in Japan. (R. B. H.)

SASKATCHEWAN, a prairie province of Canada lying between Manitoba to the east and Alberta to the west and containing part of one of the great grain-producing regions of the world. It has an area of 251,700 sq.mi., of which 31,518 sq.mi., mainly in the north. are covered by water.

Physical Geography. — Geology and *Physiography.*—Saskatchewan has purely artificial boundaries cutting across the major geologic and geographic zones of west central Canada (see CANADA: *Physical Geography;* Geographical Regions). The northern one-third is a part of the Canadian shield. Pre-Cambrian rock is exposed at the surface or underlies shallow glacial drift and sedimentary sands in a terrain which is rugged but not mountainous. Muskeg (swamps), many lakes and small streams are indicative of two immature drainage systems which carry the brackish water to Hudson bay via the Churchill or to the Arctic ocean via the Xthabasca and Mackenzie. The southern two-thirds of the province forms part of the great interior continental plains. In Saskatchewan these comprise two distinct levels or prairie steppes. The westernmost, at about 2,500 ft. above sea level. extends to the Missouri *coteau* (cuesta or scarp), a dominant feature which approximately defines the eastern edge of the remnant Tertiary formations. The Cypress hills and Wood mountains rise to 1.000 ft. above this level and comprise the youngest Tertiary beds. The second prairie steppe, at about 1,500 ft., terminates in the Manitoba escarpment, the eastern edge of Cretaceous formations on the prairies. Various series of hills between the two escarpments, including the Moose and Duck mountains and the Porcupine and Pasqua hills, are outriders of the older Tertiary beds. The province was almost entirely glaciated in Pleistocene times and the present surface soils of the plains originated from glacial depositions.

The Saskatchewan river (*q.v.*) drains a large part of the southern plains. Its two branches. entering the province from Alberta nearly 200 mi. apart. meet east of Prince Albert and flow toward Lake Winnipeg in Manitoba. A southwestern area drains southward to the Missouri river, and the southeastern corner of the province is drained by the Souris and Qu'Appelle rivers to Lake Winnipeg via the Assiniboine and Red rivers of Manitoba. Most southern Saskatchewan rivers flow through deep. U-shaped valleys which were eroded by glacial melt water in unconsolidated sedimentary beds as the last continental ice sheet retreated.

Climate, Soils and *Vegetation.*—Saskatchewan has a continental climate with relatively little marine influence, prevailing westerly winds and wide seasonal and daily ranges of temperature. Average monthly temperatures decrease northward. particularly in winter. The average January temperature in the south is 0° F. while in the extreme northeast it is −20° F. The isotherm of 65° F. in July runs along the southern border and that of 60° F. through the middle of the province. The low annual precipitation is concentrated fortunately in the growing season. Average precipitation varies from 11 in. in the southwest to 18 in. in the northeast part of the agricultural region, with wide local and seasonal fluctuations. Repeated low annual averages of precipitation led to the disastrous prairie drought of the 1930s which was accompanied by dust storms and insect infestations.

As a result of their glacial origin the clay and loam soils of the great plains in Saskatchewan are rich in mineral content. Modification in well-defined zones of vegetative cover, each in turn a characteristic of a particular set of climatic factors; has produced brown soils in the arid southwest, black soils in the prairies (grasslands) proper. degraded black soils in the parklands and gray wooded soils in the northern extremes of the plains area. The grasslands are primary producers of wheat, but the higher levels. particularly the Cypress hills, are wooded and break the monotony of the landscape. Scattered clumps of trembling aspen in the wide belt of parklands eventually thicken and merge into the mixed wood forest at a northwest-southeast line across the province between Prince Albert and Saskatoon. Northward a further transition takes place to dominantly coniferous species. It is the northern part of this mixed wood belt which contains the best of the province's merchantable timber. Still farther northward a wide expanse of potential pulpwood (chiefly black spruce and jack pine) deteriorates into a zone of little commercial value. There poor soil and low temperatures reduce the quality of the tree cover.

Wildlife.—Saskatchewan is rich in wildlife resources. The vast prairies, once the home of great buffalo herds, are still sparsely populated and continue to provide an almost unlimited habitat for deer and antelope, upland birds such as grouse. partridge and pheasant, and waterfowl—ducks, geese. cranes and swans. Deer, elk, moose and bear inhabit the parklands and forests, with caribou in the far north. Of the fur bearers. muskrat, beaver, mink. squirrel, otter and fisher are common, Nearly all Saskatchewan lakes and streams contain fish: many in sufficient abundance to be fished commercially.

History. — Saskatchewan takes its name from the Indian name for the great river of the plains, which is in full Sis-Sis-Katchewan-Sepie. the "Big Angry Water" or "Rapid river." The territory, then unexplored. was granted by Charles II in 1670 to the Hudson's Bay company for the exploitation of its fur. The first knowledge of this part of the territory came from an expedition of Henry Kelsey of the company (1690–92). Subsequent exploration was accomplished by the La Yerendrye brothers about 1750. and thereafter by Anthony Henday and Samuel Hearne. In 1774 I-Iearne established the first white habitation to remain a permanent community, at Cumherland House on the lower Saskatchewan river.

Until their merger in 1821 the Hudson's Bay company and the North-West company were rivals in the fur trade, particularly in the forested regions of the territory. They set up numerous temporary forts and trading posts. often in direct competition at one location. The consolidated Hudson's Bay company established additional permanent posts, such as Carlton House and Ft. Pitt, by the 1840s. All other settlement was confined to the vicinity of these posts.

The transfer of the territory to Canada in 1869 and railway connection from Winnipeg to St. Paul. Minn., in 1878 prompted immigration and homestead settlement. The dispossession of the resident half-breed population without proper recognition of their rights led to two uprisings. in the Red river valley in Manitoba (1869–70) and in Saskatchewan (1885). The North West Mounted Police were established in 1873. Organized government of the Northwest Territories south of latitude 60° came in 1875, with Ft. Livingstone the first government seat and Ft. Battleford taking over in 1877. In 1882 Regina was made the territorial seat of government. Completion of the Canadian Pacific railway in 1885 aided farm settlement and a surge of immigrants after 1901 led to the creation of the province of Saskatchewan in 1905, with Regina (*q.v.*) selected to be the capital city.

Rapid growth continued until World War I, the population increasing from 91.279 in 1901 to 492.432 in 1911, and municipalities, towns and cities were established. The University of Saskatchewan at Saskatoon was founded in 1907. There was wide diversity among settlers in nationality. culture and religion. Immigration slackened and practically stopped between World Wars I and TI. and the desperate depression years of the 1930s saw some emigration from Saskatchewan and some relocation within the province. Settlers from the "dust bowl" moved northward into the forested regions to resume agricultural and other activities there. The return of wetter seasons and improved crops in the 1940s encouraged reconsolidation and diversification of the provincial economy. In 1955, the jubilee year for Saskatchewan, a recognition program was undertaken to mark many historic sites throughout the province.

Population. — Saskatchewan's population, 925,181 in 1961, is concentrated in the southern half of the province. Less than 27, live north of the agricultural region. Settlement took place fairly rapidly in the grasslands and parklands, more slowly in the forest fringe. The main rail line of the Canadian National railway passing through Saskatoon and the park belt, where the risk of drought is less than on the prairies proper, enabled this zone to reach and retain the greatest nonurban density of population in the province. A gradual shift of urban-rural ratios continued after World War II, from 67, urban in 1901 to 21% in 1931 to 37% in 1956, in centres of 1.000 population and over. About 42% of Saskatchewan people were of British origin, 67, French, 16% German, 8% Scandinavian. and 9% Ukrainian, with a scattering of over 16 other national groups. About 23,300 Indians lived in Saskatchewan under federal care. The largest religious groups were United Church of Canada (30%) and Roman Catholic (24%), followed by Anglicans (11%) and Lutherans (11%). Over 24 other creeds were represented.

Government and Public Finance. — The lieutenant governor, appointed by the federal government, is the titular head in the province; he acts on the advice of the executive council. headed by the premier and comprised of selected members of the provincial legislature. The statutory number of members of the legislature is 55: they are elected for five years unless the assembly is dissolved sooner. There is a nonpolitical civil service. The province is represented at Ottawa by six senators (after 1915) and by members of the house of commons according to population; the 1952 Representation act gave Saskatchewan 17 members.

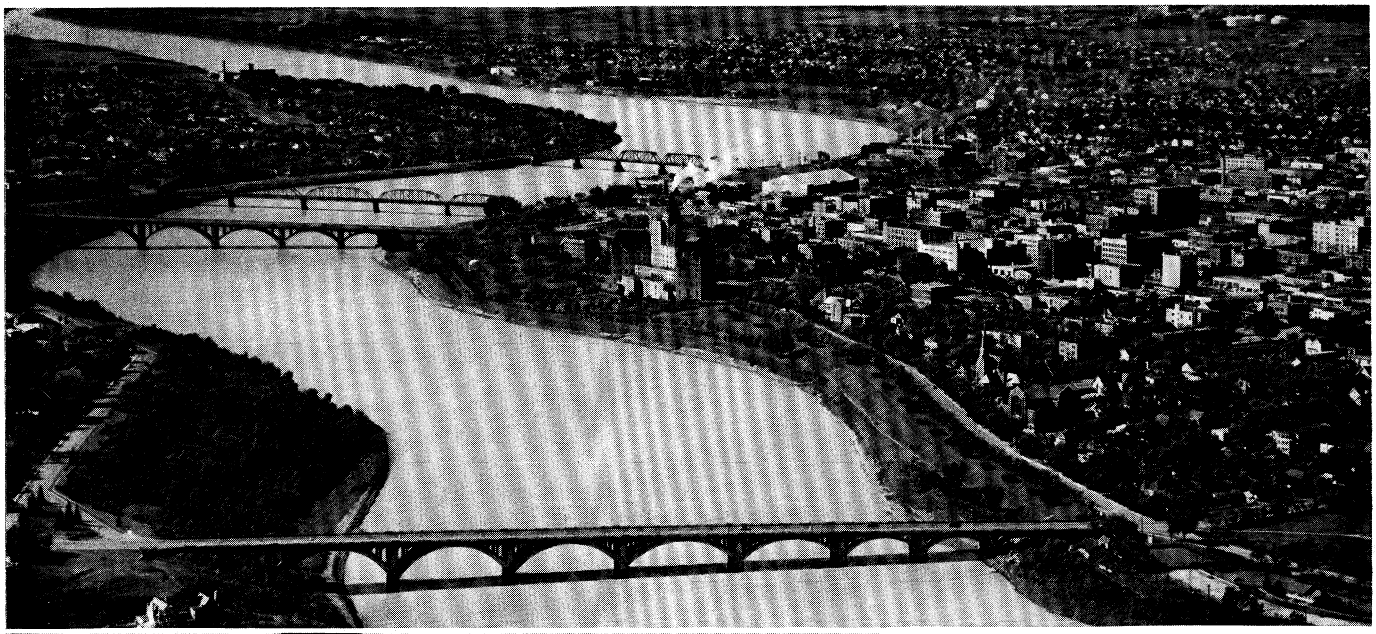
Through Saskatchewan's first 25 years as a province, the Liberal party remained in control, to be replaced for one five-year term through the worst of the drought and depression years by a Conservative administration. The Liberal party then returned, but the growing unrest and organization of farmer groups and their dissatisfaction with the control over the prairie economy exerted by eastern interests contributed to the election in 1944 of a social democratic party entitled the Co-operative Commonwealth federation (C.C.F.), headed provincially by the premier. T. C. Douglas. By 1960 there was elective municipal government in 11 cities. 106 towns, 372 incorporated villages and 296 rural municipalities. There are no counties.

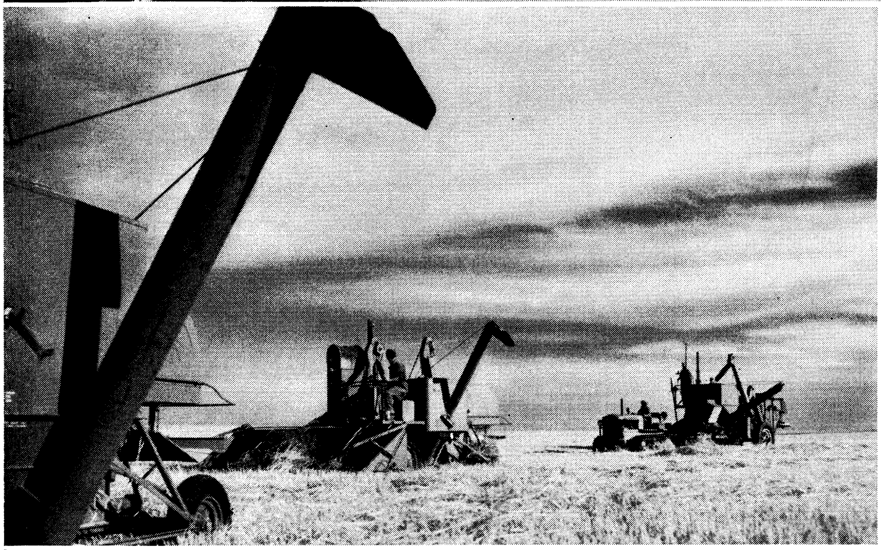
Public revenue in Saskatchewan as in other provinces is drawn from retail sales and income taxes. licences, royalties and crown corporation profits; under a dominion-provincial tax rental agreement the dominion compensates Saskatchewan for income and corporation taxes. formerly levied by the province. Provincial revenue increased from under $12,000,000 in 1921 to over $132,-000.000 in the second half of the 20th century. After the economic crisis of the 1930s, stringent provincial controls were imposed on municipal borrowing.

Education. — Throughout Canada the control of education is vested in the provinces. Elementary education in Saskatchewan is public, undenominational. compulsory and free of charge. Private denominational schools are permitted if they conform to the general standard. Both classes of schools are supported hy public funds. Enrollment in public day schools totals about 200.000. in private schools about 3,000. Other provincial institutions include a correspondence school. a school for the deaf, two teacher training colleges and a technical institute. Provincial loans and scholarships are available to university. teachers college or nursing school students. The University of Saskatchewan at Saskatoon. with an affiliated college in Regina. offers a wide variety of advanced academic training and extension services, particularly in agriculture.

Production. — Until well after World War II, Saskatchewan's economy was primarily agricultural. During the war years the output of nonfarm industry represented just 20% of the value of total commodity production. The growth of the petroleum, mining. manufacturing and construction industries was rapid in the postwar years and by 1958 nonagricultural industries accounted for 65% of gross commodity production, or $927,000,000 of $1.327.000.000. The estimated gross retail trade in 1958 was valued at $902,000,000.

Agriculture.—Still the basic industry in Saskatchewan. agriculture accounted for 66% of the net value of all production over the ten-year period to 1958. Grain crops lead production; the average wheat crop for this period was 2i7.000.000 bu. or 57% of Canada's total. Long-term average yields for wheat, oats and barley are 15, 29 and 22 bu. per acre, respectively. Other major



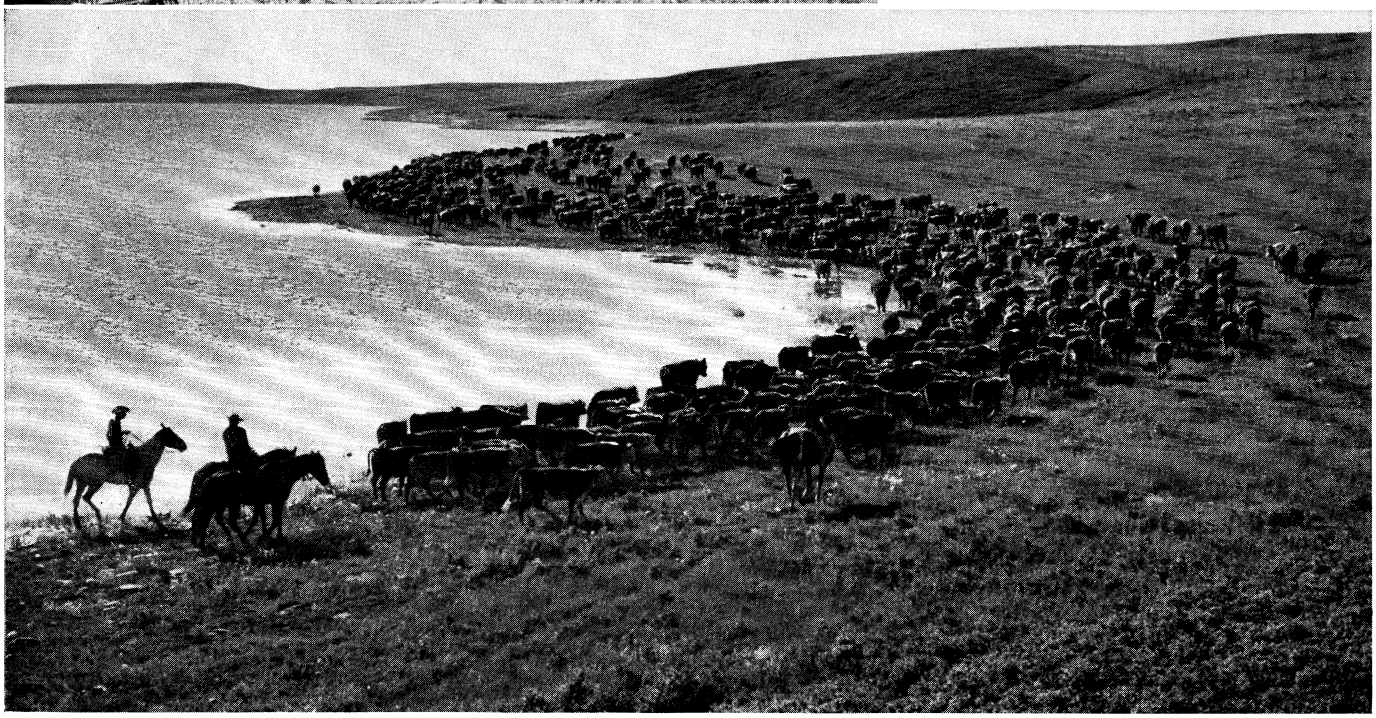


SCENES OF SASKATCHEWAN

Above: South branch of the Saskatchewan river seen at Saskatoon, second largest city of the province. The river joins its north branch at a point about 100 mi. north of Saskatoon and continues east into Manitoba where it drains into Lake Winnipeg

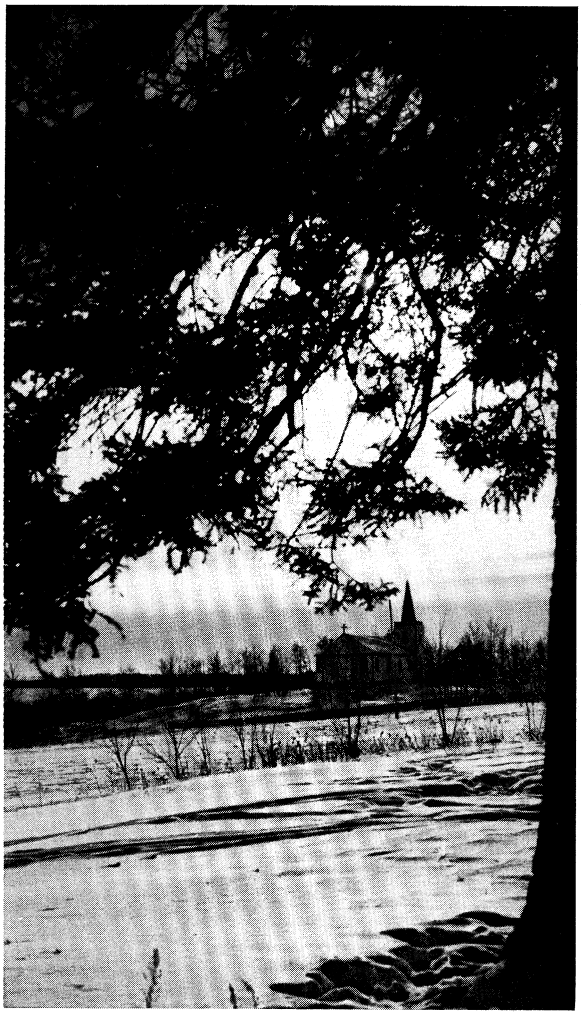
Left: Combines harvesting wheat on a farm near Swift Current, southwest Saskatchewan. Agriculture is the principal industry of the province which produces annually more than 50% of all the wheat raised in Canada

Below: Cattle roundup on a 54,000 ac. ranch near Abbey, on the edge of the Great Sand hills of southwest Saskatchewan. About 30% of the gross income of Saskatchewan farmers comes from cattle and other livestock

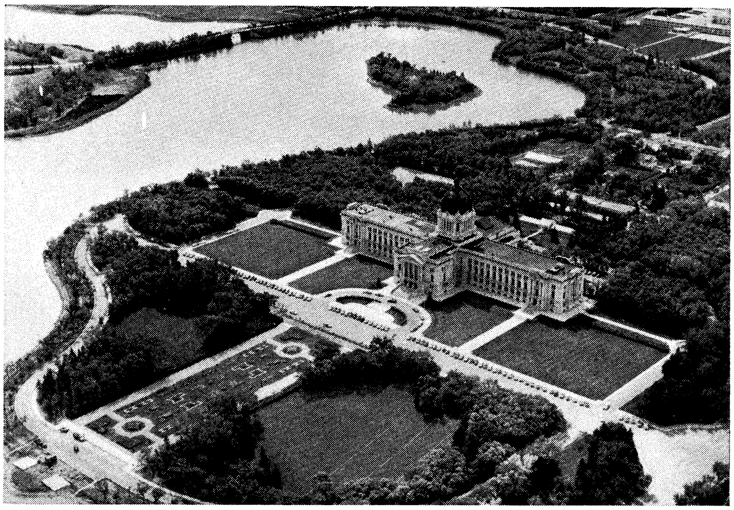


BY COURTESY OF (TOP) CANADIAN CONSULATE GENERAL, CHICAGO, PHOTO BY GEORGE HUNTER. (LEFT, BOTTOM) NATIONAL FILM BOARD OF CANADA, PHOTO (BOTTOM) BY GAR LUNNEY

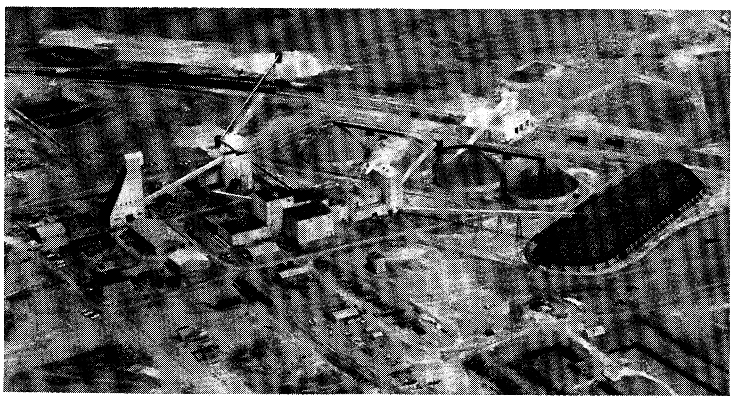
Mobile sawmill operating in a forest in the Porcupine hills, east central Saskatchewan. Forest products of the province are valued at about $9,000,000 a year



Anglican church at La Ronge, one of the few settled places in Saskatchewan north of the 55° parallel. The town is a fur trading centre for Cree Indian trappers



Legislative building and grounds, Regina, capital and largest city of Saskatchewan. The building, which houses the provincial parliament, was constructed between 1908 and 1912. Virtually all of the landscaping of the grounds, as well as of the city generally, is artificial. The area was a barren plain when Regina, first known as Pile O' Bones, was founded



Potash mine and shipping centre near Saskatoon. The industry was developed after World War II. The Saskatchewan reserves were believed to be the world's largest

INDUSTRY AND SETTLEMENTS

BY COURTESY OF (TOP, BOTTOM RIGHT) SASKATCHEWAN GOVERNMENT, (BOTTOM LEFT) CANADIAN CONSULATE GENERAL, CHICAGO: PHOTOGRAPH, (CENTRE RIGHT) HUNTING SURVEY CORP. LTD.

field crops are flax, rye and forage. Livestock production expanded during the 1950s to add stability to the agricultural economy. The value of all livestock on Saskatchewan farms was estimated at $300,000,000. Gross farm income from this source was about 30% of total farm income.

The climate limits production of many orchard and specialty crops. but research. experimentation and assistance programs of provincial and federal departments of agriculture and the provincial university have assisted greatly in improving this and the entire agricultural situation. In the 1950s the average size of Saskatchewan's 103.000 farms was 607 ac. and the average total investment per farm was $20,615. Investment in farm mechanization is exceptionally high.

Minimum economic farm-unit size varies from several sections per family (a section being 640 ac.) in the arid southwest to between one-half and one section in regions with good soil and moisture conditions. Nearly 38% of Saskatchewan's iarrns are fully owned by operators. Over 40,000,000 ac. are under cultivation and very little suitable arable land remains uncultivated. Irrigation projects, such as that on the South Saskatchewan river: are planned to provide water for land already in agricultural use. The last free homestead land was taken up in 1930.

Forestry.—The accessible commercial forest zone in Saskatchewan covers 38.000 sq.mi. Despite heavy exploitation early in the 20th century and during World Wars I and II, inventories carried out in the 1950s indicated a very large increment in both saw timber and pulpwood species, totaling 232.000.000 cu.ft. per year. with large volumes readv for cutting. The remote location in relation to major markets retarded postnar development of forest industries. particularly pulp and paper. and the annual market value of production through the 1950s averaged less than $10,000,-000. with white spruce the most used species, followed by jack wine and black swruce. After World War II the provincial government implemented conservation and development policies in forest management. organized a parachute forest-fire suppression service and launched an extensive program of forest access road construction.

Fish *and Fur.*—The most important commercially fished lakes are in the north. They include Athabasca. Reindeer. Wollaston, La Ronge and six others which all support fish-processing and freezing plants serving many lesser lakes as well. These allow better utilization, particularly in summer operations, and a more stable industry. Air transport of produce is necessary in some instances. Major commercial fish species are whitefish, lake trout and pickerel. The provincial catch averaged over 10.000.000 lb. annually from 1950 to 1957, with an average market value of $1,600,000. The expanding northern mink-rearing industry consumed a further 5.600.000 lb. in 1958.

The wild fur industry remained important to a small section of the province's people as a supplementary source of income through the 1950s. with an annual market value of more than $2,000,000. A provincial government marketing service established after World War II did much to stabilize the industry. About 55.000 reared-mink pelts were produced in 1958.

Minerals.—The metals and petroleum industries made great progress after World War II. The value of output grew from only $2.000.000 in 1931 to $36,000,000 in 1949 and to more than $204.000.000 by 1958. Base-metal operations started early in the 1930s at Flin Flon on the province's eastern boundary and contributed over $30,000,000 of the total mineral output. From a slow start based on the heavy crude oils of the Lloydminster area, the petroleum industry expanded rapidly through the 1950s to produce 45.000.000 bbl. valued at $97,000,000. Similarly, the uranium industry started production in 1954 and reached a milling capacity of 3.500 tons of ore daily. with seven mines operating. all in the Uranium-Beaverlodge area. The 1958 value of production was $58.000.000. Industrial minerals. a small but steady source of income for many years, contributed $12.000.000. Fuel production—coal and natural gas—was valued at $6.000.000. Late in 1958 Canada's first potash mine started production near Saskatoon at a rated annual capacity of 600.000 tons.

Exploration in the south for petroleum was still very active. Vast areas of the Pre-Cambrian north had not been intensively explored in spite of an apparent high potential. A northern-development road-construction program was undertaken to facilitate prospecting and exploration. Reserves in the south of industrial minerals. potash and lignite coal appear to be relatively unlimited.

Power.—The major developed source of electric power in Saskatchewan in the early 1960s was the surface lignite coal deposits of the Souris valley. which provide relatively cheap fuel for thermal generation. Most of Saskatchewan (urban and rural) receives electricity services under a provincial government plan implemented by the Saskatchewan Power corporation. This agency. which controls the province's hydroelectric potentials. undertook studies in 1958 and 1959 looking toward utilization of two sites on the Saskatchewan river system with an estimated combined potential of 500.000 h.p. One of these was the South Saskatche~vanriver dam project near Outlook. The further undeveloped potential of this river system was estimated to be 400.000 h.p.

The hydroelectric potentials of the northern rivers, chiefly the Churchill and the Fond du Lac, had not been completely determined. One Churchill river site of 100.000 h.p. was developed in the early 1930s to serve the Flin Flon mining operations. The total electric energy generated in Saskatchewan in 1958 was 1,440,-000.000 kw.hr.

Manufacturing.—Resources development in Saskatchewan stimulated a growth of secondary industries, and manufacturing made steady advances after World War II. Manufacturing production climbed from $215,000,000 in 1949 to $326,000,000 in 1958. The province then had about 1,200 manufacturing operations employing an estimated 14.000 persons.

Postwar development brought the province new industries producing cement, wire and cable, paper products, steel pipe, clay products, building board, transiormers. mobile trailer homes and a variety of operations which serve the oil and gas industries. Total capacity of the nine oil refineries in the province was 71.000 bbl. per day. with the two largest in Regina. Construction on a steel rolling mill near Regina started in 1958.

Recreation.— Prior to World War II little attention was paid to the province's recreation resources. After the war, however, major development took place, prompted by local and tourist demands resulting from easier transportation and greater leisure and prosperity. Resident and nonresident angling and hunting licence sales increased from 61.000 to 215,000 in a ten-year period. Many new businesses were established, particularly in the north, to serve the sportsmen's needs. Provincial resources authorities intensified research and improved management techniques in an effort to ensure sustained yields.

The lake and forest scenery of the northern Pre-Cambrian landscape and the many lakes still inaccessible to sportsmen other than by float aircraft in the late 1950s appeared to ensure broad expansion in the province's tourist industry as northern access improved. Cse of the northerly Prince Albert National park increased greatly for summer family recreation through the 1950s. A comparable increase was evident in the use of the developed provincial parks in the Cypress hills, at Moose mountain in the southwest and Duck mountain near Kamsack. A broad provincial program of park establishment and development throughout the southern part of the province was under way in the late 1950s.

Communications.— The southern populated area is well netted with railways. Main trans-Canada lines serve Regina and Saskatoon east and west, as well as Moose Jaw, Swift Current, North Battleford and Yorkton, with good connections to Minneapolis and Chicago. Although northern Saskatchewan is trackless, the province had over 8,700 of Canada's 44,000 mi. of track in the 1950s. In 1960 improved municipal road mileage totaled 95.000, provincial highway mileage about 6,500 with graveled surface and about 1,500 with hard-top surface. Construction mas well under way on three all-weather development roads penetrating the north. The Trans-Canada highway passing through Regina, Moose Jaw and Swift Current was completed in Saskatchewan in 1957. Trans-Canada Air Lines services Regina and Saskatoon regularly east and west. Regular north-south and intercity aircraft routes cover most of the province, including the extreme north. Saskatchewan Government Telephones corporation services all cities and towns and much of rural Saskatche an. Government-operated two-way radio services all northern points from Prince Albert.

Saskatchewan has no seaports and the rivers are generally not navigable. Lake Athabasca, however, allows lake transport from the railhead in northern Alberta to penetrate to the centre line of northern Saskatchewan.

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SASKATCHEWAN RIVER (RAPID RIVER), a river system of Alberta and Saskatchewan provinces, Can. Two large streams, the North and South Saskatchewan, which have their headwaters in the Rocky mountains in Alberta, cross the Saskatchewan boundary 200 mi. apart. unite east of Prince Albert and continue flowing eastward to empty into Lake Winnipeg. Through much of their courses both streams are well contained in deep immature valleys gouged out by escaping glacial melt water. Major tributaries are the Battle, joining the north branch, the Bow, Belly and Red Deer, joining the south branch, and the Carrot and Sturgeon Weir joining the main Saskatchewan. The length of the united Saskatchewan is 369 mi. and the total length to the head of the Bow is 1,205 mi. The Saskatchewan is believed to have been first explored by Henry Kelsey in 1690.

In the fur-trade days the river system served as an important transportation route and numerous forts and trading posts. such as Cumberland House. Carlton House. Ft. Pitt and Ft. Battleford, were located along its banks during the 18th and 19th centuries. It was later plied by steam-driven river boats in the early days of settlement, and in the forested area in Saskatchewan it served for log and lumber transport. It is now navigated only in its lower reaches.

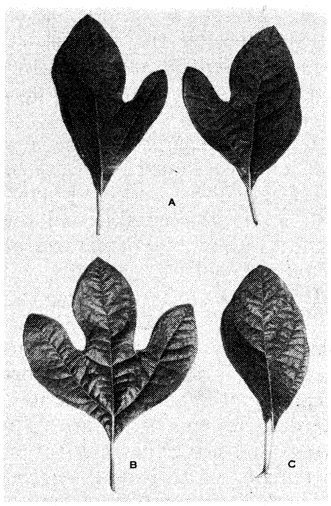
Hydroelectric development on the river began in the late 1950s; *see* SASKATCHEWAN: *Power*. (C. S. BR.)

SASKATOON, a city in the province of Saskatchewan, Can., was founded in 1883 as the proposed capital of a temperance colony and named after a local edible berry (Cree *Missaskatoomina*). Pop. (1956) 72,858; (1961) 95.526. It is situated on the banks of the South Saskatchewan river 150 mi. N.W. of Regina. almost at the centre of the settled area of the province. Both major Canadian railway systems serve the city and major provincial highways converge on it. It is served by Trans-Canada Air Lines and has regular air service with other Saskatchewan cities and the far north. It has daily and periodical newspaper services and television and radio stations; one radio station is French speaking to serve French communities to the north.

Its central position gives Saskatoon wide freight-control and distribution advantages in the province's famous wheat lands. It enjoyed rapid physical expansion and economic development after World War II. It is a major centre for grain storage and flour milling and also for livestock marketing and meat packing. It contains an oil refinery and iron foundries and serves a major potash-mining and refining industry in its vicinity.

It is the seat of the University of Saskatchewan and several affiliated colleges. a university hospital, a school of medicine, a teacher's college and school for the deaf, a National Research council laboratory and the Saskatchewan Research council headquarters. The university school of agriculture and experimental farm have made varied and major contributions to agriculture and rural life throughout the province. (C. S. BR.)

SASSAFRAS (*Sassafràs albidum*), a North American tree of the laurel family (Lauraceae). called also ague tree, with aromatic bark and foliage. It is native to sandy soils from Maine to Ontario and Iowa and south to Florida and Texas. While usually a small tree. it sometimes attains a height of 80 ft or more It has furrowed bark, bright green twigs and entire, mitten-shaped or three-lobed leaves, the three forms often on the same tnig. The yellow flowers. borne in small clusters, are followed by dark blue berries.



JOHN H. GERARD

SASSAFRAS (S. ALBIDUM) LEAVES. THE THREE FORMS. (A) MITTEN-SHAPED. (B) THREE-LOBED AND (C) ENTIRE, ARE OFTEN ON THE SAME TWIG

The root, especially its bark, is used in household medicine and in root beer; it yields oil of sassafras. used in perfumery. *See* OREGON MYRTLE: SPICEBUSH.

SASSANID or SASSANIAN DYNASTY (or SASANIAN), the ruling dynasty of the neo-Persian empire founded by Ardashir I in A.D. 226 and destroyed by the Arabs in 637. The dynasty is named after Sāsān, an ancestor of Ardashir I. (*See* PERSIA.)

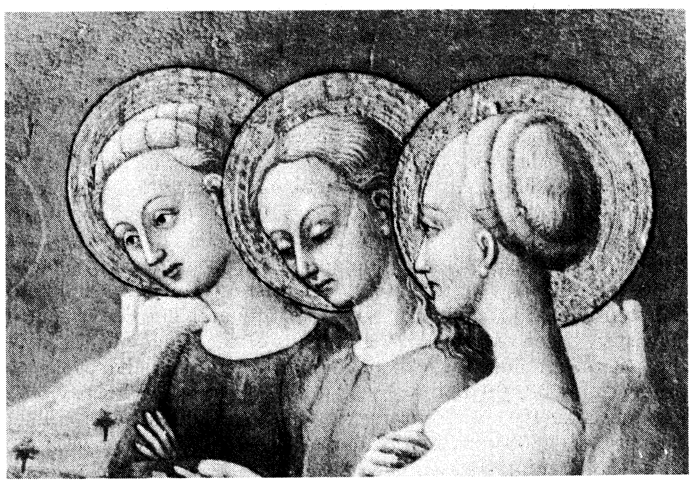
SASSARI, a town and archiepiscopal see of Sardinia. It., capital of the province of Sassari, in the northwest corner of the island. 12½ mi. by rail S.E. of Porto Torres on the north coast, 762 ft. above sea level. Pop. (1957 est.) 81.325 (commune). The town is modern. with spacious streets and squares. S. Maria di Betlemme has a good façade and Romanesque portal of the end of the 13th century. The museum in the university has an interesting collection of antiquities from all parts of the island, belonging to the prehistoric. Phoenician and Roman periods. Eleven miles to the east is the Trinità di Saccargia (12th century) with a lofty campanile, one of the finest Pisan churches in the island.

The name, in the form Thatari, first occurs in the 12th century A.D. when a church of S. Nicola is mentioned.

The town was in existence in 1217, when a body of Corsicans, driven from their island by the cruelties of a visconti of Pisa, took refuge there and gave their name to a part of it. In 1388, four years after the defeat of Meloria, Pisa ceded Sassari to Genoa; but Sassari enjoyed internal autonomy. and in 1316 published its statutes (still extant), which are perhaps in part the reproduction of earlier ones.

In 1323, however, Sassari submitted to the Aragonese king. It was sacked by the French in 1527. During World War II it was bombed by the Allies.

SASSETTA (STEFANO DI GIOVANNI) (1392?–1450), was the greatest Sienese painter of the middle 15th century. The date and place of his birth are not known. but it is believed that he was born in Cortona and that his parents moved to Siena. During the time he was an apprentice, great norks of art were being executed in Siena by famous artists whose influence is traced in some of



ALINARI

DETAIL FROM THE ".MARRIAGE OF ST. FRANCIS AND POVERTY" BY SASSETTA. IN THE MUSÉE CONDE. CHANTILLY. FRANCE

Sassetta's works.

His earliest dated work is an altarpiece designed for a chapel maintained by the Arte della Lana in Siena. Before this was completed he was engaged in the Opera del Duomo, and this connection brought him many important commissions.

Sassetta's paintings represent the religious trend of the time. He possessed a unique faculty of developing legend. His paintings show vitality, a facile quality of design and delicate pure colour. Some of his many works survive as fragments, as the chapels in which they had been painted were destroyed by earthquake. One of his best-known works is the "Journey of the Magi," in the Metropolitan Museum of Art, New York city. "The Meeting of St. Anthony and St. Paul," in the National Gallery of Art, Washington. D.C., "The Marriage of St. Francis and Poverty." in the Musée Condé. at Chantilly, and "St. Francis and the Wolf of Gubbio," in the National gallery, London, are among his other well-known paintings.

Sassetta's last work, left unfinished, mas to have been a fresco of the coronation of the Virgin, painted over the Porta Romana. He died in Siena in 1450.

SASTRI, V. S. SRINIVASA (1869–1946), Indian statesman, was horn of poor Brahmin parents at Valangiman, near Kumbakonam, Madras. on Sept. 22. 1869. He started life as a schoolmaster, but, deeply impressed by the rules of the Servants of India society, he was admitted to membership early in 1907 and succeeded to the presidency in 1915. Elected to the viceregal legislative council in 1916. he soon came to the front as the greatest Indian orator of his day. He gave discriminating support to the Montagu-Chelmsford reforms and was elected a member of the new council of state when the reforms took effect. In 1921 he served on the Indian Railway committee; represented India at the Imperial conference in London, at the League of Nations assembly at Geneva, and at the Washington conference on the reduction of naval armaments. The same year he was called to the privy council, being the third Indian to receive this distinction, and was made a freeman of the City of London. In 1922 he was deputed to Australia. New Zealand and Canada to confer with the respective governments as to the best methods of practical interpretation of the resolution of the 1921 Imperial conference on the rights of citizenship of lawfully domiciled Indians, and he achieved definite results.

In 1927 Sastri accepted appointment as first agent-general to the government of India in South Africa. with the hearty approval of Gandhi. During the first session of the round-table conference in London (Nov. 12, 1930–Jan. 19. 1931) he was an active member. In 1937 he was appointed by the government of India to inquire on Indian labour conditions in Malay. Sastri died on April 17, 1946, in the Madras presidency.

(F. H. Br.; X.)

SATAN is the English transliteration of a Hebrew word for "adversary" in the Old Testament. With the definite article the Hebrew word denotes "the adversary" par excellence, mainly in the Book of Job where the adversary comes to the heavenly court with the "sons of God" (Job i, 6). His task is to roam (the Hebrew word here has a play on sounds with the word "satan") through the earth (like a contemporaneous Persian official) seeking out acts or persons to be reported adversely (to the king); his function thus is the opposite of that of the "eyes of the Lord." which roam through the earth strengthening all that is good (II Chron. xvi, 9). Satan is cynical about disinterested human goodness and is permitted to test it under God's authority and control and within the limits God sets. (As G. Papini points out, the relations in Job between God and Satan are far closer than is usually imagined; Satan, too, belongs to the spiritual and supernatural world.) (See Job.)

In the New Testament the Greek transliteration Satanas is used and this usually appears as "Satan" in English translations. He is spoken of as the prince of evil spirits, the inveterate enemy of God and of Christ, with his throne among men (Rev. ii, 13) and takes the guise of an angel of light (II Cor. xi, 14). He can enter a man and act through him (John xiii, 27), almost as the Spirit of God in Old Testament thought could clothe itself in Gideon and rush on Samson; hence a man can be called Satan because of his acts or attitude (Matt. xvi, 23). By his subordinate demons Satan can take possession of men's bodies, afflicting them (II Cor xii, 7) or making them diseased (Matt. xii, 26; Luke xi, 18). To him sinners are delivered for the destruction of the flesh that the spirit may be saved (I Cor. v, 5). After the preaching of the 70 disciples. during which devils were subjected to them, Jesus saw Satan fall like lightning from heaven (Luke x, 18). According to the visions in the Book of Revelation. when the risen Christ returns from heaven to reign on earth, Satan will be bound with a great chain for a thousand years, then be released, but almost immediately face final defeat and be cast into eternal punishment (Rev. xx, 2. 7–10). He is identified with the ancient serpent (Rev xii, 9. xx. 2; cf Gen iii) His name, Beelzebul. used in the Gospels mainly in reference to demoniac possession, comes from the name of the god of Ekron, Baalzebub (II Kings i). (See Beelzebul.) He is also identified with the devil (diabolos), and this term occurs more frequently in the New Testament than "Satan." In the Koran the proper name "Satan" is used.

In Hebrew thought in the Old Testament there is no suggestion of any dualism, whether temporal. spatial or ethical. God himself forms light and creates darkness. makes weal and creates woe (Isa. xlv. 7). The evil spirit that terrifies men and leads them to murderous action is from the Lord (I Sam. xvi, 14). Hostile heathen powers could be spoken of as fighting against God and his people Israel, but they were the "rod of his anger" (Isa. x. 5), although there is an interesting interchange of God and Satan between two Old Testament writers (II Sam. xxiv, 1; I Chron. xxi, 1). There was thought to be a constant fight between light and darkness, chaos and law, life and death. Myths of which fragments survive in the Old Testament spoke of God's fight against the dragon of chaos, called Rahab or Leviathan (*e.g.,* Job ix, 13; Isa. xxvii, 1) and this fight. which took place at creation, continues constantly. Any philosophy of evil culled from the Bible must find room for evil within the concept of God and within his purpose his sun and rain, poured out on the good and the evil, make both weeds and nheat grow.

In later Judaism, under Persian influence, a form of duaiism developed. finding expression in cosmic speculation and in the idea of successive millenniums; traces can be seen in the Book of Daniel and in Revelation. Two ages or aeons of world history were spoken of as "this age" and "the age to come." In the former, the cosmic power of evil prevails, known variously in apocalyptic writings as Satan, Beliar. Mastema or Azazel, and identified with death and the evil impulse in man; this evil power will be overthrown by the messianic kingdom foretold in the Old Testament, and God will reign on a re-created earth, in paradise or in heaven. The devil and all his hosts were thought of as fallen angels who, like the heathen powers hostile to God, had lapsed through pride and envy into sin and abused their power as God's deputies. But Jewish thought did not depict the fallen angels as the strong energetic element in life, in contrast to the anemic. reasonable forces of good, as Blake accuses Milton of doing.

Persian dualism conceived of the conflict of good and evil as existent from the beginning, outside man, who could take sides and assist one or the other (see Dualism). Later Jewish dualism thought man himself and all nature and creation were affected by sin and the fall of man, and needed a new creation to remove the taint of evil. This was to be achieved not, as in the Old Testament, by a new heart and spirit in man (Jer. xxxi. 33 ff.; Ezek. xviii. 31) but by a dramatic divine intervention to overthrow Satan, whether in human form as the Anti-Christ (*q.v.*) or the beast or false prophet, or as a supernatural being.

Biblical ideas, mediated through the speculation of postbiblical Judaism, were transmitted to the theology of early Christian writers, in which the figure of Satan played a large part in the discussion of the nature of evil, the meaning of salvation and the purpose and efficacy of the atoning work of Christ. Early and medieval church writers discussed at length problems raised by belief in the existence of a spiritual being such as Satan in a universe created and sustained by an all-powerful, all-wise and all-loving God. Under the influence of the 18th-century revolt against belief in the supernatural. liberal Christian theology tends to treat the biblical language about Satan as "picture thinking" not. to be taken literally — as a mythological attempt to express the reality and extent of evil in the universe, existing outside and apart from man but profoundly influencing the human sphere. *See* also DEVIL.

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SATARA, the headquarters city of Satara North district, Bombay state, India, and of the former British-Indian district of Satara. The town, 10 mi. from Satara Road station on the Southern railway, is named after the "seventeen" walls, towers and gates which the fort was supposed to have had. It is 2,320 ft. above sea level, near the confluence of the rivers Kistna and Vena, 56 mi. S. of Poona. Pop. (1951) 38.521.

On the overthrow of the Yadava dynasty in 1312 Satara passed to the Mohammedan power, which was consolidated in the reign of the Bahmani kings. On their decline toward the end of the 15th century the Bijapur kings asserted themselves, and under them the Marathas rose and laid the foundation of an independent kingdom with Satara as its capital. The Maratha peshwas, who removed the capital to Poona won the ascendancy in the 18th century, but after the war of 1817 the British restored the rajah, and assigned to him the principality of Satara, with an area much larger than the subsequent district. His successor dying without male heirs in 1848, the state was resumed by the British. The district thus formed was divided after India became independent in 1947. The Satara Jagirs were a group of five states — Akalkot Bhor. Jath. Aundh, Phaltan — tributary to Satara; the last two were controlled by the Bombay governor till 1933 through the Satara Agency.

SATARA NORTH DISTRICT comprises the old Satara district, less three subdivisions, with the addition (March 8. 1948) of Phaltan state and parts of five other states. Area 4.041 sq.mi.; pop. (1961) 1,427,020. Headquarters: Satara. The Sahyadri, or main range of the Western Ghats, runs down the west side. The north is drained by the Bhima river system. The hill forests provide much timber and firewood. In some parts the average annual rainfall is over zoo in. The black loamy clay soil grows millet, pulses, oil seeds and sugar cane. Cotton cloth, blankets and brassware are manufactured.

SATARA SOUTH DISTRICT comprises four subdivisions of the old Satara district. with parts of six former principalities, added on Rlarch 8. 1948. Area 3.297 sq.mi.; pop. (1961) 1.229.640. Headquarters: Sangli ([1951] 50.287). the seat of two colleges of Poona university. The other main town is Rliraj ([1951] 40.224). Soil, forest and crops are similar to those of Satara North. but rainfall is scanty and irrigation is from the Kistna river system. The Mahadeo range runs down the eastern border.

SATELLITE, in astronomy. a small opaque body revolving around a planet. as the moon around the earth (see PLANET and the articles on individual planets).

In the theory of cubic curves, Arthur Cayley defined the satellite of a given line to be the line joining the three points in which tangents at the intersections of the given (primary) line and curve again meet the curve.

SATIE, ERIK LESLIE (1866–1925), French composer, was born at Honfleur on May 17, 1866 (his mother being an Englishwoman), and studied at the Paris conservatoire. His early works proclaimed a persistent determination to be original. and were followed by a series of equally eccentric pianoforte pieces. He exercised influence, nonetheless, upon many of his younger French contemporaries of the "advanced" school: who hailed him as a prophet. But the public at large saw in him something of the *farceur,* and his interesting attempts to be daring did not seem to be accompanied by any commensurate genuine talent.

SATIN, a term strictly denoting a true silk texture developed with a perfectly even, smooth and glossy or lustrous surface on which either warp or weft threads preponderate and thus entirely obscure the other series of threads. The principle of fabric structure observed in the construction of satin fabrics is that known as the "satin" weave. which constitutes one of the simplest elementary weaves in which the intersections of the warp and weft threads are so evenly and perfectly distributed that there are no pronounced textural features discernible in the fabric. as the threads, either of warp or of weft only, are displayed on the surface with the least possible amount of deflection by their interlacement with the threads of the other system.

A true silk satin fabric may be produced either with a warp surface or a weft surface of pure silk, with the reverse side of cotton or other textile material. In either case, the silk must be of the best quality and perfectly even.

The term "satin," however, is now applied as a general description for many fabrics constructed on the principle of the satin weaves. For example, cotton fabrics constructed on the satin-weave basis are described as "satin" or "sateen" according to whether they are developed with a warp surface or a weft surface. It is also applied indiscriminately to many other fabrics having a smooth and lustrous finish. (H. N.)

SATIN SPAR, a name given to certain fibrous minerals which exhibit, especially when cut and polished, a soft satiny or silky lustre, and are therefore sometimes used as gem or ornamental stones.

Such fibrous minerals occur usually in the form of veins or bands, having the fibres disposed transversely. The most common kind of satin spar is a white finely fibrous gypsum, used for beads, etc.

Other kinds of satin spar consist of calcium carbonate, in the form of either aragonite or calcite (*qq.v.*).

See also GYPSUM.

SATINWOOD, a beautiful light-coloured hard wood, having a rich, silky lustre, sometimes finely mottled or grained, the produce of a moderate-sized tree. *Chloroxylon swietenia* (family Meliaceae), native to the subcontinent of India and to Ceylon. A similar wood, known under the same name, is obtained in the West Indies. the tree being probably a species of *Xanthoxylum* (family Rutaceae).

Satinwood was in demand for rich furniture about the end of the 18th century, the fashion then being to ornament panels of it with painted medallions and floral scrolls and borders. It is used for inlaying and small veneers.

SATIRE, in its literary aspect, may be defined as the expression in adequate terms of the sense of amusement or disgust excited by the ridiculous or unseemly, provided that humour is a distinctly recognizable element, and that the utterance is invested with literary form. Without humour, satire is invective; without literary form, it is mere clownish jeering. The first exercise of satire no doubt consisted in gibing at personal defects. To dignify satire by rendering it the instrument of morality or the associate of poetry was a development implying considerable advance in the literary art. In the accounts that have come down to us of the writings of Archilochus, the first great master of satire, we seem to trace the elevation of the instrument of private animosity to an element in public life. Simonides of Amorgus and Hipponax were distinguished like Archilochus for the bitterness of their attacks on individuals, with which the former combined a strong ethical feeling and the latter a bright active fancy. The loss of their writings, which would have thrown great light on the politics as well as the manners of Greece, is to be lamented. With Hipponax the direct line of Greek satire is interrupted; but two new forms of literary composition, capable of being the vehicles of satire, almost simultaneously appear. Although the original intention of fable does not seem to have been satirical its adaptability to satiric purposes was soon discovered. A far more important step was the elevation of the rude fun of rustic merry-makings to a literary status by the evolution of the drama from the Bacchic festival. The means had now been found of allying the satiric spirit with exalted poetry, and their union was consummated in the comedies of Aristophanes.

A rude form of satire had existed in Italy from an early date in the shape of the Fescennine verses, the rough and licentious pleasantry of the vintage and harvest. As in Greece, these eventually were developed into a rude drama. Verse, "like to the Fescennine verses in point of style and manner," was added to accompany the mimetic action, and these probably improvised compositions were entitled *Saturae,* a term denoting *miscellany,* and derived from the *satura lanx,* "a charger filled with the first-fruits of the year's produce."

The Roman people thus had originated the name of satire, and, in so far as the Fescennine drama consisted of raillery and ridicule, possessed the thing also; but it had not yet assumed a literary form among them. The real inventor of Roman satire is Gaius Lucilius (148–103 B.C.). The fragments of Lucilius preserved are scanty, but the verdict of Horace, Cicero and Quintilian demonstrates that he was a considerable poet. It is needless to dwell on compositions so universally known as the *Satires* of Lucilius's successor Horace, in whose hands this class of composition received a new development, becoming genial, playful and persuasive. The didactic element preponderates still more in the philosophical satires of Persius. Yet another form of satire, the rhetorical, was carried to the utmost limits of excellence by Juvenal, the first example of a great tragic satirist. Nearly at the same time Martial, improving on earlier Roman models now lost, gave that satirical turn to the epigram which it only exceptionally possessed in Greece, but has ever since retained. About the same time another variety of satire came into vogue, destined to become the most important of any. The Milesian tale, a form of entertainment probably of Eastern origin, grew in the hands of Petronius and Apuleius into the satirical romance, immensely widening the satirist's field and exempting him from the restraints of metre. Petronius's "Supper of Trimalchio" is the revelation of a new vein, never fully worked till our days. As the novel arose upon the ruins of the epic, so dialogue sprang up upon the wreck of comedy. In Lucian comedy appears adapted to suit the exigencies of an age in which a living drama had become impossible. With him antique satire expires as a distinct branch of literature.

In the Byzantine empire, indeed, the link of continuity is unbroken, and such raillery of abuses as is possible under a despotism finds vent in pale copies of Lucian. The first really important satire, however, of the middle ages, is a product of western Europe, recurring to the primitive form of fable, upon which, nevertheless, it constitutes a decided advance. *Reynard the Fox* (*see* FABLE), a genuine expression of the shrewd and homely Teutonic mind, is a landmark in literature. It gave the beast-epic a development of which the ancients had not dreamed. About the same time, probably, the popular instinct, perhaps deriving a hint from Rabbinical literature, fashioned Morolf, the prototype of Sancho Panza, the incarnation of sublunar mother-wit contrasted with the starry wisdom of Solomon; and the *Till Eulenspiegel* is a kindred Teutonic creation, but later and less significant. *Piers Ploughman,* the next great work of the class, adapts the apocalyptic machinery of monastic and anchoritic vision to the purposes of satire. The clergy were scourged with their own rod by a poet and a Puritan too earnest to be urbane. The Renaissance, restoring the knowledge of classic models, enlarged the armoury of the satirist. Partly, perhaps, because Erasmus was no poet, the Lucianic dialogue was the form in the ascendant of his age. Erasmus not merely employed it against superstition and ignorance with infinite and irresistible pleasantry, but fired by his example a bolder writer, untrammelled by the dignity of an arbiter in the republic of letters. The ridicule of Ulric von Hutten's *Epistolae obscurorum virorum* is annihilating, and the art of putting the ridicule into the mouth of the victim, is perhaps the most deadly shaft in the quiver of sarcasm. It was afterwards used with even more pointed wit though with less exuberance of humour by Pascal. Sir Thomas More cannot be accounted a satirist, but his idea of an imaginary commonwealth embodied the germ of much subsequent satire.

In the succeeding period politics take the place of literature and religion, producing in France the *Satyre Ménippée,* elsewhere the satirical romance as represented by the *Argenis* of Barclay, which may be defined as the adaptation of the style of Petronius to State affairs. In Spain, where no freedom of criticism existed, the satiric spirit took refuge in the *novela picaresca,* the prototype of Le Sage and the ancestor of Fielding; Quevedo revived the mediaeval device of the vision as the vehicle of reproof; and Cervantes's immortal work might be classed as a satire were it not so much more. About the same time we notice the appearance of direct imitation of the Roman satirists in English literature in the writings of Donne, Hall and Marston. The prodigious development of the drama at this time absorbed much talent that would otherwise have been devoted to satire proper. Most of the great dramatists of the 17th century were more or less satirists, Molière perhaps the most consummate that ever existed; but, with an occasional exception like *Les Précieuses ridicules,* the range of their works is too wide to admit of their being regarded as satires. The next great example of unadulterated satire is Butler's *Hudibras.* Dignified political satire, bordering on invective, was carried to perfection in Dryden's *Absalom and Achitophel.* In France Boileau was long held to have attained the *ne plus ultra* of the Horatian style in satire and of the mock-heroic, but Pope was soon to show that further progress was possible in both. The polish, point and concentration of Pope remain unsurpassed, as do the amenity of Addison and the daring yet severely logical imagination of Swift; while the *History of John Bull* places their friend Arbuthnot in the first rank of political satirists.

The 18th century was, indeed, the age of satire. Serious poetry had for the time worn itself out; the most original geniuses of the age are decidedly prosaic, and Pope, though a true poet, is less of a poet than Dryden. In process of time imaginative power revives, but meanwhile Fielding and Smollett have fitted the novel to be the vehicle of satire and much beside, and the literary stage has for a time been almost wholly engrossed by a colossal satirist, a man who has dared the universal application of Shaftesbury's maxim that ridicule is the test of truth. The world had never before seen a satirist on the scale of Voltaire, nor had satire ever played such a part as a factor in impending change. As a master of sarcastic mockery he is unsurpassed; his manner is entirely his own; and he is one of the most intensely national of writers, notwithstanding his vast obligations to English humorists, statesmen and philosophers. English humour also played an important part in the literary regeneration of Germany, where Lessing, imbued with Pope but not mastered by him, showed how powerful an auxiliary satire can be to criticism. Another great German writer, Wieland, owes little to the English, but adapts Lucian and Petronius to the 18th century with playful if somewhat mannered grace. Goethe and Schiller, Scott and Wordsworth, are now at hand, and as imagination gains ground satire declines. Byron, who in the 18th century would have been the greatest of satirists, is hurried by the spirit of his age into passion and description, bequeathing, however, a splendid proof of the possibility of allying satire with sublimity in his *Vision of Judgment.* Two great satiric figures remain—one representative of his nation, the other most difficult to class. In all the characteristics of his genius Thackeray is thoroughly English; his satire is a thoroughly British article, a little solid, a little wanting in finish, but honest, weighty and durable. But Heine hardly belongs to any nation or country, time or place. In him the satiric spirit, long confined to established literary forms, seems to obtain unrestrained freedom.

In no age was the spirit of satire so generally diffused as in the 19th century, but many of its eminent writers, while bordering on the domains of satire, escape the definition of satirist. The term cannot be properly applied to Dickens, the keen observer of the oddities of human life; or to George Eliot, the critic of its emptiness when not inspired by a worthy purpose; or to Balzac, the painter of French society; or to Trollope, the mirror of the middle classes of England. If *Sartor Resartus* could be regarded as a satire, Carlyle would rank among the first of satirists; but the satire, though very obvious, rather accompanies than inspires the composition. The number of minor satirists of merit, on the other hand, is legion. James Russell Lowell's *Biglow Papers* represent perhaps the highest moral level yet attained by satire. Mallock, in his *New Republic,* made the most of personal mimicry, the lowest form of satire; Samuel Butler (*Erewhon*) holds an inverting mirror to the world's face with imperturbable gravity; the humour of Bernard Shaw has always an essential character of satire—the sharpest social lash. One remarkable feature of the modern age is the union of caricature (*q.v.*) with literature.

(R. G.; X.)

SATPURA, a line of hills between the Narbada and Tapti rivers in central India. It is the western element of an upland series known collectively as the Satpura Line and including the Mahadeo hills, Maikal range and Chota Nagpur plateau. Stretching westward from about 85° 5' E. almost to the shores of the Gulf of Cambay this line is usually regarded as the northern limit of the Deccan plateau.

Historically it was important as a barrier to the southern advance of the Aryan invaders and it forms the frontier between Aryan and Dravidian India. The Satpura range proper is approximately 600 mi. long and reaches heights of more than 4,000 ft. It is mainly composed of Deccan lavas and is forested. It is plateaulike in build and bordered by steep scarps both to north and south. The main railway route from Bombay to the middle and lower Ganges crosses its lower section into the Narbada valley and proceeds by way of Jubbulpore to Allahabad. (T. Her.)

SATRAP, in ancient history, the name given by the Persians to the governors of the provinces. Cyrus the Great divided his empire into provinces; a definitive organization was given by Darius, who established twenty great satrapies and fixed their tribute. The satrap was the head of the administration of his province: he collected the taxes, controlled the local officials and the subject tribes and cities, and was the supreme judge of the province to whose "chair" every civil and criminal case could be brought. He was responsible for the safety of the roads and had to put down brigands and rebels. He was assisted by a council of Persians. to which also provincials were admitted; and was controlled by a royal secretary and by emissaries of the king. The regular army of his province and the fortresses were independent of him and commanded by royal officers; but he was allowed to have troops in his own service. The great provinces were divided into many smaller districts, the governors of which are also called satraps and hyparchs. The distribution of the great satrapies was changed occasionally, and often two of them were given to the same man. When the empire decayed, the satraps often enjoyed practical independence, especially as it became customary to appoint them also as generals-in-chief of their army district, contrary to the original rule. Hence rebellions of satraps became frequent from the middle of the 5th century; under Artaxerxes II occasionally the greater part of Asia Minor and Syria were in open rebellion. The last great rebellions were put down by Artaxerxes III. The satrapic administration was retained by Alexander and his successors, especially in the Seleucid empire, where the satrap generally is designated as *strategus;* but their provinces were smaller than under the Persians. (Ed. M.)

SATSUMA REBELLION, an attempt to overthrow the newly established government of Japan led by Saigō Takamori (*q.v.*) in 1877. The rebellion led by Saigō in Satsuma province was the last of a series of warrior revolts against the government of the emperor Meiji.

These revolts were inspired by the dissatisfaction of elements of the warrior class with the reforms of the new government, which in modernizing Japanese society aimed at doing away with feudal privileges. Such reforms put the warrior class. so privileged under the old regime, on the same legal footing as the rest of the population: they abolished the warrior's right to wear swords, his exclusive privilege of bearing arms and his special rights pertaining to dress, food and living quarters. Most serious, perhaps, was the abolishment of the exclusive right to bear arms, and formation of a citizen army.

The Satsuma rebellion was the most determined and serious of the warrior revolts against liquidation as a privileged class. There was bitter and bloody fighting during the campaign, but in the end the better equipped and disciplined forces of the government's people's army prevailed. The warriors' bitterness thereafter took political rather than military forms; and embittered warriors became one of the main elements in the opposition political parties that now sprang up. See also Japan: History. (T. C. Sh.)

SATUN (Setui), a small Siamese (Thai) *changrad* or district bordering Malaya. Area 1.031 sq.mi. Pop. (1956 est.) 60,004. It produces rice and rubber.

SATURN (Saturnus), a Roman god whose cult was so overlaid with Greek features as to obscure his original native character. His name is commonly connected with Latin *satus,* and thus he is a god of son-ing or seed. The ancients themselves regarded him as an importation and equated him with the Greek Cronus (*q.v.*), which may well be correct; there is some linguistic evidence (disregarding the connection with *satus*) that he came to Rome through Etruria. Further. he was worshiped in the Greek manner (*i.e.,* with head uncovered and not wrapped in the toga as was the Roman custom).

The remains of his temple at Rome. eight columns of the pronaos, still dominate the west end of the Forum at the foot of the *clivus Capitolinus.* The present remains are of a later rebuilding, but it was the oldest temple whose building is recorded. going back to the beginning of the republic. It served as the treasury (*aerarium Saturni*) of the Roman state. Saturn's cult partner is the obscure goddess Lua, whose name is connected with *lues* (plague or destruction) and to whom captive arms mere sometimes burned. But he was also associated with Ops, the cult partner of Consus, through her identification with Rhea. wife of Cronus.

His great festival. the *Saturnalia,* became the most popular of Roman festivals, and its influence is still felt throughout the western world. Originally on Dec. 17, it mas extended first to three and eventually to seven days. The date has been connected with the minter sowing season, which in modern Italy varies from October to January. Remarkably like the Greek *Kronia* (see Cronus), it was the gayest festival of the year. All work and business were suspended. Slaves were given temporary freedom to say and do what they liked. and certain moral restrictions were eased. The streets were infected with a Mardi gras madness: a mock king was chosen (*Saturnalicius princeps*); the seasonal greeting *io Saturnalia* was heard everywhere; presents were freely exchanged. principally wax candles and little clay dolls (*sigillaria*). The cult statue of Saturn himself, traditionally bound at the feet with woolen bands. was untied. presumably to come out and join the fun. The influence of the *Saturnalia* upon the celebrations of Christmas and the New Year has been direct. Concerning the gift candles. the ancients had a quaint story that an old prophecy bade the earliest inhabitants of Latium send heads to Hades and *phota* to Saturn; that they interpreted this as meaning human sacrifices, but that Hercules advised them to use lights (the word *phos* means "light" or "man" according to accentuation) and not human "heads."

Another tradition regarding Saturn, fostered chiefly by the poets, made him an early Italian king. or perhaps Cronus in flight from Zeus. who established in Italy a new height of civilization (*Saturnia regna*) and a Golden Age (*aurea saecula;* cf. Virgil, *Aeneid,* viii, 319 ff.).

Saturday of course was named for Saturn and first appears (*Saturni dies*) in Tibullus I, iii, 18.

Bibliography.—W. W. Fowler, *Roman* Festivals, p. 268 ff. (1899); G. Wissowa, *Religion und Kultus,* 2nd ed.. p. 204 ff. (1912); Roscher's *Lexikon, s.v.;* Platner-Ashby, Topographical Dictionary, *s.v.*

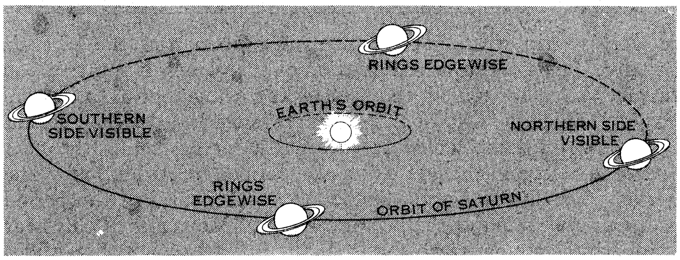
(R. B. Ld.)

SATURN, the sixth major planet in order of distance from the sun, and the most remote planet that was known before the discovery of Uranus in 1781. Its mean distance from the sun is about 885,900.000 mi. and its periodic time (time required to make a complete revolution about the sun) about $29\frac{1}{2}$ years. Its synodic period, or the interval between oppositions. is 378 days. To the naked eye Saturn, when in opposition. always appears as a star brighter than the first magnitude, but in consequence of the changing phases of its rings it varies greatly in brightness, its light being approximately trebled when the rings are open to their greatest extent. As regards colour. the planet shines with a warm, yellowish light like that of Arcturus.

Globe.—In telescopic appearance the globe of Saturn exhibits strong resemblances to Jupiter. It is even more flattened at the poles. its polar and equatorial diameters being respectively about 67,000 and 75,000 mi.; it is less bright near the margin than at the centre of the disk: and its surface is marked by dusky belts with light intermediate zones; but whereas these cloudlike hands are very conspicuous on Jupiter, they are usually feeble and ill-defined in the case of Saturn.

The volume of Saturn is about 750 times that of the earth. but the periodic times of its satellites show that it exceeds the earth only about 95 times in mass. Its mean density, therefore. is but 0.13 of that of the earth, or about 0.7 times that of water.

Rotation. — Because of the difficulty in detecting individual features of a sufficiently definite nature, the rotation of the planet



FROM "ASTRONOMY, BY R. H. BAKER (D VAN NOSTRAND COMPANY, INC.)

PHASES OF SATURN'S RINGS

has been observed only on comparatively rare occasions. The first determination was made in 1794 'by the elder Herschel, who derived a rotation period of 10 hr. 16 min. In Dec. 1876 a bright spot appeared near the equator which was observed by Asaph Hall, at Washington, for more than a month, and which showed a rotation in 10 hr. 14 min. 24 sec. A. S. Williams during 1891–94 deduced from observations of dark spots in the northern hemisphere mean rotation periods of 10 hr. 14 min. 45 sec. and 10 hr. 15 min. 10 sec. respectively, and in the same two years periods of 10 hr. 12 min. 52 sec. and 10 hr. 12 min. 36 sec. from a number of white equatorial spots.

In 1933 a very conspicuous bright spot was discovered near the equator of Saturn by W. T. Hay. Observations by William H. Wright at the Lick observatory showed that the period of rotation of the equatorial region of Saturn as determined from this spot agreed very closely with the value obtained much earlier by Hall. Spectrographic observations by Joseph H. Moore of the Lick observatory in 1936–37 confirmed the earlier discovery that the rotation period of Saturn becomes longer with increasing distance from its equator; in this respect Saturn resembles Jupiter. This results in a continual lagging behind of regions in high latitudes compared with those near the equator.

Physical Condition. — It is now clear that what is seen of Saturn is not a solid surface, but a layer of cloudlike or vaporous matter; the mean density of the globe is, indeed, less than that of any other major planet. It is further to be noted that considerations based on the large ellipticity of the disk, which is greater than would be assumed by such a globe of anything like uniform density rotating with the angular velocity of Saturn, indicate that the larger part of the planet's mass must be strongly concentrated toward the centre.

Radiometric observations made by William W. Coblentz and Carl O. Lampland indicate that the temperature of the surface is very low, of the order of $-150°$ C. A second major discovery has been the identification oi the red and infrared bands in the spectra of the outer planets with the compounds ammonia and methane. The identification was suggested by Rupert Wildt in 1932 and was definitely established a short time later by Theodore Dunham at Mount Wilson. The atmosphere of Saturn thus seems to consist, according to these investigators, of clouds of ammonia gas and crystals, methane and hydrogen. Underneath there may be a layer of ice, while the dense core itself probably consists of rocky metallic material.

Rings. — Saturn's most remarkable feature and that which renders it unique, so far as our knowledge goes, is the magnificent system of rings by which it is surrounded. That Saturn differs in appearance from other bodies was seen at once by Galileo when he turned his little telescope toward it in 1610. but his instrument was not sufficiently powerful to reveal the nature of what he saw. He noticed that the planet had a small attendant on each side, and accordingly represented it as a triple body. But during the next few years the appendages dwindled and finally disappeared, greatly to his perplexity and chagrin. as he feared he must have been misled by some kind of illusion. When they subsequently reappeared they continued to present a difficult problem to the telescopic observers of the day — sometimes seeming like arms stretching out on each side of the central body and sometimes like curved handles — and a number of curious drawings have come down to us which show how puzzled the observers were, but how near some of them came to the solution of the mystery.

The true explanation was ultimately arrived at by Christian Huygens in 1655. but. wishing for further time to make sure of his solution and yet secure himself against the possible loss of priority in the discovery, he published the following series of letters: aaaaaaa ccccc d eeeee g h iiiiiii llll mm nnnnnnnnn oooo pp q rr s ttttt uuuuu; which, when properly arranged, form the sentence *"Annulo cingitur, tenui, plano, nusquam cohaerente, ad eclipticam inclinato"* ("It is girdled by a thin flat ring, nowhere touching, inclined to the ecliptic"). These last few words explain the various appearances which so sorely puzzled the earlier observers with their imperfect instruments. The plane of the ring is inclined about 27° to the planet's orbit, and about 28° to the ecliptic, and keeps parallel to itself throughout the planet's revolution.

There are accordingly two opposite portions of the orbit, viz., near longitudes 172" and 352°, where Saturn is in Leo and Aquarius respectively, at which the ring can be presented edgewise to the earth and when this event happens (as it does either once or three times during each passage of the ring plane across the earth's orbit) the ring — because of its thinness — disappears from view even in powerful instruments. At intermediate positions, viz., when the planet is in Taurus and Gemini and in Sagittarius, it appears opened out at an angle of 27°, and is then seen to project slightly beyond the polar diameter of the planet's globe. The next important telescopic discovery as regards Saturn was the detection by G. D. Cassini, in 1675, of a black line or gap dividing the ring into two concentric rings. This is generally known as Cassini's division. The ring exterior to this division is narrower and less bright than the inner ring, while the outer portion of the latter is the most brilliant part of the whole system.

Within the second ring is yet another feature of great interest, a third ring, commonly known as the Crape ring, of which the brightness is so feeble that it long escaped detection. It was first recorded by Johann G. Galle, at Berlin, in 1838, but its existence was strangely forgotten until it was independently rediscovered in 1850 by G. P. Bond at Harvard and W. R. Dawes in England. It can be readily traced with a comparatively small telescope as a dusky band where it crosses the planet's globe, but is not so easily seen in the portions projected against the dark sky. The three rings are often denoted by the letters A, B and C. From time to time other divisions besides that of Cassini have been reported, but they seem to have been merely partial and temporary, except that known as Encke's division. in ring A, which is, perhaps, permanent, though probably not really a complete division. It usually appears as a pencillike shading rather than a sharp black line and sometimes merely as the boundary of the darker outer portion of the ring. The figures given by different authorities for the dimensions of the ring system differ somewhat, but those in Table I are approximately correct.

TABLE I.—Dimensions of Saturn's Ring System

The breadth of the Cassini division is probably rather more than 2.000 mi. The thickness of the rings is of the order of 10 mi. or less. It is noteworthy that all three are at least partly transparent; Saturn itself can be distinctly seen through the Crape ring and on some recent photographs it also shows through the

TABLE 11.—Saturn's Satellites

Name	Distance in equatorial radii of Saturn (1=37.500 mi.)	Period of revolution		Inclination of orbit to Saturn's orbit		Eccentricity	Stellar mag. at mean opposition	Discoverer	Date of discovery
		d	h	o					
Mimas	3.1	0	22.6	26	44.7	0.0190	12.1	Herschel	Sept. 17,1789
Enceladus	3.9	1	8.9	26	44.7	0.0001	11.6	Herschel	Aug. *28, 1789*
Tethys	4.9	1	21.3	26	44.7	0.0000	10.5	G. Cassini	March *1684*
Dione	6.3	2	17.7	26	44.7	0.0020	10.7	G. Cassini	March *1684*
Rhea	8.7	4	12.4	26	41.9	0.0009	10.0	G. Cassini	Dec 1672
Titan	20.2	15	22.7	26	7.1	0.0289	8.3	Huygens	March *1655*
Hyperion	24.5	21	6.6	26	0.0	0.1043	13.0	Bond	Sept. *16, 1848*
Iapetus	58.9	79	7.9	16	18.1	0.0284	10.1 to 11.9	G. Cassini	Oct. 1671
Phoebe.	214.2	550	10.6	174°.7		0.1659	14.5	Pickerinr	Aus. *1898*

outer ring. Moreover, on Feb. 9, 1917, M. A. Ainslie, at Blackheath, and J. Knight, at Rye, observed that a seventh magnitude star remained visible during its occultation by the outer ring, though Ainslie considered that it lost something like three-fourths of its light; it appeared to travel some distance along the Cassini division but did not pass behind ring B. On March 14, 1920, during the occultation of another seventh magnitude star, the star remained conspicuously visible in a 6-in. refractor at W. Reid's observatory (Rondebosch, S.Af.), even when behind the brightest part of ring B and despite the fact that, in consequence of the obliqueness of the line of sight. its light had to traverse a distance through the ring equal to eight times its real thickness.

The translucency of the ring system is also shown by the fact that it can be faintly seen against the sky as a narrow line of light on the occasions—sometimes extending over several weeks near the time of disappearance—when the plane of the rings passes between the sun and the earth. On this line of light two condensations are seen on each side of the planet, corresponding in position with the Cassini division and the Crape ring. They are apparently caused by the larger amount of sunlight transmitted at those places where the ring material is absent or relatively thin. The ring, as a whole, however, is sufficiently dense to cast a strong shadow, which is seen at such times as a narrow black band across the planet's equatorial regions.

The physical constitution of the rings is unlike that of any other object in the solar system. They are not formed of a continuous mass of solid or liquid matter, but of discrete particles of unknown minuteness, probably widely separated in proportion to their individual volumes, yet so close as to appear continuous when viewed from the earth. This constitution was first divined by J. Cassini early in the 18th century. But, although the impossibility that a continuous ring could surround a planet without falling upon it was shown by Pierre S. de Laplace and must have been evident to all investigators in celestial mechanics, Cassini's explanation was forgotten until 1857. In that year James Clerk Maxwell, in an essay which was the first to gain the newly-founded Adams prize of the University of Cambridge, made an exhaustive mathematical investigation of the satellite constitution, showing that it alone could fulfill the conditions of stability. In the light of this demonstration, it was of great interest when J. E. Keeler, at the Allegheny observatory, proved this constitution by spectroscopic observation in 1895. He found, by measuring the velocity of different parts of the ring to or from the earth, that, as we pass from its outer to its inner regions, the velocity of revolution around the planet increases, each concentric portion having the speed belonging to a satellite revolving in a circular orbit at the same distance from the planet. The relative velocities of different parts of the system are beautifully shown by the slope of the lines in a spectrogram of Saturn made by V. M. Slipher of the Lowell observatory.

Satellites.— Saturn is attended, so far as is at present known, by nine satellites. A tenth (Themis) was announced by W. H. Pickering in 1905, but its actual existence has not been satisfactorily confirmed. Details of the satellites are given in Table II.

The diameters assigned by observers to the smaller and fainter satellites are necessarily very uncertain, but that of Titan is probably not far from 3,000 mi. The diameter of Phoebe is, perhaps, only about 150 mi.

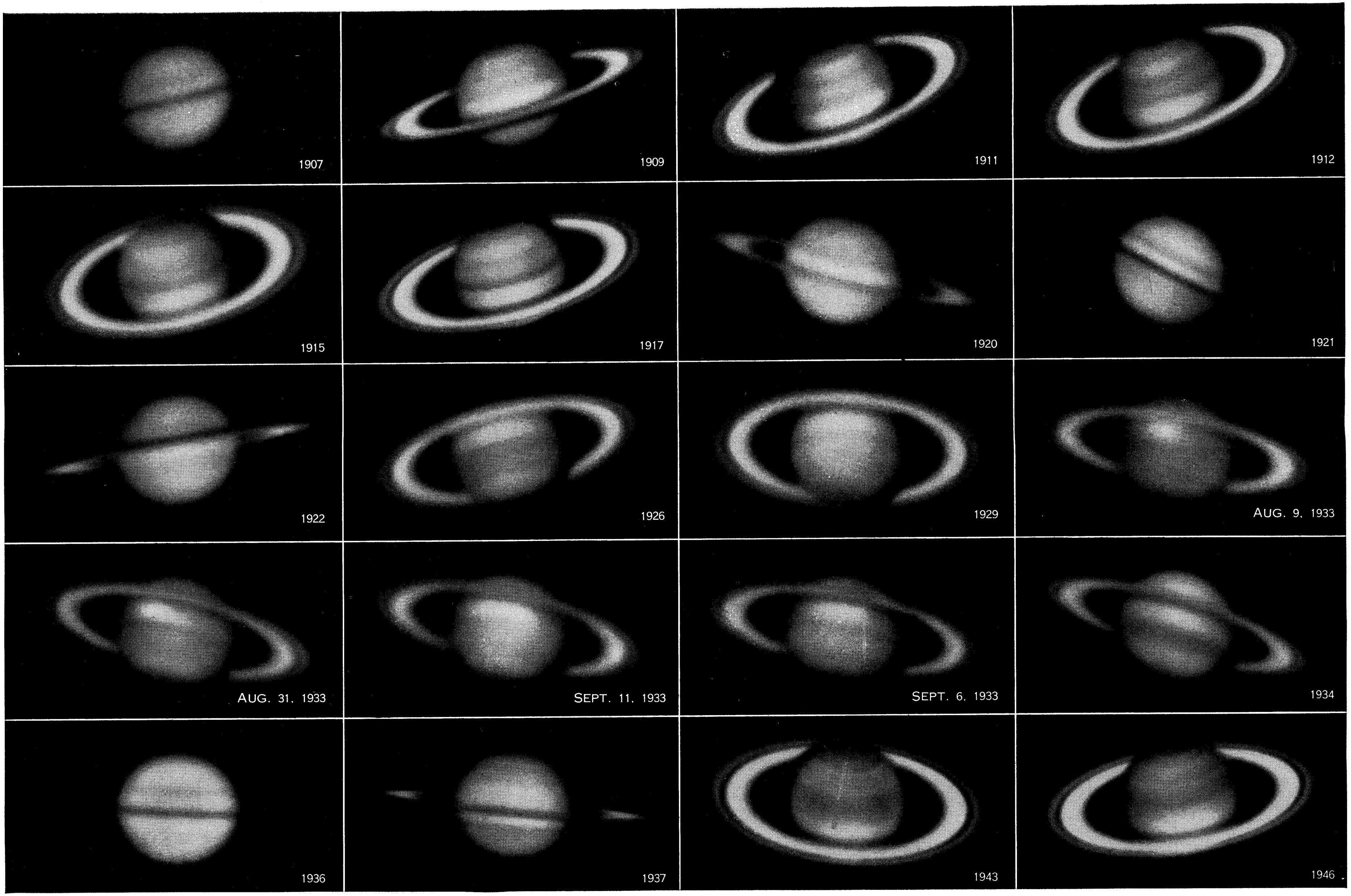
The five inner satellites seem to form a class by themselves. Their orbits are nearly circular and their planes coincide exactly or very nearly with that of the ring system and the planet's equator. Thus, so far as the position of the planes of rotation and revolution are concerned. the system keeps together as if it were rigid. This results from the mutual attraction of the various bodies. A remarkable feature of this inner system is the near approach to commensurability in the periods of revolution. The period of Tethys is nearly double that of Mimas and the period of Dione about double that of Enceladus. The result of this near approach to commensurability is a wide libration in the longitudes of the satellites, having periods very long compared with the times of revolution.

Each of the four outer satellites has some special feature of interest. Titan is much the brightest of all and is unique among all the satellites in the solar system in possessing an atmosphere. In 1944 conclusive evidence was found by Gerard P. Kuiper at the McDonald observatory that an atmosphere containing methane and possibly ammonia surrounds the satellite. Hyperion is so small as to be visible only in a powerful telescope, and has a quite eccentric orbit; its time of revolution is almost commensurable uith that of Titan the ratio of the periods being three to four, with the result that the major axis of the orbit of Hyperion has a retrograde motion of 18° 40' annually, of such a character that the conjunction of the two satellites always occurs near the apocentre of the orbit, when the distance of the orbit from that of Titan is the greatest. This is among the most interesting phenomena of celestial mechanics. Iapetus has the peculiarity of always appearing brighter when seen to the west than to the east of the planet; this is explained by the supposition that, like earth's moon, this satellite always presents the same face to the central body.

Phoebe, the outermost satellite, is more than three and one-half times as remote from Saturn as Iapetus, and the circumstances of its discovery are interesting. In studying photographs of the neighbourhood of Saturn taken at Arequipa observatory, Peru, Pickering found on each of three plates a very faint star which was missing on the other two. He concluded that these were the images of a satellite moving around the planet, which was then entering the Milky Way, where minute stars were so numerous that it was not easy to confirm the discovery. When Saturn began to emerge from the Milky Way no difficulty was found in relocating the object and proving that it was a ninth satellite. Its motion, however, was found to be retrograde or in a contrary direction to that of the other satellites. This difference of motion in a single system was, according to the knowledge of that time. a unique phenomenon, for although the satellite of Neptune and those of Uranus were known to have retrograde motions, they are the only satellites of those planets hitherto discovered. But more recently the 8th, 9th and 11th satellites of Jupiter have been found and the motion of these, like that of Phoebe, is retrograde.

See PLANET and also Index references under "Saturn" in the Index volume. (T. E. R. P.; W. W. M.)

SATURNIAN METRE (Lat. *Saturnius*), a native Italian metre, used in some of the oldest known Latin compositions. It was in later times wholly displaced by Greek metres and but few specimens survive. These are (1) inscriptions, notably some of the epitaphs of the Scigios; (2) fragments of Livius Andronicus's translation of the *Odyssey* and of Naevius's *Bellum Punicum,* with a very few remnants of other authors. The following are specimens of this verse:



BY COURTESY OF DR. E. C. SLIPHER

SATURN

Various aspects of the planet and its ring system (1907–46). In 1907, 1921 and 1936 the rings were edgewise and thus too faint to show in normal exposures; in 1915, 1929 and 1943 the rings were wide open. The great white spot of 1933 is shown on Aug. 9 and Aug. 31 almost unchanged, but on Sept. 11 it had rapidly expanded until it extended about 3/5 the way across the ball. The photograph of Sept. 6, 1933, shows the outburst of still another large white spot more than 100" in longitude following the first

Dabunt malum Metelli/ Naevio poetae
Quamde mare saevom/ vis et quoi sunt magnae.

The scansion is very doubtful; on the whole it is more likely that it is accentual than that it is quantitative. (On the accentual theory, in its most probable form, the line has 3 + 2 accents, and usually consists of 7 + 6 syllables, as *quóius fórma virtútei parísuma fúit.*) Some account of it will be found in Lindsay, *Early Latin Verse,* p. 9.

Nothing resembling the Saturnian exists in English; the example given by Macaulay ("The queen was in the parlour eating bread and honey") is not in the least like it.

SATURNIID MOTH, any of about 800 species of chiefly large, broad-winged moths of the family Saturniidae, commonly called giant silkworm moths. Although they are almost worldwide in distribution, most of the species are found in the tropics, especially in South America and tropical Africa. These night flyers are frequently vividly coloured and often remarkably patterned. Certain Asian kinds, called wild silkworms, spin a commercially valuable silk—a product not so fine, however, as that spun by the common Chinese silkworm (*Bombyx mori*) of another family (*see* SILK AND SERICULTURE).

The Saturniidae includes some of the largest insects; a few tropical specimens have a wing-span of about 9 in., whereas those in North America are smaller, having wing-spans up to 6 in. The larvae are large, usually green, caterpillars, most of which have colourful knobs or spines and, in many American sorts, irritant barbs. They are voracious leaf-eaters as caterpillars, but, unlike many other moths, the Saturniidae never feed after they have obtained wings.

Some species have been used for commercial silk from time immemorial and the silkworm which Aristotle cited (his *nekydalos*) as a familiar example of metamorphosis was almost certainly *Saturnia pyri.* Saturniids are used in the modern silk industry only in southeast Asia, and only the tusseh silkworm (*Antheraea pernyi*) and the eria, ailanthus or cynthia moth (*Samia cynthia*) have been used long enough to break into cultivated varieties. The North American polyphemus moth (*Antheraea polyphemus*) would be as useful in the silk industry as is the tusseh, except for the cost of labour.

Being large, handsome and often easy to rear, saturniids are favourites with amateur lepidopterists. They have also served as subjects in studies on hybridization and variation; more recently, the giant cecropia moth (*Platysamia cecropia*) has been used extensively in studies on endocrine control of transformation and hibernation.

Other members of the family include the emperor moth (*Saturnia pavonia*) of temperate Europe and Asia; the yellow (male) or reddish (female) io moth (*Automeris io*), the bright grass-green luna moth (*Actias luna*) and the maroon (female) to blackish (male) promethea moth (*Callosamia promethea*), all found in North America. The genera *Rothschildia* and *Copiopteryx,* common to South America, are among the most beautiful of the saturniids.

See also INSECT; LEPIDOPTERA.

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(W. T. M. F.)

SATURNINUS, LUCIUS APPULEIUS, Roman politician. Quaestor in 104 B.C., he superintended the importation of corn at Ostia, but was removed by the Senate, apparently without any charge against him being made and so went over to the popular party. Tribune in 103, Saturninus made an arrangement with Marius for the allotment of 100 *iugera* of land to each of Marius' veterans.

It was probably at this time that he introduced his law on *maiestas* (treason), which seems to have been designed to increase the power of the tribunes. In 101 he was tried for violating the law of nations in connection with the embassy of Mithridates. The envoys had arrived with large sums of money to bribe the Senate and Saturninus exposed the affair and insulted the ambassadors. He escaped by appealing to the people. He further cultivated popularity by supporting the claims to citizenship of a freedman, Equitius, who posed as a son of Tiberius Gracchus (*q.v.*). Saturninus allied himself with C. Servilius Glaucia, and the two of them acted as Marius' political agents after his return from the war with the Cimbri. By bribery and murder Marius was elected consul for the sixth time in 100, Glaucia praetor and Saturninus tribune again. Saturninus then brought forward an extension of the African agrarian scheme, which included the distribution of the land north of the Po, taken from the Cimbri, among Marius' veterans, and the foundation of a number of new citizen colonies, to which Italians were to be admitted, a feature which caused a good deal of opposition. A further clause provided that every Senator should swear to observe it within five days of its becoming law. Metellus Numidicus, Saturninus' chief enemy, alone refused, and went into exile. The law was passed eventually after considerable disorder. At last Saturninus and Glaucia found themselves in danger of being disowned by Marius, and their only hope of safety lay in retaining office. In the elections at the end of 100 Saturninus was again elected tribune, and Glaucia stood for the consulship. During the voting their partisans beat C. Memmius, the senatorial candidate, to death. The Senate declared them public enemies, and called on Marius to take up arms against them. Saturninus was defeated in a battle in the forum, and took refuge in the Capitol (Dec. 10). Forced to surrender, he and Glaucia and their followers were imprisoned in the *Curia Hostilia,* and some of the opposite party tore off the roof and stoned them to death. (*See* also ROME: *Ancient History.*)

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SATYRS, in Greek mythology, spirits half-man, half-beast. They are not mentioned in Homer; in a fragment of Hesiod they are called brothers of the mountain nymphs and Curetes, an idle and worthless race. They were a roguish but faint-hearted folk, lovers of music, wine and women, dancing with the nymphs or pursuing them, and striking terror into men. They had a special form of dance called *Sikinnis.* In early Attic art they were represented as grotesque men with horses' tails; later they approached the type of Pan (*q.v.*). A statue, supposed to be a copy of a work of Praxiteles, represents a graceful satyr leaning against a tree with a flute in his hand. In Attica there was a species of drama known as the satyric; it treated its themes in a half-comic manner and the chorus was composed of satyrs. Sophocles' *Ichneutai* and Euripides' *Cyclops* are the only extant examples. In Italy, the satyrs are often identified with the fauni (*see* FAUNUS).

In the Authorized Version of Isa. xiii, 21; xxxiv, 14 the word "satyr" is used to render the Hebrew *sĕʿīrīm,* "hairy ones." A kind of demon or supernatural being known to Hebrew folklore as inhabiting waste places is meant; a practice of sacrificing to the *sĕʿīrīm* is alluded to in Lev. xvii, 7, where the English version has "devils." They correspond to the "shaggy demon of the mountain-pass" (*azabb al-ʿakaba*) of old Arab superstition.

See also SILENUS.

SAUCE: *see* FOOD PREPARATION; FLAVOURINGS; GRAVIES.

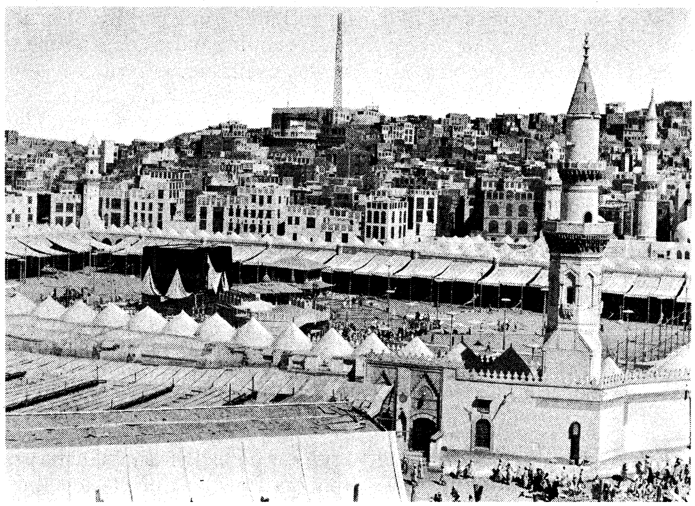
SAʿUD, ʿABD UL-ʿAZIZ IBN ʿABD UR-RAHMAN IBN FAISAL, IBN: *see* IBN SAʿUD, ʿABD UL-ʿAZĪZ IBN ʿABD UR-RAHMĀN IBN FAISAL.

SAUDI ARABIA (AL MAMLAKAH AL'ARABĪYAH AS SU'ŪDĪYAH), a kingdom of southwest Asia, ruled by the house of Saʿud in the 18th century, and founded in the 20th century as a modern kingdom by Abdul-ʿAziz II ibn Saʿud, occupies most of the Arabian peninsula. The kingdom is bounded north by Jordan, Iraq and Kuwait with two areas of neutral territory west and south of Kuwait; west by the Gulf of Aqaba and the Red sea; south by Yemen, Aden protectorate and Dhofar (Dhufar); east by Muscat and Oman, Trucial Oman, Qatar and the Persian gulf. Its boundaries with Jordan and Yemen in part and with its southern and eastern neighbours have never been fixed. The total area is 872,722 sq.mi.

PHYSICAL GEOGRAPHY

The ancient Arabian shield of igneous and metamorphic rocks protrudes eastward from the Hejaz (Al Hijaz) into Najd (Nejd) as a bulge curving round from the Gulf of Aqaba to a point less than 125 mi. W. of Riyadh and then receding toward the southern Red sea. The shield contains many extinct volcanoes surrounded by lava beds. Sloping eastward are the newer sedimentary areas in which rich oil fields are found. The shield gives symmetry to Saudi Arabia's geography, as many escarpments and sand deserts follow its contour.

Saudi Arabia's coastline on the Gulf of Aqaba and the Red sea is more than 1.100 mi long; its Persian gulf coastline, though of undetermined length, is somewhat shorter. Neither side has deep natural harbours. Islands and coral reefs in the Red sea are numerous, particularly in the Farasan bank, which runs along



PAN ASIA PHOTO NEWS FROM BLACK STAR

HOLY CITY OF MECCA WITH THE SACRED SHRINE OF THE KA'BA IN THE CENTRE OF THE COURTYARD

Saudi Arabia's coast for over 300 mi. In the Persian gulf the ownership of various islands is in dispute between Saudi Arabia on one hand and Kuwait. Iran, or Abu Dhabi (one of the Trucial states) on the other. A treaty signed in 1958 established a water boundary between Saudi Arabia and Bahrain.

Saudi Arabia's highest mountains are in Asir (*q.v.*) where peaks rise to over 9.000 ft. The mountains of Al Tubayq dominate the undefined border between Jordan and Saudi Arabia east of Aqaba. Southeast of Jabal Shammar escarpments parallel the bulge of the shield, the most prominent being Jabal Tuwayq, 800 mi. long from north to south. The Red sea coast plains are narrow, whereas plains in the central and eastern regions sometimes stretch over great distances. In the north the Syrian desert reaches down into Saudi Arabia. The largest sand deserts lie east of the shield; the Great Nafud in the north and the Rub' al Khali (the Empty Quarter) in the south, connected by the Ad Dahna sand belt.

The Asir mountains constitute the only area in the kingdom receiving adequate rainfall. Virtually all the rest of the country is desert, apart from scattered oases fed by underground water sources or flash floods. Winters are cool, and spring and fall days are often agreeable. but spells of good weather are interspersed with gusts or storms of swirling dust and sand. The fierce summer heat, tempered by aridity in the higher regions of the interior. is aggravated along the coasts by high humidity. (See also ARABIA: *Regional* Geography.) (G. S. RE.)

HISTORY

For archaeology, exploration and earlier history see ARABIA. The history of Saudi Arabia begins properly from Sept. 18, 1932, when by royal decree of King Abdul-'Aziz II ibn Sa'ud the dual kingdom of Hejaz (*q.v.*) and Najd with its dependencies, administered since 1927 as two separate units under slightly different systems, was unified under the style of "The Kingdom of Sa'udi Arabia." The change was far from being purely nominal, though no attempt was made to "liberalize" the supreme authority of the king as the absolute monarch of the new regime. It did however, represent a substantial change of direction. or attitude, in the domestic and foreign policies of the realm. Until 1926, when Ibn Sa'ud had finally extended his power over the whole of inner Arabia. the country had remained in almost total isolation from the rest of the world because of its poverty, its desert character and its fanatical religious xenophobia. The only foreign countries with which Ibn Sa'ud was acquainted were Turkey and Great Britain; but the conquest of the Hejaz had brought him into contact with other powers. and the new circumstances compelled him to take stock of his position. It was indeed the U.S.S.R. which took the lead. both in recognizing his new status and in raising its consul general to ministerial rank. Britain and France did the same soon afterward at discreet intervals.

Preliminary Period, 1926–32.—Ibn Sa'ud, enriched since 1926 by the substantial revenues of the Meccan pilgrimage, had realized from the beginning that the progress and stability of his regime would depend largely on co-operation with the west, particularly in the technical and economic spheres. He had not hesitated to temper the puritan breezes of his native Najd to the latitudinarian exigencies of his new province and the mildness of his attitude to the non-Muslim strangers within his gate had surprised those who had confidently predicted a sharp turn of the puritan screw on the Hejaz. long accustomed to Turkish apparatus and European contacts. At the same time it had caused some searching of heart among the divines and fanatics of his desert realm. where the Wahhabi brotherhood (known as *al-Ikhwan*), already acclimatized to the use of western instruments of war. tended to challenge the legality of infidel contributions to peaceful progress, such as the automobile, the airplane, the telephone and radiotelegraphy. Ibn Sa'ud had gradually disarmed the opposition to his projects by tactful persuasion; but there still remained a hard core of irreconcilable elements, the very elements which he himself had created and trained to carry the victorious banners of God through the length and breadth of the land he now ruled. In 1920 Faisal al-Dawish. Sultan ibn Bijad and other leaders of the *Ikhwan*, accusing him of betraying the cause for which they had fought so stoutly, took the law into their own hands, and staged an attack on Iraq and its British protectors.

This rebellion was crushed and Ibn Sa'ud had exorcised, though not without reluctance, the Frankenstein of his own creation. For the third time the Wahhabi movement had received its quietus: this time at the hands of its friends and probably for ever. Ibn Sa'ud was at last free to give his undivided attention to the development of his country, and to the problems of foreign policy which beset him on all sides. Above all he was concerned to assert and maintain the complete independence of his country and the exclusive supremacy of Islam therein. And, subject to their respect for these fundamental objectives, he was not only ready to co-operate with all nations but prepared to regard with sympathy some of the practices which had taken root in the Hejaz and other areas as the result of foreign contacts. The Wahhabi anathema on tobacco was not pressed in the Hejaz. and gradually became a dead letter elsewhere. The ban on music was progressively stifled by the radio. The amenities of air travel dispelled the myth of divine displeasure at indulgence therein. And so on until the latitudinarian spirit, slowly at first but with ever increasing momentum. dispersed the inhibitions of the puritan regime. On the other hand Ibn Sa'ud had rigorously set his face against any foreign interference whatever in the internal politics of the realm. An Indian Muslim delegation had received no encouragement in its idea that the Hejaz would be better governed as a pan-Islamic republic than by Ibn Sa'ud. The Egyptians had been sharply reminded that the protection of their annual pilgrimage was the exclusive concern of the Saudi government, and had ceased to send their traditional military escorts and bands. Britain and other European states had been politely warned against interference in the processes of Islamic law relating to crime. slavery, etc. Requests for permission to construct churches and other public places of worship for non-Islamic communities were courteously rejected.

The Reigns of Ibn **Sa'ud and Sa'ud IV.**—All these problems had been disposed of in the course of the seven years, as it were. of gestation. preceding the proclamation of the birth of Saudi Arabia. From the beginning it enjoyed full international recognition of its complete independence, though it was not until after the death of King Fuad I of Egypt in 1936 that diplomatic relations with that country, disturbed by a pilgrimage incident in 1926, were restored. After this, however, the relations of the two countries were a model of international co-operation scarcely ruffled by the Egyptian revolution of 1952, or by an unfortunate accusation by President Gamal Abdal Kasser in 1958 that King Sa'ud was plotting his assassination.

The political events of the years 1932–60 can be disposed of very briefly. In 1934 Ibn Sa'ud was involved in war with the Yemen over a boundary dispute; but a brief campaign. which carried the Saudi army as far south as Hudaida (al Hudaydah) in six weeks, ended in the treaty of Ta'if. The frontier was duly agreed and demarcated after which the relations of the two countries became uniformly cordial. During World War II Ibn Sa'ud declared his neutrality, though his personal bias in favour of the western allies was never in doubt. In 1945 he somewhat reluctantly agreed to declare war on Germany, and was thus able to take his country into the Cnited Kations organization as a founder member. He also joined the Arab league (*q.v.*), of which he and his successor always remained the most cordial of supporters. In 1946 Ibn Sa'ud paid a state visit to Egypt as the guest of King Faruk. It was on this occasion that he conceived the idea of a railway link between Riyadh and the Persian gulf; and five years later he had the satisfaction of inaugurating the new line on the arrival of the first train from the modernized port of Ad Dammam. In 1952 he celebrated the golden jubilee of his accession to the throne and on Nov. 9, 1953, he died at At Ta'if, at the age of 73, after a reign as long and distinguished as any in Arabian history. He had prepared the ground on which his successors would build a new regime, and he had provided the resources with which they could do so with every hope of success (see also IBN SA'UD).

It was his eldest surviving son Sa'ud ibn Abd Abdul-'Aziz who ascended the throne (as Sa'ud IV), while his second brother Faisal was proclaimed heir apparent. The opening years of the reign were mainly concerned with domestic policy and economic development, in which respects great progress was undoubtedly made. There was an enormous increase in the populations of Riyadh and Jidda. International airports at Dhahran and Jidda, and a large one at Riyadh emphasized the significance of Arabia in the nevi world. Roads, schools, hospitals, mosques, palaces and blocks of flats sprang up like mushrooms. Financial difficulties, at one time threatening disaster, were largely overcome. Commerce thrived as never before; revenue was buoyant, and ever increasing; government servants of all grades were lavishly paid, contented and ambitious. The very character of the principal urban societies was transformed out of all recognition by a heavy influx of *bourgeoisie* from the neighbouring lands. with its westernized outlook and apparel, though the court and all persons of Najdi origin still preserved their traditional garb, apart from the adoption of European footwear. The foreign ways of immigrant wives were tolerated, though without approval and with occasional attempts at restriction; and there was no sign of official recognition of the inevitability of female emancipation in modern Arabia.

In the international sphere the Americans dominated the scene without interference in administrative matters, while the Saudi government, perhaps wisely: showed no inclination to assert itself in the field of purely Arab politics, being content to work for Arab unity through the Arab league and to recognize the dominance of Egypt and Iraq in Arab counsels. Such Communist elements as intruded into the country at times were sternly discouraged; and the Saudi monarchy was firmly established.

Foreign and Domestic Problems.—In 1932, Ibn Sa'ud had found himself confronted by two important issues: the finalization of his relations with Britain and the various Arab states and principalities under British control or protection, and the fixation of his frontiers therewith; and the reinforcement of his depleted financial resources, severely strained by the cost of his operations against the *Ikhwan* rebels.

Negotiations with Britain during the 1930s failed to settle disputed boundaries in the south and east. Among these were the undefined landward boundaries of the Sultanate of Muscat and Oman which was in close treaty relationship with Britain and of the British-protected Trucial sheikhdoms. The area was considered important as a potential source of oil but no action was taken to disturb the established regimes until in 1952 tribal forces under Saudi Arabian control occupied the Buraimi oasis which Britain regarded as belonging partly to the Sultanate of Muscat and partly to the sheikhdom of Abu Dhabi. To counterbalance the Saudi Arabian influence a force of Oman levies was sent to the Abu Dhabi portions of the oasis. In Jan. 1953 the two forces came into collision. In July 1954 the British and Saudi governments agreed to submit the dispute to an arbitration tribunal. but when the tribunal met in Geneva in Sept 1955 the British representative. Sir Reader Bullard. withdrew accusing the Saudi authorities of extensive bribery to induce local sheikhs to transfer their allegiance. The negotiations broke down and levies from Muscat under British command reoccupied the oasis. During the Suez crisis in 1956 Saudi Arabia broke off diplomatic relations with Britain.

If oil was thus the basic cause of Anglo-Arabian estrangement, it was also to calm the troubled seas of Saudi finance beyond the wildest expectations of all concerned. The history and statistics of oil extraction in Saudi Arabia are set out in The *Economy* below. In terms of finance the result was that compared with the position after the conquest of the Hejaz in 1926 the country's annual revenue had by the early 1960s increased thirtyfold.

This sudden access of wealth was not an unmixed blessing. Inexperience. extravagance, and even corruption, to say nothing of the advent of fortune hunters from other Arab countries. raised their hydra heads in an orgy of ill-considered spending. The American way of life imposed itself easily on a hitherto xenophobe population. only to increase its xenophobia. The impoverished became rich overnight; yet the economy wilted. In March 1958 King Sa'ud issued a decree transferring full executive powers to Faisal but retained his right of veto. Faisal introduced a regime of austerity. The currency position, threatened with disaster, was restored to equilibrium and efforts were made to eliminate the worst features of the extravagance and corruption which wealth had encouraged. Attention was focused on useful projects such as the building of schools. hospitals and roads, and a modest beginning had already been made in higher education with the establishment of a university at Riyadh. The economy campaign proved unpopular with members of the royal family, whose subsidies and salaries were cut, and King Sa'ud forced the resignation of Faisal in Dec. 1960. The king then assumed the office of prime minister and appointed a new cabinet.

In July 1961, following the Iraqi sovereignty claim over Kuwait, Saudi Arabia sent troops in response to the Kuwait ruler's request for British and Saudi military assistance. The five-year pact which permitted the U.S. air force to lease Dhahran base on the Persian gulf was terminated in 1962. (H. ST. J. B. P.; X.)

POPULATION

In 1956, the population of Saudi Arabia was estimated at 6,036,000. There are no verified figures of the exact population as no accurate census has yet been taken. It is estimated that 78% of the population is nomadic and it is probable that both the town estimates and the estimated proportion of nomads are higher than a census would prove. Estimates of the principal cities are: Mecca 1250,000); Riyadh (150.000); Al Hufuf (Hofuf) (82,600); Jidda (200,000); Medina 160,000). Other towns are Abha (25.000); 'Cnayzah (Anaiza) (25,000); Buraydah (Buraida) (30.000); Ad Dammam (Damman) (30 600); Dhahran (12,000); Ha'il (30,000); Al Rhubar (20.000); Al Qunfudah and Najran (10.000 each); Al Qatif (30.000); Ras Tanura (15.000); Ta'if (50.000).

Arabs. like the people of Europe and America, are of the Caucasian family but there are some of Negroid ancestry because of past importations of Africans. The Saudi Arabs recognize no colour line and mixed racial strains abound in Saudi Arabia, especially in the Red sea coastal plain called the Tihama. But on the interior plateau of Najd, the hue of the Najdis and Bedouins in general is largely the brown Mediterranean type. The colouring of the people in towns varies from white to light brown. The Arab population are predominantly Sunni Muslims who mostly adhere to the Wahhabism (puritanical) interpretation. There are no native Christians or Jews but several thousand Christians (U.S., European and Arab) are employed in the oil industry. Jews have been barred from Saudi Arabia since 1948 and non-Muslims are forbidden to enter the sacred cities of Mecca and Medina.

The creation of industries in addition to the enormous developments of the Arabian American Oil company (Aramco) have been responsible for the growth of population (since 1945) in the cities of Jidda. Riyadh, Dhahran, Ad Dammam (*qq.v.*), Al Khubar and Al Qatif, where the increase has been two- to tenfold. For anthropology. see ARABIA: The People; ARAB; BEDOUIN.. For language see ARABIC LANGUAGE. (K. S. Tw.)

ADMINISTRATION AND SOCIAL CONDITIONS

Government. — The government of Saudi Arabia is patriarchal rather than constitutional. The nearly absolute rule of the king is bound by the laws of the *Shari'ah* (Islamic law, *q.v.*) which became clear when he was declared king of the Hejaz in 1926. The king (*malik*) rules the state with the help of the royal court. his cabinet or diwan (instituted in 1958), which includes a council of ministers (set up by decree in 1953), drawn largely from the royal family. The government is assisted by a consultative council and by the *'Ulama,* a council comprised of learned religious men.

The laws of Islam provide the country with civil and penal codes and also regulate religious problems. But the king has the power to issue a decree where the religious law is not applicable. The king is accessible to his subjects and hears complaints from all classes. At an appointed hour. all may appear and ask for justice. There can be no appeal against the king's decision. In 1932 it was proposed to provide the whole country with a single constitution but pending the implementation of this. the state has maintained its dual character with its two capitals: Riyadh as the seat of the government and Mecca as the spiritual capital (see also HEJAZ and NAJD).

The organized judiciary is an independent agency in the state and the public law is claimed to be derived from the Koran. The Cadis usually judge according to the predominant Hanbalite version of the *Shari'ah* law. Punishment is similar to that in the Mosaic code. the penalty for murder is decapitation by the sword; for theft (with violence) the left hand is amputated; for adultery the woman may be stoned to death. Justice. when not theoretically in conflict with religious law, can also be governed by tribal and customary law (*'urf*).

Administratively, the kingdom of Saudi Arabia is divided into provincial areas: Hejaz, Najd, the Al Hasa (Eastern Province). the Northern Frontiers district and Asir. There are municipal councils in most of the towns and villages. More than half the population are governed locally by tribal councils, the central government maintaining control through territorial amirs or sheikhs.

Living Conditions, Health and Welfare. — It is sometimes thought that Arabs live only in tents. This is true of the estimated 78% of the population who are Bedouins. But there are thousands of farmers and landholders who live in two- to five-storied buildings of mud-brick and stone, similar to the dwellings in the towns. After World War II many apartments, government offices and fine houses of reinforced concrete were constructed.

With the oil economy came the concept of hired labour and people are now also employed in government services, in various private enterprises, in construction and in mining. The greatest single industry is the oil operation of Aramco and this employed more than 16.000 persons in the early 1960s, most of whom were Saudi Arabs. In 1935, wages paid in this industry were $\frac{1}{2}$ rial and food per day (1 rial = $.27). Wages have now reached a minimum of 8 rials.

The traditional welfare system based on kinship continues to function throughout Saudi Arabia. The government has no extensive welfare programs although considerable sums have been earmarked for various development projects. Aramco has instituted a modern welfare plan which includes provision for pension plans, accident compensation and medical and educational services. Almsgiving, being one of the traditional good works of Islam, is common.

The scarcity of water contributes to unsanitary living conditions in many parts of the country. Malnutrition. a major health problem, gives rise to rickets, scurvy, anemia and trachoma. There is a high incidence of malaria, tuberculosis, venereal and parasitic infections. The annual influx of pilgrims aggravates public health problems, although the Saudi government has assumed the responsibility of caring for the sick and has established quarantine stations. notably at Jidda. Progress was made after the formation of a ministry of health in 1951 and hospitals, some with mobile units. were established in the major population centres.

Slavery still exists in Saudi Arabia. A royal decree of Oct. 1936 made the importation of slaves illegal unless the importers could prove that the slaves were recognized as such in the country of their origin. The conditions and rights of the existing slaves were also regulated by this decree.

Education. — Elementary education is free to all Saudi Arabs. The modern school system includes elementary, secondary, commercial and industrial schools, training institutes for teachers, and night schools. By the early 1960s there were about 600 government educational institutions staffed by about 4,500 instructors (many from neighbouring Arab countries) and attended by 75,000 students. There are many anti-illiteracy centres throughout the kingdom and in 1959 a royal decree authorized the establishment of government schools for girls. The King Sa'ud university at Riyadh (established in 1957) has colleges of arts and sciences, to which colleges of commerce and pharmacy were added in 1959–60.

Defense. — The Wahhabis have always been the backbone of the traditional militia. No accurate figures are known for the regular army but 500,000 is a probable maximum. A military academy at Riyadh provides for the training of about 600 officers a year. Since 1947 the U.S. government has conducted training of Saudi Arabs at Dhahran air base and U.S. aid has been expanded to provide for the establishment of a U.S. military training mission with army, navy and air force branches. In 1958 the ministry of defense announced a five-year plan calling for 58,000 men to be recruited annually. (K. S. Tw.; X.)

THE ECONOMY

The kingdom of Saudi Arabia inherited the primitive, tribal economy of Arabia. Many of the people are nomads, engaged in raising camels, sheep and goats. Agricultural production is localized and poor. Locust invasions are periodic. The scarcity of rain and water is a perpetual problem; the oases provide a few staple crops; dams have been built to trap the seasonal valley floods, and some irrigation is practised. But it was always difficult for the country to be self-sustaining even in essential foodstuffs, and the ordinary necessities of life (such as rice, flour, sugar. tea and piece goods) must be imported. Commodities which were produced and could be exported to pay for these imports included skins, hides and wool (all imperfectly prepared for foreign markets); dates from the Medina region (now suitably packaged); horses (but the importance of the Arabian horse as an export item has declined) and camels; coffee from Asir, and pearls from the Persian gulf. Asir has rock salt, and salt deposits especially in the Red sea could be further exploited: little attention has been given to fishing in either Red sea or Persian gulf. A notable experiment is the royal farm at Al Kharj, but this covers only about 3.000 ac. south of Riyadh. (See also ARABIA: Vegetation, *Animal Life* and *Natural* Resources.)

The New Oil Economy. — The discovery of oil changed the entire economic situation of Saudi Arabia. As early as 1923 Abdul-'Aziz II granted an oil prospecting concession to a British company, but this concession was never exploited.

In 1933 a large oil concession, to terminate in 1999, was secured by Standard Oil of California, which eventually shared ownership of the operating concern, the Arabian American Oil company (Aramco), with Texaco, Standard Oil (New Jersey), and Socony Mobil Oil on a 30-30-30-10 basis. Although oil was discovered in 1938, World War II curtailed activities until near its end. Rapid expansion began with the completion in 1945 of the Ras Tanura refinery, the rated capacity of which was later increased to 189,000 bbl. a day. Abqaiq (Buqayq) and Ghawar took their place among the world's largest producing fields, and in the early 1960s production of crude oil reached a daily average in excess of 1,500,000 bbl. In 1950 Aramco's owners put into operation the Trans-Arabian Pipe Line (Tapline), which runs 752.8 mi. from Al Qaysumah (300 mi. N.W. of Dhahran) in Saudi Arabia across Jordan and Syria to its Mediterranean terminal at Sidon, Lebanon. The capacity of the line was later increased to 470,000 bbl. a day. Crude oil not refined at Ras Tanura or pumped through Tapline is shipped from Ras Tanura port or piped to Bahrain for refining.

In 1951 Aramco discovered the first offshore field in the near east at Saffaniyah just south of the Saudi Arabia–Kuwait neutral zone. Intensive exploration of the Rub' al Khali began in 1950. Operations in this forbidding desert have led to the development of new techniques, particularly in the field of transportation. Water has been found in a number of deep wells drilled in the heart of the sands.

In 1950 Saudi Arabia and Aramco made a new agreement for sharing profits on the basis of the so-called 50/50 principle, this being the first application of this principle in the near east, where it was later widely adopted. This agreement gave Saudi Arabia a substantially larger return from the venture.

In 1949 Saudi Arabia granted a concession to the Pacific Western Oil corporation (later the Getty Oil company) for its interest in the Saudi Arabia–Kuwait neutral zone. Oil was discovered in the zone in 1953, and Saudi Arabia's share of the production reached about 55,000 bbl. a day. Another concession was secured in 1958 by the Arabian Oil Company Ltd. of Tokyo for Saudi Arabia's interest in the neutral zone offshore, with the provision that Saudi Arabia should receive 56% of this company's profits. The first well drilled in the neutral zone offshore in 1960 proved a successful strike.

Since 1955 Saudi Arabia has been surpassed in crude oil production only by Kuwait in the near east and by the United States, Venezuela and the Soviet Union. Saudi Arabia's proven reserves were estimated at 50,000,000,000 bbl., approximately 15% of the world total.

The oil fields also contain enormous quantities of natural gas: proven reserves in Saudi Arabia were estimated at more than 20,000,000,000,000 cu.ft. Aramco has developed the capacity to reinject about 400,000,000 cu.ft. a day to conserve gas for future use and to reinforce the underground pressure needed for oil production. Some gas is liquefied for use locally and for sale abroad.

Mining.—In 1934 the Saudi Arabian Mining syndicate obtained a concession. After examination of 55 ancient mining sites, work began at one, Mahd adh Dhahab in the Hejaz mountains. Gold and silver worth over $30,000,000 were extracted before the concession was relinquished in 1954 as no longer profitable. In 1954 the Saudi Arabian government, the United States Geological survey and Aramco undertook jointly an elaborate mapping program employing aerial photography to provide the basis for a more systematic survey of mineral resources. Large deposits of iron ore occur in northern Hejaz. Salt and gypsum are exploited commercially and cement is manufactured.

Trade and Finance.—Under the oil economy, trade in the few wares which the country had to offer, other than oil and gas, declined. In 1958 the government formed an Economic Development committee and trade agreements were negotiated with various countries. Many imports, such as machinery, motor vehicles and grain, became increasingly important as the economy grew more complex. The United States, Federal Republic of Germany and Japan are now the main suppliers, with the United Arab Republic ahead of other Arab states. In 1958 a severe check was placed on the import of luxuries in order to strengthen the national currency. In Jan. 1961 a Supreme Planning board (replacing the Economic Development committee) was formed to supervise the country's economic development.

The discovery of oil caused a drastic change in Saudi Arabia's finances. Freed from the old dependence on the pilgrim traffic to Mecca and Medina (the traditional source of national income), customs duties, and taxes on crops and livestock, which together provided a maximum of about 60,000,000 Saudi rials annually, the government's income by the early 1960s had risen to more than 2,100,000,000 rials, most of which came directly or indirectly from the oil industry. Oil revenues permitted a favourable balance of trade. In 1958 the government introduced its first realistic budget, and as a result of the improvement in the financial situation the rial was stabilized in 1960 at 4.5 rials to the U.S. dollar and established as the only legal tender. New rial notes were issued to replace the "pilgrim receipts" then in circulation; the Saudi gold sovereign was withdrawn and exchanged at a fixed rate of rials.

Transport and Communications.—Difficulties of terrain kept the various regions largely isolated, with the camel as the chief means of transportation, until mechanical transport was introduced in the 20th century. The Hejaz railway, completed from Syria to Medina in 1908, was damaged during World War I and its Hejaz stretch abandoned in 1924. After the unification of the kingdom, all areas were linked together by radio communications. Penetration of the interior by airplane became common after World War II; the principal cities were equipped with airports, and airlines brought the country closer to the rest of the world. In 1951 a railroad, 350 mi. long, was completed to the capital Riyadh from the new port of Ad Dammam on the Persian gulf just south of the oil-shipping port of Ras Tanura. The government also built a modern port on the Red sea at Jidda, the gateway to Mecca. Asphalt roads now speed pilgrims from Jidda to Mecca (45 mi.) and Medina (280 mi.), and other roads have been finished in the plan for a network of first-class arteries, which includes a transpeninsular highway. Even where asphalt is not laid, passable motor roads traverse the desert wherever necessary. A road paralleling Tapline leads to the neighbouring northern states of Jordan and Syria.

See also references under "Saudi Arabia" in the Index volume.

(G. S. Re.; X.)

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SAUERKRAUT is a food product of characteristic flavour, obtained by full fermentation, chiefly lactic, of properly prepared and shredded cabbage in the presence of not less than 2% nor more than 3% salt. It contains, upon the completion of fermentation, not less than 1.5% and usually not more than 2% lactic acid. The characteristic flavour and the lactic acid are produced by a sequence of bacteria which find ideal conditions for growth in the presence of the added salt and the nutrients which it withdraws from the shredded cabbage. Many refer to sauerkraut simply as "kraut." The word "sauerkraut" comes from the German *sauer,* "acid" and *kraut,* "cabbage." Sauerkraut is used as a delicious relish when served raw and as a vegetable when cooked. It is rich in vitamin C (ascorbic acid) and is excellent to add bulk without corresponding fattening properties. The juice is canned and used, as an appetizer. (F. W. FN.)

SAUGUS, a town (township) of Essex county, Mass., U.S., is located on the Saugus river 10 mi. N. of Boston. Settlement dates from 1629; the town was incorporated 1815. The Hammersmith ironworks, built on the river through the efforts of John Winthrop the Younger. operated from 1646 to 1676, producing up to eight tons of pig iron per week; the blast furnace. forges and slitting mill were restored in 1954 as an industrial shrine. The town was a manufacturing centre for shoes and woolen goods in the 19th century but is now chiefly residential. It has a council-manager form of government in effect since 1948. For comparative population figures see table in MASSACHUSETTS: *Population.* (HO. ST.)

SAUK or SAC. an Algonkian-speaking Indian tribe closely related to the Fox (*q.v.*) and Kickapoo. and once forming with these and the Shawnee a single tribe prohahly living in the Ohio valley. When first encountered by the French in 1667 they had been driven westward by the Iroquois to the region of Green Bay, Wis. Later they settled along the Mississippi river between Rock Island. Ill., and St. Louis, Mo., and formed a close alliance with the Fox. In 1804 the U.S. commander at St. Louis persuaded some of their minor chiefs to cede most of the tribal lands to the United States and although the Sauk protested that this treaty was illegal they were unable to prevent its enforcement. When a group led by Black Hawk (*q.v.*) refused to leave Illinois it was attacked by the state militia. overtaken while trying to escape across the Mississippi, and massacred. After the Black Hawk War the Sauk were forced to relinquish more territory; later they were moved to Kansas and eventually were settled in Oklahoma.

Sauk culture was of the prairie type. In summer the tribe lived in bark-house villages along bluffs near river bottoms where women raised corn and other crops. After the harvest the village broke up into family groups, which erected minter houses of poles covered with reed mats; in spring the tribe gathered on the Iowa prairies to hunt buffalo. Matrilocal residence was the rule in summer, when kinswomen co-operated in tending crops, but winter and spring brought a shift to patrilocal residence. The kinship system was of Omaha type, and the social organization included patrilineal clans that were crosscut by a nonhereditary dual division with important military and ritual functions. Regulating the inheritance of personal names. the clans also controlled religious ceremonies through ownership of sacred packs on which ritual was based. Some ceremonies, however, were held by secret societies. The Sauk were governed by a tribal council and hereditary chiefs; when war broke out these were temporarily replaced by war chiefs selected for their military ability. Early estimates of their population ranged from 1,500 to 3,000. In 1960 there were about 1,000 Sauk.

See Alanson Skinner. "Observations on the Ethnography of the Sauk Indians," *Bulletin* of the Public Museum of the City of Milwaukee, v (1923–25); Charles Callender, *Central Algonkian Social Organization,* Anthropological Publications of the Public Museum of the City oi Milwaukee (1961). (CH. C.)

SAUL, son of Kish, a Benjamite, was the first king of Israel. He began to reign *c.* 1025 B.C. The traditions as to his history are closely interwoven with those concerning Samuel and David. Various views may be taken of these records, among the most dramatic in sacred literature, but it is generally recognized by scholars that the stories of 1 Samuel preserve two different traditions about the rise of the monarchy in Israel. In each there is an account of Saul's election; each relates that he mas anointed by Samuel and records his rejection. It is probable that two distinct continuous histories have been combined in the existing text of Samuel. According to the later of the two traditions the elders of Israel, seeing that the sons of Samuel, who are destined to succeed him, are corrupt, demand that he shall make them a king "to judge them like all the nations." Samuel is displeased, but Yahweh reluctantly—for such a request was a grave affront to the deity, the true king of Israel—bids him concede the demand. The seer points out to the people that a king will oppress them, but fails to dissuade them (1 Sam. viii). He summons a solemn assembly at Mizpah, and. once more reminding them of their folly, chooses Saul, by lot under Yahweh's direction (x, 17–24). In an elaborate sermon (xii), he succeeds in convincing the people that their action has been sinful. And hardly has Saul seated himself upon the throne when Yahweh rejects him, and bids Samuel anoint David to succeed him in due time (xvi, 1–13). *See* SAMUEL.

The earlier tradition, which is distinctly more primitive in its religious ideas, contributes other sidelights on the matter. Samuel, to whom Saul comes seeking the seer's help in the finding of some lost asses, is previously warned by Yahweh that the suppliant is the divinely chosen saviour who is to deliver Israel from Philistine oppression. With wholehearted enthusiasm Samuel anoints Saul to be "prince over Yahweh's inheritance" (ix–x. 1). Saul and his son Jonathan achieve notable victories over the Philistines (xiii). According to this tradition Saul is a God-given saviour, like the heroes in Judges, who rescues his people from the grievous domination of the Philistines. An appropriate introduction to this narrative is missing from 1 Samuel. but the introduction to the story of Jephthah (Judg. x, 6–16)—to which what follows is certainly not the obvious sequel—would very well fit it. The suggestion has therefore been made that possibly according to an old tradition Saul was the immediate successor of Jephthah (*cf.* *Cambridge Ancient History,* vol. ii, p. 371ff.).

Though the reign of Saul was marked by considerable successes he was hampered by friction n·ithin as well as by foes without. Comparatively early his relations with Samuel seem to have become strained, and his declining years were embittered by the growing importance of his rival, David. Finally he fell a victim to his ancient enemies, the Philistines, who inflicted a heavy defeat on Israel in the battle of Mount Gilboa, where his sons were slain, and he himself perished. Here, again, there are two distinct accounts. According to one. being "greatly distressed by reason of the archers," he implored his armour bearer to kill him, that he might not be slain by uncircumcised Philistines, and when his armour bearer refused fell upon his own sword (1 Sam. xxxi, 1–7). The other story (2 Sam. i, 1–10) represents him as making a similar request to an Amalekite camp follower, who, unlike the armour bearer, complies. It is possible that this is a fiction on the part of the Amalekite, though the context hardly suggests such a view.

According to one estimate of the documents, the character of Saul was depreciated by Judean historians anxious to exalt David and by antimonarchists whose ideal was Samuel. Others have found in the narrative an ethical significance of perpetual value. However, Saul played a considerable part in the freeing of Israel from the Philistine yoke. Though his reign ended in the gloom of tragedy he achieved notable successes on the battlefield, and was a greater king than the existing narratives would lead us to suppose. This is borne out by the ascription to him of important victories (cf. 1 Sam, xiv, 42–51) and even more by the ancient lament irom the "book of Jashar" (2 Sam. i, 19–27), which paints the fallen king as "mighty," a warrior whose "sword returned not empty," "swifter than an eagle," "stronger than a lion," who brought good spoil to his people and whose death was to the Philistines a source oi exultation. That he maintained his position despite the popularity of David, and that his kingdom endured for a time after his death even with a weakling like his son Ishbosheth as its nominal head, point in the same direction. In short, we may discern in the scriptural narratives the figure of a brave, impulsive, superstitious man, whose contribution toward the building up oi the kingdom has been underestimated. (W. L. W.)

SAULT SAINTE MARIE, a city in Ontario! Can., and a port of entry, is on the north bank of St. Mary's river, the outlet from Lake Superior into Lake Huron, opposite the U.S. city of the same name. Pop. (1961) 43.038. Known to the French explorers from the time of Étienne Brulé, it was named Sault de Gaston early in the 17th century. The name was changed to Sault Ste. Marie ("Rapids of Saint Mary") in 1669 when a permanent mission was established by the French. The North West company established a trading post in 1783 and built a small lock to handle canoes and small boats for trading purposes, this being completed in 1797–98. The lock was destroyed by U.S. troops in the War of 1812 and rebuilt as a historical site late in the 19th century.

The growth of Sault Ste. Marie has been intimately associated with the rapids and the locks and canal around them. The present Canadian lock was built for military purposes in the late 19th century after use of U.S. locks was denied to Canadian troops sent to suppress the Riel rebellion of 1870. It was later widened to its present size: 16.8 ft. deep, 59 ft. wide and 900 ft. long. The canal itself is 1.38 mi. long.

In the middle part of the 20th century the locks and canal handled about 3,000,000 tons of shipping annually, considerably less than the U.S. system paralleling it. Cheap transportation led to the development of heavy industry. In the 1960s the Algoma steel plant, for example, had an annual capacity of more than 1,000,000 tons. Of the gainfully employed inhabitants of the city. more than half were engaged in manufacturing, and of those four-fifths were in iron and steel.

In addition, the "Soo" is a retail and wholesale centre and a notable tourist headquarters. (F. A. CK.)

SAULT SAINTE MARIE, a city of Michigan, U.S., the seat of Chippewa county and a port of entry, is located at the northeast end of the upper peninsula of Michigan on the south shore of the St. Mary's river, the connecting waterway between Lake Superior and the lower Great Lakes. A canal and four parallel locks provide a navigable channel for shipping past the rapids which mark a 20-ft. drop in elevation. Ferry service and a railroad bridge connect it with city of the same name in Ontario. It is a dairy, hay and small grain area and is the oldest settlement in Michigan. From 1917 it has had a commission-manager form of government. Its strategic location. both economically and geographically, makes the Sault a centre of government activity: the St. Rlary's Falls canal (popularly called Soo locks) is operated and maintained by the U.S. army corps of engineers; the U.S. air force maintains the Kincheloe air force base 18 mi. S. of the Sault and a radar base at the city limits; customs and immigration offices are at Sault Ste. Marie; and the U.S. coast guard has a base from which it maintains and controls navigation in the area. From 1948 the Sault branch of Michigan College of Mining and Technology has occupied buildings formerly used by historic Fort Brady, built in 1822 shortly after the United States took possession of the area. It is the centre of a summer and winter resort area with fine fishing, hunting and skiing. The manufacture of carbide and wood products provide the main industry.

The flags of three nations have flown at Sault Ste. Marie since the first white man, explorer Étienne Brulé, visited the area some time between 1615 and 1622. Jesuit missionaries are credited with naming the rapids and river Ste. Marie and are said to have introduced Christianity there. The site was a favoured residence and stopping place for Ojibwa Indians because of the great catches of whitefish that could be taken from the rapids. In 1668 Father Jacques Marquette founded a mission at Sault Ste. Marie and thereby established the first permanent white settlement in Michigan. The French took official possession of the interior of North America in a ceremony at the Sault in 1671. British occupation began in 1762. By the treaty of Paris (1783) Great Britain ceded land east of the Mississippi to the United States; however, it was not until 1820 that the C.S. flag nas raised at the Sault by Lewis Cass, governor of Michigan territory. Writings by Henry Rowe Schoolcraft (*q.v.*), first Indian agent in Sault Ste. Marie, provided source material for Longfellow's poem *Song* of *Hiawatha.*

Sault Ste Marie was incorporated as a village in 1879 and as a city in 1887. The original canal and state lock was opened in 1855.

The navigation season is limited to eight months because of severe winter conditions. Handling this lake traffic are the Poe, Davis, Sabin and MacArthur locks on the Michigan side of the St. Mary's river, and one lock on the Canadian shore. Construction of a new lock, 1,000 ft. long, on the site of the Poe lock was begun in 1961 as a part of the St. Lawrence seaway program of development on the Great Lakes. For comparative population figures *see* table in MICHIGAN: *Population* (G. A. Os.)

SAUMAREZ, JAMES SAUMAREZ (or SAUSMAREZ), BARON DE (1757–1836), English admiral, was born at St. Peter Port. Guernsey, on March 11, 1757. He entered the navy as midshipman at the age of 13. For his bravery at the attack of Charleston in 1776, on board the "Bristol," he was raised to the rank of lieutenant, and he was promoted commander for his gallant services off the Dogger Bank, hug. 5, 1781, when he was wounded. In command of the "Russell" (70 guns), he contributed to Rodney's victory over De Grasse (April 12, 1782). For the capture of "La Réunion," a French frigate, in 1793, he was knighted. He took part in the defeat of the French fleet off Lorient (June 1795), distinguished himself in the battle of Cape St. Vincent (Feb. 1797) and was present at the blockade of Cadiz (Feb. 1797–April 1798) and at the battle of the Nile, where he was wounded. On his return from Egypt he received the command of the "Caesar" (84), with orders to watch the French fleet off Brest during the winters of 1799 and 1800. Between July 6 and 12, 1801, he routed a superior combined force of French and Spanish ships at Algeciras. On the outbreak of the war with Russia in 1809 he was given command of the Baltic fleet. He held it during the wars preceding the fall of Napoleon, and his tact was conspicuously shown toward the government of Sweden at the crisis of the invasion of Russia. At the peace of 1814 he attained the rank of admiral; Charles XIII (Bernadotte) bestowed on him the grand cross of the military Order of the Sword. Saumarez was raised to the peerage in 1831, and died at Guernsey on Oct. 9, 1836.

SAUMUR, a town of western France. capital of an *arrondissement* in the *département* of Maine-et-Loire, 28 mi. S.E. of Angers on the railway to Tours. Pop. (1954) 15,528. The Saumur caves along the Loire and on both sides of the valley of the Thouet must have been occupied at a very remote period. The Tour du Tronc (9th century), the old stronghold of Saumur, served as a place of refuge for the inhabitants of the surrounding district during foreign invasions (whence perhaps the name Saumur, from *Salons Murus*) and became the nucleus of a monastery built by monks from St. Florent Le Vieil. On the same site rose the castle of Saumur 200 years later. The town fell into the hands of Foulques Nerra, duke of Anjou, in 1025, and passed in the 13th century into the possession of the kings of France. After the Reformation the town became the metropolis of Protestantism in France and the seat of a theological seminary which, as opposed to that of Sedan, represented the more liberal side of French Protestantism (Cameron, Amyraut. etc.). In 1623 the fortifications mere dismantled; and the revocation of the edict of Nantes reduced the population by more than one half. In June 1793, the town was occupied by the Vendéens, against whom it soon afterwards became a base for the republican army.

Saumur stands on the left bank of the Loire and on an island in the river. Two stone bridges unite the town on the island with the two banks of the river. The church of St. Pierre, of the 12th century, has a 17th-century façade and a Renaissance nave; and Notre-Dame of Nantilly has a remarkable façade, a doorway and choir of the 12th century, and a nave of the 11th. St. Jean is a 12th-century building in the purest Gothic style of Anjou. St. Nicolas-du-Chardonnet, 12th century Gothic, has a fine modern spire. The *hôtel* de *ville* is a 16th century building and the town has many houses of the 15th, 16th and 17th centuries, notably that known as the Maison de la Reine Cécile (15th century), built by René, duke of Xnjou. The castle was built between the 11th century and the 13th. and remodelled in the 16th. There is also an interesting almshouse, with its chambers in part dug out in the rock. The famous cavalry school of Saumur was founded in 1768. Saumur carries on a large trade in the sparkling white nines made in the neighbourhood, as well as in brandy, and it manufactures enamels and rosaries.

SAUSAGE is one of the older forms of processed food. The word is derived from the Latin *salsus,* meaning salted (and thereby preserved) meat. but mixtures of meat. blood. offal and other ingredients, encased in animal gut or other suitable materials and generally referred to as sausages, were known considerably prior to Roman times. The first authenticated reference appears in Homer's *Odyssey,* probably written about the 9th century B.C., and later Greek literature frequently mentions sausage, using the general term *oryae* or referring to specific types such as salami. Athenaeus, in the *Deipnosophistai* (*c.* A.D. 228), says: "Epicharmus mentions sausages. calling them oryae. a name by which he even entitles one of his plays. the *Orya;* this was about 500 B.C." Again: "Aristophanes says in the *Clouds* (423 B.C.): 'Let them make sausages of me and serve me up to the students.' " Salami, according to the *Deipnosophistai,* was mentioned by Eubulus in the *Lakones* and by Mnesimachus in his play the *Hippotrophos.* Since the time of Christ: sausage has been mentioned frequently in the literature of most peoples, and similar products were known to tribes such as the American Indians While the term *salsus* was used by the Romans to denote meat preserved through the use of salt. various kinds of sausage were generally popular with Romans and Greeks of all classes at the time of the Caesars. The ancient Romans were extremely fond of a sausage made of fresh pork and white pine nuts chopped fine with cumin seed: bay leaves and black pepper. So popular was this sausage that it became ritualistically identified with the Lupercalian and Floralian festivals and was condemned by the early Christian church because of this association. As a result. Constantine the Great. when he became emperor of Rome and embraced Christianity. prohibited sausage eating. This prohibition remained in effect throughout the reigns of several Christian emperors but was finally repealed because of popular protest and because of bootlegging.

Sausage making became a culinary art in the middle ages, and certain of the modern popular sausages derived their names from the cities in which they originated; *e.g.*, frankfurters (Frankfurt-on-Main, Ger.), bologna (Bologna, It.), romano (Rome), genoa salami (Genoa, It.), berliner (Berlin), gothaer (Gotha, Ger.), goteborg (Goteborg, Swed.), lyons (Lyons. Fr.), arles (Arles, Fr.). While there is no documentary proof, it has been deduced that salami may have been named for the ancient Grecian city Salamis, on the east coast of Cyprus.

Basically, all sausage is comminuted meat. although similar preparations have been made from fish and even from vegetables, and described as fish sausage, pea sausage, etc. The various types of meat sausage. of which about 200 are known to exist, differ primarily in the types of meat they contain, in their spicing and in their preparation. In general. preparation consists of the mincing. hashing or comminuting of lean meat, fat and in certain cases offal. the admixture of spices, curing salts or other ingredients, and the filling of the mixture into some form of casing. Commonly used natural casings are ox, pig or sheep gut. the diameter of which determines the size of the sausage. In some districts sausages are also filled into cloth bags which are treated with paraffin wax to prevent loss of moisture. In the U.S. the use of synthetic casings far exceeds that of natural materials. After filling, sausages may be smoked, cooked or air-dried, or treated with a combination of these processes. It is generally agreed that the main types of sausage comprise fresh, cooked, smoked; smoked and cooked, semi-dry and dry.

Fresh sausages are made from fresh meats, mainly beef and pork. sometimes with the admixture of veal or mutton. Fresh pork sausages, Bratwurst and fresh thuringer are examples of this type.

Cooked sausages are also made largely from fresh. uncured meats, although cured meats are sometimes incorporated. They are cooked after filling and smoked (if at all) after cooking. Examples include liver sausage and blood sausage.

Smoked sausages are made from cured meats and are subjected after filling to the heat and flavouring effect of wood smoke. They may subsequently be marketed uncooked (*e.g.,* smoked pork sausage. *mettwurst*), but most of these sausages are subjected to at least some degree of cooking. Sausages of this type include frankfurters. bologna, berliner and German *mortadella.*

Dry sausages may also be subdivided into various groups. depending on whether or not they are smoked before drying and on the degree to which they are dried. Essentially they are all made by comminuting the fresh meat'and other ingredients along with saltpetre, after which they are cured for two or three days. The mixture is then encased and the sausage is either cooked in a smokehouse at a high temperature prior to drying in air (cooked salami, thuringer *cervelat,* kosher salami) or is dried without smoking. Unsmoked dried sausages include Italian, Hungarian and German salamis and a wide variety of lesser-known sausages of European origin.

In Great Britain, and to a lesser extent in other countries of Europe. the pattern of sausage production follows that of the United States, more and more being produced by large factories distributing their branded goods on a nation-wide scale and less by small butchers catering for a local trade. In consequence, a considerable measure of standardization is occurring and many regional varieties of sausage are tending to disappear. Although liver sausages, black puddings (a type of blood sausage) and several types of continental sausage are produced, by far the greater bulk of sausages eaten in Great Britain are fresh pork or beef sausages.

The sale of sausages in cans is also increasing. probably stimulated by government orders for canned sausages for the feeding of the armed forces. In Great Britain, many of these canned sausages are produced by domestic firms, but there is a growing import trade.

Perhaps the most significant modern development, however, at least in the United States and Great Britain. was the development of "skinless" sausages. which met with such success that in the U.S. their consumption soon exceeded that of the traditional cased forms. In their preparation the ingredients are first filled into cellulose casings, which are tied off automatically into links. This casing is then immersed in hot and then in iced water, so that a small amount of protein from the meat is denatured and separated into a thin film immediately below the cellulose case. When this case is removed. the layer around the individual sausage links within the case prevents them from collapsing or sticking together during subsequent handling. They are sold wrapped in transparent film in packs of standard weight.

The development of skinless sausages greatly increased the demand for cellulose casings, but other synthetic casings are also growing in popularity. These artificial casings are in the main inedible. but edible casings are being prepared synthetically from derivatives of alginic acid.

Recipes for sausages are legion and are in some cases regulated to a certain extent by government legislation. Thus it is prohibited in Germany to use any binding material of a cereal or other nature. In the United States, on the other hand, the addition of up to 3.5% of cereal, starch or dried milk is permissible if declared. The British authorities allow sausages to contain considerable amounts of cereal filler. During World War II, statutory regulations were passed calling for the presence of not less than 65% meat in fresh pork sausages and not less than 50% meat in fresh beef sausages. These regulations mere rescinded in 1953, but courts tend to uphold prosecutions for adulteration on the basis of these figures.

Other additives to sausages may give rise to confusion where trade is carried out between one country and another. Thus, regulations differ concerning the use of various artificial colours and added preservatives, and of chemical emulsifying agents, such as various phosphate derivatives. which are used widely in some countries. In Great Britain, certain selected colours from a permitted list may be employed. and sulfur dioxide may be added as a preservative to the extent of 450 parts per 1,000,000. The use of phosphates is not controlled.

Of the continental European countries, Italy is generally considered to produce the greatest bulk of sausages. although Germany produces the greatest variety. Demand is especially high in Tuscany and many varieties are produced in and around Florence. but the largest producing area is centred around Bologna. Production is widespread through Germany — Frankfurt and Hamburg are particularly noted for high-class sausages. Hungary and Poland are also large sausage producing and eating countries; Switzerland and the Scandinavian countries provide their own types. Sausage production in Spain is greatest in Catalonia, the old town of Vich being noted for its sausages, which are prepared exclusively from lean pork and a small quantity of bacon, without the admixture of other meat.

Fresh pork and beef sausages, most popular in Great Britain. are prepared by chopping together selected proportions of lean meat with fat, cereal filler such as rusk; water, spices and salt, usually in a revolving bowl chopper. The mixture is then filled into hog or sheep casings or into cellulose casings for the production of skinless sausages. The sausages are linked, so many to the pound. and are usually marketed in cellulose-wrapped packages of standard weight.

In the United States, the main demand is for frankfurters, wieners and Vienna-type sausages, which are used in enormous quantities for the production of hot dogs. These are made to an almost identical formula. consisting of about 60% cured beef and 40% cured pork spiced nith nhite pepper, sugar. cloves coriander and nutmeg. The chopped mixture is filled into natural casings and is then smoked in hardwood smoke and cooked in steam or water. Frankfurters and Vienna sausages of varying composition are also made in several European countries. Bologna is made in the United States with a similar meat content, spiced with black pepper, cloves, coriander and ginger. It is filled into large beef or artificial casings and smoked and cooked before sale. Similar products are made in various European countries. Polony is a corruption of bologna, which it resembles.

Salamis consist mainly of cured lean pork, coarsely chopped. and some cured lean beef, finely chopped. The meats are moistened with red wine, flavoured with various spices and stuffed into large casings before being air dried. for from two to three weeks. Some types are also smoked for long periods. Savaloys are short thick sausages originally compounded of pigs' brains, the word being a corruption of the French *cervelet.* The name is applied to a type of highly seasoned and dried pork sausage. sufficiently cooked for it to keep a considerable time. *Cervelats,* a name presumably derived from the same source, are produced in several countries, including Switzerland and Sweden. They are generally compounded from about equal mixtures of cured pork and beef and are usually less highly spiced than salamis.

Liver sausages are made in virtually all countries, from finely ground fat pork and liver, along with spices and onions or other flavourings. Haggis (*q.v.*), the national dish of Scotland, is in essence a sausage (rarely looked upon as such). (J. I. A.)

SAUSSURE, FERDINAND DE (1857–1913), Swiss linguist, one of the most influential linguists of modern times, was born on Nov. 26, 1857, at Geneva. the scion of a family of scientists and writers. He studied at the universities of Geneva. Leipzig and Berlin, and obtained a doctorate at Leipzig in 1880. From 1881 to 1891 he was instructor at the *Ecole des Hautes Études* in Paris; from 1901 to 1913 he was professor of Indo-European linguistics and Sanskrit, from 1907 to 1913 also professor of general linguistics at the University of Geneva. Saussure attained his eminent position not through published works but through the school of linguistics he founded and the excellence of his disciples. The only book from his own pen was written when he was 21 years old: *Mémoire sur le système primitif des voyelles dans les langues indo-européennes* (Paris: 1878). But the most important work under his name. *Cours de linguistique générale* (2nd ed., 1922), is a collection of lectures published posthumously by his students. Saussure's principal tenet was that language is, and must be dealt with as, a social phenomenon. a structured system of signs that can be viewed descriptively (synchronically'i and historically (diachronically). The systematic structure *(langue)* is realized and becomes manifest in actual speech events *(parole)*— *a* dichotomy that has proved extremely useful and fruitful. His own Geneva school, the French and the Prague schools of linguistics, and particularly the structuralists everywhere, owe much to Saussure. He died on Feb. 22, 1913, at Geneva. (E. PM.)

SAUSSURE, HORACE BÉNÉDICT DE (1740–1799), Swiss physicist, known principally for his studies of the Alps, was born at Geneva on Feb. 17, 1740. From 1762 to 1786 he taught at the academy of Geneva. His early devotion to botanical studies led him to undertake numerous journeys in the Alps, and from 1773 onward he devoted much of his time to the study of that area. His interests included geology, physics and chemistry also.

In meteorology. the field of study in which he made the greatest contribution, he carefully investigated atmospheric humidity and developed the hair hygrometer. an instrument for measuring humidity. Descriptions of seven of his Alpine journeys were published in *Voyages dans les Alpes* (1779–96). De Saussure was elected a fellow of the Royal society and in 1772 founded at Geneva the Society for the Advancement of the Arts. He died in Geneva on Jan. 22. 1799.

SAUVEUR, ALBERT (1863–1939), U.S. metallurgist and teacher. who prior to 1900 developed methods of improving the quality of steel through studies of the crystal structure of metals. He pioneered the technique of photomicrographs in the late 1800s to further his studies of metal microstructures. Sauveur's work in the heat treatment of metal is still a scientific landmark. Born in Louvain. Belg., June 21, 1863. of French parentage, Sauveur received his early education in Europe and graduated from the Massachusetts Institute of Technology, Cambridge, in 1889. After a period of work as a chemist and metallurgist, he left industry in 1899 for Harvard university as an instructor. In 1905 he became a professor of metallurgy and in 1924 he was appointed the Gordon McKay professor of mining and metallurgy at the university. From 1898 to 1903 Sauveur was editor of *Metallographist,* and in the period 1903–06 he served as editor of *Iron and Steel Age.* He received many medals and honorary degrees from U.S. and European societies and universities. The Legion of Honour of France and the French Academy both elected him an officer. A national award established in 1934 by the American Society for Metals bears his name. Sauveur served the French and U.S. governments in World War I as a metals consultant, and in 1925 he was a U S. delegate to the Pan-American Scientific congress in Lima, Peru. He died in Boston, Mass., Jan. 26. 1939. (R. T. B.)

SAVAGE, RICHARD (d. 1743), English poet, was born about 1697. probably of humble parentage. A romantic account of his origin and early life, for which he supplied the material, appeared in Curll's *Poetical Register* in 1719. On this and other information provided by Savage, Samuel Johnson founded his *Life of Savage,* one of the most elaborate of the *Lives.* It was printed anonymously in 1744, and made the poet the object of an interest which would be hardly justified by his writings. In 1698 Charles Gerrard. 2nd earl of Macclesfield, obtained a divorce from his wife, Anna. daughter of Sir Richard Mason, who shortly afterward married Col. Henry Brett. Lady Macclesfield had two children by Richard Savage. 4th earl Rivers, the second of whom was born at Fox Court, Holborn, on Jan. 16, 1697, and christened two days later at St. Andrews, Holborn, as Richard Smith. Six months later the child was placed with Anne Portlock in Covent Garden; nothing more is positively knonn of him. In 1718 Savage claimed to be this child. His statements were suspicious, and Mrs. Brett maintained that he was an impostor. The matter was thoroughly investigated for the first time by W. Moy Thomas, who published the results of his researches in *Notes and Queries* (second series, vol. vi. 1858). Savage, impostor or not. blackmailed Mrs. Brett and her family with some success, for after the publication of *The Bastard* (1728), her nephew John Brownlow, Viscount Tyrconnel, purchased his silence by taking him into his house and allowing him a pension of £200 a year. Savage wrote tno successful plays: *Love in a Veil* (1718), adapted from the Spanish, and *Sir Thomas Overbury* (1724). *Miscellaneous Poems* was published by subscription in 1726. In 1727 he was arrested for the murder of James Sinclair, and only escaped the death penalty by the intercession of Frances, countess of Hertford (d. 1754).

Savage was at his best as a satirist, and in *The Author to be Let* he published a quantity of scandal about his fellow scribblers. Proud as he was, he was servile enough to supply Pope with petty gossip about the authors attacked in the *Dunciad.* His most considerable poem. *The Wanderer* (1729), shows the influence of Thomson's *Seasons,* part of which had already appeared. Savage tried without success to obtain patronage from Walpole, and hoped in vain to be made poet laureate. In 1732 Queen Caroline settled on him a pension of £50 a year. Meanwhile he had quarreled with Lord Tyrconnel, and at the queen's death was reduced to absolute poverty. Pope had been the most faithful of his friends, and had made him a small regular allowance. With others he now raised money to send him out of reach of his creditors. Savage went to Swansea, but he resented bitterly the conditions imposed by his patrons, and removed to Bristol, where he was imprisoned for debt. All his friends had ceased to help him except Pope, and in 1743 he, too, wrote to break off the connection. Savage died in prison Aug. 1, 1743.

See Johnson's *Life of Savage,* and *Notes and Queries* as already quoted He is the subject of a novel, *Rtchard Savage* (1842), *by* Charles Whitehead, illustrated by John Leech. *Richard Savage,* a play in four acts by J. M. Rarrie and H. B. Marriott-Watson, was presented at the Criterion theatre, London, in 1891. The dramatists took considerable liberties with the facts of Savage's career. *See* also S. V. Makower, *Richard Savage, a Mystery in Biography (1909).*

SAVANNA or **SAVANNAH,** originally a meadowland or large, grassy, treeless tract, but now also including level areas with tall grasses and isolated clumps of trees. as in Nigeria, where the more appropriate name would be park savanna. It has also been commonly applied to the grassy plains south of the centre of North America, and is there the equivalent of prairie (*q.v.*).

SAVANNAH, the leading seaport in Georgia, U.S.. is situated at the mouth of the Savannah river on an elevation of 42 ft., 18 mi. W. of the Atlantic coast; it is 260 mi. S.E. of Atlanta and 140 mi. S. of Columbia, S.C. The city was laid out by James Oglethorpe according to plans drawn in England, with rectilinear streets crossing at right angles, the plat being symmetrical with numerous squares reserved for public parks. These parks, studded with semitropical trees and flowers and surrounded with Georgian colonial and Greek revival buildings, give the city an atmosphere of tranquility and grace. It exceeds all Georgia cities in historical interest and it is a leading tourist and recreation centre. It is also a city of commercial and industrial importance. Pop. (1960) city 149,245; standard metropolitan statistical area (Chatham county) 188,299. (For comparative population figures for the city see table in GEORGIA: *Population.*)

History.— The original Georgia settlement in 1733. Savannah was the seat of colonial government and remained the capital of the commonwealth until 1786, although sharing this distinction with Augusta after 1778 (see also GEORGIA: History). Among the early residents were the brothers John and Charles Wesley, who came in 1736, John as a representative of the Society for the Propagation of the Gospel, Charles as secretary to Oglethorpe. Charles Wesley stayed only a few months; John Wesley remained until 1738. The evangelist George Whitefield visited the settlement for the first time in 1738 and several times thereafter; he founded in Savannah the Bethesda orphanage (later burned).

As early as 1744 there was established at Savannah an exporting and importing firm engaging in coastwise traffic and by 1750 the port was clearing vessels directly to Europe. Lumber products, sago powder, rice, indigo, beef, pork, animal skins, tar and turpentine were its early exports. In 1769 Savannah merchants condemned the British acts of trade and adopted nonimportation agreements but its revolutionary sentiment was comparatively moderate. During the American Revolution the town remained only briefly in rebel hands, being occupied by loyalist forces from 1778 to near the end of the conflict. After the war Gen. Nathanael Greene, who is buried in the city, settled on an estate, 14 mi. N. of Savannah, granted him by the state of Georgia. It was while visiting the Greene family there in 1793 that Eli Whitney invented the cotton gin. There was a devastating fire in the city in 1796, and in 1820 another fire coupled with a yellow-fever epidemic destroyed considerable life and property. Cholera swept the city in 1834 and hit the slave population severely.

In the meantime the importance of the port was increasing, partly as a result of improved transportation in the hinterland. The town's early means of contact with other communities was provided by rivers and coastal waters, but by the end of the 18th century a network of roads connected it with points in the back country. The "Savannah," the first steamboat to cross the Atlantic, sailed from Savannah for Liverpool in 1819. Commercial rivalry with Charleston and Augusta caused Savannah citizens to promote a railroad, known as the Central of Georgia, which was completed to Macon in 1843. By 1860 the Atlantic and Gulf railroad connected Savannah with points in southern Georgia. The city's commerce suffered during the Civil War as a result of the Union blockade but the city was not captured until late in 1864, when it became the objective of Gen. W. T. Sherman's march to the sea. The city was occupied by Federal troops on Dec. 21, 1864.

After the Civil War Savannah recovered fairly rapidly in spite of a yellow-fever epidemic in 1876. It remained the largest urban centre in Georgia until it was surpassed by Atlanta in 1880. Savannah's history in the 20th century is largely its increasing industrialization and its increasing importance as a maritime centre. It has a council-manager form of government, in effect since 1954.

Population Characteristics.— Both the city of Savannah and its metropolitan area increased in population during the middle part of the 20th century. the rate of increase between 1950 and 1960 being 23.2% in the city and 22.9% in the metropolitan area. The population of the city in 1960 was 35.7% native-born white, 1.4% foreign-born white and 62.9% nonwhite. Although the percentage of foreign-born residents is low, in the past it has been the highest in Georgia. In 1870, for example, the foreign-born comprised 24.2% of the white population. Among the foreign-born the Irish have predominated.

Commerce, Industry and Transportation.— In the latter part of the 20th century manufacturing was the leading occupation but wholesale and retail trade ranked a close second, with public utilities, including transportation and communication, being third. Professional and related services ranked next. Less than 1% of the people of the county were engaged in farming.

The city is served by railroads and state and federal highway systems, with bridges spanning the Savannah river and other water barriers in the vicinity. It has two airports and about 1,500 vessels enter the port of Savannah annually. Piers, docks, wharves and storage warehouses are located along the west side of the Savannah river. Savannah is the leading manufacturing port city between Baltimore and New Orleans. its industry including over 300 processing firms: the principal operations being pulp and paper, sugar refining, packaging. shipbuilding and repair. building materials (including felt, asphalt and roofing). fertilizers, castings and chemicals. The Hunter air force base. a permanent installation of the strategic air command, is located near the city, and within 40 mi. are two other military installations, the marine corps recruit depot at Parris Island. S.C.. and Ft. Stewart, a C.S. army antiaircraft and tank training centre.

Education and Cultural Activities.— Savannah was the earliest centre of artistic and cultural interest in Georgia. In 1801 a library society was established there. followed shortly by a theatre which brought to the community the outstanding productions of the times. The Telfair Academy of Arts and Sciences, a museum of permanent collections of all phases of art, was founded in the city in 1875. The community has several public libraries, a symphony orchestra, a little theatre, an annual camellia show and other similar attractions. Located in the heart of the city are Armstrong Junior college and the Savannah State college, both units of the university system of Georgia (see GEORGIA: *Education*). A Savannah woman, Juliette Gordon Low (1860–1927). is considered the founder of the Girl Scout movement in the U.S.; a number of places of interest in this connection are marked in the city. (Js. C. B.)

SAVANNAH RIVER, rising in northwest South Carolina, U.S., is formed 8 mi. N.W. of Hartwell, Ga.. by the confluence of the Tugaloo and Seneca rivers and serves as a natural boundary between Georgia and South Carolina. Its course is southeastward past Augusta and Savannah, Ga., to the Atlantic, a distance of 314 mi. North of Augusta the Savannah is fed by the Broad and Little rivers and south of Augusta by Brier creek. It is navigable for barge traffic from its mouth on the Atlantic to Augusta. 212 mi. upstream. The river is used extensively for hydroelectric power. The Hartwell dam near Augusta, scheduled for completion in 1963. was planned to provide the major upstream impoundment of the Savannah for hydroelectric, flood control and navigation purposes. There are three other dams near Augusta; the largest of these, Clark Hill dam, is 230 ft. high and 5,660 ft. long. The U.S. Atomic Energy commission's Savannah River plant is in Aiken and Barnwell counties in South Carolina, across the river from Augusta. Clark Hill provides power for the Atomic Energy plant and the river serves as a coolant for plant processes. Savannah. 17 mi. upstream from the mouth of the river, was the centre for James Edward Oglethorpe's initial Georgia colony. Deep-draft navigation by ocean vessels extends 5 mi. upstream beyond the city. At Savannah are one of the world's largest naval stores markets, large state-owned docks operated by the Georgia ports authority and a large refinery for processing sugar imported from the Caribbean. Union Bag–Camp Paper company's plant, near Savannah, is a large integrated pulp-paper plant, its capacity in the early 1960s being 1,900 tons of paper products daily. Many of the former rice and cotton plantations along the lower Savannah river are large producers of pulp wood. (M. C. P.)

SAVARY, ANNE JEAN MARIE RENÉ, Duke of Rovigo (1774–1833), French general and diplomatist, was born at Marcq in the Ardennes on April 26, 1774. He was educated at the college of St. Louis at Metz and entered the royal army in 1790.

After Marengo Napoleon Bonaparte gave him command of the gendarmes charged with the duty of guarding the first consul. In the discovery of the various ramifications of the Cadoudal-Pichegru conspiracy, Savary showed great skill and activity. He was in command of the troops at Vincennes when the duc d'Enghien (*q.v.*) was executed. In Feb. 1805 he became general of division. Shortly before the battle of Austerlitz (Dec. 2, 1805) he was sent by Napoleon with a message to the emperor Alexander I with a request for an armistice, a device which precipitated the attack which brought disaster to the Russians. After the battle Savary again took a message to Alexander, which induced him to treat for an armistice.

In the campaign of 1806 Savary showed signal daring in the pursuit of the Prussians after the battle of Jena. Early in the next year he received command of a corps, and gained a success at Ostrolenka (Feb. 16, 1807).

After the treaty of Tilsit (July 7, 1807) Savary proceeded to St. Petersburg as ambassador, but was soon replaced. Napoleon needed him in Madrid. With the title of duke of Rovigo, Savary set out for Spain. With Joachim Murat Savary made skilful use of the schisms in the Spanish royal family, and persuaded Charles IV, who had recently abdicated under duress, and his son Ferdinand VII, to refer their claims to Napoleon. Savary induced Ferdinand to cross the Pyrenees and proceed to Bayonne—a step which cost him his crown and his liberty until 1814. In Sept. 1808 Savary accompanied the emperor to the interview at Erfurt with the emperor Alexander. On the disgrace of Joseph Fouché (*q.v.*) in the spring of 1810, Savary received his appointment, the ministry of police. This office now became a veritable inquisition. Savary was among the last to desert the emperor at the time of his abdication (April 11, 1814) and among the first to welcome his return in 1815, when he became inspector general of gendarmerie and a peer of France.

After Waterloo Savary accompanied the emperor to Rochefort and sailed with him to Plymouth. He was not allowed to accompany him to St. Helena, but underwent several months' "internment" at Malta. Finally he was allowed to return to France and regained civic rights. The July revolution (1830) brought him into favour, and in 1831 he received the command of the French army in Algeria. He died at Paris in June 1833.

Bibliography.—*Mémoires du duc de Rovigo*, 4 vol. (1828), English ed. also in 4 vol. (1828), a new French edition annotated by D. Lacroix, 5 vol. (1900); *Extrait des mémoires de M. le duc de Rovigo concernant le catastrophe de M. le duc d'Enghien (1823).*

SAVE or Sava, a river of Yugoslavia and an affluent of the Danube. The Save rises in the Triglav group in Carniola from the Sava Bohinjka and the Sava Dolinka, which join at Radovljica. It then flows through Carniola and Croatia-Slavonia and joins the Danube at Belgrade. The Save has a length of 584 mi., the area of its basin being 36.957 sq.mi. It is navigable for river steamers from Sisak to its mouth. (*See* Danube.)

SAVERNAKE FOREST is a great beech wood covering 5,000 ac. on the chalk downs just south of the market town of Marlborough in Wiltshire, Eng.

From the Norman conquest until 1550 Savernake was a crown forest and a royal hunting ground extending over 20 sq.mi.; later it passed into private ownership. The ancient hereditary office of warden was held from 1083 to 1427 by the Esturmys, and later by the earl of Cardigan, their lineal descendant.

The finest scenic feature is the Grand avenue of lofty beeches which runs for 3 mi. from the main London-Bath road to Tottenham house. The forestry commission assumed responsibility for administering the woodlands. (H. L. En.; X.)

SAVIGNY, FRIEDRICH KARL VON (1779–1861), German legal scholar, one of the originators of the influential historical school of jurisprudence, was born in Frankfurt am Main Feb. 21, 1779. In Savigny's classic words, law "is first developed by custom and popular faith. next by judicial decisions—everywhere. therefore. by internal silently operating powers: not by the arbitrary will of a law-giver." Savigny became a doctor of law at the University of Marburg in 1800 and was one of the first members of the German nobility to teach in a university. He subsequently taught criminal law, Roman law and its history and property and contract law at Marburg and Landshut but spent most of his academic career (1810–42) at the University of Berlin. In 1803 his book on possession, *Das Recht des Besitzes*, was published. Soon thereafter he turned to the historical and jurisprudential interests that dominated the remainder of his career.

The immediate occasion that led him in that direction was the publication of a book, *Civilistiche Abhandlungen*, in 1814, by Anton Thibaut, a professor at Heidelberg, who demanded immediate codification of German law. Thibaut's book reflected the rise of German nationalism after the Napoleonic wars and a reaction against Roman and other foreign law. Savigny vigorously opposed codification in a monograph, *Vom Beruf unserer Zeit fur Gesetzgebung und Rechtswissenschaft* (1814), which gave much impetus to the emerging historical theory of law. Historical jurisprudence viewed law as a slow, almost imperceptible growth. like language.

This jurisprudential perspective was a phase of the romantic movement, which had begun in the latter part of the 18th century, and it took the form in Germany of a movement back to the simplest tribal origins of the German people, to their folk songs and tales and to their distinctive ethos, their *Volksgeist* ("national spirit"). The movement found expression in the philosophy of Johann Gottfried von Herder, the fairy tales of the Grimm brothers and Barthold Niebuhr's Roman history. The national spirit was the ultimate datum to be explored in its various manifestations. From this point of view law is not something that can be made but originates in the unique spirit of the people and is expressed spontaneously in custom and, much later, in the formal decisions of the judges. Accordingly, legislation and codes can, at most, give only verbal expression to existing law the actuality and meaning of which can be discovered by careful historical investigations. Thus, historical jurisprudence opposed not only codification but also natural-law philosophy as illusory and fictitious. Instead of assuming that familiar law was "universal," as Savigny charged was done in natural-law philosophy, historical jurisprudence insisted on thorough research into legal origins and transformations.

While the philosophy of historical jurisprudence was in the 20th century perverted by the Nazis in their glorification of the German *Volk*, it is certain that Savigny would have thoroughly disapproved of racist interpretations. He was a pioneering legal scientist who made lasting contributions to jurisprudence, especially in revealing the continuity of present legal institutions with past ones; in laying the foundations of legal sociology; and in articulating the methods of historical research. These contributions greatly influenced all the social disciplines. (*See* also Jurisprudence, Comparative.)

In 1815, shortly after the appearance of his epochal book, Savigny, Karl Friedrich Eichhorn and Johann Friedrich Ludwig Goschen founded the *Zeitschrift fur geschicktliche Rechtswissenschaft* as the organ of the new historical school. In 1815 also, the first volume of his six-volume treatise on medieval Roman law, *Geschichte des romischen Rechts im Mittelalter*, appeared, the last of which was published in 18.31.

Savigny then devoted himself to an elaborate treatise on modem Roman lam, *System des heutigen romischen Rechts* (8 vol., 1840–49), which contains his theory of private international law and his further study on possession and error. In March 1842 he was appointed high chancellor of Prussia by Frederick William IV and, after carrying out several important reforms especially in regard to bills of exchange and divorce, he resigned in 1848. In 1850 appeared his collected minor works, *Vermischte Schriften*, in 5 volumes, and in 1851–53 he published a book in 2 volumes on contracts *(Das Obligationenrecht)*, a supplement to his work on modern Roman law.

Savigny died in Berlin on Oct. 25, 1861.

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SAVILE, SIR HENRY (1549–1622), warden of Merton college. Oxford, and provost of Eton, was the son of Henry Savile of Bradley, near Halifax, in Yorkshire. He was educated at Brasenose college, Oxford, where he matriculated in 1561 He became a fellow of Merton in 1565, proceeded B.A. in 1566 and M.A. in 1570. He established a reputation as a Greek scholar and mathematician by voluntary lectures on the *Almagest* and in 1575 became junior proctor. In 1578 he traveled on the continent of Europe, where he collected manuscripts. On his return he was named Greek tutor to the queen and in 1535 was established as warden of Merton. He proved a successful and autocratic head under whom the college flourished. A translation of four Books of the Histories of Tacitus, with a learned *Commentary* on *Roman Warfare* in 1591, enhanced his reputation. On May 26. 1596, he obtained the provostship of Eton, the reward of persistent begging. In Feb. 1601 he was put under arrest on suspicion of having been concerned in the rebellion of the earl of Essex. He was soon released and his friendship with the faction of Essex brought him the favour of James 1.

In 1604 Savile was knighted and in that year he was named one of the body of scholars appointed to prepare the authorized version of the Bible He was entrusted with parts of the Gospels, the Acts of the Apostles and the Book of Revelation. His edition of Chrysostom (8 vol., fol. 1610–13) was printed by the king's printer, William Norton, in a private press erected at the expense of Sir Henry, who imported the type. At the same press he published an edition of the *Cyropaediu* in 1618. In 1619 he founded and endowed the Savilian professorships of geometry and astronomy at Oxford. He died at Eton on Feb 19, 1622.

See W. D. Macray, *Annals of the Bodleian Library (1868)*; Sir N. C. Maxwell-Lyte, *History of Eton College,* 3rd ed. *(1899)*.

SAVINGS, NATIONAL. Saving means the setting aside for future use of part of current income—the excess over the amount currently consumed or paid in taxes. Saving may thus be performed by anybody having an income—by an individual, a family or by a business firm.

Because of disagreement as to the sense in which a government body has an income, there is some difference of opinion among economists as to whether or not it is appropriate to say that governments (as distinct from the citizens and businesses under their jurisdiction) carry on saving. Rut whether or not the government is said to save, the nation may he said to save the sum of the amounts saved by the individuals and business firms (plus government bodies if they are considered to have savings) which it includes. Since there are always some individuals and businesses whose current expenses and taxes outrun their incomes. and whose savings are therefore negative, national savings must be thought of as a net total with negative savings subtracted.

Forms Taken by Savings.—Saving is often spoken of loosely as if it mere synonymous with the piling up of savings deposits. or of idle cash. This interpretation is misleading. While it is true by definition that savings are not spent on the consumption of the saver, it does not follow that they are not spent at all; what is saved often is spent. It may be spent directly by the saver or indirectly by business firms he helps to finance, on the purchase of new items being added to the community's stock of wealth, such as new houses or machinery. It may be spent indirectly on the consumption of some other person who borrows or sells property to finance his negative savings. It may help to finance a government deficit, thus supporting whatever spending the government is carrying on, whether for battleships. highways, food to feed the hungry or for routine government expenses.

Part of current savings—sometimes a small part, sometimes a large part—appears in the form of increase in savings deposits and other cash assets held by the individuals or business firms doing the saving. The remainder is represented in their accounts by additions to their holdings of physical property, acquisition of government or private securities, reduction of their debts owed to others, etc.

Savings and Investment.—Under the generally accepted use of terms. it will always be found at the end of any accounting period thst if the revenues and expenditures of government are equal (the budget balanced) and if all government expenditures are on current account, national savings for the period amount to just as much as investment in new buildings, equipment, etc. This is a matter of definition. Saving means the excess of national income over consumption and taxes. Investment is taken to mean the excess of net national product (which is the same thing as national income) over the parts of the product made up of consumption goods and services and items bought by government expenditures.

Since economic progress depends largely on the increase of wealth through investment, it follows also that economic progress is linked with the achievement of national savings. Some increase in production might be possible without any net national savings. through increasing the labour force, finding new ways to use existing equipment and labour. and replscing old equipment and buildings as they wear out *(see* DEPRECIATION) with more modern types.

But to make full use both of the growing labour force and of new methods of production requires a net increase of plant. equipment, etc.; besides this there is always a backlog of opportunities to increase production. with pre-existing methods and labour force, for which more equipment would have been required.

The need of investment and savings to increase production is of course most acute in countries where modern technology has not yet been put into operation and in devastated areas where houses, workshops, transportation equipment, etc., have been destroyed.

This is the meaning of the much-misunderstood doctrine of "abstinence": if there is to be an increase of productive wealth, somewhere in the economic system somebody must abstain from consuming his entire income. It does not necessarily follow that those who abstain from consuming are suffering. On the contrary, insofar as saving is left to individuals. it is performed chiefly by persons with high incomes who both save heavily and consume considerably more than the average.

But for the community as a whole it is impossible both to consume the whole of current income and to build up productive wealth.

It should be observed that these propositions do not prove that economic progress either will or will not be served by an increased inclination to thrift on the part of individuals and business firms. Progress depends on the achievement of substantial investment and therefore of substantial savings. But as John Maynard Keynes pointed out, decisions to save and decisions to invest are taken by different persons operating under different incentives. A decision by one individual to save more, unaccompanied by a decision by him or anybody else to invest more. cannot be guaranteed to increase the volume of saving and investment actually realized; in fact, many economists argue that the effect would be to decrease that volume. This point will be examined further below.

Effect of Government on Savings-Investment Relation.—If the government's revenues and expenditures are unequal, the relation of savings to investment just described is modified. In a period of depression, for example. the tax base shrinks and reduces revenue. while the addition of relief, etc.. to government responsibility increases expenditure. Government is therefore obliged to finance its expenditures in part either by borrowing, by paying out cash on hand or by issuing money. Some savers, consequently. either use their savings to buy government securities. or hold more cash, or have larger balances with banks and other credit institutions while the latter have more cash and government securities. The same is true when a government deficit is incurred for war purposes.

In these circumstances it is no longer true that the net total of savings made by individuals and businesses is equal to the net total invested by individuals and businesses in new productive wealth. Private savings exceed private investment by the amount of the deficit Whether national savings are said to exceed national investment is a matter of language. Some part of government expenditure (used to pay for productive wealth such as hydroelectric dams, roads, needed buildings, recreation facilities) can reasonably be described as investment. Any excess of the deficit over such government investment can be described as negative saving by government, reducing the net total of national savings. This way of using language has the advantage of stressing the fact that when government savings are positive (*i.e.*, when government has an excess of revenue over current expenses, the excess serving to reduce government's net debt and to finance government investment) there can be an increase of the nation's productive wealth in the absence of private saving. It has the drawback, however, of inviting dispute as to the scope and measurement of government activity to be classified as investment (particularly in time of war) and leaving statistical measurements of national savings with a much wider range of possible error than measurements of private savings. See also INVESTMENT, ECONOMIC ASPECTS OF; INVESTMENTS: INDIVIDUAL.

Ways of Estimating Savings.—For an individual there are two ways to measure his savings for a given accounting period. One is to estimate his income and subtract his current expenditure: the difference being his savings. The alternative is to examine his balance sheet (his property and his debtsj at the beginning and end of the period and measure the increase in net worth which reflects his saving. While the figures taken out of the individual's accounts under these two procedures are different, the two are logically equivalent. In either case it is necessary to make sure that we do not include in income (or in the increase of net worth) any items which reflect merely changes in price levels at which pieces of property are valued, or items reflecting events not regarded as linked with income—broadly speaking.. to exclude capital gains and losses (whether realized or "paper") from income. For example, losses due to property destruction by enemy action in wartime, or gains due to a rise of prices on the stock market, would be excluded in income determination. If income is measured by the rules generally adopted by national income statisticians, the result is to exclude not merely the effects of price changes but some actual physical changes—chiefly losses —in wealth. The net total of savings estimated in this way tends to exceed the value of additions to the nation's stock of wealth to the extent that war damage, uninsured fire losses and similar events fail to appear in the income account. On the other hand, it tends to fall short to the extent that new wealth is found (for example through mineral discoveries) or that wealth becomes more useful through new techniques (for example, through the development of dry farming techniques which made previously worthless land take on value).

For national totals, estimates based on changes in national wealth would be too unreliable for use because of the inaccuracy of the reports on which wealth statistics are based. the extraordinary difficulty of allowances for price changes, and other drawbacks. But the general principles just described suggest three other ways of estimating national savings: (1) by estimating investment, with adjustments for government; (2) by estimating income of individuals, personal taxes paid, and consumption expenditures to give savings of individuals by subtraction, with separate estimates for savings of business corporations and of government bodies; and (3) by estimating changes in the various asset and liability accounts of individuals which reflect current savings. with separate estimates for the savings of business corporations and of government bodies. All these methods are in practical use.

War Savings.—Savings under war conditions follow different patterns than in peace. Individuals and businesses set aside a larger proportion of their incomes: so that net private savings grow enormously. On the other hand, private investment is restricted because war needs divert labour and materials from making buildings and equipment for private use. Public construction and acquisition of equipment by government expands, but most of the resulting facilities are either used up in the war or are inconvertible to civilian uses thereafter. The consequence is a great growth in the paper wealth of individuals and business firms (corresponding to the growth of the government's debt) with little or no growth in actual productive wealth.

Not much precise information is available about savings during World War I. Interwar studies reveal that individuals and business firms saved in 1919 a much larger proportion of income than in any year in the 1920s. and that savings in 1920, though declining, were still high. For World War II, comparatively reliable studies made at the time show that the proportion of income saved rose well above peacetime levels during 1941 and continued to rise thereafter. At the peak of war activity, individuals were saving nearly one-third of their disposable incomes (*i.e.*, income payments less personal taxes), and corporations well over one-half of theirs.

The total wartime accumulation by individuals amounted to far more than the income of any single year of the interwar period, and the great bulk took the form of additional currency, bank deposits, government securities and claims upon life insurance companies.

It is probable that the savings of the richer groups of the population made up a much smaller proportion of the war savings than of peacetime savings, bdt the difference must not be exaggerated. About half of the wartime accumulation of individuals and corporations was accounted for by the growth in their holdings of government bonds—more than two-thirds in denominations of $500 and upward—which were not to any great extent small savings. The proportion of the growth in ,bank deposits, currency and insurance claims representing large savers was probably still higher.

Motives for Saving.—Saving is a very complex phenomenon. Different savers save for different reasons, and a given saver for a mixture of reasons. At any given moment: furthermore, many individuals find themselves spending less or more than their incomes simply because their incomes are more or less than was expected when commitments to spend were made. This is true especially for farmers and self-employed business and professional men whose incomes are subject to unexpected fluctuations.

Insofar as saving goes back to decisions to save, the main motives seem to be the following: (1) provision for a future period when income is expected to be less or the need for expenditure greater than at present—for example, provision for retirement, education or vacations; (2) provision against unpredictable decline in income or growth in need—for example, against sickness in the family or loss of earning power by the breadwinner; (3) acquisition of higher income, either by improving the equipment, etc., of a business, or by being housed better or at less expense, or by obtaining interest, dividends, rent or other property income; (4) gain in social status through acquiring property; or (5) direct subjective satisfaction from accumulation ("miser's" instinct). Pulling against these motives, of course, is the desirability of current consumption, and the desirability of having more leisure at the expense of potential income.

This hypothesis about the motives for saving explains the record fairly well. High-income individuals have greater incentives to save than ion-income individuals, for example, because the former are: (1) a group many of whose members are enjoying temporary increase of income and must expect a drop later on; (2) have better opportunities to place savings where they will yield income; (3) are more able to gain power and social approbation by saving and (4) are less hard-pressed to maintain what they regard as necessary standards of consumption and of leisure. Rural people are more inclined to save than urban people of like income because: (1) their incomes are more uncertain; (2) their opportunities to gain income from saving are better and the fruits of their savings, in buildings, livestock, equipment, etc., are. more visible and thus more conducive to improved social standing and direct enjoyment and (3) their standards of consumption and of leisure are less exacting. War savings are higher than peacetime savings because: (1) incomes are regarded as abnormaiiy high and are above immediately previous levels; (2) ordinary outlets for negative savings (retirement of elderly people, education, prolonged vacations and medical treatments) are reduced; (3) incomes are less secure; (4) social pressures to save are intensified and (5) normal standards of consumption and leisure are suspended. The fact that the rising trend of real per capita income did not bring a rising trend in the proportion saved in the prewar and interwar period is explained by: (1) progressive urbanization; (2) rising standards of consumption and leisure; (3) the trend away from private houses and away from direct ownership by individuals of tangible business property (which reduces both opportunities to gain income and opportunities to gain social status and direct satisfaction by increase of property); (4) the downward drift in interest rates and (5) increased importance of some sources of negative savings (in particular the increased stress upon higher education and the increased proportion in the population of elderly people who tend to live on past savings).

See also CAPITAL AND IKTEREST; CONSUMPTION; DEBT, PUBLIC; INCOME: ECONOMIC DEFINITION; NATIONAL IKCOME; SOCIAL SECURITY. (A. G. HT.; X.)

SAVINGS AND LOAN ASSOCIATION, a co-operative savings institution of the type originally established to make loans to members for the purchase of homes. Such associations are also known in the United States as building and loan associations, co-operative banks, homestead societies, building societies and savings associations. The identifying labels nhich promise to become most common are savings and loan associations in the United States and building societies in Great Britain.

UNITED STATES

The modern savings and loan association in the United States resembles a bank, but is differently constituted. The savers purchase shares of stock and are thus owners of the association! not depositors. They receive dividends on their shares in proportion to the profits of the organization. The association is pledged to repurchase the shares bought by savers, after reasonable notice, but invests most of its funds in long-term mortgages. These features have characterized U.S. associations since their origin and have made them highly successful in home mortgage financing. By the early 1960s savings and loan associations held about 38% of the mortgage debt on nonfarm homes in the United States.

Origins and Development. — Savings and credit institutions for noncommercial groups developed in the United States in the first half of the 19th century. The savings and loan associations were, at first, informally organized groups of neighbours or of men in the same industry who pooled their savings to purchase homes. Though there were many plans for saving and borrowing, a common pattern was followed. Each member was committed to make regular payments to a fund. A member could borrow from the fund to purchase a home. His share and his home were the collateral for the loan. The borrowing member would continue his regular payments to the fund and also make interest payments. Both savers and borrowers were penalized by fines and forfeitures if they did not maintain regular payments. The association was not a permanent institution but was created for the period necessary to enable each of the members in turn to purchase homes. By the end of the 19th century these small neighbourly associations were replaced by permanent institutions which had members who were not saving to purchase homes and borrowers who were not members of the association before making their loans.

Savers and Owners. — Associations in the United States may be chartered by the federal or state governments. All federally chartered associations are mutually owned; every saving member is an owner and can vote for the selection of the management. State chartered associations may be mutual or stock associations. If they are stock associations, the savers receive investment certificates which do not carry the right to vote or to claim the residual profits of the association. In all cases the savers are not depositors; as noted above, they do not stand in the same relation to the association as does a saver in a bank. The depositor in the bank is a creditor of the bank; the saver in an association has an ownership right or investment. In practice, since the associations must compete for savings with other institutions, withdrawal requests are usually honoured promptly.

The formal difference of ownership shares as against deposits is of importance. The associations can be less liquid than banks; *i.e.*, more of the assets of the associations can go into long term investments since they are not required to meet every unexpected demand by depositors for their funds. Therefore associations allocate a larger percentage of their assets to mortgages. Compared to other institutions the associations write mortgages for longer periods and their loans are for a larger percentage of the appraised value of the property. Since mortgages of this type are more risky the associations' interest rate is usually higher.

There are many patterns of savings in use. Originally the associations were characterized by forced savings schemes. Individuals were expected to make regular payments to accumulate sufficient funds for the ownership of a stated number of shares. Since there nere many possible plans to accumulate an ownership share, there were several types of shares offered. If individuals did not maintain the payments for the shares the savers might be forced to pay a fine, lose part of their dividends or lose a bonus dividend. Forced savings are no longer popular and the usual form of savings is as flexible as that offered by a savings bank.

Amortized Loans. — The loan repayment provisions of the early associations were the prototype of the amortization plans used in repayment of mortgages in the 20th century. It was the pioneering work of the savings and loan associations that provided the experience for the federal government's policies in the 1930s for the reform of mortgage financing. The association plan, referred to as the direct reduction loan plan, involved a constant payment each month which in successive months would devote a larger percentage of the payment to principal than interest.

The associations generally prefer conventional mortgages to those insured by the Federal Housing administration (FHA) or guaranteed by the Veterans administration (VA) because these mortgages earn a higher interest rate. A higher interest rate gives the associations a higher profit and enables them to pay a higher dividend rate to savers. A higher interest rate is necessary in order to compensate savers for the slightly greater risk of investment in an association.

Local Nature. — The early associations in the United States aere small and local, and this feature of the associations is still important. The federally chartered associations must make most of their loans on property within a 50-mi. radius of the home office. More frequently the associations restrict themselves to a city or a neighbourhood within a city, though they may solicit savings from investors in a much wider area. Area restrictions serve to limit the size of the associations but their growth in the 1950s was nevertheless rapid. The more than 6,200 associations in existence in 1960 represented only a 17% increase over the total number in existence in the year 1900, but during this 60-year period the assets of the associations had increased 100-fold. The assets of the average association increased from approximately $100,000 in 1900 to more than $10,000,000 in 1960. Some associations in the early 1960s had assets exceeding $100,000,000. These associations were no longer small groups of neighbours or fellow workers joined together to provide homes for themselves but had become big business enterprises that extended credit to nonmembers and sought funds from investors over a wide area. Their size and diffusion of ownership meant that government controls were necessary to avoid abuses.

Public Policies.--;\lost state regulations are based on a detailed regulatory code adopted by the legislature which severely restrains the associations' freedom of action. In addition all associations which are members of the Federal Home Loan Bank system are subject to examination according to the detailed regulatory code adopted by the Federal Home Loan Bank board. The major purposes of the regulations are to make certain that an association is complying with its governing charter and that its investments are sound. By 1960 the great majority of all associations were members of the Federal Home Loan Bank system.

Members of the system may receive loans from the Federal Home Loan Bank board.

The Federal Savings and Loan Insurance corporation was established in 1934 to insure savings up to $5.000. In 1952 the ceiling was extended to $10,000. (See also HOUSING: II. Housing in the United States.) (J. Ms.)

GREAT BRITAIN

Building societies in Great Britain perform essentially the same functions as savings and loan associations in the United States. They accept money from the public, pay interest on it. allow it to be withdrawn and, in brief, provide a convenient investment service. They also lend money on the security of a mortgage of freehold or leasehold property. Although the earliest building societies undertook the construction of houses, this function was abandoned about the middle of the 19th century and consequently the name building society has become a misnomer. The term is. however, compulsory by law and although various alternatives have been suggested, none has met with universal acceptance.

History and Development. — In the latter half of the 18th century in Great Britain the artisans of the new machine age were emerging as a social group and, in order to give themselves some measure of self-protection against the misfortunes of life, many of them made regular contributions to sick and burial clubs and friendly societies. It was a similar motive — security — which led to the formation of building societies, and according to S. J. Price, who undertook extensive research on this subject, the earliest society of which any record has been found was established in Birmingham in or before 1775.

The early societies were all "terminating"; that is to say, they were intended to have a limited life. Each member agreed to pay a fixed sum at regular intervals from the establishment of the society until it mas disbanded. From this steady income the society bought a piece of land and built houses one after another until each of the subscribers had been housed. When the cost of the land and all the houses had been met, the society was dissolved.

As time went on societies began to borrow money from people who did not themselves want to buy a house and this accretion of funds enabled the borrowing members to purchase a house with less delay. As a result of this development there was no longer any need to bring each society to an end when all its original members had received an advance, so that gradually the "terminating" societies were replaced by "permanent" societies.

Building societies were first certified under the Friendly Societies acts of 1829 and 1834. Their rapid rise led, in 1836, to a special act which extended the friendly society regulations to them in so far as they were applicable, binding all members of a society by the rules. which were certified by specially appointed officers who gave security. Provision was made for control by a committee of management. The society's property mas vested in trustees empowered to bring and defend actions and to settle disputes by arbitration. Exemptions were given from stamp duty and the usury laws. By 1850 over 2,000 societies were registered in the United Kingdom.

In 1870 a royal commission was appointed to inquire into the working of friendly societies and building societies. As a result, an act was passed in 1874 and this remained the basis of later practice. Under this act the societies became corporate bodies possessing full legal powers corresponding to those of a limited company. The liability of an investing member was limited to the amount actually paid or in arrears on his shares and that of a borrowing member to the amount still payable under the terms of his mortgage.

The assets of the movement in 1890 have been estimated at £51,000,000 and from then until 1918 there was a steady but unspectacular growth to £68,000,000. Between 1919 and 1939 and again after 1945 there was an immense expansion of activity so that by the end of 1961 the total assets were more than £3,400,000.000.

Organization and Control. — Apart from statutory control, building societies are governed by their own rules. Management is vested in a small body, usually consisting of between 5 and 12 persons and termed the board of directors The directors are elected by the members in general meeting. The chief official is usually called either the general manager or the secretary.

The rules deal with such matters as the rights of members, the duties and powers of directors and officers, the holding of meetings of members and the method of voting. They also regulate the society's borrowing powers, the way in which shares are to be issued. how withdrawals are to be paid and upon what conditions advances may be granted and repaid.

Building societies are under the supervision of the chief registrar of friendly societies, who is, by virtue of office, also registrar of building societies. This official has a number of powers and duties derived from the Building Societies acts. He registers new societies, approves their names. examines their rules and receives from each society an annual report which is open for inspection by the public. The report consists of a list of names of the directors and officers. together with the society's accounts in great detail. A new society may not advertise for funds until the registrar gives it permission to do so. If the registrar considers it expedient he may, with the consent of the treasury, control and prohibit advertising and even prevent a society from accepting new investments from the public. Each year the registrar prepares a report on building societies which is submitted to parliament. The movement is nationally represented by the Building Societies association (founded in 1869).

Investment. — Building societies issue shares although they do not have a fixed share capital and do not offer shares for sale or purchase on the stock exchange. In a leading building society case, Lord Dunedin referred to the "so-called shares" of a building society and added that, though the word was the same, there was nothing more than a faint analogy between them and the shares of a joint-stock company. Building society shares are commonly called "paid-up shares" and the denominations vary from one society to another.

Some societies operate savings accounts under which the saver undertakes to pay a meekly or monthly amount over a period of time until he has accumulated the amount of a fully paid share. and societies often offer a higher rate of interest to encourage this type of regular saving.

There is no legal limit to the total amount of shares that a society may issue or to the number of shares that can be held by one person. In practice, however, nearly all societies impose a limit of £5,000 on the holding of any one member — husband and wife being regarded as one for this purpose. This limitation is due to sperial income tax arrangements with the board of inland revenue by which the income tax due on interest received from a building society is paid by the society. The arrangements do not cover surtax, which is paid by the investor on the gross equivalent (at the standard rate) and not on the amount of interest actually received. The tax paid by a society on behalf of investors who are individuals is computed at a special "composite" rate, This rate is fixed by reference to the proportionate amounts invested in building societies by (1) persons liable to tax at the standard rate; (2) persons liable at a reduced rate; and (3) persons not liable to pay any income tax. In genera!, interest on shares held by a limited company or other corporate body is liable to tax at the standard rate, as is interest on a holding of more than £5.000 by a private person.

Interest on shares is paid every half year or year either by warrant or by addition to the shareholder's account with the society. Some societies calculate interest by the day and some by the month. The length of notice required and the conditions on which withdrawals are to be paid are governed by the rules of the society. In practice most societies pay withdrawals at a month's notice. waiving even that period where the amount is small or the money is urgently required.

The Building Societies acts enable a society to include in its rules the power to borrow money either from an individual or from a corporate body. Such loans are known as deposits. The depositor is a creditor of the society and therefore entitled to priority of repayment over all the shareholders and his rate of interest is normally lower. The income tax arrangements for deposits are the same as for shares. A depositor is not a member and therefore has no voting rights. The act of 1874 limits the amount a society may take on deposit to two-thirds of the amount due on mortgages. By law, deposits cannot be accepted on terms of less than one month's notice for withdrawal, although in practice if the depositor requires his money urgently such notice is often waived by the society. In general, the larger the amount of the deposit, the longer is the notice required.

Mortgages. — Building societies can lend money only on the security of a first mortgage of freehold or leasehold property. In consideration of the advance which the society makes. the borrower charges his property to the society as security until the loan has been repaid. This is effected by means of a mortgage deed, on which stamp duty is payable according to the amount of the loan. The borrower becomes a member of the society and subject to its rules.

As a general rule societies lend their funds mainly on the security of private dwelling houses purchased for owner occupation. Some societies occasionally make loans on blocks of flats. commercial or industrial premises and farms, but the total value of such loans in any year is strictly regulated by the Building Societies act, 1960.. Many societies make loans on shops which have living accommodation.

Within the framework of the society's general lending policy the amount of the loan will be related to the value of the property, its suitability as security, the standing and reliability of the borrower and the value of any authorized additional security. The deeds of the property are retained by the society until the mortgage has been repaid.

The rate of interest charged on a mortgage loan is determined by various factors, which include the general level of interest rates. the rates paid by the society to investors. the composite rate of income tax and the level of management expenses. Interest is paid to the society without the deduction of tax, but a borrower obtains an allowance against his liability to income tax in respect of the interest paid.

The bulk of repayments are monthly, by a fixed sum from which the interest for the month is appropriated and the balance applied in reduction of the outstanding principal. Most societies calculate interest on an annual basis.

If a borrower should default in his repayments, the society can sue him on his personal covenant either for the principal debt outstanding or for the amount of subscriptions in arrears. Alternatively, the society can proceed against the property by taking possession, by appointing a receiver of the rents or by selling it.

When the mortgage debt has been fully repaid, the society will endorse the mortgage deed with a statutory vacating receipt. This receipt. which is sealed by the society, acknowledges payment of all money due under the deed. The mortgage deed together with the title deeds are then returned to the mortgagor.

Under the House Purchase and Housing act, 1959, the registrar of building societies was empowered to "designate" certain societies which means that investments with them are trustee investments.

Economic and Social Aspects. — The building society movement in the range of its membership and the magnitude of its financial resources touches the life of the country at many points.

From 1919 onward building societies in Great Britain attracted large sums. mainly from the smaller investors, because they offered security, a reasonable rate of interest, prompt withdrawal facilities and freedom from income tax deduction. Despite the unemployment of the interwar years, wage earners in general nere better off than in 1914. Many workers had a margin of income which gave them an opportunity to save and the "small savings" institutions, including building societies, benefited. During the years of full employment and comprehensive social insurance which succeeded World War II. the margin for saving increased even further and the share of that saving which went to building societies is shown by the fact that in 1946 total investments stood at £809,828,000, while by the end of 1961 they had exceeded £3,100,000,000.

The complementary function of building societies is the promotion of home ownership. After World War I the nation became aware of an acute housing shortage and the government gave direct encouragement to building. Between 1919 and March 1940 some 4,000,000 houses were built in England and Wales and of these about 2,500,000 were built by private enterprise without subsidy of any kind. The existence of the building societies' mortgage service made this private enterprise building possible.

Home ownership also expanded after World War II, although under the Labour government, which came into power in 1945, greater encouragement was given to building by local authorities of houses to rent than to private enterprise building. It was not until 1951 nhen the Conservatives took office that legislation was introduced to increase the proportion of private building allowed and to permit council houses to be sold. This gave a great impetus to building societies, and borrowers increased from 1,579,000 in 1951 to nearly 2,425,000 ten years later.

The steady growth in the number of investors and borrowers was accompanied by a gradual reduction in the number of societies, due mainly to the difficulty of the smaller societies in attracting sufficient funds from the public and in maintaining the necessary administrative machinery.

Development Abroad. — The building society idea has spread far and wide. There are societies in many countries of the commonwealth, most of them closely following British practice. In 1831 the building society idea was carried by three Englishmen to the United States, where societies flourish under the name of savings and loan associations. Similar bodies have been established in most countries of Europe and also in parts of Central and South America.

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(C G. HN.)

SAVINGS BANKS. A savings bank is one of the many institutional arrangements that society makes in order to bring together lenders and borrowers of funds. Although it is customarily looked upon as an agency utilized by individuals who wish to accumulate funds for future spending, the savings bank is also a lending institution and could not exist in its present form were it not. It performs an important economic function in its dual capacity of borrowing from individuals who wish to consume less than their income and of lending to others who wish to spend more. It is one of a number of institutions that serve to direct the flow of money income in such a way that a portion of the economic resources of a society are turned from the production of goods for current consumption to the creation of an addition to its total stock of capital. or its wealth.

As an agency of savings the bank facilitates the process by which an individual voluntarily abstains from spending the total of his current income in order to accumulate claims against future income. As a lending agency the savings bank assists individuals or groups who wish to spend more than their current income by promising to spend less than their future income. It is, then, an institution which brings together those who have more than enough for their current needs and those who have less than enough. It performs its economic function by exchanging future and present claims. An individual who makes a savings deposit sells his present claim against income currently produced for a claim which is redeemable at some future date; that is, he exchanges a portion of his current money receipts, which are redeemable in goods and services, for a savings deposit which will be withdrawn and redeemed at some future date. The evidence of the savings depositor's claim is his passbook. An individual or a group that wishes to borrow sells claims against future income —the evidence for which is some kind of a promise to pay—for claims against present income. The consequence of such transactions is the promotion of "real" saving, which is an increase in capital, as distinguished from "money" saving, which can be merely the act of not spending, or of hoarding.

There are other institutions than savings banks which perform a similar economic function in their dual capacity of receiving deposits (*i.e.*, of borrowing) and making loans. The most important of these are the savings departments of commercial banks; building and loan, or savings and loan, associations; insurance companies; investment trusts; and a number of minor (in terms of magnitude of deposits) of savings institutions, such as credit unions and similar co-operative credit organizations, industrial savings plans, and school savings programs. The act of bringing together saver and spender. or lender and borrower, need not be the work of an intermediary agency but the product of a direct relationship—a consideration that is of ever greater concern to savings banks. Individuals aho wish to save may purchase claims against future income directly from those who wish to borrow and will guarantee the redemption of the claims, the evidence of the transactions being a share, bond or other security. It is shown below (Table II) that the proportion of individual saving that is done by the direct purchase of securities is increasing.

History.—Savings banking is the product of two historical forces, one of which operated uniquely to create it alone and the other to create all savings institutions. The development of a liberal economic order, based upon specialization and exchange, presupposed an effective supply of money, in the creation of which all credit institutions participated. Such an order (dating from about 1550) carried with it certain ethical presuppositions concerning the nature of man, among which was the notion that he was capable of looking after himself amid the uncertainties of a market system. Savings banking, then, in addition to being one of the many credit institutions which an exchange economy finds indispensable is also a product of the effort to secure the individual against the caprices of capitalism. Not long in coming was recognition of the fact that if individuals were to be considered self-responsible they must have institutions enabling them to provide for such uncertainties as they might encounter. The original plans for savings banks were more than tinged uith a spirit of benevolence and paternalism emanating from the more fortunate members of the community who wished to help the poor and at the same time relieve themselves of the burden of charity.

In 1610, the Frenchman, Hugues de Lestre, published a treatise in which he urged the establishment of savings institutions for the poor in order that their lot might be bettered and that the rich might avoid the necessity of alms-giving. Seventy-seven years after, the irrepressible Daniel Defoe, finding himself in a debtor's prison, wrote a tract on the wonders that could be wrought by the practice of thrift. To this end, he proposed that the government establish a pension office. If each person in the realm—rich and poor. of all ages—were to pay each year four shillings into a common fund husbanded by the state, they could "forever banish beggary and poverty out of the kingdom." Such a happy state could be purchased for the price of "two pots of beer a month." While the French and English continued to write about savings hanks, elsewhere in Europe they were developing out of the municipal pawnshops, the most famous of which was the Monte de Pieth that for centuries operated in the Italian city states as a savings and loan agency. The eventual product of this development was the municipal savings bank. Almost concurrent was the development of private savings banks in Germany, the first of which began in Hamburg in 1778.

The first savings bank in Britain was founded in 1810 by the Rev. Henry Duncan, pastor of an impoverished flock in Dumfrieshire, Scotland. Duncan, who had been a student of the classical economist, Dugald Stewart, established the "Savings and Friendly Society," the members of which were divided into three classes: ordinary, who made regular deposits; extraordinary. who contributed to a surplus fund out of which premiums were paid to encourage frequent deposits; and honorary members. The bank was not operated for profit, and its officers devoted their time to its governance as a philanthropic service. Penalties were imposed upon those who did not deposit regularly, and ordinary members who wished to withdraw their savings had first to obtain the permission of the "Court of Directors" of the society. Duncan's bank was the origin of the trustee savings banks in the United Kingdom and of the mutual savings banks in America. Its success was soon indisputable, and by 1827 the plan had spread over Scotland, England and Ireland where £15,000,000 had been deposited. Most of these banks were motivated by a mixture of benevolence and economic insight. They soon became subject to governmental regulation, and in 1863 the Trustee Savings Bank act was passed. In 1861 the post office savings bank system was inaugurated, under the auspices of Gladstone, and the trustee banks declined in relative importance.

The origin of savings banking in the United States was quite similar to that in Britain, for the first banks were non-profit institutions founded for charitable purposes. The original bank was the Provident Institution for Savings, of Boston, which received its charter in December 1816. One month earlier, the Philadelphia Saving Fund society began business but was not incorporated until 1819. The Bank for Savings of New York, was incorporated in 1819 by the Society for the Prevention of Pauperism. The founders' roll of American savings banks includes a number of men of some historical importance, such as Condy Raguet, Thomas Eddy, James Savage, and Clement and Alexander Biddle. Out of these early organizations developed the mutual savings banks of America which are still largely confined to their place of origin in the north Atlantic states. Their growth was unexceptional until the decade preceding the Civil War when the number of banks increased from 108 to 300, the number of depositors from 250,000 to 700,000, and total balances from $50,000,000 to $150,000,000. By 1875 this latter figure had risen to $900,000,000 and by 1913 to almost $5,000,000,000—even though the period betneen the close of the Civil War and the turn of the century was one of falling prices.

The success of mutual banks resulted in the creation of additional savings institutions, but the mutual structure was not copied by the new banks, which began in the middle and far western states. These were organizations operated for profit and managed in the interest of the shareholders. Stock savings banks were established, and commercial banks began to accept savings deposits toward the end of the 19th century. Prior to 1913, however, the national banks (see BANKING) did not distinguish between savings, or time, deposits and demand deposits, because there was no legal basis for such a distinction in the National Bank act under which they operated Their acceptance of savings deposits brought them into competition with the mutual, stock and state banks.

When the federal reserve system was established in 1913, a distinction was made between kinds of deposits, and a lower reserve requirement was fixed for time deposits—those which could be withdrawn only after prior notice has been given.

The proliferation of savings plans late in the century brought a demand from many quarters for the institution of a savings system under the control and operation of the post office, and in 1910 the postal savings system was started.

In the entire history of savings banks, the inter-war period was the most eventful. Like other banks they reeled under two, near-fatal, blows. The first of these was the monetary disorder that fell upon almost every nation, in the reckless depreciation of currency and its irresponsible aftermath. The effect was to shake the confidence of the people in the value of money and to evoke a flight from currency to the hoarding of goods. In such circumstances. it is suicidal for an individual to abstain from current consumption in order to accumulate claims against future income, for the claims nhich the bank hands over to him may be worthless. That this nas well realized in Germany—where inflation drove the mark down to one one-billionth of its original value—is evident in the decline of savings bank deposits from 19,700,000,000 gold marks in 1913 to 4,600,000,000 gold marks in 1927. Inflation or the fear of inflation—which ever verges upon the probable in a world of budgetary disorder—will produce a flight from the currency and the disorganization of banking.

The second catastrophe nas the great depression of 1929. Depression, or deflation. produces a movement away from the holding of stocks of goods to the hoarding of money, and as the movement gains momentum these hoards are withdrawn from the banks and held privately. Concurrent with the heavy withdrawal of deposits after 1929 was a substantial decline in the value of bank assets, making it impossible for many banks to meet their obligations to depositors. The failure of thousands of banks created suspicions about the soundness of others until they, too, failed. The crisis reached its climax in the United States when all banks were closed by presidential decree in the spring of 1933 and later re-opened under new conditions. The effect of the depression, particularly in the United States, was to disturb profoundly the confidence of the people in the banking system and to disclose the inadequacy of conventional standards of bank management. It demonstrated that even the most scrupulous practices in maintaining required reserves and holding only prescribed investments did not render a bank capable of meeting all of its obligations when all depositors demanded payment and when earning assets were shrinking in value.

In the course of some 130 years both the purpose and practice of savings banking have changed drastically, and in these changes are reflected the changing character of individual saving habits. The banks are no longer benevolent institutions created by the wealthier members of the community for the succor of their less fortunate fellow citizens. They are avowed profit-making enterprises. as in the case of commercial banks engaging in the savings deposit business, or co-operative agencies, or public institutions operated by local or national governments. In the eastern United States uhere mutual savings banks still flourish, their early overtones of philanthropy and paternalism have passed away. Savings bank practices have also changed. Originally the monies received from depositors were invested in government securities, which were long in maturing, comparatively safe and bore a low rate of interest. Today savings deposits are invested as well in the securities of private enterprises, and, in the case of commercial banks in the federal reserve system and of most state banks, they may be loaned out for short periods to businessmen. That banking law now permits deposits to be invested in more venturesome enterprises, which while more profitable are more risky, is more important than that most banks now hold a large proportion of their earning assets in the form of government securities.

A stable postwar world, with a great demand for capital, can repeat the experience of the period following World War I when banks eagerly sought after deposits and offered numerous inducements to save. Not only was the rate of interest on savings deposits then incredibly high (when compared to what the founders of savings banking thought desirable) but the banks sought out custom by establishing financial services for their depositors. Since the beginning of the 20th century savings banks have encountered mounting competition from other outlets for individual savings, such as insurance companies, postal savings banks, investment trusts, co-operative agencies, and, greatest of all. from governments seeking to borrow from individuals. Finally, it should be noted that changes in the savings habits of individuals have lessened the permanence of their deposits. Studies made of the decade from 1930 to 1940 disclose that in the United States the majority of deposits were made, not as security against misfortune and old age, but for future spending anticipated with a considerable degree of certainty. with the consequence that the rate of turnover of deposits is antithetical to what were once conceived to be proper savings practices. In one important American bank—believed to be representative of many others—three-fourths of all savings deposits were withdrawn before they were five years old. It has also been discovered that in this decade the amount by which savings deposits increased was only a little greater than the amount of interest earned on the principal, which indicates, in effect, that individual savings deposits contributed in this period virtually none of the funds used in the formation of capital in the United States

All of these changes are symptomatic of the changing character of individual savings. The causes which once compelled an individual to lay aside funds for a rainy day have either disappeared or have found a different expression. The uncertainty that once haunted members of western, industrial society has become less terrible as governments have assumed the responsibility of looking after the jobless, the aged and the infirm—a development that is signalized by social security legislation and the socializing of charity. Moreover, those individuals who are able to invest against misfortune have alternative methods of doing it, such as purchasing insurance policies or, simply. securities of enterprises or governments. Savings deposits are still useful for accumulating funds for large expenditures—as for education and travel—but even for this purpose they are not as essential as they once were. The development of mass credit institutions—installment selling, small loan agencies, and the like—has diminished the necessity of saving to spend. Finally, the very notion of thrift has lost much of its enticement, because the contemporary man discounts the future at an inordinately high rate. He is a victim of what Adam Smith called "the passion for present enjoyment," and is refractory to the very instinct which Smith believed would redeem him—the desire to save which "comes with us from the womb, and never leaves us till we go into the grave." Not only does thrift no longer keep its high place among the cardinal virtues but is often looked upon as a pernicious practice by many of those very people who were once among its arch-advocates: the economists.

SAVINGS BANKS IN THE UNITED STATES

Savings banks in the United States are of three principal kinds: commercial banks in their savings deposit departments; mutual savings banks; and the postal savings system. In addition. although not banks, savings and loan associations and credit unions receive the savings of the public in savings accounts.

Savings Accounts Trends.—During the 1920s, total savings accounts rose from $17,300,000,000 to $34,600,000,000, an increase of over $1,700,000,000 per year. About two-thirds of this increase was in time deposits at commercial banks and savings deposits in mutual savings banks. During the 1930s, because of sharp declines during the depression years, total accumulations in savings accounts fell off $2,700,000,000. The sharpest drop relatively was in savings capital of savings and loan associations. followed by the decline in time deposits at commercial banks. Time deposits in mutual savings banks showed a steady rise during these years except in 1932 and 1933, and postal savings rose sharply during the depression years. During the 1940s, total holdings of savings accounts much more than doubled, reaching $73,100,000,000 in 1950. Particularly large savings were accumulated during the World War II period and the first three postwar years. The average annual increase in total savings accounts in this decade was $4,100,000,000 per year. In the five year. 1951 through 19jj there was a further marked increase in total holdings of savings accounts to an aggregate at the end of 1955 of $110,800,000,000. The average accumulation of funds in savings accounts during these five years was $7,500,000,000 per year.

At the end of 1955, time deposits in commercial banks constituted the largest aggregate of savings accounts or accumulated "over-the-counter" savings of any set of financial institutions in the United States. As indicated in Table I. savings accounts in commercial banks then totalled $46,000,000,000. Total savings capital in all savings and loan associations amounted to $32,300,000,000. Total time deposits in all mutual savings banks aggregated $28,200,000,000.

Total holdings of savings accounts. chiefly by individuals, are shown in Table I for selected years from 1920 through 1955.

In the early 1950s, time deposits in commercial hanks and time deposits in mutual savings banks lagged behind savings accounts in savings and loan associations in terms of rate of increase. In dollars, the increase in savings capital at all savings and loan associations from 1950 to 195j almost equalled the increase in savings accounts at the other four sets of institutions. In percentage terms. time deposits in commercial banks rose almost 33%, and time deposits at all mutual savings banks rose over 40%. During the same span of time total savings accounts at all savings and loan associations rose about 130%. Thus. during this period savings balances in savings and loan associations showed phenomenal

TABLE I.—*Holdings of Savings Accounts in Banks and Savings Institutions, December 31, 1920–1955*
(In billions of dollars)

Years	Commercial banks	Mutual savings banks	Postal savings	Savings and loan associations	Credit unions	Total savings accounts
1920	$10.5	$4.8	$0.2	$1.7	*	$17.3
1930	18.6	9.4	0.3	6.3	*	34.6
1940	15.4	10.6	1.3	4.3	$0.2	31.9
1950	35.2	20.0	3.0	14.0	0.9	73.1
1955	46.0	28.2	2.0	32.3	2.4	110.8

*Less than $50,000,000

Data shown are time deposits of individuals, partnerships and corporations for commercial banks and mutual savings banks; total savings capital, including savings accounts, deposits, and investment securities, for savings and loan associations; total amounts due depositors for postal savings; and share capital and members' deposits for credit unions.

Source: Federal Home Loan Bank Board.

gains, while the increases in savings deposits in commercial banks and mutual savings banks were more moderate. Postal savings deposits declined from a peak in 1947. Credit unions showed a large percentage increase.

Commercial Banks.—Time deposits in commercial banks, most of which are savings deposits, comprise a significant portion of total deposits of these institutions. On Dec. 31, 1955, time deposits, other than interbank, in all commercial banks aggregated $48,500,000,000, about 25.7% of their total deposits, which amounted to $188,300,000,000. Over the years, as shown in Table II, time deposits in commercial banks have increased substantially in amount.

During World War II, time deposits declined relatively from about one-fourth of total deposits in all commercial banks to about one-fifth. In the postwar period, however, time deposits have risen faster than other deposits. In the early 1950s time deposits other than interbank in all commercial banks rose 32.8%, whereas demand deposits and interbank deposits went up 17.7%. As a result, time deposits have again risen to their pre-World War II relationship to total deposits in commercial banks.

Wide differences exist among individual commercial banks in the importance of time and savings deposits in their deposit structure. In 1954, out of the total of 6,609 member banks of the federal reserve system, 1,311 had a ratio of time deposits to total deposits of 50% and over. Member banks numbering 2,696 had a ratio between 25% and 50%, and 2,602 member banks had a ratio under 25%, including 263 member banks with no time deposits. There were significant differences among these groups of banks, of course, in the role of interest on time deposits in disposition of total earnings, varying from 21.3% to 14.0% to 4.5%, respectively. Some large, medium-sized and small institutions fell into each of the three classes.

By reserve classification, the New York central reserve city member banks had in 1954 a ratio of time deposits to total deposits of 12.7%, and the Chicago (Ill.) central reserve city member banks a ratio of 17.1%. Corresponding ratios were 26.0% for reserve city member banks, 32.6% for country member banks, and 35.4% for insured commercial banks not members of the federal reserve system. Among federal reserve districts, the ratio of time deposits to total deposits was highest in the Philadelphia and New York districts and lowest in the Dallas and Kansas City districts.

A national bank is permitted to make mortgage loans equal in the aggregate to its unimpaired capital and surplus or to 60% of its time and savings deposits, whichever is the greater. These limitations as to aggregate mortgage loans, however, do not apply to Veterans Administration (VA)-guaranteed loans. State banks are generally subject to much the same general type of limitations that govern national banks, with variations according to the laws of each individual state. Total mortgage loans held by all commercial banks on Dec. 31, 1955 amounted to $21,100,000,000, about 43% of their total time deposits. This ratio rose after 1940, there being 28% in 1940, 16% in 1945 and 38% in 1950, reflecting strong commercial bank participation in mortgage lending.

No member bank of the federal reserve system or insured nonmember bank may pay any interest on any deposit which is payable on demand. Furthermore, the legal minimum and maximum reserve requirements for member banks against time deposits are between 3% and 6%, much less than the ranges of reserve requirements for member banks against demand deposits. Accordingly, in regulations of the board of governors of the federal reserve system, the terms "time deposits" and "savings deposits" are strictly defined. Savings deposits are evidenced by a passbook, and may be accepted only from individuals or nonprofit organizations, with the legal possibility of requiring notice of withdrawal. Furthermore, the board of governors of the federal reserve system, under provisions of the Federal Reserve act, establishes maximum rates that may be paid by member banks on time deposits—$2\frac{1}{2}\%$ after January 1, 1936 on savings deposits. The rate payable by a member bank may not in any event exceed the maximum rate payable by state banks and trust companies on like deposits under the laws of the states in which the member bank is located. The same maximum rates of payment were established for insured nonmember banks by the Federal Deposit Insurance corporation (FDIC), effective Feb. 1, 1936.

Mutual Savings Banks.—Mutual savings banks concentrate on savings deposits and generally accept no commercial or checking accounts. Such banks have no capital stock and are purely mutual organizations. With no shareholders, the mutual savings banks are governed by boards of trustees, most of them self-perpetuating bodies, made up of outstanding business and professional men. Mutual savings banks operate exclusively under state law and state charter and are supervised and examined by the state banking departments in their respective states. Most mutual savings banks are quite old institutions, and many have celebrated their 100th anniversaries.

All the net income of these financial institutions after operating expenses is paid to the depositors as dividends or is allocated to reserves for future losses. In the aggregate, total reserves and surplus of all mutual savings banks was 10.1% of total deposits at the close of 1955. Mutual savings banks pay "dividends" or "interest-dividends" to their depositors, but these have come to be viewed as interest.

At the close of 1955, the mutual savings banks had more than 16,000,000 regular accounts, with an average deposit of $1,742. Such regular accounts comprised $27,900,000,000 of total mutual savings bank deposits of almost $28,200,000,000. There were also about 5,000,000 additional accounts in school savings, club, payroll and other accounts: making a total number of accounts of just over 21,000,000.

Several states place a limit on the maximum amount which any one person or organization may have on deposit in any one savings bank. The laws pertaining to mutual savings banks provide that depositors may be required to give notice (typically 60 or 90 days) as stated in the savings account passbook before withdrawals are paid. In fact, however, savings banks ordinarily meet withdrawals without requiring notice. The ratio of turnover of mutual savings banks has increased over the last several years, as has the ratio of withdrawals to gross inflow of savings, indicating a greater use of mutual savings deposits for short-term purposes.

Fewer than half of the mutual savings banks are insured by the Federal Deposit Insurance corporation, but the insured institutions hold a large proportion of total deposits in mutual savings banks. On June 30, 1955, the 218 mutual savings banks which were members of the FDIC held total deposits of $20,600,000,000, while the 310 such banks which were not members had total deposits of $6,700,000,000. In Massachusetts and Connecticut the mutuals are insured under state insurance funds.

The mutual savings banks have a long history of conservative operation, with emphasis placed on safety and availability of savings entrusted to them, rather than on earning a high rate of dividend. In particular, the savings banks went into the great depression with substantial reserves and strong liquidity positions. "Runs" on mutual savings banks by their depositors were not as drastic as those in commercial banks. As a result, in spite of losses on some investments and mortgages, the savings banks went through the depression without a single failure or liquidation. No mutual savings bank had to go "on notice" or delay the meeting of withdrawal requests, except when all banks were closed during the bank holiday.

As in many types of financial institutions, the deposits or assets of the larger mutual savings banks comprise a large proportion of the total aggregates for all mutual savings banks. On Dec. 31, 1955 there were 100 mutual savings banks with deposits of $65,000,000 or more. Total deposits of these 100 largest mutual savings banks constituted $20,700,000,000 or about 75%, of the total deposits of $28,200,000,000 in all of the 527 mutual savings banks in the United States. The largest bank had deposits just over $1,250,000,000, while five others were over $500,000,000 and 11 others had deposits over $300,000,000. Fifteen mutual savings banks had total deposits from $200,000,000 to $300,000,000 and 3j banks had total deposits from $100,000,000 to $200,000,000. Of the 25 largest mutual savings banks, 18 were in New York city.

Mutual savings banks are in operation in 17 states, but are concentrated in the New England and Middle Atlantic seaboard states. On Dec. 31, 195j. New York mutual savings banks had total deposits of $16,500,000,000. Massachusetts mutual savings banks had total deposits of $4,500,000,000; Connecticut, $1,800,000,000; Pennsylvania, $1,500,000,000; and New Jersey. $1,000,000,000. Other states with mutual savings banks included Maine, New Hampshire. Vermont and Rhode Island in New England, and Delaware and Maryland in the Middle-Atlantic area. Mutual savings banks were also in operation in Ohio, Indiana, Wisconsin and Minnesota in the midwest, and in Washington and Oregon on the Pacific coast.

The investment powers of mutual savings banks are closely prescribed by state laws and by rules and regulations of state supervisory authorities. Investments in securities, for instance, are usually confined to a "legal list" of authorized securities from which the savings banks determine their bond portfolio. Some states limit real estate mortgage investments to 60% to 75% of savings bank deposits.

After World War II the legal investment provisions of various states were changed to enable the mutual savings banks to broaden their investments and so to increase earnings. Particularly important in this respect was the enactment of legislation which permitted mutual savings banks to purchase Federal Housing authority (FHA)-insured and VA-guaranteed mortgages without reference to the location of the residential property against which such loans had been made. New York passed such legislation for FHA-insured mortgages in 1948 and for VA-guaranteed mortgages in 1951. These laws provided substantially enlarged outlets for investment in mortgages, particularly by the large metropolitan savings banks, and gave rise to much greater marketability of FHA-insured and VA-guaranteed mortgage loans over the nation. In 1953 a New York law also permitted a savings bank to borrow funds for purposes other than paying depositors up to 5% of its assets. This measure was adopted to help savings banks meet varying mortgage commitments without having to sell securities. During the postwar period, the majority of mutual savings banks states legalized the purchase of some type of equity securities having an adequate earnings and dividend record and within certain restrictions in relation to surplus and assets. In certain states mutual savings banks were permitted to invest in large-scale housing developments.

Over the years the distribution of the earning asset portfolios of mutual savings banks among various classes of loans and investments shifted greatly. depending on rates of return available on the different types of legal investments, changes in risk characteristics and relative supplies available of the various classes of investments. In 1929 real estate mortgages comprised about 60%, and railroad. public utility and state and municipal bonds about 30% of total assets of all mutual savings banks. During the depression and the late 1930s, mortgage and corporate and municipal bondholdings declined both absolutely and relatively. and savings hanks substantially expanded their holdings of C.S. government bonds. On Dec. 31, 1940, as Table II indicates, mortgage loans comprised 42%, United States government obligations. 26%, and other securities 16% of total assets. During World War II and the first two years in the postwar period. the proceeds of the net increase in mutual savings bank deposits and some further reduction in holdings of mortgage loans and other securities were invested in U.S. government securities. At the peak in 1947, holdings of U.S. government obligations exceeded $12,000,000,000 and comprised over 60% of total assets of all mutual savings banks. Since then major emphasis has been placed upon real estate mortgages through investment of the proceeds both of net increases in savings deposits and of reduced holdings of United States government obligations.

On Dec. 31, 1955, total assets of all mutual savings banks stood at $31,300,000,000; total deposits at $28,100,000,000; and total reserves and surplus at $2,800,000,000. Mortgage loans held totalled $17,500,000,000; U.S. government obligations. $8,500,000,000; and other securities. $4,000,000,000. Included in this latter category were investments in corporate stocks, primarily bank stocks and preferred stocks. amounting to about $650,000,000. Mortgage loans exceeded 55% of total assets, the highest proportion since the late 1920s, and U.S. government obligations comprised only 27%, the lowest since 1940. Of the mortgage loans, $15,600,000,000 was residential. with $5,800,000,000 in VA-guaranteed mortgages, $4,200,000,000 in FHA-insured mortgages, and $5,600,000,000 in conventional mortgage loans. Nonfarm nonresidential mortgages totalled $1,800,000,000.

A special service offered by several mutual savings banks in Massachusetts. New York and Connecticut is savings bank life insurance, sold over-the-counter to reduce sales costs, in limited amounts which average less than $2,000. At the start of 1956, $856,000,000 of such life insurance was in force: and almost 700,000 policies had been issued.

Postal Savings System.— The postal savings system was authorized by congress in 1910. It was established partly as an aftermath to the panic of 1907 and partly to attract deposits from those who lacked confidence in usual banking institutions and from the many immigrants in those times who frequently sent their savings to institutions in Europe. Over the years, both before and after its founding, the postal savings system met vigorous opposition from banking circles as an unwarranted duplication of private facilities.

The U.S. government is solemnly pledged to the payment of postal savings deposits. Accounts may be opened and deposits made by any competent individual person over 10 years of age. Deposits with the postal savings system are evidenced by certificates issued in denominations from $1 through $500. No depositor may have to his credit more than $2,500, exclusive of accumulated interest. The depositor may at any time withdraw all or any part of his deposits, with any interest payable thereon, from the post office where the deposits were made.

Postal savings deposits earn interest at the rate of 2% a year. except in Mississippi, where the rate in 1954 was 1½%. The general rate of 2% has been in effect ever since the establishment of the postal savings system. Until recent years, only simple interest was paid. Interest has been compounded annually, however, on deposits represented by postal savings certificates issued on or after Sept. 1. 1954. The assets of the postal savings system are invested mainly in U.S. government obligations. although funds may also be redeposited in local banks at a required rate of 2½%.

Until 1930, growth of the postal savings system was limited, partly because the banks paid much higher rates than 2%, and total postal savings due depositors amounted to only $169,000,000 at the end of 1929. With the bank failures during the early 1930s, however, people withdrew savings from commercial banks and put them in postal savings deposits. By the end of 1933 the postal savings system had grown to $1,229,000,000, eight times its size before the great depression.

Then followed several years of little change in postal savings. and amounts due depositors totalled $1,315,000,000 at the end of 1939. During World War II. as a part of the general upsurge in savings at that time, and continuing in the early postwar period. the postal savings system experienced another period of rapid growth. reaching a high point of $3,523,000,000 late in 1947. Postal savings then declined. in part under the impact of vigorous competition from savings and loan associations and banks. The total amount due depositors by the postal savings system was just under $2,000,000,000 in Dec. 1955.

Savings and Loan Associations. — The most striking development in "over-the-counter" savings in the United States after World War II was the phenomenal growth of savings and loan associations. Total savings capital at these institutions rose from $7,400,000,000 at the end of 1945 to $14,000,000,000 in 1950 to $32,300,000,000 at the end of 1955. The increase during 1955 was just under $5,000,000,000 as compared with corresponding increases in time deposits at all mutual savings banks of $1,900,000,000 and at all commercial banks of $1,300,000,000.

Savings accounts in savings and loan associations are most commonly evidenced by a passbook. Ordinarily they are payable on demand but written notice of withdrawal may be required. They are not deposits, in a legal sense, and the return on them is called dividends, not interest. In 1955 at all savings and loan associations, withdrawals totalled $8,700,000,000 and gross inflow of new savings capital was $13,700,000,000 making the net inflow of savings just under $5,000,000,000.

TABLE II —*Assets, Liabilities and Capital Accounts for All Commercial Bunks, Mutual Sailings Banks, Postal Savings System and Savings and Loan Associations*
(In billions of dollars)

	Dec. 31, 1940	Dec. 31, 1945	Dec. 31, 1950	Dec. 31, 1955
All Commercial Banks				
Assets				
Cash assets	27.1	34.8	40.3	44.0
Real estate loans	4.6	4.8	13.7	21.1
Other loans	14.2	21.3	38.5	61.7
U.S. government obligations	17.8	90.6	62.0	61.8
Othersecurities.	7.4	7.3	12.4	16.5
Other assets	1.9	1.5	2.0	3.0
Total assets	73.0	160.3	168.9	208.1
Liabiiities and Capital Accounts				
Interbank deposits	10.9	14.1	14.0	15.6
Other demand deposits	38.6	105.9	104.7	124.2
Other time deposits	15.8	30.2	36.5	48.5
Other liabilities	.7	1.1	2.1	4.4
Total capital accounts	7.0	9.0	11.6	15.4
Total liabilities and capital accounts	73.0	160.3	168.9	208.1
All Mutual Savings Banks				
Assets				
Cashassets.	1.0	.6	.8	1.0
Mortgage loans	5.0	4.3	8.3	17.5
Other loans	*	*	*	.2
U.S. government obligations	3.2	10.7	10.9	8.5
Othersecurities.	2.1	1.2	2.3	4.0
Otherassets	.7	.2	.1	.1
Total assets	12.0	17.0	22.4	31.3
Liabilities and Capital Accounts				
Interbank deposits	*	*	*	*
Other demand deposits	*	*	*	*
Other time deposits	10.7	15.4	20.0	28.2
Other liabilities	*	*	.1	.3
Total surplus and reserves	1.3	1.6	2.3	2.8
Total liabilities and capital accounts	12.0	17.0	22.4	31.3
Postal Savings System				
Assets				
Cash assets	.1	.2	.1	.1
U.S. government obligations	1.2	2.8	2.9	1.9
Total assets	1.3	3.0	3.0	2.0
Liabilities				
Depositors' balances	1.3	2.9	2.9	1.9
Otherliabilities	*	.1	.1	.1
Total liabilities	1.3	3.0	3.0	2.0
All Savings and Loan Associations				
~~Assets~~ -				
Cash assets	.3	.5	.9	2.1
First mortgage loans	4.4	5.5	13.7	31.6
Other loans	.1	*	.2	.5
U.S government obligations	.1	2.4	1.5	2.4
Other assets	.8	.3	.6	1.3
Total assets	5.7	8.7	16.9	37.9
Liabilities and Capital Accounts				
Savings capital	4.3	7.4	14.0	32.3
Other liabilities	.9	.7	1.6	3.0
General reserves and undivided profits	.5	.6	1.3	2.6
Total liabilities and capital accounts	i.7	8.7	16.0	17.0

Source: Board of Governors of the Federal Reserve System, National Association of Mutual. Savings Banks and Federal Home Loan Bank Board.

Early in 19jj there were about 6,000 savings and loan associations. of which 4,400 were chartered by states and 1.600 had a federal charter. The state or federal chartering authorities also supervise and examine the associations in the public interest. The Federal Savings and Loan Insurance corporation insures savings accounts up to $10,000 in insured savings associations. including all those with federal charters and about 1,800 state-chartered associations. Total assets of insured institutions comprise about 90% of the combined assets of the entire savings and loan business. The Federal Home Loan Bank system makes advances to member savings and loan institutions to maintain liquidity or to provide funds for mortgage lending. Funds for these purposes are derived in part from deposits received from and capital stock sold to member institutions and in part irom notes sold in the capital markets.

At the end of 1955, as shown in Table II. mortgage loans held by all savings and loan associations totalled $31,600,000,000, about 83% of their total assets. Holdings of cash and U.S. government obligations were $4.500,000,000, about 12% of total assets. Total reserves and undivided profits were $2,600,000,000, about 8% of total savings capital.

More than three-fourths of the mortgage loans held by savings and loan associations are conventional loans, the remainder being VA-guaranteed or FHA-insured. In the early 1950s savings and loan associations undertook about $37\frac{1}{2}$% of total home financing.

Economic Significance. — The gathering together of savings of the public and the investment of these funds by the savings banks and savings institutions is a service to the U.S. economy of the greatest importance. In the capital markets the annual increase in savings accounts is the largest single component of the supply of funds. Likewise, home mortgages, in which much of "over-the-counter" savings are invested. comprise the largest single component, by far. of the demand for funds. Such savings and investment are vital to the progress and growth of the nation.

Accordingly, in the early 1950s there was renewed attention to the economic importance of savings, and particularly to savings deposits and savings accounts. There was also intensified competition among financial institutions for the favour of the public and the opportunity to be entrusted with savings. Nowhere was competition stiffer than among commercial banks. mutual savings banks and savings and loan associations. Competition took several forms. Fundamental. of course, is the seeking of what is deemed fair treatment of net earnings under the federal income tax law. Rivalry was keen in new and attractive office quarters. in range of services offered and in advertising and public relations. Competition was sharp in rate of interest or dividend. At the same time, "over-the-counter" savings were under pressure from alternative forms of saving. such as social security and pension funds and the attractiveness of common stocks. Attitudes toward savings were challenged by inflation, by less cyclical instability in the economy after World War II, and by government welfare programs.

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BRITISH AND EUROPEAN SAVINGS BANKING

The United Kingdom. — The first savings bank was established at Ruthwell. Dumfriesshire, Scot., in 1810. by the parish minister. the Rev. Henry Duncan. From then onward the movement spread through Scotland and England. with the result that in 1817 the first savings bank bill governing these institutions was passed, constituting the first act of its type ever to be adopted by any country (its main regulations are still in force). The principal act is the one of 1954, under which all trustee savings banks are certified.

The popularity of the trustee savings banks quickly spread: by 1859 there were 63j savings banks holding deposits amounting to £39,000,000; by 195j there were 84 separate trustee savings banks with more than 1,320 offices and funds amounting to more than £1,198,000,000.

The trustee savings banks are not conducted for private profit, their sole concern being to offer the most convenient and remunerative method of saving compatible with sound administration and security. They combine the security offered by close connection with the state with the freedom that comes from independent management. The banks are under the direction of bodies of trustees and managers who may not receive any payment for their services. The banks are subject to government supervision and are also inspected on behalf of the Trustee Savings Banks Inspection committee. The funds of the ordinary departments of the banks are invested with the commissioners for the reduction of the national debt. while the funds of the special investment department (where a slightly higher rate of interest is paid) are! with the commissioners' approval, invested in government securities and with municipal authorities.

The British Post Office Savings bank. founded by W. E. Gladstone in 1861as a department of the general post office. has been a model for similar banks in other countries; it works under government guarantee. (*See* POST AND POSTAL SERVICES: *The British Post Office us Banker.*) The amount standing to the credit of the depositors on Dec. 31.1955, was £1,698,652,000. The rate of interest in the post office savings bank is similar to that paid in the ordinary departments of the trustee savings banks, namely $2\frac{1}{2}\%$ per annum; and in both institutions the annual limit of deposit is £500, with a present total limit of £3.000.

The post office and the trustee savings banks, together with the National Savings committee (formed in 1916 to help to finance World War I by the sale of savings certificates) and their counterparts in Scotland and Northern Ireland. form the National Savings movement. which promotes the sale of national savings certificates and encourages deposits in savings banks.

The progress of savings from 1913 to 1955 is indicated in Table III.

TABLE III.—*Savings in the United Kingdom, 1913–1955*

Year	Millions of £ sterling				£ per head	
	In trustee savings banks (Nov. 20)	In post office savings banks (Dec. 31)	Savings certificates* (Dec. 31)	Total	Money value	Real value†
1913	68.5	187.2	—	255.7	6.1	9.5
1924	107.0	280.4	451.4	838.8	18.7	16.7
1934	181.9	354.8	494.3	1,031.0	22.1	24.6
1939	251.7	551.3	540.9	1,343.9	28.0	27.5
1944	526.8	1,492.1	1,716.5	3,735.4	76.4	52.3
1949	856.8	1,948.7	2,143.1	4,948.6	98.2	54.5
1952	953.7	1,813.3	2,233.4	5,000.4	98.8	44.7
1955	1,053.9	1,698.7	2,388.7	5,140.9	—	—

*Including accrued interest. †In terms of the prices of 1938

In addition to the sale of national savings certificates, the savings banks purchase government stocks and bonds, and government life annuities for their depositors. The total amount of stock held on their registers amounted to £124,500,000 in 19jj.

In Scotland there are. moreover, a few savings banks entirely independent of government supervision; and in England there is also the Birmingham Municipal bank, which is somewhat similar to the special investment department of the trustee savings banks but has in addition a house-purchase department. The joint-stock banks also accept savings deposits. while other large savings institutions are the building and co-operative societies.

The chancellor of the exchequer in his 1956 budget speech intimated that interest up to £1j on deposits in the post office savings banks and in the ordinary department of trustee savings banks would be free of income tax for each individual. It was also decided that the total limit of deposit in the special investment department of trustee savings banks would be increased from £1,000 to £2.000. In order further to stimulate savings through the national savings movement the chancellor of the exchequer announced the introduction of new issues of national savings certificates and defense bonds which would carry increased rates of interest. These concessions to depositors and investors through the national savings movement were made for the purpose of increasing savings in order to assist the nation in its fight against inflation.

France.— The first French savings bank was that of Paris, the Caisse d'Épargne de Paris. instituted in 1818. Soon thereafter other savings banks were established at Bordeaux. Rouen, Metz. Marseilles and Nantes, and by the end of 1955 there were 585 savings banks (including those in the countries of the French Union) with 3.785 offices. 12,750,000 depositors and funds amounting to 842,285,000,000 metropolitan francs.

The French savings hanks, like the British trustee savings banks, are controlled by a board of management. the members of which are chosen irom among well-known citizens of the locality. Government permission is required for the establishment of a new savings bank or a new branch office. and the banks are not permitted to encroach upon each other's territories by establishing branch offices in other localities than their own.

The maximum deposit for individual saving is 500.000 metropolitan francs. The funds of the banks are deposited with the Caisse des Dépôts et Consignations, a government institution, which invests them in government securities or in securities guaranteed by the government; in debentures issued by chambers of commerce; with the Crédit Foncier de France; or in French and foreign securities authorized by the minister of finance.

In 1950 an act was passed permitting the savings banks to use part of their deposits to grant credits in accordance with their own judgment to public bodies and institutions, for the purpose, primarily, of stimulating the national economy and the building of low-rent houses.

In addition to the savings banks there is the Caisse Xationale d'Épargne Postale, which is well-established throughout France and is the equivalent of the post office savings bank in the U.K., with deposits at Dec. 31, 19j5, of j59.933.560,000 fr.

German Federal Republic.— The German savings banks (*Sparkassen*) are mostly municipal savings banks. They are common welfare institutions juridically independent. incorporated under the provisions of public law and enjoying the guarantee of the municipalities. These are called "official savings banks"; but there are also a few private savings banks which do not enjoy a municipal guarantee. The legal regulations concerning savings banks are voted separately by each province. Until 194j there were five such juridical zones in Western Germany; viz., I'russia. Bavaria, Württemberg. Baden and Hesse. Through the dissolution of the Prussian state three new provinces, Schleswig-Holstein, Lower Saxony and Xorth Rhine-Westphalia. were created. each having its own savings bank laws. One of the characteristics of the German savings banks is that normal savings activities. the short-term current account and transier deposits *(Giro)* are handled simultaneously.

In 193; after World War II. the German savings banks founded the General League of the Savings Banks and Clearing House association. which has the legal character of a nonincorporated association. to promote the interests of its members. of member regional associations and of clearing houses through advice, assistance, the exchange of' experience. etc.

At Dec. 31.195j, there were 880 separate savings banks in the Federal Republic. with nearly 7,000 branches and agencies and a total of 13,248,000,000 DM. of savings deposited.

The **U.S.S.R.**—The new savings banks in the U.S.S.R. began early in 1923. The principal aim of these hanks. which are state organizations, is to collect the people's available resources by means of deposits or of subscriptions to state loans and to direct these resources to funds necessary lor national economy. The general management of the savings banks and of state credit. which is a section of the ministry of finance. invests the funds of the savings banks. controls their functioning and issues instructions relating to the technique of their operations. The funds of the savings banks are paid into the state savings bank. which invests them in government bonds.

The foundation capital of the savings banks. supplied by the government. was 10,000,000 roubles. The reserve funds are made up irom sums deducted from profits; another part of the net profit goes to the treasury, the remainder to the fund for the improvement of the material condition of the personnel.

At the end of 1950 the total deposits in these savings banks amounted to 17.000,000,000 roubles; the interest paid on deposits amounted to 5% on six months' notice and 6% for other deposits.

Other avenues through which Soviet families may invest their money include state loans: collective deposits with the co-operative banks *(Vsekobunk)*. municipal banks (*Tsekombank*) and rural banks (*Selkhozbank*); and payments to mutual-help associations and to social insurance. (R. T. H. S.)

SAVINKOV, BORIS (pen-name, Ropshin) (1879–1925), Russian revolutionary, joined the socialist-revolutionary party at the beginning of the 20th century and reached a high position in the councils of the party, becoming one of the five members of its "Militant Organization" and thus jointly responsible with the other members of that committee for the planning and execution of numerous terrorist assassinations. During the years immediately preceding 1914 he withdrew from active membership of the party, and in his novel *The White Horse* revealed a deeply pessimistic view of the position of the "intelligentsia" in pre-war Russia. From 1914 onwards he took a strongly pro-war attitude, and after the February 1917 revolution he became Kerensky's able assistant, holding the position of vice-minister for war in the 2nd coalition government of August. He played an equivocal part in the Kornilov affair, and after the Bolshevik revolution devoted himself to anti-Soviet activities. He was caught by the G.P.U. secretly entering Soviet Russia for purposes never clearly elucidated, was brought to trial in Moscow for his anti-Soviet activities, and was sentenced to ten years' imprisonment. He died in prison in 1925.

SAVOFF, MICHAEL (1857–1928), Bulgarian general and statesman, after three years in the Russian Staff academy in St. Petersburg, became a captain in the Bulgarian army when, on the outbreak of war with Serbia, he commanded one wing of the Bulgarian army at their brilliant victory of Slivnitza. In 1887 he was appointed assistant to the minister of war, and in 1891 minister. He resigned in 1897, but after a further period in the army, and as commandant of the military academy at Sofia, he again held the same office in 1902 in Petroff's cabinet. The military law of 1904 was largely due to him. He retired into private life in 1908, but was appointed commander-in-chief of the Bulgarian army during the 1st and 2nd Balkan wars (1912–13). Savoff signed the orders of June 29, 1913, commanding the Bulgarian Fourth army to attack the Greek and Serbian force, thus opening the second Balkan War. For this he was recalled and an enquiry opened which was, however, never concluded; Savoff declared that the order had been given him by King Ferdinand. Although holding no command in R'orld War I, owing to ill health, he strongly urged that Bulgaria join the Central Powers in order to recover Macedonia from Serbia. In Sept. 1918 he returned to Bulgaria from abroad in an attempt to overthrow the Malinoff cabinet, and keep Bulgaria in the war, but found that King Ferdinand had already abdicated. On Oct. 22, 1922, he mas appointed Bulgarian minister in Paris, but retired after the anti-Agrarian *coup d'état* of June 9, 1923. He died on July 22, 1928, at Vallier-de-Thiey, Alpes-Maritimes.

SAVOIE, a *département* of France, formed in 1860 of the old provinces of Haute Savoie, Savoie, the Tarentaise and the Maurienne, which constituted the southern portion of the duchy of Savoy. It is bounded north by the *département* of Haute-Savoie, east and southeast by Italy, southwest by the *département* of Hautes Alpes, and west by those of the Isère and the Ain. Pop. (1954) 252,192; area 2,389 sq.mi. It is mainly made up of the basin of the Isère. Probably the Isère formerly communicated with the Rhône past Chambéry and the Lac du Bourget. The sources of the Isère and of the Arc are separated by the ridge of the Col du l'Iseran (9,173 ft.). The loftiest points are the Grande Casse (12,667 ft.), the culminating summit of the Vanoise group, the Mont Pourri (12,428 ft.), the Pointe de Charbonel (12.306 ft.), the Aiguille de la Grande Sassière (12.323 ft.), the Dent Parrachée (12,083 ft.), the Levanna (11,942 ft.) and the Aiguilles d'Arves (11.529 ft.). A small portion of the department (including both shores of the Lac du Bourget) is in the part of the duchy of Savoy neutralized in 1815. The chief products are cattle and dairy products and wine. There are general inanufactures and tobacco is grown. It is divided into 3 *arrondissements* (Chambéry, the chief town, Albertville and St.-Jean-de-bfaurienne), 29 cantons and 330 communes. It forms the dioceses of Chambdry (an archbishopric), Moutiers-Tarentaise, St.-Jean-de-hlaurienne and Anneçy, it is in the XIVth military region (Lyons), and is in the *académie* (educational division) of Chambéry, where is its court of appeal. There are mineral springs at Aix-les-Bains (*q.v.*), while other sulfur springs rise at Marlioz and at Challes, those of Salins being saline, and those of Brides (the best known after Aix) alkaline. For the history of the district *see* SAVOY, HOUSE OF.

See J. J. Vernier, *Dict. top. du dép. de la* **Savoie** (1897).

SAVONA, a seaport and episcopal see of Liguria, Italy, the capital of the province of Savona, 27 mi. W.S.W. of Genoa by rail, 33 ft. above sea level, and after Genoa and Nice the most important city of the Riviera. Pop. (1957 est.) 69,817, commune. The greater part of the town is now modern with fine streets with porticoes. It is surrounded with green-clad hills and luxuriant orange groves. Near the shore stands the castle built by the Genoese in 1542, on the area of the old cathedral, and now occupied by large ironworks. The cathedral (1589–1604) is a late Renaissance building with a 12th century font, fine choir-stalls and pulpit (1500). In the Cappella Sistina, to the north. stands the finely carved tomb erected by Sixtus IV to his parents. Facing the cathedral is the Della Rovere palace erected by Cardinal Giulio della Rovere (Julius II) from the plans of Giuliano da Sangallo, now occupied by various public buildings, the prefecture. the post-office and law-courts.

The municipal picture gallery is interesting. and there are some fine old buildings in the town. Good majolica was made in the 16th. 17th and 18th centuries. The Teatro Chiabrera was erected in 1853 in honour of the lyric poet Chisbrera (1552–1637). The harbour, dating from 1815, has since 1880 been provided with a dock excavated in the rock, 986 ft. long, 460 ft. wide and 23 ft. deep. Savona is one of the chief seats of the Italian iron industry, having ironworks and foundries, shipbuilding, railway workshops, a railway signal factory. engineering shops, brass foundry, tinplate works, sulphur mills and glassworks. In 1934–36 an average of 4.014 vessels of 4,279,943 tons entered and cleared the port yearly. Most of the goods were imports, almost entirely foreign coal and petrol. The coal imported at Savona is dealt with by an extensive telpherage system. There is a railway through the mountains from Savona to Turin (91 mi. N.N.W.). The city was bombed by the Allies during World War II.

Savona is the ancient *Savo,* a town of the Ingauni, but less important than Vada Sabatia (Vado), 4 mi. to the W., up to which the coast road from Rome was reconstructed in 109 B.C., from which a road diverged across the Apennines to Placentia. In 1191 Savona bought up the territorial claims of the marquesses Del Carretto. Its whole history is that of a long struggle against the preponderance of Genoa. As early as the 12th century the Savonese built themselves a sufficient harbour; but in the 16th century the Genoese, fearing that Francis I of France intended to make it a great seat of Mediterranean trade, rendered it useless by sinking at its mouth vessels filled with large stones.

SAVONAROLA, GIROLAMO (1452–1498), Italian monk and reformer, born at Ferrara on Sept. 21, 1452, was the third child of Michele Savonarola and his wife Elena Bonaccossi of Mantua. Elena was tenderly loved by her famous son, and his letters Prove that she retained his fullest confidence through all the vicissitudes of his career. Girolamo was intended for the medical profession, but even as a boy he had intense pleasure in reading St. Thomas Aquinas and the Arab commentators of Aristotle. was skilled in the subtleties of the schools, wrote verses and studied music and design. To the mystic young student all festivities were repulsive, and although reared in a courtier-household he early asserted his individuality by his contempt for court life. At the age of 19 he was passionately in love with the daughter of a neighbour, a Strozzi exiled from Florence, but his suit was repulsed with disdain and this probably decided his career. He was full of doubt and self-distrust, but in 1474 his doubts were dispelled by a sermon heard at Faenza and he entered the monastery of St. Domenico at Bologna, where his novitiate was marked by a fervour of humility. He passed six quiet years in the convent: but his poems written during that period are expressive of burning indignation against the corruptions of the church.

In 1482 he reluctantly accepted a mission to Ferrara, and later he was sent to the convent of St. Mark in Florence. In 1483 he was Lenten preacher in the church of St. Lorenzo, but his plain, earnest exhortations attracted few hearers. His first success as a preacher was gained at San Gimignano (1484-85), but it was only at Brescia in the following year that his power as an orator was fully revealed. In a sermon on the Apocalypse he shook men's souls by his terrible threats of the wrath to come, and drew tears from their eyes by the tender pathos of his assurances of divine mercy. Soon, at a Dominican council at Reggio, Savonarola had occasion to display his theological learning and subtlety. The famous Pico della Mirandola was particularly impressed by the friar's attainments, and is said to have urged Lorenzo de' Medici to recall him from Lombardy. When Savonarola returned to Florence in 1490, his fame as an orator had gone there before him, and on Aug. 1, 1490, he first preached in the church of St. Mark.

Prior of St. Mark's.—In 1491 he was invited to preach in the cathedral, and his rule over Florence may be said to begin from that date. Lorenzo sent leading citizens to him to urge him to show more respect to the head of the state. Savonarola rejected their advice and foretold the impending deaths of Lorenzo, of the pope and of the king of Naples. In the July of the same year he was elected prior of St. Mark's. As the convent had been rebuilt by Cosimo, and enriched by the bounty of the Medici, it was considered the duty of the new superior to present his homage to Lorenzo. Savonarola, however, refused to conform to the usage. His election was due to God, not Lorenzo. In April 1492, Lorenzo de' Medici was on his death-bed at Careggi. Oppressed by the weight of his sins, he summoned the unyielding prior to shrive his soul. Savonarola reluctantly came and offered absolution upon three conditions. Lorenzo asked in what they consisted. First, "You must repent and feel true faith in God's mercy." Lorenzo assented. Secondly, "You must give up your ill-gotten wealth." This, too, Lorenzo promised, after some hesitation; but upon hearing the third clause, "You must restore the liberties of Florence," Lorenzo turned his face to the wall and made no reply. Savonarola waited a few moments and then went away. And shortly after Lorenzo died unabsolved.

Savonarola's influence now rapidly increased. The same year Innocent VIII. died (July 1492) and men's minds were full of anxiety, an anxiety increased by the scandalous election of Cardinal Borgia to the papal chair. During the delivery of one of his Advent sermons, Savonarola beheld the vision, recorded in contemporary medals and engravings, that is almost a symbol of his doctrine. A hand appeared to him bearing a flaming sword inscribed with the words: "Gladius Domini supra terram cito et velociter." He heard supernatural voices proclaiming mercy to the faithful, vengeance on the guilty, and mighty cries that the wrath of God was at hand. Then the sword bent towards the earth, the sky darkened, thunder pealed, lightning flashed, and the whole world was wasted by famine, bloodshed and pestilence. He was presently addressing enthusiastic congregations at Prato and Bologna whence he returned to Florence. He was rapturously welcomed by the community of St. Mark's, and at once proceeded to re-establish the discipline of the order. For this purpose he obtained, after much difficulty, a papal brief emancipating the Dominicans of St. Mark from the rule of the Lombard vicars of that order. He thus became an independent authority, no longer at the command of distant superiors. He relegated many of the brethren to a quieter retreat outside the city, only retaining in Florence those best fitted to aid in intellectual labour. Meanwhile he thundered forth predictions of heavenly wrath. In 1494 the duke of Milan demanded the aid of France, and King Charles VIII. brought an army across the Alps. The incompetent policy of Piero de' Medici, Lorenzo's successor, towards Charles drove Florence to revolt. But even at this crisis Savonarola's influence was all-powerful, and a bloodless revolution was effected. The resuscitated republic sent a fresh embassy to the French king, to arrange the terms of his reception in Florence. Savonarola was one of the envoys, Charles being known to entertain the greatest veneration for the friar who had so long predicted his coming and declared it to be divinely ordained. Charles entered Florence on Nov. 17, 1494, but the exorbitance of his demands soon showed that he came as a foe. The signory resolved to be rid of their dangerous guest; and, when Charles threatened to sound his trumpets unless the sums exacted were paid, Capponi tore up the treaty in his face and made the memorable reply: "Then we will ring our bells." The monarch, alarmed at the dangerous possibilities of fighting in the narrow streets of the city, accepted moderate terms, and, yielding to Savonarola's remonstrances, left Florence on Nov. 24.

The citizens turned to the patriot monk whose words had freed them of King Charles, and Savonarola became the law-giver of Florence. The first thing done at his instance was to relieve the starving populace within and without the walls; shops were opened to give work to the unemployed; all taxes, especially those weighing on the lower classes, were reduced; the strictest administration of justice was enforced, and all men were exhorted to place their trust in the Lord. And, after much debate as to the constitution of the new republic, Savonarola's influence carried the day in favour of Soderini's proposal of a universal or general government, with a great council on the Venetian plan. Savonarola's programme of the new government was comprised in the following formula: (1) fear of God and purification of manners; (2) promotion of the public welfare in preference to private interests; (3) a general amnesty to political offenders; (4) a council on the Venetian model, but with no doge. At first the new machinery acted well; the public mind was tranquil.

Dictator of Florence.—Without holding any official post in the commonwealth he had created, the prior of St. Mark's was the dictator of Florence, and guarded the public weal with extraordinary political wisdom. At his instance the tyrannical system of arbitrary imposts and so-called voluntary loans was abolished, and replaced by a tax of 10% (la decima) on all real property. His counsels were always given as addenda to the religious exhortations in which he denounced the sins of his country and the pollution of the church, and urged Florence to cast off iniquity and become a truly Christian city, a pattern not only to Rome but to the world at large. His eloquence was now at the flood. Pleasure-loving Florence was completely changed. Abjuring pomps and vanities, its citizens observed the ascetic régime of the cloister. Hymns and psalms rang in the streets that had so recently echoed with Lorenzo's dissolute songs. Both sexes dressed with Puritan plainness; husbands and wives quitted their homes for convents and persons of all ranks—nobles, scholars and artists—renounced the world to assume the Dominican robe. Still more wonderful was Savonarola's influence over children, and their response to his appeals is a proof of the magnetic power of his goodness and purity. He organized the boys of Florence in a species of sacred militia and it was with the aid of these youthful enthusiasts that Savonarola arranged the religious carnival of 1496, when the citizens gave their costliest possessions in alms to the poor, and tonsured monks, crowned with flowers, sang hymns and performed wild dances for the glory of God. In the same spirit, and to point the doctrine of renunciation of worldly enjoyments, he celebrated the carnival of 1497 by the famous "burning of the vanities" (*i.e.* masks and other objects pertaining to the carnival festivities, indecent books and pictures, etc.) in the Piazza della Signoria. Nevertheless the artistic value of the objects consumed has been greatly exaggerated by some writers. Savonarola was foe neither to art nor to learning. On the contrary, so great was his respect for both that, when there was a question of selling the Medici library to pay that family's debts he saved the collection at the expense of the convent purse.

Conflict with the Pope.—Meanwhile his uncompromising spirit roused the hatred of political adversaries as well as of the degraded court of Rome. Even now, when his authority was at its highest, when his fame filled the land, and the vast cathedral and its precincts lacked space for the crowds flocking to hear him, his enemies were secretly preparing his downfall. Events were taking a turn hostile to the prior and Alexander VI., having seen a transcript of one of Savonarola's denunciations of his crimes, resolved to silence this daring preacher.

Bribery was the first weapon employed, and a cardinal's hat was held out as a bait. But Savonarola indignantly spurned the offer. So long as King Charles remained in Italy Alexander's concern for his own safety prevented vigorous measures against the friar, but no Borgia ever forgave an enemy. He bided his time and in July 1495, a papal brief courteously summoned Savonarola to Rome. In terms of equal courtesy the prior declined the invitation, nor did he obey a second less softly worded, in September. Then came a third, threatening Florence with an interdict in case of renewed refusal. 'Savonarola disregarded the command, but went to preach for a while in other Tuscan cities. But in Lent his celebrated sermons upon Amos were delivered in the Duomo, and again he urged the necessity of reforming the church, striving by ingenious arguments to reconcile rebellion against Alexander with unalterable fidelity to the Holy See. Alexander now issued a brief, uniting St. Mark's to a new Tuscan branch of the Dominicans, thus depriving Savonarola of his independent power, while Piero de' Medici's followers continued their intrigues, and party spirit increased in virulence. The citizens were growing weary of the monastic austerities imposed on them, and Alexander foresaw that his revenge was at hand.

A signory openly hostile to Savonarola took office in May, and, in feigned anxiety for the public peace, besought him to suspend his discourses. Shortly afterwards the threatened bull of excommunication was launched against him, and Fra Mariano was in Rome stimulating the pope's wrath. Savonarola remained undaunted. The sentence was null and void, he said. His mission was divinely inspired; and Alexander, elected simoniacally and laden with crimes, was no true pope. Nevertheless the reading of the bull in the Duomo with the appropriate, terrifying ceremonial, made a deep impression on the Florentines. But in July Savonarola's friends were again in power and did their best to have his excommunication removed. During this time Rome was horror-struck by the mysterious murder of the young duke of Gandia, and the bereaved pope mourned his son with the wildest grief. Savonarola wrote him a letter of condolence, boldly urging him to bow to the will of Heaven and repent while there was yet time.

Florence then was plunged in new troubles through Medicean intrigues, and a conspiracy for the restoration of Piero was discovered and resulted in the execution of five leading citizens including Bernardo del Nero, a very aged man of lofty talents and position. It is said that at least Bernardo del Nero would have been spared had Savonarola raised his voice, but the prior would not ask mercy for them. This silence proved fatal to his popularity with moderate men. He was now interdicted from preaching even in his own convent and again summoned to Rome. As before, the mandate was disobeyed. He refrained from public preaching, but held conferences in St. Mark's with large gatherings of his disciples, and defied the interdict on Christmas Day by publicly celebrating mass and heading a procession through the cloisters. In 1498 the Piagnoni, as Savonarola's followers were called, were again at the head of the state, and at their request the prior resumed his sermons in the Duomo, while his dearest disciple, Fra Domenico Buonvicini, filled the pulpit of St. Lorenzo. For the last time the carnival was again kept with strange religious festivities, and some valuable books and works of art were sacrificed in a second bonfire of "vanities." But menacing briefs poured in from Rome, the city itself was threatened with interdict, and the Florentine ambassador could barely obtain a short delay. Now, too, the Piagnoni quitted office; the new signory was less friendly, and the prior was persuaded by his adherents to retire to St. Mark's. Alexander now demanded that the Florentines should silence the man themselves or send him to be judged by a Roman tribunal. Savonarola now despatched letters to the rulers of Europe adjuring them to assemble a council to condemn this antipope. But the papal threats were now urgent, and the signory entreated Savonarola to cease preaching. He obeyed, and concluded his last discourse with the most touching farewell.

The government hoped that Alexander would be appeased and Florence allowed to breathe freely. But although silenced, the prophet was doomed. A creature of the Arrabbiati, a Franciscan friar named Francesco di Puglia, challenged Savonarola to prove the truth of his doctrines by the ordeal of fire. At first the prior treated the provocation with merited contempt, but his too zealous disciple Fra Domenico accepted the challenge and, when the Franciscan declared that he would enter the fire with Savonarola alone, Fra Domenico protested his willingness to enter it with any one in defence of his master's cause. As Savonarola resolutely declined the trial, the Franciscan deputed a convert, one Giuliano dei Rondinelli, to go through the ordeal with Fra Domenico. Savonarola, perceiving that a trap was being laid for him, discountenanced the "experiment" until his calmer judgment was at last overborne by the fanaticism of his followers. On April 7, 1498, an immense throng gathered in the Piazza della Signoria to enjoy the barbarous sight. The Dominicans, led by Savonarola, and the Franciscans came forward, but neither Rondinelli nor Fra Francesco appeared and there were angry disputes between the two groups of friars. It was now late in the day, and a storm shower gave the authorities a pretext for declaring that heaven was against the ordeal. The Franciscans slipped away unobserved, but Savonarola raising the host attempted to lead his monks across the piazza in solemn order as before. On this the popular fury burst forth. Defrauded of their cruel diversion, the people were wild with rage. Fra Girolamo's power was suddenly at an end. Against the real culprits, the Franciscans, no anger was felt; the zealous prior, the prophet and lawgiver of Florence, was made the popular scapegoat. Notwithstanding the anguish that must have filled his heart, the fallen man preserved his dignity and calm. Mounting his own pulpit in St. Mark's he quietly related the events of the day to the faithful assembled in the church, and then withdrew to his cell, while the mob outside clamoured for his blood.

Arrest and Trial.—The next morning the government decided on his arrest, and no sooner was this made public than the populace rushed to the attack of the convent. The monks and their few remaining friends made a most desperate defence. In vain Savonarola besought them to lay down their arms. When the church was finally stormed Savonarola was seen praying at the altar, with Fra Domenico, armed with an enormous candlestick, guarding him from the blows of the mob. A few disciples dragged their beloved master to the inner library and urged him to escape, when a cowardly monk, one Malatesta Sacramoro, cried out that the shepherd should lay down his life for his flock. Thereupon Savonarola turned, bade farewell to the brethren, and, accompanied by the faithful Domenico, quietly surrendered to his enemies. The prisoners were conveyed to the Palazzo Vecchio.

Now came an exultant brief from the pope. His well-beloved Florentines were true sons of the church, but must crown their good deeds by despatching the criminals to Rome. The signory refused to send their prisoners to Rome but they did Rome's behests. Day after day Savonarola was tortured, and in his agony, with a frame weakened by constant austerity and the mental strain of the past months, he made every admission demanded by his tormentors. But directly he was released from the rack he always withdrew the confessions uttered in the delirium of pain. These being too incoherent to serve for a legal report, a false account of the friar's avowals was drawn up and published. Alexander was frantically eager to see his enemy die in Rome. But the signory insisted that the false prophet should suffer death before the Florentines whom he had so long led astray. The matter was finally compromised. A second mock trial was held by two apostolic commissioners specially appointed by the pope. Meanwhile the trial of Brothers Domenico and Silvestro was still in progress. The former remained faithful to his master and himself. No extremity of torture could make him recant or extract a syllable to Savonarola's hurt; he steadfastly repeated his belief in the divinity of the prior's mission. Fra Silvestro on the contrary gave way at mere sight of the rack, and owned himself and his master guilty of every crime laid to their charge.

The two commissioners soon ended their task. They had the pope's orders that Savonarola was to die "even were he a second John the Baptist." On three successive days they "examined" the prior with worse tortures than before. On May 22 sentence of death was pronounced on him and his two disciples. Savonarola listened unmoved to the awful words and then quietly resumed his interrupted devotions. Fra Domenico exulted in the thought of dying by his master's side; Fra Silvestro, on the contrary, raved with despair. The only favour Savonarola craved before death was a short interview with his fellow victims, This the signory unwillingly granted. The memorable meeting took place in the hall of the Cinquecento. During their 40 days of confinement and torture each one had been told that the other had recanted, and the false report of Savonarola's confession had been shown to the two monks. The three were now face to face for the first time. Fra Domenico's loyalty had never wavered, and the weak Silvestro's enthusiasm rekindled at sight of his chief. Savonarola prayed with the two men, gave them his blessing, and exhorted them by the memory of their Saviour's crucifixion to submit meekly to their fate. The following morning he prophesied that dire calamities would befall Florence during the reign of a pope named Clement. The carefully recorded prediction was verified by the siege of 1529.

The execution took place the same morning. First came the ceremonial of degradation. Sacerdotal robes were thrown over the victims, and then roughly stripped off by two Dominicans, the bishop of Vasona and the prior of Sta. Maria Novella. To the bishop's formula, "I separate thee from the church militant and from the church triumphant," Savonarola replied: "That is beyond thy powers." His disciples' bodies already dangled from the arms of the cross before he was hung on the centre beam. Then the pile was fired. At dusk the martyrs' remains were thrown into the Arno.

Every year on the anniversary of Savonarola's martyrdom flowers are strewn on the spot where it took place.

Savonarola's writings may be classed in three categories: — (I) numerous sermons, collected mainly by Lorenzo Violi, one of his most enthusiastic hearers; (2) an immense number of devotional and moral essays and some theological works, of which *Il Trionfo della Croce* is the chief; (3) a few short poems and a political treatise on the government of Florence. Although his faith in the dogmas of the Roman Catholic Church never swerved, his strenuous protests against papal corruptions, his reliance on the Bible as his surest guide, and his intense moral earnestness undoubtedly connect Savonarola with the movement that heralded the Reformation.

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(P. V.; L. V.)

SAVOY, HOUSE OF, a dynasty which ruled the territory of Savoy and Piedmont for nine centuries, and from 1860 to 1946 over the kingdom of Italy. The name of Savoy (Sabaudia) was known to the Romans during the decline of the empire. In the 5th century the territory was conquered by the Burgundians, and formed part of their kingdom; nearly a hundred years later it was occupied by the Franks. It was included in Charlemagne's empire and was divided by him into counties, which evolved there, as elsewhere, into hereditary fiefs; but after the break-up of Charlemagne's empire, the Burgundian kingdom revived and Savoy was again absorbed in it. After the collapse of that monarchy its territories passed to the German kings, and Savoy was divided between the counts of Provence, of Albon, of Gex, of Bresse, of the Genevois. of hlaurienne, the lords of Habsburg, of Zähringen, etc., and several prelates.

Early Counts. — The founder of the house of Savoy was Umberto Biancamano (Humbert the White-handed), a feudal lord, who in 1003 was count of Salmourenc in the Viennois, in 1017 of Nyon on the Lake of Geneva, and in 1024 of the Val d'Aosta on the eastern slope of the Western Alps. In 1034 he obtained part of Maurienne as a reward for helping King Conrad the Salic to make good his claims on Burgundy. He also obtained the counties of Savoy, Belley, part of the Tarantaise, and the Chablais. With these territories Umberto commanded three of the great Alpine passes, *viz.*, the Mont Cenis and the two St. Bernards. His son Oddone married Adelaide, eldest daughter and heiress of Odelrico Manfredi, marquess of Susa, a descendant of Arduino of Ivrea, king of Italy, who ruled over the counties of Turin, Auriate, Asti, Bredulo, Vercelli, etc., corresponding roughly to modern Piedmont and part of Liguria (1045). Umberto died c. 1048? and was succeeded by his son, Amadeus I., at whose death the country passed to Oddone. Oddone ruled over territories on both sides of the Alps. He died in 1060, and was succeeded by his widow, Adelaide; but before her death in 1091 his son, Peter I., became count, and subsequently the latter's brother, Amadeus II.

Under Humbert II. (1080) occurred the first clash with the Piedmontese communes. but he and his successors, Amadeus III. (who died on his way home from the crusades) and Thomas I. (1189), adopted a policy of conciliation towards them.

Thomas, who reigned until 1233. acquired extensions of territory in the Bugey, Vaud and Romont to the west of the Alps, and Carignano, Pinerolo, Moncalieri and Vigone to the east; he also exercised sway over Geneva, Albenga, Savona and Saluzzo. At his death these territories were divided among his sons, Thomas II. obtaining Piedmont, Aimone the Chablais, Peter and Philip other fiefs, and Amadeus IV., the eldest, Savoy and a general overlordship over his brothers' estates. Thomas II., during the wars in Piedmont, was made prisoner by the citizens of Turin, but was afterwards liberated.

Amadeus V. (1285–1323), son of Thomas II., reunited the county of Savoy (his own territory), the principality of Piedmont, ruled by his nephew Philip, prince of Achaea (a title acquired through his wife, Isabella of Villehardouin, heiress of Achaea and the Morea), and Vaud, ruled by his brother Louis. But although this division was formally recognized in 1295. Amadeus succeeded in enforcing his own supremacy over the whole country and in regaining by war, purchase or treaty, the fiefs lost by his predecessors. He fought against the dauphins of Viennois, the counts of Genevois, the people of Sion and Geneva, the marquesses of Saluzzo and Montferrat, and the barons of Faucigny, acted as peacemaker between France and England, accompanied the Emperor Henry VII. of Luxemburg on his expedition to Italy, reorganized the finances of the realm and reinforced the Salic law of succession. He was succeeded by his sons, Edward (1323–1329), known as "the Liberal," on account of his extravagance, and Aimone, the Peaceful (1329–1343), who strove to repair the harm done to the state's exchequer by his predecessor and proved one of the best princes of his line.

Amadeus VI. (1343–1383), son of Aimone, the Peaceful, and known as the *Conte Verde* or Green Count because of the costume he habitually wore at tourneys, succeeded at the age of nine. He won a reputation as a bold knight in the fields of chivalry and inaugurated a new policy by devoting more attention to his Italian possessions than to those on the French side of the Alps and in Switzerland. In 1366 he led an expedition to the East against the Turks; and he arbitrated between Milan and the house of Montferrat (1379), between the Scaligeri and the Visconti, and between Venice and Genoa after the "War of Chioggia" (1381). Amadeus was the first sovereign to introduce a system of gratuitous legal assistance for the poor. He espoused the cause of Louis, duke of Anjou, and while aiding that prince in his attempt to recover the kingdom of Naples he died of the plague, leaving his realm to his son, Amadeus VII., the *Conte Rosso* or "Red Count" (1383–1391); the latter added Nice (1388) and other territories to his domains.

Amadeus VIII. (1391–1451), count, extended his territories both in Savoy itself and in Italy, and in 1416 was created duke by the emperor Sigismund. In 1430 he promulgated a general

GENEALOGICAL TABLE OF THE HOUSE OF SAVOY.

Humbert the Whitehanded (Umberto Biancamano) (d. c. 1048?).

Amadeus . (d. c. 1056). — Oddone or Otto = Adelaide, heiress of Turin (d. 1091)

Peter I. (d. 1078). — Amadeus I . (d. 1080). — Bertha = Emperor Henry IV.

Humbert II. the Fat (d. 1103).

Amadeus III. (d. 1148 or 1149). — Alice or Adelaide = Louis VI. of France.

Humbert III. the Saint (d. 1189).

Thomas I. (d 1233)

Amadeus IV. (d. 1253). — Pete! II., earl of Richmond (d. 1268). — Philip I. (d. 1285). — Thomas II., count of Piedmont (d. 1259). — Boniface, archbishop of Canterbury (d. 1270).

Boniface (d. 1263).

Louis I. of Vaud (d. 1302.) — Amadeus V. the Great (d. 1323). — Thomas III. (d. 1282).

Edward t e Liberal (d. 1329). — Aimone the Peaceful (d. 1343). — Anne = the eastern emperor, Andronicus III. — Philip, prince of Achaea (d. 1334).

Amadeus VI. (d. 1383). — James (d. 1367).

Amadeus VII. (d. 1391). — Amadeus (d. 1402). — Louis (d. 1418).

Amadeus VIII., first duke of Savoy, afterwards Pope Felix V. (d. 1451).

Louis (d. 1465). — Philip, count of Geneva (d. 1444).

Amadeus Ik. (d. 1472). — Philip II. (d. 1497). — Louis, king of Cyprus (d. 1482).

Philibert I. (d. 1482). — Charles I. (d. 1490). — Philibert II. (d. 1504). — Charles III. (d 1553). — Philip, founder of the house of Nemours (d. 1533). — Louise = Charles, count of Angoulême

Charles II. (d. 1496). — Emmanuel Philibert (d. 1580). — Francis I. of France.

Charles Emmanuel I. (d. 1630).

Victor Amadeus I. = Christina, daughter of Henry N. of France (d. 1637). — Thomas Francis, prince of Carignano (d. 1656).

Francis yacinth (d. 1638). — Charles Emmanuel II. (d. 1675). — Emmanuel Philibert (d. 1709). — Eugene Maurice count of Soissons (d. 1673).

Victor Amadeus II. (d. 1732). King of Sardinia, 1720; abdicated 1730 = Anne of Orleans, granddaughter of Charles I. of England. — Victor Amadeus (d. 1741). — Eugene. the famous general (d. 1736).

Charles Emmanuel III. (d. 1773). — Louis Victor (d. 1778).

Victor Amadeus III. (d. 1796). — Victor Amadeus (d. 1780).

Charles Emmanuel (d. 1800).

Charles Emmanuel IV. (d. 1819); abdicated 1802. — Victor Emmanuel I. (d. 1824); abdicated 1821. — Charles Felix (d. 1831). — Charles Albert (d. 1849). King of Sardinia; abdicated 1849.

Victor Emmanuel II. (d. 1878). King of Italy, 1861. — Ferdinand, uke of Genoa (d. 1855).

Humbert (d. 1900), king of Italy = Margherita of Savoy-Genoa. — Amadeus (d. 1890), duke of Aosta. King of Spain, 1870–73. — Clothilde = Prince Napoleon (d. 1891). — Maria Pia (d. 1911) = Louis, king of Portugal. — Margherita = Humbert, (d. 1926) king of Italy. — Thomas, duke of Genoa (d. 1931).

Victor Emmanuel III., king of Italy (d. 1947) = Elena Petrovich-Niegbsh (1873-1952); abdicated 1946. — Emmanuel Philibert, duke of Aosta (d. 1931). — Victor Emmanuel, count of Turin (d. 1946). — Louis Amadeus, duke of the Abruzzi (d. 1933). — Humbert, count of Salemi (d. 1918).

Yolanda Margherita (b. 1901). — Mafalda (b. 1902). — Humbert II (b. 1904) king of Italy = Marie José of Belgium; monarchy terminated 1946. — Giovanna (b. 1907). — Maria (b. 1914). — Amadeus, duke of Aoata (d. 1942). — Aimone, duke of Aosta (d. 1948). — Ferdinand, duke of Genoa (b. 1884). — Philibert, duke of Pistoia (b. 1895). — Maria! Rona Margherita (b. 1896). — Adalbert, duke of Bergamo (b. 1898). — Eugene (b. 1906).

statute of laws for the whole duchy, in spite of the opposition of the nobles and cities whose privileges were thereby curtailed. In 1434 he retired to the hermitage of Ripaille on the Lake of Geneva, but continued to conduct the chief affairs of the State and to mediate between foreign Powers, leaving matters of less importance to his son Louis. Five years later the council of Basel elected Amadeus pope, in spite of his not being a priest, and deposed Eugenius IV. Amadeus accepted the dignity, assuming the style of Felix V. In 1449 Amadeus abdicated and returned to his hermitage at Ripaille, where he died two years later.

15th Century.— Under Louis, Savoy began to decline, for he was indolent, incapable, and ruled by his wife, Anne of Lusignan, daughter of the king of Cyprus, who induced him to fit out an expedition to Cyprus, which brought him no advantage save the barren title of king of Cyprus, Jerusalem and Armenia. He went to France to seek aid of King Louis XI. against his nobles, and died there in 1465. In spite of his incapacity he acquired the city of Freiburg and the homage of the lords of Monaco. He was succeeded by his son, Amadeus IX. (1455–1472), who on account of ill-health left the duchy in the hands of his wife, Yolande, sister of Louis XI. During the minority of his son Philibert I. (1472–1482) Savoy lost Freiburg and many other territories. Philibert was succeeded by his brother Charles I. (1482–1490), who, freed by Louis XI. from the dangerous protection of Philip of Bresse and by death from that of the French king, crushed the rebellious nobles and seized Saluzzo (1487). He did much to raise the fortunes of his house, but died at the age of 31. Under his successors the duchy lost ground until the accession of Emmanuel Philibert in 1553.

Emmanuel Philibert.—At the time of his accession, Emmanuel Philibert was serving in the Spanish armies. Emmanuel could not take possession of the duchy at once, but continued to serve the emperor as governor-general of the Low Countries. By his victory at St. Quentin over the French in 1557 he proved himself one of the first generals of the day, and by the terms of the subsequent treaty of Cateau Cambrésis he was reinstated in most of his hereditary possessions (1559). Under Emmanuel Philibert Savoy lost all traces of constitutional government and became an absolute despotism of the type then predominating throughout the greater part of Europe. At the same time he raised his country from ruin and degradation into a prosperous and powerful monarchy.

Charles **Emmanuel** I.—His son and successor, Charles Emmanuel I. (*q.v.*), surnamed the Great, strengthened the tendency of Savoy to become less of a French and more of an Italian Power. In 1588 he wrested Saluzzo from the French, but his expeditions to Provence and Switzerland were unsuccessful. In the war between France and Spain after the accession of Henry IV., he took the Spanish side, and at the peace of Lyons (1601), although he gave up all his territories beyond the Rhone, his possession of Saluzzo was confirmed. His attempt to capture Geneva by treachery (1602) failed, and although on the death of Francesco Gonzaga, duke of Mantua and Montferrat, he seized the latter city (1612) he was forced by Spain and her allies to relinquish it. The Spaniards invaded the duchy, but after several years of hard fighting the peace of 1618 left his territory almost intact. In 1628 he sided with Spain against France; the armies of the latter overran the duchy. and Charles Emmanuel died in 1630. (See CHARLES EMMANUEL I.) His son, Victor Amadeus I. (1630–1637), succeeded to little more than a title, but by his alliance with France—his wife, Christina, being a daughter of Henry IV.—he managed to regain moat of his territories. He proved a wise and popular ruler, and his early death was much deplored. He was succeeded by his second son, Charles Emmanuel II., who, being a minor, remained under the regency of his mother. That princess, in spite of her French origin, resisted the attempts of France, then dominated by Cardinal Richelieu, to govern Savoy, but her quarrels with her brothers-in-law led to civil war, in which the latter obtained the help of Spain, and Christina that of France. In the end the duchess succeeded in patching up these feuds and saving the dynasty, and in 1648 Charles Emmanuel II. assumed the government. The war between France and Spain continued, and Savoy, on whose territory much of the fighting took place, suffered severely in consequence. By the treaty of the Pyrenees *(1669)* Savoy regained most of the towns occupied by France.

Victor Amadeus 11.—Charles died in *1675* and was succeeded by his only son, Victor Amadeus II. (*q.v.*). The French king's arrogant treatment of Victor Amadeus spurred the latter to join the league of Austria, Spain and Venice against him in *1690.* The campaign was carried on with varying success, but usually to the advantage of Louis, and the French victory at Marsiglia and the conduct of the allies induced Victor to come to terms with France *(1696).* By the treaty of Ryswick a general peace was concluded. In the War of the Spanish Succession *(1700)* Victor fought on the French side, until, dissatisfied with the continued insolence of Louis XIV. and of Philip of Spain, he went to the Austrians in *1704.* The French invaded Piedmont, but were totally defeated at the siege of Turin by Victor Amadeus and Prince Eugene of Savoy (1706), and eventually driven from the country. By the treaty of Utrecht *(1713)* Victor received the long-coveted Montferrat and was made king of Sicily; but in *1718* the powers obliged him to exchange that kingdom for Sardinia, which conferred on the rulers of Savoy and Piedmont the title subsequently borne by them until they assumed that of kings of Italy. In *1730* he abdicated in favour of his son, Charles Emmanuel.

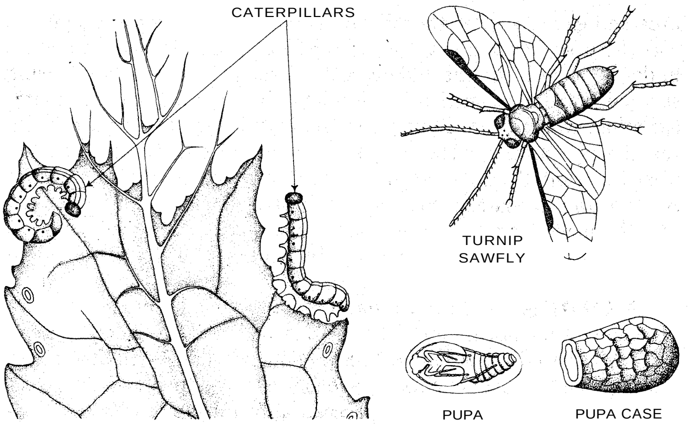
Charles **Emmanuel** 111.—Charles Emmanuel III. (1730–1773), a born soldier, took part in the War of the Polish Succession on the side of France against Austria, and for his victory at Guastalla *(1734)* was awarded the duchy of Milan, which, however, he was forced to relinquish at the peace of Vienna (1736), retaining only Novara and Tortona. In the War of the Austrian Succession, which broke out on the death of the Emperor Charles VI., he took the side of Maria Theresa *(1742).* By the peace of Aix-la-Chapelle in *1748,* following on the defeat of the French, Savoy gained some further accessions of territory in Piedmont. The reign of Charles's son, Victor Amadeus III. (1773–1796), was a period of decadence; the king was incapable and extravagant, and he chose equally incapable ministers. On the outbreak of the French Revolution he sided with the royalists and was eventually brought into conflict with the French republic. The army being demoralized and the treasury empty, the kingdom fell an easy prey to the republican forces. Savoy became a French province, and, although the Piedmontese troops resisted bravely for four years in the face of continual defeats, Victor at last gave up the struggle and signed the armistice of Cherasco. On his death in *1796,* he was succeeded in turn by his three sons, Charles Emmanuel IV., Victor Emmanuel I. and Charles Felix.

Charles **Emmanuel IV.**—Charles Emmanuel (1796–1802), believing in Bonaparte's promises, was induced to enter into a confederation with France and give up the citadel of Turin to the French, which meant the end of his country's independence. Realizing his folly he abdicated on Dec. *6, 1798,* and retired to Sardinia, while the French occupied the whole of Piedmont. After the defeat of the French by the Austro-Russian armies during Bonaparte's absence in Egypt, Charles Emmanuel landed at Leghorn, hoping to regain his kingdom; but Napoleon returned, and by his brilliant victory at Marengo he reaffirmed his position in Italy. The king retired to Naples, abdicated once more (1802), and entered the Society of Jesus; he died in Rome in *1819.* Victor Emmanuel I. *(1802–1820)* remained in Sardinia until by the Final Act of the Congress of Vienna (June *9, 1815)* his dominions were restored to him, with the addition of Genoa.

Italian Allegiance.— From this time the fortunes of the house of Savoy are bound up with those of Italy. *(See* ITALY: ***History.)*** Victor Emmanuel I. abdicated in *1821* in favour of his brother Charles Felix *(1821–1831).* The latter being without a son, the succession devolved upon Charles Albert, of the cadet line of the princes of Carignano, who were descended from Thomas, youngest son of Charles Emmanuel I. Charles Albert abdicated, on the evening of his defeat at Novara (April *20,* 1849), in favour of his son Victor Emmanuel II. (1849–1878), who on Feb. *18, 1861,* was proclaimed king of Italy. Victor Emmanuel had married in *1842* Maria Adelaide, daughter of the archduke Rainer, who bore him several children, viz., Princess Clothilde (1843–1891), who married Prince Napoleon; Humbert (*q.v.*), who succeeded him; Amadeus, duke of Aosta *(1845–1890)*; Oddone, duke of Montferrat *(1846–1866)*; and Princess Maria Pia *(1847–1911).* Humbert was succeeded by his only son, Victor Emmanuel III (*q.v.*), who on May *9, 1946,* abdicated in favour of his only son, Humbert II. On June *2, 1946,* however, the Italian people voted to end the monarchy.

The second son of Victor Emmanuel II, Amadeus, duke of Aosta, was offered the crown of Spain by the Cortes in *1870,* which he accepted, hut, finding that his rule was not popular, he abdicated in *1873* rather than cause civil war. In *1867* he married Princess Maria Vittoria dal Pozzo della Cisterna, who bore him three sons, viz., Emmanuel Philibert, duke of Aosta (1869–1931), Victor Emmanuel, count of Turin, and Louis Amadeus, duke of the Abruzzi *(1873–1933).* The first wife of Amadeus, duke of Aosta, having died in *1876,* he married Princess Maria Letizia Bonaparte in *1888,* who bore him a son, Humbert, count of Salemi *(1889–1918).* (L. V.)

SAWFLY, name given to members of the division Chalasto-



LIFE CYCLE OF **TURNIP** SAWFLY (ATHALIA SPINARUM)

gastra of the order Hymenoptera (*q.v.*), characterized by the broad base to the abdomen, where it joins the thorax and by the wing veins being less reduced than in other members of the order. Their name is derived from the fact that the lower or anterior blades of the ovipositor are toothed and sawlike. Their larvae are usually caterpillars and in most cases may be distinguished from those of moths and butterflies by having six or more pairs of abdominal feet and only a single pair of simple eyes or ocelli. When disturbed they roll themselves in a spiral fashion and some species discharge a thin fluid from glands above the spiracles. The females lay their eggs in incisions in plants, cut by the sawlike blades of the ovipositor, and the larvae are vegetable feeders. Species of several genera, notably *Pontania,* form galls on willows. The cause of the gall is stated to be a secretion injected along with the egg, and it has been suggested that it contains an enzyme which acts upon the plant so as to induce gall formation.

Reproduction in sawflies is of considerable interest: in many species males are unknown and parthenogenesis (*q.v.*) is the rule. In the gooseberry sawfly the unfertilized eggs give rise only to males, where the fertilized eggs produce individuals of both sexes, females predominating.

The true sawflies belong to the large family Tenthredinidae. and the larvae of many of these are injurious to plants. Thus, the gooseberry sawfly, *Nematus ribesii,* is very destructive to that plant and to currants, while the pear slug, *Caliroa limacina,* attacks pears. These two species and also the larch saafly, *Lygaeonetnatus erichsonii,* were accidentally imported from Europe into North America, where they likewise became destructive. Other harmful species in Europe are *Athalia spinarum,* the turnip sawfly, and *Lophyrus pini,* which attacks plantations of Scotch firs. The best remedy is to shake off and destroy the young larvae from bushes, where practicable, or to spray with an arsenical wash.

The small families Cephidae and Siricidae have larvae that are borers. The Cephidae make burrows, usually in stems; the best-known species is *Cephus pygmaeus,* which attacks wheat. It is destructive in North America, where *Janus integer,* the stem girdler of the currant is also troublesome; the latter seldom causes appreciable injury in Great Britain. The Siricidae bore into solid timber and are known as wood wasps or horntails. *Sirex gigas* is the most familiar European wood wasp and is not uncommon in Great Britain. (A. D. I.)

SAWMILL, a mill in which logs are cut into rough-squared sections or into planks and boards for sale or further treatment. The word is often applied to a mill equipped with planing, molding, tenoning and other machines for finishing processes. The biggest mills are usually situated where timber can be brought by river or rail, and the design of the mill is in some degree affected by the mode of transportation. More space is necessary for storage in the rail-borne system. Water-borne logs float into the mill and are dragged out in turn by a winch. An overhead crane serves the stock yard in the rail system, and carries the logs to the machines.

The cutting is performed on various kinds of big machines, a preliminary operation often being that of crosscutting to obtain convenient lengths. Cutting up into the various thicknesses is done by either reciprocating saws or band saws. (known also as circular saws), the log being held on a table which feeds it past the saw. The log frame is a machine with a set of vertically reciprocating blades, suitably spaced apart: it divides a log into boards at one pass of the table. The number of blades may be few, not exceeding four in some cases for cutting thick pieces, or as many as fifty for thin boards Resawing machines are those for further dealing with material partly broken up. such as flitches and deals. The great quantity of sawdust and chips from the machines is neatly disposed of by pneumatic ducts ending in the boiler house. *See* also LUMBERING: *U.S. Methods of Manufacture;* WOODWORKING MACHINERY.

SAW (or SCRUB) **PALMETTO** (*Serenoa repens*), a single species of small palms found in sandy soil from South Carolina to Florida and Texas. It generally has creeping stems, prickly leaf-stalks, fan-shaped leaves 2–23 ft. across, divided to or below the middle into 20 or more parts, and fragrant floners followed by almost round, black, one-seeded fruits. The leaves, both fresh and dried, are sent north in large quantities for Christmas decorations. (J. M. BL.)

SAWS AND SAWING MACHINES: *see* MACHINE TOOLS; WOODWORKING MACHINERY.

SAX, ANTOINE JOSEPH, known as ADOLPHE (1814–1894), maker of musical instruments, nas born at Dinant in Belgium on Nov. 6, 1814, and died in Paris in 1894. In 1835 he perfected a bass clarinet superior to any that had preceded it. He went to Paris in 1842, and set up a workshop in the Rue St. Georges. Sax discovered that it is the proportions given to a column of air vibrating in a sonorous tube, and these alone, that determine the character of the timbre produced. In 1835 he patented his saxhorn and a family of cylinder instruments called saxotrombas On June 22, 1836 he registered the saxophone. He also effected various improvements in piston instruments, of which the most important nas the substitution of a single ascending piston for a number of descending ones.

SAXE, MAURICE, COMTE DE (1696–1750), marshal of France, was the natural son of Augustus II of Saxony and the countess Aurora Konigsmark. He served under Prince Eugene in the Netherlands, and under Peter the Great against the Swedes. After receiving in 1711 formal recognition from his father, with the rank of count, he accompanied him to Pomerania. and in 1712 he took part in the siege of Stralsund. After serving in a campaign against the Turks in 1717, he had in 1720 obtained a commission as *maréchal de camp.* In 1725 negotiations were entered into for his election as duke of Courland. He was chosen duke in 1726, but found it impossible to resist opposition to his claims, although he maintained his authority till 1727, when he withdrew and took up his residence in Paris. On the outbreak of the war in 1734 he served under Marshal Berwick. On the opening of the Austrian Succession War in 1741, he took command of a division of the army sent to invade Austria, and on Nov. 19 surprised Prague during the night, and took it by assault. After capturing the fortress of Eger on April 19, 1742, he received leave of absence, and went to Russia to push his claims on the duchy of Courland, but obtaining no success he returned to his command. On March 26, 1743, he was promoted to be marshal of France.

Marshal Saxe was now one of the first generals of the age. In 1744 he was chosen to command the expedition to England on behalf of the Pretender, which assembled at Dunkirk but did not proceed farther. After its abortive issue he received an independent command in the Netherlands, and by dexterous maneuvering succeeded in continually harassing the superior forces of the enemy without risking a decisive battle. In the following year he besieged Tournai and inflicted a severe defeat on the relieving army of the duke of Cumberland at Fontenoy (*q.v.*). Thenceforward to the end of the war he commanded in the Netherlands with success. On Nov. 30, 1750, he died at Chambord.

Saxe was the author of a remarkable work on the art of war, *Mes Réveries.* It was published posthumously in 1757 (ed.

Paris. 1877). Saxe's Lettres et mémoires choisis appeared in 1794.

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SAXE-ALTENBURG. The district, later the duchy of Saxe-Altenburg, came into the possession of the margrave of Meissen about 1329, and later with Meissen formed part of the electorate of Saxony. In 1603 Saxe-Altenburg was made a separate duchy, lasting until 1672. In 1825 it again became a separate duchy under Frederick, previously duke of Saxe-Hildburghausen. His family's reign was ended by the German revolution of 1918.

SAXE-COBURG-GOTHA, formerly a sovereign duchy of Germany and a constituent member of the German empire, and after 1919 incorporated into Thuringia (*q.v.*).

History.— The district of Coburg came into the possession of the family of Wettin in the 14th century, and after the Wettins had become electors of Saxony this part of their lands fell at the partition of 1485 to the Ernestine branch of the house. From that time onward Coburg, Gotha and Saalfeld were frequently partitioned and repartitioned until 1826, when Ernest, duke of Saxe-Coburg-Saalfeld, exchanged Saalfeld for Gotha, took the title of duke of Saxe-Coburg-Gotha and became the founder of the house which ruled until the revolution of 1918.

SAXE-MEININGEN, GEORGE II, DUKE OF (1826–1914), famous for the company of actors he developed at his court theatre, was born at Meiningen on April 2, 1826, and succeeded his father, Bernhard. as duke in 1866. His company toured through Europe from 1874 to 1890, under the direction of Ludwig Chronegk, presenting 2,591 performances, largely of Shakespeare and Schiller, in 36 cities in nine countries. Antoine and Stanislavsky were among those impressed by the Meininger s ensemble acting, realistic crowd scenes and detailed historical accuracy in settings and costumes. Lee Simonson, on dubious grounds, credited the duke with many innovations and with extensive and enduring influence on theatre art (*The Stage Is Set*, New York, 1932). However, Duke George probably was the first *régisseur;* a talented designer, he imposed his interpretation on the whole production. He died on June 25, 1914.

See Max Grube, *Geschichte der Meininger* (1926); Argus Tresidder, "The Meininger and Their Influence," *Quarterly Journal of Speech*, 79:467–475 (Nov. 1935). (B. HT.)

SAXE-MEININGEN, a former duchy of Germany, and after 1919 a part of Thuringia (*q.v.*).

History.— The Duchy of Saxe-Meiningen, or more correctly Saxe-Meiningen-Hildburghausen, was founded in 1681 by Bernard, the third son of Ernest the Pious, duke of Saxe-Gotha, and consisted originally of the district around Meiningen. By the rearrangement of the Saxon duchies in 1826, the area of Saxe-Meiningen more than doubled by the addition of the duchies of Saxe-Hildburghausen and Saxe-Saalfeld, and the districts of Themar, Kranichfeld and Kamburg. Saxe-Meiningen became a member of the new German empire in 1871. In 1918 the ruling family lost power in the general revolution.

SAXE-WEIMAR-EISENACH, formerly a grand duchy of Germany and a sovereign and constituent state of the German empire, and after 1919 part of Thuringia (*q.v.*).

History.— In early times Weimar and district belonged to the counts of Orlamünde, and from the end of the 10th century until 1067 it was the seat of the counts of Weimar. In the 14th century it passed to the elector of Saxony, falling at the partition of 1485 to the Ernestine branch of the Wettin family. In 1641, having inherited Coburg and Eisenach, the three brothers, William, Albert and Ernest, founded the three principalities of Saxe-Weimar, Saxe-Eisenach. and Saxe-Gotha. Eisenach fell to Saxe-Weimar in 1644, and although the enlarged principality of Saxe-Weimar-Eisenach was temporarily split up into the lines Saxe-Weimar, Saxe-Eisenach and Saxe-Jena, it was united under Ernest Augustus, who began to reign in 1728. Charles Augustus, who assumed the government in 1775, attracted to his court scholars such as Goethe, Schiller and Herder.

The Congress of Vienna in 1815 added about 660 sq.mi. to its area and gave its ruler the title of grand duke. Charles Augustus was the first German sovereign to give a constitution to his state under article xiii of the federal act. Freedom of the press being secured under its constitution, Weimar became a focus of liberal agitation, which drew down upon the grand duke the wrath of the reactionary powers. He was thus forced to curtail some of the liberties granted. In 1866 the grand duchy joined Prussia against Austria and afterward entered the North German confederation and the new German empire (see GERMANY: *History*). In 1919 it was absorbed in the former republican state of Thuringia, with the capital at Weimar.

SAXHORN, the generic name of a family of brass wind instruments (not horns but valve bugles) with cup-shaped mouthpieces, invented by Adolphe Sax and in use chiefly in European military bands, instruments of a brighter tone quality being preferred in the United States for the same purposes. (See BOMBARDON; BUGLE; HORN; TUBA; VALVES [PISTONS].)

SAXIFRAGACEAE, the Saxifrage family of the order Rosales. embraces about 80 genera and 1,200 species of dicotyledonous plants of cosmopolitan distribution with concentration in the north temperate zone and subarctic regions. There are more than 40 genera in the western hemisphere, found from Alaska to Cape Horn. The plants are annual or perennial herbs, shrubs or small trees. The leaves are simple or compound, alternate or opposite, without stipules, often in basal rosettes. Floners are arranged in cymose clusters, bisexual, rarely unisexual, polygamous or neutral, with regular or bilateral symmetry, and with conical or cuplike floral axis free from the ovary, or the ovary imbedded in the floral axis and fused with it. The calyx is made up of four to five sepals, usually united and prolonged to a floral tube with a glandular disc; corolla, of four to five separate petals, is common; there may be five to ten or many stamens, and one pistil, mostly two carpellate, with parietal or axile placentation; styles and stigmas are mostly separate; fruit is a many-seeded capsule or a juicy berry.

Saxifraga, or rock-breaker (garden saxifrage) is the largest genus, comprising 325 species, of which 15 are British. They are crevice-loving herbs, of arctic and alpine habitats, usually with tufted leaves from crowns of rhizomes anchored by roots in mossy fissures or wet meadows. Many are prized ornamentals in rock gardens, including *S. umbrosa* (London pride), with crimson-dotted petals, and *S. rosacea* (rose saxifrage), with scarlet petals. *S. sarmentosa* (strawberry geranium) is a popular house plant, with attractive panicles of irregular flowers, propagating by a profusion of runners with terminal rosettes of leaves. (See also SAXIFRAGE.)

Chrysoplenium (golden saxifrage), including 50 species of delicate creeping herbs found in springheads and creek beds, has fourparted flowers, the eight golden anthers compensating for the lack of petals.

Parnassia (grass-of-Pamassus, *q.v.*) includes 40–45 species with circumpolar distribution; *P. palustris,* of shores and wet meadows, has showy white flowers.

Heuchera (alum root), with 30 species, is exclusively a North American genus. The plants are characterized by a naked flowering stem with rosette leaves from thick rhizomes which contain astringent principle. *H. sanguinea* (coral bells) is a rock garden favourite because of its graceful panicle of showy flowers. Any species, indeed, is suitable for rock gardens.

Astilbe (without lustre), a genus of about 20 Asian and 2 American species, are ornamental herbs with twice or thrice compound leaves, small numerous flowers in terminal clusters and fruits often follicular from distinct carpels. *A. japonica* is preferred in gardens.

The genus *Ribes* (currant and gooseberry, *qq.v.*) includes 140 species of smooth or prickly shrubs, widely distributed. *R. sativum* (garden currant) and *R. grossularia* (or *Grossularia reclinata;* the English gooseberry) bear edible berries. Among ornamentals are *R. odoratum* (golden currant) and *R. sanguineum* (cherry currant). All species of *Ribes* are valuable shrubs in providing shelter and food for wild life. but they also are the alternate host for the fungus that causes blister rust in white pine.

Philadelphus (*q.v.*), or mock orange, is a genus consisting of about 70 species, several Asian, 1 European and the remainder American. *P. coronarius* and its many forms are widely cultivated for their attractive clusters of showy-white fragrant flowers.

Deutzia, a genus of 70 species of Asian and 2 Mexican shrubs, has profusely flowering ornamentals. Among choice species for borders is *D. gracilis*, with slender arching branches.

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SAXIFRAGE (*Saxifraga*). a genus of plants which gives its name to the family Saxifragaceae of which it is a member. There are about 325 species distributed in the temperate and arctic parts of the northern hemisphere, frequently at considerable heights on the mountains. and also found on the Andes. They are mostly herbs, native to mountains and rocky places, with perennial rootstocks and leaves in tufts or scattered on the flower-stalks. The arrangement of the flowers is various, as also are the size and colour of the flowers themselves.

Some 8j species occur in North America, most numerously in the Rocky mountain region. Well-known species are the early saxifrage (*S. virginiensis)* and the swamp saxifrage (S. *pennsylvanica),* of the eastern United States and Canada, and the tufted saxifrage *(S. caespitosa),* found on rocks in mountains across the continent. Many species are in cultivation, including the numerous alpine species, such as *S. cotyledon*, with tall panicles studded with white flowers, and others, many adapted for rockwork. The strawberry geranium *(S. sarmentosa)* is a common conservatory and window plant. Fifteen species are found in Britain, some alpine plants of great beauty (S. *oppositifolia, S. nivalis, S. aizoides,* etc.) and others! like *S. granulata,* frequenting meadows and low ground, while *S. tridactylites* may be found on almost any dry wall. *S. umbrosa* is London pride or St. Patrick's cabbage, a common garden plant, a native of the Spanish peninsula and also of the mountains of west and southwest Ireland.

The saxifrages are among the most interesting alpine plants for culture in the rock garden. Some grow best in clefts in the rocks, others in gritty detritus characteristic of moraines. Nearly 200 species are cultivated by fanciers. Most of them prefer gritty soils: perfect drainage and freedom from acid conditions. Many are from alpine fell fields and will not stand too much midday heat. Among the best for rock gardens in the U.S. are *S. aizoon* (with several varieties); *S. apiculata,* a cushion plant; S. *cochlearis,* best grown in crushed limestone; *S. decipiens* (with hybrids of several colours); *S. hosti,* a cushion plant with white flowers; *S. moschata,* a dwarf, mosslike species; and *S. oppositifolia,* which makes prostrate mats and has many varieties. (N. TR.; X.)

SAXO GRAMMATICUS (mid-12th century–early 13th century), Danish historian whose *Gesta Danorum* is the first important work on the history of Denmark and the first Danish contribution to world literature. Little is known except that he was a Sealander belonging to a family of warriors, and that he was probably a clerk in the service of Absalon (archbishop of Lund from 1178–1201). Saxo is first mentioned in Svend Aggesen's *Historia Regum Danicæ compendiosa* (1185) as writing the history of Svend Estridsen (d. 1076).

The *Gesta Danorum* was written at the suggestion of Archbishop Absalon: its 16 volumes begin with the legendary King Dan and end with the conquest of Pomerania by Canute VI in 118j. The original manuscript is lost except for four leaves which were found in a French book in 1863. The preface, dedicated to Absalon's successor, Anders Sunesen, and King Valdemar II, must have been written before 1222. Like the rest of the work, it is written in a brilliant, ornate Latin, clearly influenced by the style of Valerius Maximus, Curtius and Justin. It was his Latin eloquence which in the early 14th century caused Saxo to be called "Grammaticus."

The first nine books of the *Gesta Danorum* give an account of some 60 legendary Danish kings. For this part Saxo depended on ancient lays, romantic sagas and the accounts of Icelanders. Most famous are his tales about Uffe (Anglo-Saxon, Offa), hmleth (Hamlet [*q.v.*]), Hading, Rolf Krake, the giant Starkad, Harald Hildetand and Ragnar Lodbrok. Saxo incorporated also myths of national gods such as Balder and Hother whom tradition claimed as Danish kings, and myths of foreign heroes, including the Gothic Jarmunrik (A. S. Eormenric) and the Germans Hedin and Hild. Three heroic poems are especially noteworthy, translated by Saxo into Latin hexameters, a medium which must have been incongruously alien to the concentrated, pithy style of the originals. the oldest known Danish poetry. They are *Bjarkemaalet*, a battle hymn designed to arouse warlike feelings; *Ingjaldskvadet*, a poem stressing the corruptive danger of luxury upon the old Viking spirit; and *Hagbard and Signe*, a tragedy of love and family feuds.

The last seven books comprise Saxo's account of the historical period. but he only achieves independent authority when writing of events close to his own time (from book 14 onward). Archbishop Absalon and his family, and oral accounts by Danish warriors, seem to have been Saxo's main sources for this period. His work is noteworthy for its sense of patriotic purpose based on a belief in the unifying influence of the monarchy. By presenting a 2,000-year long panorama of Danish history, he aimed to show his country's antiquity and traditions. Saxo's work became a source of inspiration to many of the 19th-century romantic poets in Denmark.

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SAXONS, a Teutonic people mentioned for the first time by Ptolemy about the middle of the 2nd century. At that time they are said to have inhabited the neck of the Cimbric peninsula, by which we have probably to understand the modern province of Schleswig, together with three islands lying off its western coast. We next hear of them in connection with piratical expeditions in the North sea about the year 286. These raids became more frequent during the 4th century, and at the beginning of the jth century the northern coast of Gaul and the south-east coast of Britain were known at *litora Saxonica*. During the same period the Saxons appear to have conquered a considerable portion of north-west Germany. According to their own traditions they landed at Hadeln in the neighbourhood of Cuxhaven and seized the surrounding districts from the Thuringians. By the middle of the 4th century they had advanced westwards into the basin of the Ysel, and in the following centuries we find them in possession of the whole of the basin of the Ems, except the coast district, while that of the Weser with all its tributaries belonged to them as far south as the Diemel, where they bordered on the Hessian Franks, the ancient Chatti. The conquest of the Boructuari who dwelt between the Lippe and the Ruhr marks the extent of their progress towards the south-west. This took place shortly before the end of the 7th century. They frequently came into conflict with the Franks and on several occasions had to submit to their supremacy. No thorough conquest was, however, carried until the time of Charlemagne, who, between the years 772 and 785, annexed the whole region as far as the Elbe, destroying in 772 the Irminsul, their great sanctuary, near Marsberg on the Diemel. Up to this time they had remained entirely heathen. At the beginning of the following century Charlemagne also conquered the Saxons known as Nordalbingi in western Holstein, a district which had perhaps been occupied by a southward movement from the original home of the tribe.

It is doubtful how far the Saxons who invaded Britain were really distinct from the Angli, for all their affinities both in language and custom are with the latter and not with the Saxons (Old Saxons) of the Continent. During the 5th century we hear also of Saxon settlements on the coasts of Gaul. The most important were those at the mouth of the Loire founded in the time of Childeric, Clovis's father, and at Bayeux, in a district which remained in their possession until towards the close of the 6th century. From the 6th century onwards, however, we hear practically nothing of the Saxons as a seafaring people. Almost all the southern coast of the North sea had now come into the possession of the Frisians, and one can hardly help concluding that most of the maritime Saxons had either voluntarily or by conquest become incorporated in that kingdom.

See Ptolemy ii, 11; Eutropius ix, 21; Zosimus iii, 6; Ammianus Marcellinus xxvi, 4. 5, xxvii, 8. 5, xxviii, 2. 12, 7. 8, xxx, 5. 1 and 4; *Notitia dignitatum;* Gregory of Tours, *Historia Francorum,* ii, 19, iv, 10. 14, v, 27, x. 9; Bede, *Hist. Eccl.* v, 10 *seq.; Annales Einhardi; Translatio S. Alexandri;* Hucbald, *Vita S. Lebuini;* Widukind. *Res Gestae Saxonicae,* i. *1* ff. (F. G. M. B.)

SAXONY, one of the German *Länder,* ranking among the constituent states of the German reich fifth in area and third in population, bounded in 1938 S. by Czechoslovakia, on the west by Bavaria and Thuringia and on the west, north and east by Prussia. Its frontiers have a circuit of 760 mi. and, with the exception of some small exclaves and enclaves, it forms a compact whole of a triangular shape, its base extending from northeast to southwest, and its apex pointing northwest. Its greatest length is 130 mi.; greatest breadth 93 mi., and total area 5,789 sq.mi.

Physical Features.—Saxony belongs almost entirely to the central mountain region of Germany, only the districts along the north border and around Leipzig descending into the great north-European plain. The chief mountain range is the Erzgebirge, stretching for 90 mi. along the south border, and reaching in the Fichtelberg (3,979 ft. and 3,953 ft.) the highest elevation in the country. The west and southwest are occupied by ramifications and subsidiary groups of this range, such as the Central Saxon chain, and the Oschatz group. The southeast angle of Saxony is occupied by the mountains of Upper Lusatia (highest summit 2.600 ft.). Northwest from this group. and along both banks of the Elbe, which divides it from the Erzgebirge, extends the picturesque Saxon Switzerland. The action of water and ice upon the soft sandstone of which the hills here are chiefly composed has produced deep gorges and isolated fantastic peaks, but the highest summit attains a height of only 1,830 ft.; the more interesting peaks, as the Lilienstein, Konigstein and the Bastei, are lower. Saxony lies almost wholly in the basin of the Elbe, which has a navigable course of 72 mi. from southeast to northwest. The Mulde, formed of two branches, is the second river of Saxony; others are the Black Elster, the White Elster, the Pleisse and the Spree, all part of the Elbe system. There are no lakes of any size. The best known of many mineral springs is at Bad Elster in the Vogtland.

Climate.—The climate is mildest in the valleys of the Elbe, Mulde and Pleisse and severest in the Erzgebirge. The average temperature varies from 48° to 50° The Erzgebirge is the rainiest district, 27½ to 33½ in. falling yearly; the amount decreases as one proceeds northward, and Leipzig, with an average annual rainfall of 17 in., enjoys the driest climate.

Population.—In 1939 the population of Saxony was 5,206,822, or 899.4 per square mile. Except the free towns, Saxony is the most densely peopled member of the German reich. The growth of the population after 1815, when Saxony received its present limits, has been as follows: (1815) 1,178,802; (1830) 1,402,066; (1840) 1,706,275; (1864) 2,344,094; (1875) 2,760,586; (1895) 3,787,688; (1905) 4,508,601. The preponderating industrial activity fosters the tendency of the population to concentrate in towns, and no German area, with the exception of the Hanseatic towns, has so large a proportion of urban population. The people of Saxony are chiefly of pure Teutonic stock; a proportion are Germanized Slavs, and to the south of Bautzen there is a large settlement of Wends, who retain their language.

The chief towns are Leipzig (pop. 1939, 701,606), Dresden (625,174), Chemnitz (334,563), Plauen (110,342), Zwickau (85,-484), Meissen (47,833), Bautzen (41,793), Zittau (38,271), Freiberg (35,847), Freital (36,6523, Pirna (36,130), Reichenbach (31,266), Glauchau (33,586), and Krimmitschau (26,942). Other important towns are Meerane and Werdau.

Communications.—The roads in Saxony are numerous and good, and there are over 1,268 mi. of railway. The only navigable river is the Elbe.

Agriculture.—Saxony is one of the most fertile parts of Germany, and is highly developed agriculturally. Fertility diminishes as we ascend towards the south, until on the bleak crest of the Erzgebirge cultivation ceases. In 1834 a law mas passed providing for the union of the scattered lands belonging to each proprietor, and that may be considered the dawn of modern Saxon agriculture. The richest grain districts are near Meissen, Grimma, Bautzen, Dobeln and Pirna. The chief crop is rye, but oats are hardly second to it. Wheat and barley are grown in considerably less quantity. Very large quantities of potatoes are grown, especially in the Vogtland. Beet is also grown extensively. Flax is grown in the Erzgebirge and Lusatian mountains, where the manufacture of linen was at one time a flourishing domestic industry. Enormous quantities of cherries, plums and apples are annually borne by the trees round Leipzig, Dresden and Colditz. The Saxon vineyards, chiefly on the banks of the Elbe near Meissen and Dresden, have passed through difficult times of late years, owing to the ravages of the phylloxera.

Livestock.—Cattle rearing, which has been an industry since the advent of the Wends in the 6th century, is important on the extensive pastures of the Erzgebirge and in the Vogtland. In 1765 the regent Prince Xaver imported 300 merino sheep from Spain, and so improved the native breed by this new strain that Saxon sheep mere eagerly imported by foreign nations to improve their flocks, and "Saxon electoral wool" became one of the best brands in the market. Sheep farming, however, has considerably declined within the last few decades. Swine furnish a very large proportion of the flesh diet of the people. Geese abound particularly round Leipzig and in Upper Lusatia, poultry about Bautzen.

Forests.—The forests of Saxony are extensive and have long been well cared for both by government and by private proprietors. The famous school of forestry at Tharandt was founded in 1811. The Vogtland is the most densely wooded portion of Saxony, and next comes the Erzgebirge.

Mining.—Silver was raised in the 12th century, and argentiferous lead is still the most valuable ore mined; tin, iron and cobalt rank next, and coal is one of the chief exports. Copper, zinc and bismuth are also worked. The country is divided into four mining districts: Freiberg, where silver and lead are the chief products; Altenberg, where tin is mainly raised; Schneeberg, yielding cobalt, nickel and ironstone; and Johanngeorgenstadt, with ironstone and silver mines. The coal is found principally in two fields—one near Zwickau, and the other in the governmental district of Dresden. Brown coal or lignite is found chiefly in the north and northwest. Peat is especially abundant on the Erzgebirge. Immense quantities of bricks are made ail over the country. Excellent sandstone for building is found on the hills of the Elbe. Fine porcelain clay occurs near Meissen, and coarser varieties elsewhere.

Industries.—The central-European position of Saxony has fostered its commerce; and its manufactures have been encouraged by the abundant water power throughout the country. Nearly one-half of the motive power used in Saxon factories is supplied by the streams, of which the Blulde, in this respect, is the chief. The early foundation of the Leipzig fairs, and the enlightened policy of the rulers of the country, have also done much to develop its commercial and industrial resources. The manufacture of textiles is carried on at Zwickau, Chemnitz, Glauchau, Meerane, Hohenstein, Kamenz, Pulsnitz and Bischofsmerda. The centre of the cotton manufacture (especially of cotton hosiery) is Chemnitz; cotton muslins are made throughout the Vogtland, ribbons at Pulsnitz and its neighbourhood. Woollen cloth and buckskin are woven at Kamenz, Bischofswerda and Grossenhain, all in the northeast, woollen and half-woollen underclothing at Chemnitz, Glauchau, Meerane and Reichenbach; while Bautzen and Limbach produce woollen stockings. Linen is manufactured chiefly in the mountains of Lusatia, where the looms are still to some extent found in the homes of the weavers. Damask is produced at Gross-Schonau and other places. Lacemaking, discovered or introduced by Barbara Uttmann in the latter half of the 16th century, and now fostered by government schools, was long an important domestic industry among the villages of the Erzgebirge, and has attained to a great industry in Plauen. Straw plaiting is carried on by the inhabitants of the mountain slopes between Gottleuba and Lockwitz. Waxcloth is manufactured at Leipzig and artificial flowers at Leipzig and Dresden. Stoneware and earthenware are made at Chemnitz, Zwickau, Rautzen and Meissen, porcelain (Dresden china) at Meissen, chemicals in and near Leipzig. Dobeln. Werdau and Lossnitz are the chief seats of the Saxon leather trade; cigars are very extensively made in the town and district of Leipzig, and hats and pianofortes at Leipzig, Dresden and Chemnitz. Paper is made chiefly in the west of Saxony. Machinery of all kinds is produced, from the sewing machines of Dresden to the steam locomotives and marine engines of Chemnitz. The last-named place. though the centre of the iron manufacture of Saxony, has to import every pound of iron by railway. The leading branch is the machinery used in the industries of the country—mining. paper making and weaving. The very large printing trade of Leipzig encourages the manufacture of printing presses in that city. There are a number of active breweries in Saxony. The smelting and refining of the metal ores is also an important industry.

The principal exports are wool, woollen, cotton, linen goods, machinery, china. pianofortes, cigarettes, flannels, stockings, curtains and lace. cloth from Reichenbach and Zittau, watches of superlative value from Glashutte and tops from the Vogtland.

Government. — The republican constitution of 1920 provided for a Lnndfng of 96 members. After 1933 this was superseded by the administration of a National Socialist district leader (*Gauleiter*) and federal governor (*Reichsstatthalter*), Martin Mutschmann. appointed by Hitler.

The Saxon *Oberlandesgericht* has its seat at Dresden, and the *Reichsgericht*—the supreme court of law for the whole German reich—at Leipzig.

Church. — The great majority of the inhabitants of Saxony are Protestants. The government of the Evangelical-Lutheran Church was vested in the Evangelical consistory at Dresden. Its representative assembly consisting of clergymen and lay members was called a synod (*Synode*). The Moravian Brethren established their chief seat at Herrnhut.

Education. — Of the four universities founded by the Saxon electors at Leipzig, Jena. Wittenberg, later transferred to Halle, and Erfurt. now extinct, only the first is included in Saxony. There are famous endowed schools (*Fürstenschulen*) at Meissen and Grimma. Saxony is particularly well equipped with technical schools. the textile industries being especially fostered by numerous schools of weaving, embroidery and lacemaking; but the mining academy at Freiberg and the school of forestry at Tharandt are probably the most widely known. The conservatory of music at Leipzig and the art collections at Dresden have a world-wide reputation.

HISTORY

The name "Saxony" has been borne by two distinct blocks of territory. The first was the district in the northwest of Germany, inhabited originally by the Saxons, which became a duchy and attained its greatest size and prosperity under Henry the Lion in the 12th century. In 1180 it was broken up, and the name of Saxony disappeared from the greater part of it, remaining only with the districts around Lauenburg and Wittenberg. Five centuries later Lauenburg was incorporated with Hanover, and Wittenberg is the nucleus of modern Saxony. the name being thus transferred from the west to the east of Germany. In 1423 Meissen and Thuringia were united with Saxe-Kittenberg under Frederick of bleissen. and gradually the name "Saxony" spread over all the lands ruled by this prince and his descendants.

The earlier Saxony was the district lying between the Elbe and the Saale on the east. the Eider on the north and the Rhine on the west, with a fluctuating boundary on the south. This territory was a stronghold of Germanic heathenism and included at Eresburg, the modern hlarsberp, one of the chief Germanic sanctuaries. marked by the *Irminsul*, a wooden pillar which was the centre of Saxon worship. The prolonged resistance which the Saxons offered to Christianity was chiefly a result of their hostility to the Franks, who threatened their independence. The reduction of the Saxons was attempted by Charles Martel and Pippin the Short and was finally carried through in a series of campaigns by Charles the Great (Charlemagne, *q.v.*). Before his death Saxony passed under Frankish supremacy, and within a century it had come to form an outpost of German and Christian influence against the Slavs of the provinces south of the Baltic.

The conversion of the Saxons to Christianity, which during this time had been steadily progressing. was continued in the reign of the emperor Louis I. Bishoprics were established at Bremen Munster, Verden, Minden, Paderborn, Osnabriick. Hildesheim, Hamburg and Halberstadt. The abbey of Corvey soon became a centre of learning for the country, and the Saxons undertook with the eagerness of converts the conversion of their heathen neighbours. Toward the middle of the century there were signs of a reaction against Frankish rule and toward heathenism among the Saxon free peasantry, but it had no permanent result, and the connection with the empire mas unbroken. By the treaty of Verdun in 843 Saxony fell to Louis the German, but he paid little attention to the northern part of his kingdom, which was harassed by the Normans and the Slavs. About 850. however, he appointed a Saxon noble named Liudolf as margrave to defend the *Limes Saxoniae*, a narrow strip of land on the eastern frontier. Liudolf, who is sometimes called "duke of the East Saxons," carried on a vigorous warfare against the Slavs and extended his influence over other parts of Saxony. He died in 866 and was succeeded by his son Bruno, who was killed fighting the Normans in 880. Liudolf's second son. Otto the Illustrious, was recognized as duke of Saxony by King Conrad I. and on the death of Burkhard, margrave of Thuringia in 908, obtained authority over that country also. He made himself practically independent in Saxony and played an important part in the affairs of the empire. He died in 912 and his son Henry I, the Fowler, not only retained his hold over Saxony and Thuringia but in 919 was elected German king. He extended the Saxon frontier almost to the Oder. improved the Saxon forces by training and equipment, established new marks and erected forts on the frontiers for which he provided regular garrisons. Towns were walled, where it was decreed markets and assemblies should be held, churches and monasteries were founded, civilization was extended and learning encouraged. Henry's son, Otto the Great, was crowned emperor in 962, and his descendants held this dignity until the death of the emperor Otto III in 1002. Under this able dynasty the Slavs .were driven back, the domestic policy of Henry the Fowler was continued, the Saxon court became a centre of learning visited by Italian scholars, and in 968 an archbishopric was founded at Magdeburg for the lands east of the Elbe. The extent of Otto the Great's dominions compelled him to delegate much of his authority in Saxony. and in 960 he gave to a trusted relative. Hermann Billung, certain duties and privileges on the eastern frontier and from time to time appointed him as his representative in Saxony. Hermann gradually extended his authority, and when he died in 973 was followed by his son Bernard I. who was undoubtedly duke of Saxony in 986. When Henry II was chosen German king in 1002 he met the Saxons at Merseburg, and on promising to observe their laws Bernard gave him the sacred lance. thus entrusting Saxony to his care. Bernard was succeeded by his son Bernard II, who took up a hostile attitude toward the German kings, Conrad II and Henry III. His son and successor Ordulf, who became duke in 1059, carried on a long and obstinate struggle with Adalbert, archbishop of Bremen, who was compelled to cede one-third of his possessions to Ordulf's son Magnus in 1066. The emperor Henry III sought to win the allegiance of the Saxons by residing among them. He built a castle at Goslar and the Harzburg; and his successor, Henry IV, also spent much time in Saxony.

In 1070 Otto of Nordheim, duke of Bavaria, who held large estates in that country, was accused of a plot to murder Henry, and his lands were confiscated. Otto; in alliance with Magnus, won considerable support in Saxony, but after some fighting both submitted and were imprisoned: and Magnus was still in confinement when on his father's death in 1072 he became titular duke oi Saxony. As he refused to give up his duchy he was kept in prison, while Henry confiscated the estates of powerful nobles, demanded the restoration of ducal lands by the bishops, and garrisoned newly-erected forts with Swabians. These proceedings aroused suspicion and discontent, which were increased when the emperor assembled an army, ostensibly to attack the Slavs. The Saxon nobles refused to join the host until their grievances were redressed, and in 1073 a league was formed at Wormesleben. When the insurgents under Duke Otto were joined by the Thuringians, Henry was compelled in 1074 to make various concessions to them, and in particular to release Magnus. At last Henry, having obtained help from the princes of the Rhineland, attacked and defeated the Saxons at Hohenburg near Langensalza but pardoned Otto, whom he appointed administrator of the country. The Saxons, however, were not quite subdued; risings took place from time to time, and the opponents of Henry IV. found considerable support in Saxony. During the century which followed the death of Hermann Billung, there had been constant warfare with the Slavs, but although the emperors had often taken the field, the Saxons had been driven back to the Elbe, which was at this time their eastern boundary. In 1106 Magnus died, and the German king Henry V. bestowed the duchy upon Lothair, count of Supplinburg, whose wife Richenza inherited the Saxon estates of her grandfather Otto of Nordheim, on the death of her brother Otto in 1116. Lothair quickly made himself independent, defeated Henry at Welfesholz in 1115, and prosecuted the war against the Slavs with vigour. In 1125 he became German king, and in 1137 gave Saxony to Henry the Proud, duke of Bavaria, who had married his daughter Gertrude, and whose mother Wulfhild was a daughter of Magnus Billung. The succeeding German king Conrad III. refused to allow Henry to hold two duchies, and gave Saxony to Albert the Bear, margrave of Brandenburg, who like his rival was a grandson of Magnus Billung. Albert's attempts to obtain possession failed, and after Henry's death in 1139 he formally renounced Saxony in favour of Henry's son, Henry the Lion (*q.v.*). The new duke improved its internal condition, increased its political importance, and pushed its eastern frontier towards the Oder. In 1180, however, he was placed under the imperial ban and Saxony was broken up. Henry retained Brunswick and Luneburg; Westphalia, as the western portion of the duchy was called, was given to Philip, archbishop of Cologne, and a large part of the land was divided among nine bishops and a number of counts who thus became immediate vassals of the emperor. The title duke of Saxony was given to Bernard, the sixth son of Albert the Bear, together with the small territories of Lauenburg and Wittenberg, which were thus the only portions of the former duchy which now bore the name of Saxony. Bernard, whose paternal grandmother, Eilicke, was a daughter of Magnus Billung, took a prominent part in German affairs, but lost Lauenburg which was seized by Waldemar II., king of Denmark. Dying in 1212, Bernard was succeeded in Wittenberg by his younger son Albert I., who recovered Lauenburg after the defeat of Waldemar at Bornhoved in 1227. Albert died in 1260, and soon after his death his two sons divided his territories, when the elder son John took Lauenburg which was sometimes called lower Saxony, and the younger, Albert II., took Wittenberg or upper Saxony. Both retained the ducal title and claimed the electoral privilege, a claim which the Lauenburg line refused to abandon when it was awarded to the Wittenberg line by the Golden Bull of 1356.

Saxe-Lauenburg was governed by John until his death in 1285, when it passed to his three sons John II., Albert III. and Eric I. As Albert had no sons the duchy was soon divided into two parts, until on the death of duke Eric III., a grandson of John II., in 1401, it was reunited by Eric IV., a grandson of Eric I. When Eric IV. died in 1412 he was succeeded by his son Eric V., who made strenuous but vain efforts to obtain the electoral duchy of Saxe-Wittenberg, which fell vacant on the death of the elector Albert III. in 1422. Eric died in 1436 and was followed by his brother Bernard IV., whose claim to exercise the electoral vote was quashed by the electors in 1438; and who was succeeded by his son John IV. in 1463. The next duke, John's son Magnus I., spent much time in struggles with the archbishop of Bremen and the bishop of Ratzeburg; he also assisted the progress of the Reformation in Lauenburg. Magnus, who was formally invested with the duchy by the emperor Charles V. in 1530, was the first duke to abandon the claim to the electoral privilege. After his death in 1543 his son Francis I. reigned for the succeeding 28 years, and his grandsons, Magnus II. and Francis II., until 1619. Francis, who did something to improve the administration of his duchy, was succeeded in turn by his two sons and his two grandsons; but on the death of Julius Francis, the younger of his grandsons, in 1689 the family became extinct.

Several claimants to Saxe-Lauenburg thereupon appeared, the most prominent of whom were George William, duke of Lüneburg-Celle, and John George III., elector of Saxony. George William based his claim upon a treaty of mutual succession made in 1369 between his ancestor Magnus II., duke of Brunswick, and the reigning dukes of Saxe-Lauenburg. John George had a double claim. Duke Magnus I. had promised that in case of the extinction of his family Lauenburg should pass to the family of Wettin, an arrangement which had been confirmed by the emperor Maximilian I. in 1507. Secondly, John George himself had concluded a similar treaty with Julius Francis in 1671. In 1689 the elector received the homage of the people of Lauenburg. George William, however, took Ratzeburg, and held it against the troops of a third claimant, Christian V., king of Denmark; and in 1702 he bought off the claim of John George, his successor being invested with the duchy in 1728. Since that date its history has been identified with that of Hanover (*q.v.*).

In Saxe-Wittenberg Albert II. was succeeded in 1298 by his son Rudolph I., who was followed in 1356 by his son Rudolph II. He in turn was succeeded in 1370 by his half-brother Wenceslaus, who temporarily acquired the duchy of Ldneburg for his house. He was followed in 1388 by his eldest son Rudolph III. Lavish expenditure during the progress of the council of Constance reduced Rudolph to poverty and on the death in 1422 of his brother Albert III., who succeeded him in 1419, this branch of the family became extinct.

THE ELECTORATE

A new era in the history of Saxony dates from 1423, when the Emperor Sigismund bestowed the vacant electoral duchy of Saxe-Wittenberg upon Frederick, margrave of Meissen. Frederick was a member of the family of Wettin, which since his day has played a prominent part in the history of Europe, and he owed his new dignity to the money and other assistance which he had given to the emperor during the Hussite war. The new and more honourable title of elector of Saxony now superseded his other titles, and the name Saxony gradually spread over his other possessions, which included Meissen and Thuringia as well as Saxe-Wittenberg. His new position as elector combined with his personal qualities to make him one of the most powerful princes in Germany, and had the principle of primogeniture been established in his country, Saxony and not Prussia might later have been the leading power in the German empire. He died in 1428, just before his lands were ravaged by the Hussites in 1429 and 1430. The division of his territory between his two sons, the elector Frederick II. and William, occasioned a destructive internecine war. Frederick II.'s two sons, Ernest and Albert, succeeded to their father's possessions in 1464, and for 20 years ruled together peaceably. The land prospered rapidly during this respite from the horrors of war. The childless death of their uncle William in 1482 brought Thuringia to the two princes, and Albert insisted on a division of their common possessions. The important partition of Leipzig accordingly took place in 1485, and resulted in the foundation of the two main lines of the Saxon house. The lands were never again united. Ernest, the elder brother, obtained Saxe-Wittenberg with the electoral dignity, Thuringia and the Saxon Vogtland; while Albert received Meissen, Osterland being divided between them. Something was still held in common, and the division was probably made intricate to render war difficult.

The Reformation Period.—The elector Ernest was succeeded in 1486 by his son, Frederick the Wise, one of the most illustrious princes in German history. Under him Saxony was perhaps the most influential state in the empire, and became the cradle of the Reformation. He died in 1525 while the Peasants' War was desolating his land, and was succeeded by his brother John, who was an enthusiastic supporter of the reformed faith and who shared with Philip, landgrave of Hesse, the leadership of the league of Schmalkalden. John's son and successor, John Frederick the Magnanimous, who became elector in 1532, might with equal propriety have been surnamed the Unfortunate. He took part in the war of the league of Schmalkalden, but in 1547 he was captured at Mühlberg by the Emperor Charles V. and was forced to sign the capitulation of Wittenberg. This deed transferred the electoral title and a large part of the electoral lands from the Ernestine to the Albertine branch of the house, whose astute representative, Maurice, had taken the imperial side during the war. Only a few scattered territories were reserved for John Frederick's sons, although these were increased by the treaty of Naumburg in 1554, and on them were founded the Ernestine duchies of Saxe-Gotha, Saxe-Weimar, Saxe-Coburg, Saxe-Meiningen and Saxe-Altenburg. For the second time in the history of the Saxon electorate the younger line secured the higher dignity, for the Wittenberg line was junior to the Lauenburg line. The Albertine line became later the royal line of Saxony.

Maurice, who became elector of Saxony in consequence of the capitulation of Wittenberg, was a Protestant, but he did not allow his religious faith to blind him to his political interests. He refused to join the other Protestant princes in the league of Schmalkalden, but made a secret treaty with Charles V. His fidelity to Charles V. was rewarded by the capitulation of Wittenberg. All the lands torn from John Frederick were not, however, assigned to Maurice; he was forced to acknowledge the superiority of Bohemia over the Vogtland and the Silesian duchy of Sagan. Moreover, Roman Catholic prelates were reinstated in the bishoprics of Meissen, Merseburg and Naumburg-Zeitz. Recognizing now as a Protestant prince that the best alliance for securing his new possessions was not with the emperor, but with the other Protestant princes, Maurice began to withdraw from the former and to conciliate the latter. In 1552, suddenly marching against Charles at Innsbruck, he drove him to flight and then extorted from him the peace of Passau.

Amid the distractions of outward affairs, Maurice had not neglected the internal interests of Saxony. To its educational advantages, already conspicuous, he added the three *Fürstenschulen* at Pforta, Grimma and Meissen, and for administrative purposes, especially for the collection of taxes, he divided the country into the four circles of the Electorate, Thuringia, Meissen and Leipzig. During his reign coal-mining began in Saxony. Over 200 religious houses were suppressed, the funds being partly applied to educational purposes. The country had four universities, those of Leipzig, Wittenberg, Jena and Erfurt; books began to increase rapidly, and, by virtue of Luther's translation of the Bible, the Saxon dialect became the ruling dialect of Germany.

Augustus I., brother and successor of Maurice, was one of the best domestic rulers that Saxony ever had. He increased the area of the country by the "circles" of Neustadt and the Vogtland, and by parts of Henneberg and the silver-yielding Mansfeld, and he devoted his long reign to the development of its resources. Under him lace-making began on the Erzgebirge, and cloth-making flourished at Zwickau. With all his virtues, however, Augustus was an intolerant Lutheran, and used very severe means to exterminate the Calvinists. Under John George (succeeded 1611) the country was devastated by the Thirty Years' War. After the death of Gustavus Adolphus at the battle of Lützen, not far from Leipzig, in 1632, the elector, who was at heart an imperialist, detached himself from Sweden with whom he had been allied since 1629, and in 1635 concluded the peace of Prague with the emperor. By this peace he was confirmed in the possession of Upper and Lower Lusatia. Saxony had now to suffer from the Swedes a repetition of the devastations of Wallenstein. No other country in Germany was so scourged by this terrible war. When the war was ended by the peace of Westphalia in 1648, Saxony found that its influence had begun to decline in Germany. John George's will made the decline worse by detaching the three duchies of Saxe-Weissenfels, Saxe-Merseburg and Saxe-Zeitz as appanages for his younger sons. By 1746, however, these lines were all extinct, and their possessions had returned to the main line.

The 18th Century.—The next three electors, who each bore the name of John George, had uneventful reigns. John George IV. was succeeded in 1694 by his brother Frederick Augustus I., or Augustus the Strong. This prince was elected king of Poland as Augustus II. in 1697, but any weight which the royal title might have given him in the empire was more than counterbalanced by the fact that he became a Roman Catholic in order to qualify for the new dignity. In order to defray the expenses of Poland's wars with Charles XII. Augustus pawned and sold large districts of Saxon territory, while he drained the electorate of both men and money.

From this reign dates the privy council (*Geheimes Kabinet*), which lasted till 1830. The caste privileges of the estates (Stande) were increased by Augustus, a fact which tended to alienate them more from the people, and so to decrease their power. Frederick Augustus II., who succeeded his father in the electorate in 1733, and was afterwards elected to the throne of Poland as Augustus III., was an indolent prince, wholly under the influence of Count Heinrich von Briihl (*q.v.*). Under him Saxony sided with Prussia in the First Silesian War, and with Austria in the other two. It gained nothing in the first, lost much in the second, and in the third, the Seven Years' War (1756–63), suffered renewed miseries. The country was deserted by its king and his minister, who retired to Poland. By the end of the war it had lost 90,000 men and 100,000,000 thalers; its coinage was debased and its trade ruined; and the whole country was in a state of frantic disorder. The elector died seven months after his return from Poland; Brühl died 23 days later. The connection with Poland was now at an end. The elector's son and successor, Frederick Christian, survived his father only two months, dying also in 1763, leaving a son, Frederick Augustus III., a boy of 13. Prince Xaver, the elector's uncle, was appointed guardian, and he set himself to the work of healing the wounds of the country.

THE KINGDOM OF SAXONY

Frederick assumed the government in 1768, and in his long and eventful reign, which saw the electorate elevated to the dignity of a kingdom, though deprived of more than half its area, he won the surname of the Just. As he was the first king of Saxony, he is usually styled Frederick Augustus I. When the Bavarian succession fell open in 1777, Frederick Augustus joined Prussia in protesting against the absorption of Bavaria by Austria, and Saxon troops took part in the bloodless "potato-war" The elector commuted his claims in right of his mother, the Bavarian princess Maria Antonia, for 6,000,000 florins, which he spent chiefly in redeeming Saxon territory that had been pawned to other German states. When Saxony joined the *Fürstenbund* in 1785, it had an area of 15,185 sq.m. and a population of nearly 2,000,000, but its various parts had not yet been combined into a homogeneous whole, for the two Lusatias, Querfurt, Henneberg and the ecclesiastical foundations of Naumburg and Merseburg had each a separate diet and government, independent of the diet of the electorate proper. In 1791 Frederick declined the proffered crown of Poland. Next year saw the beginning of the great struggle between France and Germany. Frederick's first policy was one of abstention but when war broke out in 1806 against Napoleon, 22,000 Saxon troops shared the defeat of the Prussians at Jena, but the elector immediately afterwards abandoned his former ally. At the peace of Posen (Dec. 11, 1806) Frederick assumed the title of king of Saxony, and entered the Confederation of the Rhine as an independent sovereign, promising a contingent of 20,000 men to Napoleon.

In 1807 his submission was rewarded with the duchy of Warsaw (to which Cracow and part of Galicia were added in 1809) and the district of Kottbus, though he had to surrender some of his former territory to the new kingdom of Westphalia. The king of Saxony's faith in Napoleon was shaken by the disasters of the Russian campaign, but when the allies invaded Saxony in the spring of 1813, he refused to declare against Napoleon and fled to Prague, though he withdrew his contingent from the French army. After Napoleon's victory at Liitzen (May 2, 1813), the Saxon king and the Saxon army were once more at the disposal of the French. During the battle of Leipzig in Oct. 1813, the popular Saxon feeling was displayed by the desertion of the Saxon troops to the side of the allies. Frederick was taken prisoner in Leipzig, and the government of his kingdom was assumed for a year by the Russians. The congress of Vienna assigned the northern portion, consisting of 7,800 sq m., with 864,404 inhabitants, to Prussia, leaving 5,790 sq.m., with a population of 1,182,744, to Frederick, who was permitted to retain his royal title. On June 8, 1815, King Frederick joined the new German Confederation.

Constitutionalism. — From the partition in 1815 to the war of 1866 the history of Saxony is mainly a narrative of the slow growth of constitutionalism and popular liberty within its limits. Its influence on the general history of Europe ceased when the old empire was dissolved. In the new German empire it was too completely overshadowed by Prussia to have any objective importance by itself. Frederick lived 12 years after the division of his kingdom. The commercial and industrial interests of the country continued to be fostered, but only a few of the most unavoidable political reforms were granted. Religious equality was extended to the Reformed Church in 1818, and the separate diet of Upper Lusatia was abolished. Frederick Augustus was succeeded in 1827 by his brother Anthony who initiated a few unimportant reforms An active opposition began to make itself evident in the diet and in the press, and in 1830, under the influence of the July revolution in Paris, riots broke out in Leipzig and Dresden, and a constitution was promised. After consultation with the diet the king promulgated, on Sept. 4, 1831, a new constitution by which the feudal estates were replaced by two chambers, largely elective, and the privy council by a responsible ministry of six departments.

While Saxony's political liberty was thus enlarged, its commerce and credit were stimulated by its adhesion to the Prussian Zollverein and by the construction of railways. Anthony had died in 1836, and Frederick Augustus II., since 1830 co-regent, became sole king. The burning questions were the publicity of legal proceedings and the freedom of the press; and on these the government sustained its first heavy defeat in the lower chamber in 1842. In 1843 the prime minister Lindenau was forced by the action of the aristocratic party to resign, and was replaced by Julius Traugott von Konneritz (1792–1866), a statesman of reactionary views. This increased the opposition of the Liberal middle classes to the Government. Religious considerations arising out of the attitude of the Government towards the "German Catholics," and a new constitution for the Protestant Church, began to mingle with purely political questions.

Warned by the sympathy excited in Saxony by the revolutionary events at Paris in 1848, the king dismissed his reactionary ministry, and a Liberal cabinet took its place in March 1848. The privileges of the nobles were curtailed; the administration of justice was put on a better footing; the press was unshackled; publicity in legal proceedings was granted; trial by jury was introduced for some special cases; and the German Catholics were recognized. The feudal character of the first chamber was abolished, and its members made mainly elective from among the highest tax-payers, while an almost universal suffrage was introduced for the second chamber. The first demand of the overwhelmingly democratic diet returned under this reform bill was that the king should accept the German constitution elaborated by the Frankfort parliament. Frederick, alleging the danger of acting without the concurrence of Prussia, refused, and dissolved the diet. The public demonstration at Dresden in favour of the Frankfort constitution was prohibited on May 2, 1849. The people seized the town and barricaded the streets; Dresden was almost destitute of troops; and the king fled to the Konigstein. The rebels then appointed a provisional Government, consisting of Tzschirner, Heubner and Todt, though the true leader of the insurrection was the Russian Bakunin. Meanwhile Prussian troops had arrived to aid the Government, and after two days' fierce street fighting the rising was quelled. The bond with Prussia now became closer, and Frederick entered with Prussia and Hanover into the temporary "alliance of the three kings"; but in 1850 he accepted the invitation of Austria to send deputies to the restored federal diet at Frankfort. The first chamber immediately protested against this step, and refused to consider the question of a pressing loan. The king retorted by dissolving the diet and summoning the old estates abolished in 1848. Beust became minister for both home and foreign affairs in 1852, and under his guidance the policy of Saxony became more and more hostile to Prussia and friendly to Austria.

The sudden death of the king in 1854 left the throne to his brother John whose name is known in German literature as a translator and annotator of Dante. His brother's ministers remained but their views gradually became somewhat liberalized with the spirit of the times. Beust, however, still retained his federalistic and philo-Austrian views. When war was declared between Prussia and Austria in 1866, Saxony took the side of Austria. On the conclusion of peace Saxony lost no territory, but had to pay a war indemnity of 10,000,000 thalers, and was compelled to enter the North German Confederation.

Franchise. — During the peace negotiations Beust had resigned and entered the Austrian service, and on Nov. 15 the king in his speech from the throne announced his intention of being faithful to the new Confederation as he had been to the old. On Feb 7, 1867, a military convention was signed with Prussia which placed the army under the king of Prussia. The postal and telegraph systems were also placed under the control of Prussia, and the representation of the Saxon cro n at foreign courts was merged in that of the Confederation. A new electoral law reformed the Saxon diet by abolishing the old distinction between the various "estates" and lowering the qualification for the franchise; the result was a Liberal majority in the lower house and a period of civil and ecclesiastical reform. John was succeeded in 1873 by his elder son Albert (1832–1902) who had added to his military reputation during the war of 1870. Under this prince the course of politics in Saxony presented little of general interest, except perhaps the spread of the doctrines of Social Democracy, which was especially remarkable in Saxony. The number of Social Democratic delegates in a diet of 80 members rose from 5 in 1885 to 14 in 1895. So alarming did the growth appear, that the other parties combined, and on March 28, 1896, a new electoral law was passed, introducing indirect election and a franchise based on a triple division of classes determined by the amount paid in direct taxation. This resulted in 1901 in the complete elimination of the Socialists from the diet. On June 7, 1902, King Albert died, and was succeeded by his brother as King George. An extraordinary situation had been created by the electoral law of 1896. This law had in effect secured the misrepresentation of the mass of the people in the diet, the representation of the country population at the expense of that of the towns, of the interests of agriculture as opposed to those of industry. The result was displayed in the elections of 1903 to the German imperial parliament, when, under the system of universal suffrage, of 23 members returned 22 were Social Democrats. This led to proposals for a slight modification in the franchise for the Saxon diet (1904), which were not accepted. In the elections of 1906, however, only 8 of the Social Democrats succeeded in retaining their seats. In 1907 the Government announced their intention of modifying the electoral system in Saxony by the adding of representation for certain professions to that of the three classes of the electorate. This was, however, far from satisfying the parties of the extreme Left, and the strength of Social Democracy in Saxony was even more strikingly displayed in 1909 when, in spite of plural voting, under a complicated franchise, 25 Socialist members were returned to the Saxon diet.

King George died on Oct. 15, 1904, and was succeeded by his son as King Frederick Augustus III., under whom the conflict about the constitution continued. The Left demanded a reform of the first chamber, the upper house, which should break the predominance of the agrarians in that house and allow to commerce, industry and handicrafts a greater influence. This was reinforced in 1917 by the agitation of the extreme Left in the diet for the early conclusion of peace.

The Revolution. — On Oct. 26, 1918, the cabinet gave place to a more liberal government under Dr. Heinze. On Nov. 9, 1918, when the revolution broke out, King Frederick Augustus abdicated, and was later compensated by a grant of 300,000 marks. A new republican constitution was adopted on Nov. 1, 1920, but the revolutionary agitation remained active. Max Holz, the most famous guerrilla leader of the communists, was at last defeated and captured early in 1921. In 1923 the strong revolutionary feeling of the Saxons was shown by the proceedings of the Zeigner ministry which depended upon an alliance of socialists and communists against the bourgeoisie and large capitalists It was expelled from office by the reich government who occupied the country with troops and replaced the ministry by a conservative coalition. In 1924 Zeigner was condemned to three years' imprisonment on a charge of bribery and destroying official documents.

The excesses of the communists and the violence of the conflicts in the alternating control by radicals and reactionaries for half a century in Saxony facilitated the seizure of power by the national socialists in 1933.

The chief authority for the early history of Saxony is Widukind, whose *Res gestae Saxonicae* is printed, together with the works of other chroniclers, in the *Monumenta Germaniae historica, Scriptores*. Collections which may be consulted are: *Codex diplomaticus Saxoniae regiae* (Leipzig. 1862–79); the *Archiv fur die sächsische Geschichte*, edited by K. von Weber (Leipzig. 1862–79); the *Biblzotlzek der sächsischen Geschichte und Landeskunde*, edited by G. Buchholz (Leipzig, 1903); and the *Bibliographie der Sächsischen Geschichte* (Leipzig, 1918, *et sqq.*, published by the *Sächsische Kommission für Geschichte*). See GERMANY. *bibliography.*

SAXOPHONE, a modern hybrid musical instrument invented by Adolphe Sax, having the clarinet mouthpiece with single reed applied to a conical brass tube. In general appearance the saxophone resembles the bass clarinet, but the tube of the latter is cylindrical and of wood; both instruments are doubled up near the bell, which is shaped somewhat like the flower of the gloxinia. The mouthpiece in both is fixed to a curved tube at right angles to the main bore. In the case of the saxophone, however, owing to its conical bore, the quality of tone materially differs from that of the clarinet. The reed mouthpiece in combination with a conical tube allows the performer to give the ordinary harmonic series unbroken, which means in practice that the octave or second member of the harmonic series is first overblown. The saxophone is therefore one of the class known as octave instruments. The fundamental note given out by the tube when the lateral holes are closed is that of an open organ pipe of the same length, whereas when, as in the clarinet family, the reed mouthpiece is combined with a cylindrical bore, the tube behaves as though it were closed at one end, and its notes are an octave lower in pitch. Hence the bass clarinet to give the same note as a bass saxophone would need to be only half as long. The quality of tone of this family of instruments is inferior to that of the clarinets and has affinities with that of the harmonium. According to Berlioz it had kinship also uith the timbre of the 'cello and cor anglais, with, however, a brazen tinge.

The saxophone has not enjoyed much favour hitherto with high-class composers. though Richard Strauss scored for a quartet of the instruments in his Sinfonia Domestica. In military bands, however. it has proved of great service and it has acquired vogue as a leading member of the jazz orchestra.

SAY, JEAN BAPTISTE (1767–1832), French economist, best known for his law of markets, which remained a central tenet of orthodox economics until the great depression of the 1930s, was born at Lyons on Jan. 5, 1767.

Say's law postulates that supply creates its own demand; hence there can be no general deficiency of effective demand to cause economic depression and unemployment. Actual depression Say attributed to temporarily misdirected production, which must automatically right itself because the overproducers of particular products will suffer losses; they must either redirect their production to conform with consumers' preferences or be forced out of business by continuing losses. An obvious implication of Say's law is the self-adjusting nature of the capitalist system. Consequently there is no need for government intervention in economic affairs.

Say was perhaps the first important economist to distinguish clearly between entrepreneur and capitalist and to assign to the former the creative role of combining the other factors of production — labour, land and capital. His career as a businessman, as well as a professor of economics. contributed to his insight into entrepreneurial activity. He died in Paris on Nov. 15, 1832.

Say's principal work is *Traité d'économie politique* (1st ed., 1803; 6th ed., 1846).

See E. Teilhac, *L'Oeuvre économique de Jean Baptiste Say* (1927); Leo Rogin, *The Meaning and Validity of Economic Theory*, ch. 6 (1956). (D. DD.)

SAY, (JEAN BAPTISTE) LÉON (1826–1896), French statesman and economist, born in Paris on June 6, 1826, was descended from a long line of well-known economists, including J. B. Say (*q.v.*), his grandfather.

After the fall of Napoleon III's empire in 1871, Say entered public life and became influential in the affairs of the third republic. As minister of finance during the 1870s, his outstanding achievement was payment of the huge war indemnity to Germany long before the prescribed time. Say sought to lower taxes and to remove all barriers to internal commerce. He repealed duties on many articles of prime utility, such as paper. and lowered postal rates to facilitate freer communication. He successfully opposed imposition of an income tax.

Say also championed free international trade and in 1880 went to England to negotiate a commercial treaty. With the revival of protectionism in France, Say organized a league against the high price of bread. He was an ardent advocate of *laissez faire* and a bitter antagonist of socialism, and he opposed every attempt at state intervention. He was elected president of the senate in 1880 but resigned from that body in 1889 in the belief that his efforts for liberalism were more urgently needed in the chamber of deputies.

Say died in Paris on April 22, 1896.

Throughout his career Say was an indefatigable writer and lecturer on economic subjects. Although he exerted a wide influence on his contemporaries, he was content with the existing framework of economic analysis and made no significant contribution to economic science. He was a prominent member of learned French academies.

A selection of his most important writings appeared posthumously under the title *Les Finances de la France sous la troisième république* (1898–1901).

See G. Michel, *Leon Say* (1900). (D. DD.)

SAY, THOMAS (1787–1834), U.S. Quaker naturalist. often termed "the father of descriptive entomology in America." was born at Philadelphia. Pa., on June 27, 1787. He was an original member of the Philadelphia Academy of Natural Sciences. founded in 1812; and after various activities. including two expeditions to the Rocky mountains. he became curator of the American Philosophical society in 1821 and was professor of natural history at the University of Pennsylvania from 1822 to 1828. During this period he took part in other expeditions, and with Robert Owen unsuccessfully attempted to found an ideal community at the village of New Harmony. Ind.. where he spent the remainder of his life. dying there on Oct. 10, 1834.

His work was almost entirely taxonomic and his writings for the most part purely descriptive. His entomological papers in various journals were collected by J. L. Le Conte and published in two volumes: *The Complete Writings of Thomas Say on the Entomology of North America* (1859). His works on conchology were collected by W. G. Binney and published in 1858 as *The Complete Writings of Thomas Say on the Conchology of the United States*, with 7j plates, many of them drawn by his wife. His paleontological writings were reprinted in 1896 by G. D. Harris in *Bulletin of American Paleontology*, vol. 1, no. v.

(ED. HE.)

SAYAD, a descendant of Ali, the son-in-law of Mohammed, by Fatima, Mohammed's daughter. Many of the Pathan tribes in West Pakistan, such as the Bangash of Kohat and the Mishwanis of the I-Iazara border, claim Sayad origin. The apostles who completed the conversion of the Pathans to Islam were called Sayads if they came from the west, and Sheikhs if they came from the east; hence doubtless many false claims to Sayad origin. In Afghanistan the Sayads have much of the commerce in their hands, as their holy character allows them to pass unharmed where other Pathans would be murdered.

The Sayads reigned at Delhi during the first half of the 15th century. Their name again figures in Indian history at the breakup of the Mogul empire, when two Sayad brothers created and dethroned emperors at their will (1714–1720).

SAYAN MOUNTAINS, in central Asia, forming the eastern continuation of the Sailyugem or Altai range, stretching from 89° E. to 106" E. They are the border ridge between the plateau of northwest Mongolia and Siberia. The geology is imperfectly known; the mountains are of the Hercynian age. The general elevation is 7,000 to 9,000 ft.; peaks, consisting largely of granites and metamorphic rocks, reach 10,000 ft. and 11,457 ft., *e.g.,* in Munku Sardyk; and the principal passes lie at 6,000 to 7,500 ft. above the sea; *e.g.,* Muztag 7,480 ft., Mongol 8,432 ft., Tenghyz 7,480 ft. and Obo-sarym 6,100 ft. In 92° E. the system is pierced by the Bei-kem or upper Yenisei, and in 106° E., it terminates above the depression of the Selenga-Orkhon valley. From the Mongolian plateau the ascent is gentle, but from the plains of Siberia it is much steeper, despite the fact that the range is masked by a broad belt of subsidiary ranges; *e.g.,* the Usinsk, Oya, Tunkun, Kitoe and Belaya ranges. Between the breach of the Yenisei and the Kosso-gol (lake) in 100° 30' E. the system bears also the name of Yerghik-taiga. The higher regions carry good forests of larch, pitch pine, cedar, birch and alder, with rhododendrons and species of *Berberis* and *Ribes.* Lichens and mosses clothe many of the boulders that are scattered around about the upper slopes.

SAYAT-NOVA (pseudonym of ARUTHIN SAYADIAN) (1712–1795), Armenian troubadour, famous for his love songs, was born at Tiflis. He worked first as a weaver and later (1750–65) became the court minstrel of Irakli II of Georgia. In 1770 he entered a monastery in Haghbat, and he was martyred in 1795 by the Persian invaders of Georgia.

Most of his extant songs are in Azeri Turkish, the rest in Armenian and Georgian. (C. J. F. D.)

SAYCE, ARCHIBALD HENRY (1845–1933), British philologist, whose services to Babylonian and Assyrian scholarship cannot be overestimated, was born at Shirehampton on Sept. 25, 1815. He was educated at Bath, and at Queen's college, Oxford, becoming a fellow in 1869.

In 1870 he was ordained. From 1891 to 1919 he was professor of Assyriology at Oxford. He was a member of the Old Testament Revision company (1874–84); deputy professor of comparative philology in Oxford (1876–90); Hibbert lecturer (1887); Gifford lecturer (1900–02 j.

Sayce died on Feb. 4, 1933, at Bath.

Among his more important works are: *Assyrian Grammar* (1872); *Principles of Comparative Philology* (1874); *Introduction to the Science of Language* (1879); *Early History of the Hebrews* (1897); *Israel and the Surrounding Nations* (1898); *Babylonians and Assyrians* (1900); and *Archaeology of the Cuneiform Inscriptions* (1907). He also contributed important articles to *Encyclopædia Britannica* and published his *Reminiscences* in 1923.

SAYE AND SELE, WILLIAM FIENNES, 1ST VISCOUNT (1582–1662), was the only son of Richard Fiennes, 7th Baron Saye and Sele, and was descended from James Fiennes, Lord Saye and Sele, who was lord chamberlain and lord treasurer under Henry VI and was beheaded by the rebels under Jack Cade on July 4, 1450.

Fiennes was educated at New College, Oxford; he succeeded to his father's barony in 1613, and in parliament opposed the policy of James I, undergoing a brief imprisonment for objecting to a benevolence in 1622, and he showed great animus against Lord Bacon. In 1624 he was advanced to the rank of a viscount. In the'early parliaments of Charles I he was in Clarendon's words "the oracle of those who were called Puritans in the worst sense, and steered all their counsels and designs." His energies found a new outlet in helping to colonize Providence Island. and in interesting himself in other and similar enterprises in America. Although Saye resisted the levy of ship money, he accompanied Charles on his march against the Scots in 1639; but, with only one other peer, he refused to take the oath binding him to fight for the king to "the utmost of my power and hazard of my life."

When the Civil War broke out, however, Saye was on the committee of safety, was made lord lieutenant of Gloucestershire, Oxfordshire and Cheshire and, raising a regiment, occupied Oxford. He was a member of the committee of both kingdoms; was mainly responsible for passing the Self-Denying ordinance through the house of lords; and in 1647 stood up for the army in its struggle with the parliament. In 1648, both at the treaty of Newport and elsewhere, Saye was anxious that Charles should come to terms, and he retired into private life after the execution of the king, becoming a privy councilor again upon the restoration of Charles II. He died at his residence. Broughton castle near Banbury, on April 14, 1662. On several occasions Saye outwitted the advisers of Charles I by his strict compliance with legal forms. He was a thorough aristocrat, and his ideas far the government of colonies in America included the establishment of an hereditary aristocracy.

Old Saybrook in Connecticut is named after Viscount Saye and Lord Brooke.

SAYERS, TOM (1826–1865), English middleweight boxing champion, was born on May 25, 1826, at Pimlico, Eng. In 1849 he left bricklaying to become a fighter. Despite his size (height 5 ft. 8½ in.; weight 155 lb.), the "Little Wonder" often fought much bigger opponents, yet he lost only one bout during the ten years he fought—that to Kat Langham on Oct. 18, 1853, in 61 rounds.

In 1860, in the first international heavyweight title match in boxing history, he fought America's great champion John C. Heenan. Although he was outweighed by 40 lb. and was nine years older, Sayers was made the 2 to 1 betting favourite over Heenan. The fight lasted 2 hr. 20 min. and after 42 rounds ended in a draw when Sayers injured his right arm. Sayers then retired from the ring, and the British raised £3,000 (about $15,000) by public subscription for him.

He died on Nov. 8. 1865. (J. D. McC.)

SAYYID AHMAD KHAN, SIR (1817–1898), distinguished Indian Moslem scholar and educationist, was born in Delhi on Oct. 17, 1817. After his father's death in 1836, against the wishes of his family, he entered the civil service. During the Indian Mutiny (1857–58) he was instrumental in saving the lives of many Europeans by sending them, at great risk to himself, into safety at Meerut. The government awarded him a pension and he was appointed a companion of the Star of India (being made knight commander in 1888). In 1869 he visited England with his two sons in order to make arrangements for their education. On his return to India he founded a college at Ghazipur in which western methods of instruction were adopted and the teaching was carried on in English. In spite of the opposition of the more conservative Moslems, he was so successful that in 1875 he opened the Mohammedan Anglo-Oriental college at Aligarh. Although he retired from public life in the following year, he accepted membership of the legislative council of India (1878–82). Until his death at Aligarh on March 2, 1898, the rest of Sir Sayyid's life was occupied by literary research and the advancement of his college, which received its first charter as a university in 1920.

See G. F. I. Graham, *The Life and Work of Sir Syed Ahnted Khan* (1909); J. M. S. Baljon, Jr., *The Reforms and Religious Ideas of Sir Sayyid Ahmad Khan* (1949). (S. J. C.)

SAZONOV, SERGHEI DMITRIEVICH (1866–1927), Russian statesman, was born in the province of Ryazan, July 29, 1866, the son of a landed proprietor, and educated at the Alexandrovsky Lyceum, St. Petersburg (Leningrad), a high school for the sons of noblemen destined mainly for the civil service. Having occupied various diplomatic posts in Rome and served six years in the Russian Embassy in London he was promoted, in 1906, to be Minister-Resident at the Vatican, where his engaging manners, frankness and taste for ecclesiastical affairs enabled him to make great headway. In 1909 he entered the Ministry of Foreign Affairs as coadjutor to Izvolsky, whom he succeeded as Minister in 1910—an appointment ascribed to the influence of his brother-in-law, Stolypin.

Sazonov's line of action was definitely traced for him by the European situation on the one hand and by the limitation of his rôle to that of confidential secretary to the Emperor on the other. His chief functions were to parry Austria's fitful thrusts at Serbia, to curb Serbia's explosive impatience, buoying her up with hopes of a vast legacy to fall due on the death of the Emperor Francis Joseph, and to bespeak the help of England. Italy, Rumania (to whom he also held out hopes of a legacy) and Bulgaria in the coming struggle. These tasks exceeded his powers, and his abortive Near-Eastern policy did not prevent Russia's ruinous collapse during World War I. Yet if his work was not to prove permanent he carried it out with considerable skill, and defended himself ably in his memoirs against the charge that he was seeking to precipitate a World War; although he admitted knowledge of the fact that Hartwig, in Belgrade, was working against his avowed aims. Meanwhile, Sazonov genuinely worked for present peace, to gain time for Stolypin's far-reaching domestic reforms and to allow Russia to consolidate her insecure domestic and military situation.

The arrangements arrived at during the tsar's visit to Potsdam (Nov. 4–5, 1910) and the kaiser's return visit to Wolfsgarten (Nov. 11) respecting the Baghdad railway, North Persia and the maintenance of Turkey, eased the strain, but failed to dispel the atmosphere of mistrust. Sazonov was suspected of a lack of straightforwardness by the kaiser. Russia's diplomatic representatives abroad were largely to blame for this. Other covert moves also lent colour to the charges of underhand dealing. For example, on the conclusion of the Balkan alliance of 1912. Sazonov decided to seek Germany's help in overawing the Balkan states and thus preserving peace. He accordingly arranged an interview between the tsar and the kaiser at Baltischport on July 4–5, 1912, which mas followed by a three days' exchange of views between the German chancellor and the members of the Russian government in St. Petersburg. Yet he concealed from Germany the existence of the Balkan alliance which had been communicated to him. Sazonov next repaired to London, Paris and Berlin and the Great Powers authorized Berchtold and him to announce their determination to uphold the *status quo,* so that if the Balkan states broke the peace their victory would be fruitless. The veto was successfully ignored by the Balkan powers, and a European crisis was the result.

Sazonov was next employed in drafting, with Bethmann Hollweg, a scheme of reforms for Armenia (Nov. 5, 1913). Immediately afterward. a fresh conflict with Germany arose over the dispatch of General Liman von Sanders to Constantinople. Sazonov gave vent to his dissatisfaction in unusually strong terms, but on the kaiser ordering Liman to lay down the command of the first Turkish army corps. while retaining his other functions, Nicholas II let the matter drop. Sazonov then drafted a memorandum to the tsar on Russia's claim to the freedom of the Straits and three months later convened a council of political and military experts to discuss the ways and means of realizing the scheme in case of a European war. But the military experts announced that in the plans of campaign no such side-problems could be included.

On learning of the Austro-Hungarian ultimatum to Serbia on July 24, 1914, Sazonov appealed unsuccessfully to Austria to extend the time limit. and advised Serbia to accept all demands except those concerning its sovereign rights. Meanwhile, Russia adopted the military measures known as "premobilization" (July 2j), the tsar and Sazonov planning a partial mobilization to follow in case Serbia should be attacked. But the general staff objected that with no plan ready for a transition from partial to general mobilization, and with war seeming unavoidable, the latter was imperative. Sazonov insisted on waiting; meanahile Berchtold declared war against Serbia (July 28), whereupon Sazonov (in the night of July 28–29) advised the tsar to sign the order.

A belated telegram. however, from the kaiser adjuring him to preserve peace for the sake of the monarchic principle moved the tsar to nithdraw the order for general, and substitute that for partial, mobilization. This command was obeyed in words but the military experts having convinced Sazonov that it would be suicidal, the minister next morning (July 30) presented himself to the tsar and obtained his consent to the radical measure advocated by the general staff. Next morning this order was posted and the catastrophe, already inevitable, broke loose.

During the war Sazonov countered all influences tending to the abandonment of the struggle by Russia, but he followed the tsar's lead in demanding first the opening of the Straits and the internationalization of Constantinople and later on the annexation of the Turkish capital. The hostility of Turkey and Bulgaria impeded assistance from the Allies, whereupon Sazonov made a bid for the help of the Poles in the shape of a Home Rule scheme, but the proposal was scouted in court circles and he was dismissed. His fall was gently broken by his appointment as ambassador to Great Britain, but before he reached his destination the revolution of hlarch 1917 had deposed the tsar. Sazonov, however, represented the government that had deposed the tsar, but it too was suddenly swept away. He was next appointed minister for foreign affairs by Admiral Kolchak; but after 1920 he retired into private life, settling at Versailles, where he occupied himself in writing his memoirs (Eng. trans., *Fateful Years,* 1928). Sazonov died at Nice. Dec 23, 1927.

SBEITLA (anc. SUFETULA), a ruined city of Tunisia, 66 mi. S W. of Kairawan. The chief ruin is the Forum. 238 ft by 198 ft., having three small and one large entrance. The great gateway is a fine monumental arch in fair preservation, with an inscription to Antoninus Pius. Facing the arch, their rear walls forming one side of the enclosure, are three temples, connected with one another by arches, and forming one design. The length of the entire façade is 118 ft.

The principal chamber of the central temple, which is of the Composite order, is 44 ft. long; those of the side temples, in the Corinthian style, are smaller. The walls of the middle temple are ornamented with engaged columns; those of the other buildings with pilasters. The porticos have been repaired, and run round the other three sides of the enclosure, which is still partly paved. The other ruins include baths, remains of a theatre, an amphitheatre, a triumphal arch of Diocletian, two churches of the priest Servas and the bishop Bellator, a chapel of the bishop Jucundus (411–419), a still serviceable bridge which also carried an aqueduct, and several square Byzantine forts.

The early history of Sufetula is preserved only in certain inscriptions. Under Antoninus and Marcus Aurelius it was a flourishing city, the district, now desolate, being then very fertile and covered with forests of olives. It was partly rebuilt during the Byzantine occupation and became a centre of Christianity. At the Arab invasion it was the capital of the exarch Gregorius.

SCABIES or ITCH, a skin disease caused by a species of mite, *Sarcoptes scabiei.* In addition to the variety that lives in the skin of man, physiological varieties of *S. scabiei* parasitize monkeys, cattle, horses, swine and certain other animals; occasionally man may receive transitory infections through contact with animals. There are also several other species of itch or mange mites that live on or in the skin of domestic and mild animals and birds. The fertilized female of S. *scabiei* burrows into the horny layer of the skin. Eggs are deposited in the burrow; the succeeding stages include the larva. nymph, adult male and female. Larvae and nymphs are found in the hair follicles. Mating occurs on the surface of the skin, and it is the newly fertilized female that passes from the infected person to a new victim. Such transmission usually results from bodily contact.

The disease is characterized by intense itching (especially at night), rash, follicular papules and vesicles. Scratching may lead to secondary bacterial infections. One remedy is to apply sulfur ointment following a hot bath. More effective treatment is obtained through application of an emulsion or lotion containing benzyl benzoate or hexachlorocyclohexane in coconut oil or in vanishing cream. Domestic animals may be treated with sprays or dips containing benzyl benzoate, hexachlorocyclohexane or tetraethylthiuram monosulfide. (L. E. R.)

SCABIOSA, a genus of about 80 species of Eurasian annual or perennial herbs belonging to the teasel family (Dipsacaceae), and commonly grown in gardens for ornament under the names of scabios, mourning bride or pincushion flower. In medieval times preparations of the plant were used medicinally, primarily to allay itching, hence the derivation of the generic name from the Latin *scabiosus,* meaning itchy, mangy or scabby.

The annual sweet scabios (*S. atropurpurea*) and its variants and the perennial pincushion flower (*S. caucasica*) are the commonest sorts: available in a wide range of colours (exclusive of brilliant red, deep yellow, orange or brown). Other perennial species frequently grown are *S. graminifolia* with grasslike leaves and lavender-blue flowers; *S. ochroleuca* with yellowish-white flowers; *S. columbaria* with lilac flowers; and *S. fischeri* with bluish-purple flowers. Most scabiosas grow to heights of 1½ to 3 ft., have toothed or lobed leaves, and produce almost globular to conical showy flower heads, usually 1 to 3 in. across. They are excellent as cut flowers.

Scabiosas are easily grown in ordinary garden soil in a sunny location. Seed may be planted in midspring; if pinched back when small the resulting bushy plants will produce blooms all summer if old flower heads are removed. The perennials, after two or three years' growth, may be increased by root division in early spring.

The garden plant known as shepherd's- or sheep's bit scabious is *Jasione perennis,* a member of the bellflower family. (G. H. M. L.)

SCAEVOLA, the name of a famous family of ancient Rome, the most important members of which were:

1. GAIUS MUCIUS SCAEVOLA, a legendary hero. who volunteered to assassinate Lars Porsena when he was besieging Rome. He reached Porsena's tent, but slew his secretary by mistake. Before the royal tribunal Mucius declared that he was one of 300 noble youths who had sworn to take the king's life, and that he had been chosen by lot to make the attempt first. Threatened with death or torture, Mucius thrust his right hand into the fire blazing upon an altar, and held it there until it was consumed. The king, deeply impressed and dreading a further attempt upon his life, ordered Mucius to be liberated, made peace with the Romans and withdrew his forces. Mucius was rewarded with a grant of land beyond the Tiber, known as the "Mucia Prata" in the time of Dionysius of Halicarnassus, and received the name of Scaevola ("left-handed"). The story is presumably an attempt to explain the name Scaevola (Livy ii. 12 ; Dion. Halic. v. 27–30). The Mucius of the legend is described as a patrician; the following were undoubtedly plebeians.

2. PUBLIUS MUCIUS SCAEVOLA, Roman orator and jurist, consul 133 B.C. during the time of the Gracchan disturbances. He was not opposed to moderate reforms, and refused to use violence against Tiberius Gracchus. After the murder of Gracchus, however, he expressed his approval of the act. He was an opponent of the younger Scipio Africanus, for which he was attacked by the satirist Lucilius (Persius i. 115; Juvenal i. 154). In 130 he succeeded his brother Mucianus as *pontifex maximus.* During his tenure of office he published a digest in 80 books of the official annals kept by himself and his predecessors. Cicero frequently mentions him as a lawyer of repute, and he is cited several times in the Digest. He was also a famous player at ball and the game called Duodecim Scripta; after he had lost a game, he was able to recall the moves and throws in their order.

See A. H. J. Greenidge, *History of Rome.*

3. QUINTUS MUCIUS SCAEVOLA, son of (2), usually called "*Pontifex Maximus,*" to distinguish him from (4), consul in 95 B.C. with L. Licinius Crassus the orator. He and his colleague brought forward the *lex Licinia Mucia de civibus regundis* which closed Roman citizenship to the allies in future, and was largely responsible for the Social War. After his consulship Scaevola was governor of the province of Asia, and dealt severely with the tax-farmers. In honour of his memory the Greeks of Asia set aside a day for the celebration of festivities and games called Mucia. He was subsequently appointed *Pontifcx Maximus,* and, in accordance with custom, dispensed free legal advice, which mas extensively sought, even by men of the standing of Servius Sulpicius. He regulated the priestly colleges, and insisted on observance of the traditional ritual, though he himself believed that religion was only for the uneducated. He was proscribed by the Marian party, and in 82, when the younger Marius, after his defeat by Sulla at Sacriportus, gave orders for the evacuation of Rome and the massacre of the chief men of the opposite party, Scaevola, while attempting to reconcile the opposing factions, was slain at the altar of Vesta and his body thrown into the Tiber. He had already escaped an attempt made upon his life by Gaius Fimbria at the funeral of the elder Marius in 86.

Scaevola was the iounder of the scientific studv of Roman law and the author of a systematic treatise on the subject, in eighteen books, frequently quoted and followed by subsequent writers. It was a compilation of legislative enactments, judicial precedents and authorities, from older collections, partly also from oral tradition. A small handbook called "Ὅροι (*Definitions*) is the oldest work from which any excerpts are made in the *Digest,* and the first example of a special kind of judicial literature (*libri definitionum* or *regularum*). *It* consisted of short rules of law and explanations of legal terms and phrases. A number of speeches by him, praised by Cicero ior their elegance oi diction, were in existence in ancient times.

4. QUINTUS MUCIUS SCAEVOLA (*c.* 159–88 B.C.), uncle of (3), from whom he is distinguished by the appellation of "*Augur.*" He was instructed in law by his father, and in philosophy by the Stoic Panaetius of Rhodes. In 121 he was governor of Asia. Accused of extortion on his return, he defended himself successfully. In 117 he was consul. He was a great authority on law, and at an advanced age he gave instruction to Cicero and Atticus. He had a high appreciation of Rfarius, and refused to vote for Sulla's motion declaring him a public enemy. Scaevola is one of the interlocutors in Cicero's *De oratore, De amicitia* and *De republica.*

For the legal importance oi the Scaevolas, *see* A. Schneider, *Die drei Scaevola Ciceros* (Munich, 1879), with full reierences to ancient and modern authorities.

SCAFELL (pronounced and sometimes written SCAWFELL), a mountain of Cumberland, Eng., in the Lake district (*q.v.*). The name is specially applied to the southern point (3,162 ft. in height) of a certain range or mass, but Scafell pike, separated from Scafell by the steep narrow ridge of Mickledore, is the highest point in England (3,210 ft.). The ridge continues northeast to Great End (2,984 ft.), which falls abruptly to a flat terrace on which lies Sprinkling tarn. The range thus defined may be termed the Scafell mass. Northwest from the pike the lesser height of Lingmell (2,649 ft.) is thrown out, and the steep flank of the range sweeps down to the head of Wastdale. On the east an even steeper wall, with splendid crags, falls to Eskdale. Above Mickledore ridge Scafell rises nearly sheer, with bold clefts.

SCAFFOLD, an elevated platform of temporary nature used to support materials and workmen in the construction or repair of a structure or machine. The term also denotes a platform used for the execution of criminals. The surface of the scaffold consists of one or more planks of convenient size and length. The method of support is varied to suit the immediate need and its form determines the type of scaffolding. Temporary built-up seats for an athletic contest are sometimes referred to as scaffolds but should be called temporary bleachers.

Timber Scaffolding. — In this type of scaffold the support for the planks is provided by a timber frame fabricated and erected at the site. The frame may consist of vertical posts, horizontal longitudinal members called ledgers, transverse members supported by the ledgers, and longitudinal and transverse cross bracing. The planks rest on the transverse members.

The posts are generally arranged in pairs with one post close to the wall and the other about 4 or 5 ft. out from the wall. Pairs of posts are placed along the wall at intervals of from 8 to 12 ft. The pairs are fastened together by ledgers running parallel to the wall and by braces. Transverse members may be cantilevered across the ledgers or may be supported by a ledger and the wall.

The posts are 2×4s for light loads and short spans or 4×4s where heavier frames are needed. The posts are usually supported on a sill resting on the ground.

As with all scaffolding, the timber must be thoroughly braced and should also be tied to the wall by suitable lashings. If a scaffold is carried up on the inside of the wall as well as on the outside, the two should be tied together through window openings to provide greater stability. The vertical spacing of the ledgers is determined by the size of lift or working space desired. The members are fastened together by nails or lashings as custom dictates.

Trestle Supports. — This type is used to carry the staging where little or no adjustment of height needs to be made for each use and where the scaffolding needs to be spread over a large area, as when plastering the ceiling of a house. The trestles may be of special design or may simply be wooden sawhorses of the type used by carpenters. Some specially designed trestles may be adjusted to provide for working heights of from 7 to 18 ft. One type of adjustable trestle is shown in fig. 1.

Putlog Trestles. — This type consists of one A-frame and adjustable vertical support similar to a single-end support of the trestle shown in fig. 1. A horizontal member, the putlog, is supported at one end by the A-frame and at the other end by the wall. Planks span across the putlogs.

Common Trestle. — This type consists of two ladders so hinged that they form an inverted V when opened; they fold together for ease in transporting or storing Two such units provide the end supports for simple or extension planks. The rungs in the ladders are spaced so that adjustments of plank heights may be made about every ten inches. The side rails of one leg of the inverted V may vary in length from 6 to 10 ft.

Extension Trestles. — The basic support unit for this type comprises two ladders similar to those of the common trestle and a third section of ladder in a vertical position and supported by the two inclined ladders forming an inverted Y. These support units may be procured in different heights and each height is adjustable. Two of the inverted Ys may support a plank for the working area or that plank may support one end of several planks to provide a wider working platform.

Scaffold Brackets. — Scaffolding is supported in frame (lumber) construction by brackets attached to the wall. A horizontal member 3 to $3\frac{1}{2}$ ft. long has one end fastened to the nall by nails and the outer end supported by a V-frame at about 45° and nailed to the timber frame. In some cases the horizontal member is so formed that it may be hooked around one of the wall studs (the

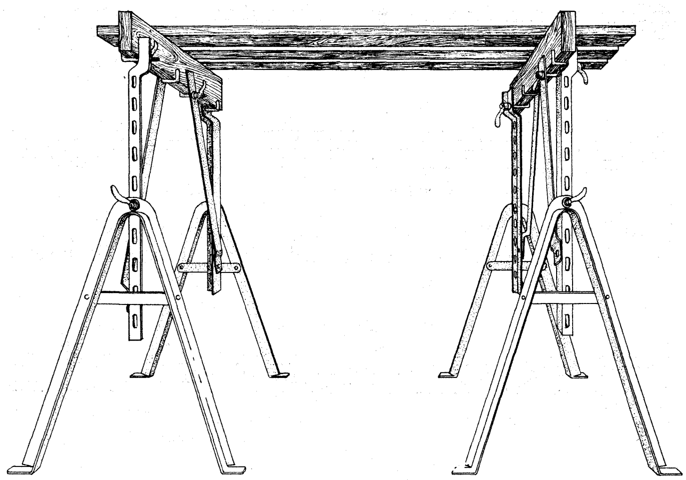


FIG. 1.— STEEL TRESTLE

vertical members in standard frame construction). The horizontal member may be manufactured with a screw end which is placed through a hole in the sheathing and fastened by a wing nut.

The diagonal support is similar in the three types. Special corner brackets are provided to turn the scaffold planks around

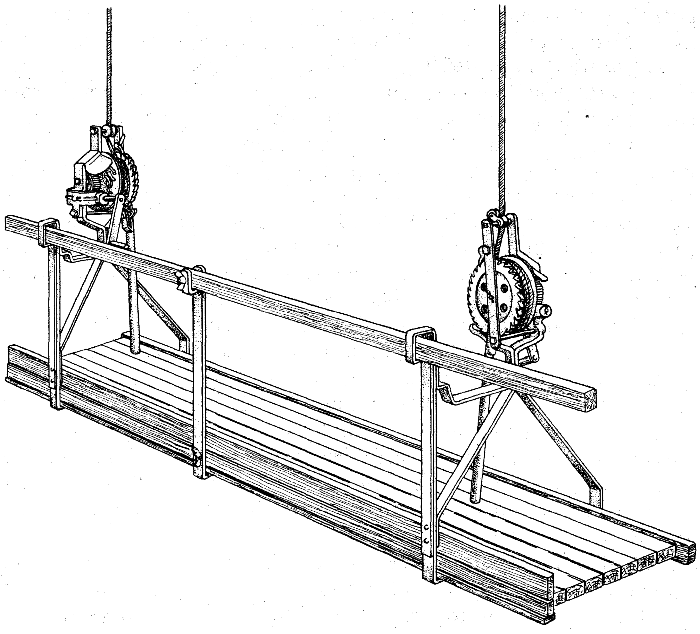


FIG. 2.— SWINGING SCAFFOLDING

a corner. The wall brackets may be folded for ease in handling and storage.

Adjustable **Roofing** Brackets. — These generally consist of a rectangular frame with one member extending beyond the rectangle so it may be held by one or more nails. Attached to the frame are two members which provide an essentially horizontal support for the plank; this triangular frame may be adjusted to provide the horizontal support on a roof of any pitch. Another type of roof bracket provides support for 2×4 staging so the 4-in dimension is normal to the roof surface. This serves as footing for shinglers.

Ladder Jacks. — A ladder jack is a Y-shaped frame with an adjustable bracket which may be placed on the rungs of a ladder to provide support for staging. Two ladders, each with a jack, are used to support one span of plank. The arms of the Y hook over a rung of the ladder and the stem generally extends to the second rung below and may be clipped to it. The bracket may be adjusted to provide horizontal support for staging for different inclinations of the ladder. The jacks may be attached above the ladder or hung underneath. An alternate type hooks around the rails of the ladder instead of around the rungs. Scaffolding provided in this manner is frequently used in painting houses.

Tubular Scaffolding. — Because of its convenience and economy, steel or aluminum tubular scaffolding has very largely replaced timber scaffolding except for installations in remote areas. Tubular scaffolding can easily be erected in any shape, length or height. Furthermore, sections of the tubular scaffolding may be mounted on casters to provide a highly mobile staging. The walkway or working platform generally consists of 2×10 or 2×12 wooden planks. The scaffolding may be enclosed with canvas for protection against the weather. Tubular scaffolding may be purchased or rented.

Two general types of tubular scaffolding are available: (1) Sectional scaffolding which is made up of standard end frames fastened together with diagonal and horizontal braces; in some cases a horizontal member, known as a bridging trestle, may be attached to the end frames. The end frames are usually about 5 ft. wide and vary in height from 3 to 10 ft. They are available in several patterns depending upon specific use. The diameter of the tubing in the end frames is about $1\frac{5}{8}$ in. (2) The second type comprises pipes or tubing of 2 to $2\frac{1}{2}$ in. diameter in lengths of 6 to 20 ft. and fastened together by couplers to form rigid frames, The standard coupler fastens members meeting at right angles and the adjustable coupler fastens members meeting at other than right angles. The scaffolding planks are supported by the "bearer." the horizontal tube connecting posts in the direction generally perpendicular to the wall. This type can easily be assembled to encompass a blast furnace or smokestack.

Suspended Scaffolding.—This type consists of a horizontal putlog attached to two drum mechanisms. Cables extend from each drum to an outrigger beam attached overhead to the structure frame. Ratchet devices on the drums permit the raising or lowering of the putlogs, which are spaced 6 to 9 ft. apart. Planks span between putlogs and provide the working surface. An outside guardrail and kick board are generally required. In some cases an attachment is provided for supporting an overhead protecting plank. The drum mechanisms are equipped with 100 to 150 ft. of $\frac{1}{2}$ in. diameter galvanized steel wire rope.

A second and lighter form of suspended scaffolding has a supporting device in the form of a stirrup about 30 in. wide with vertical legs attached to a single lifting drum. The wire rope from the drum is attached overhead to an outrigger or cornice hook. The staging, about 10 to 12 ft. long, is supported by a stirrup near each end. Guardrails and kick boards complete the assembly. The scaffolding may be raised or lowered by a ratchet mechanism on the drum and operated by the workman on the scaffolding.

Tubular Hoisting Tower.—Steel tubes or pipes about 3 in. in diameter nith standard connections may be quickly assembled into tubular hoisting towers. Pipe of different weight (standard, extra heavy or double extra heavy) is used depending upon the function of the section and its vertical position in the tower. A member may be attached to one leg to form a "Chicago boom," the leg of the tower forming the mast.

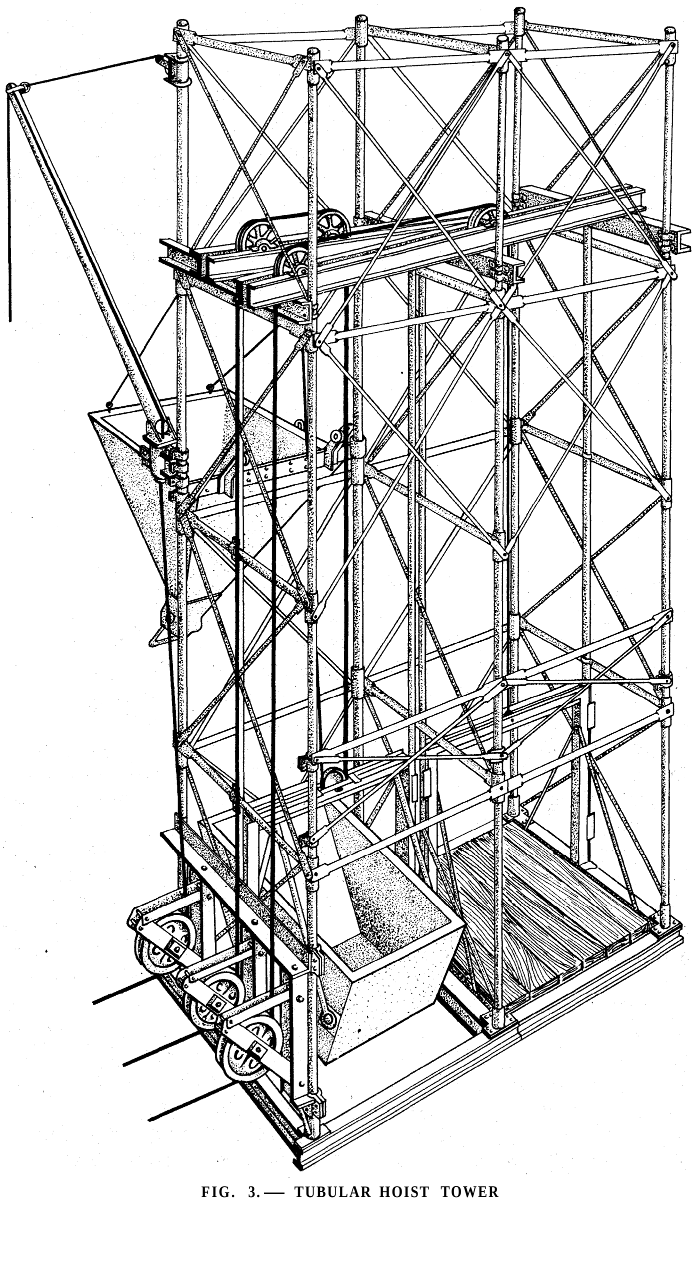


FIG. 3.— TUBULAR HOIST TOWER

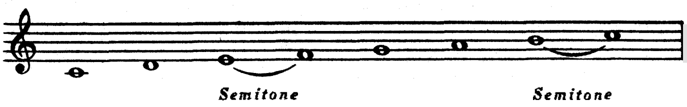
Shoring.—The sectional tubular scaffolding units may be used to form the shoring for concrete forms. The end frames are mounted on adjustable bases which rest on a timber plate or other firm support. (F. W. St.)

SCALE, in music, signifies any selected sequence of notes or intervals dividing the octave. This is a theoretical conception by which the material of an existing or a historical practice can be systematized for readier understanding and explanation. Theoretically, the octave can be divided into a number of microtones; *i.e.,* tones smaller than a semitone. In antiquity and currently in the orient. but not to any marked extent in the west. intervals smaller than a semitone were in regular use. Such a practice yields a scale that is unfamiliar to the modern western listener.

Pentatonic Scale.––Many historical and some existing traditions of music make use of five notes only (with their octave transpositions) and such a practice yields a pentatonic scale. This is a "gapped" scale: *i.e.,* a scale containing intervals of more than a tone. One of the more familiar pentatonic scales is the equivalent of the black notes of the keyboard.

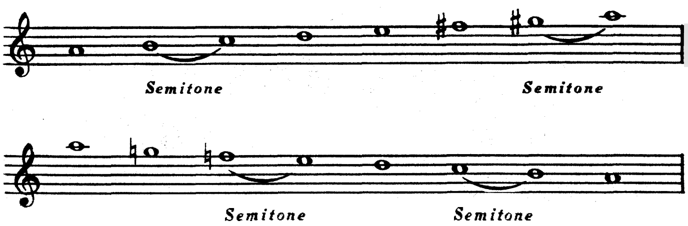
Diatonic Scale.—The division of the octave into seven notes appears very early in western music. Medieval musicians employed a variety of seven-note scales, known as modes. These contained two semitone intervals that occurred in a different relation to the "final" in each mode. Two modes, the Ionian and the Aeolian (in a slightly modified form), remain in general use as the diatonic major and minor scales. In each major and each minor scale the semitone intervals occur in the same relation to the key note (or tonic). In the major scale the semitones occur between notes 3–4 and 7–8.

Ex. 1.



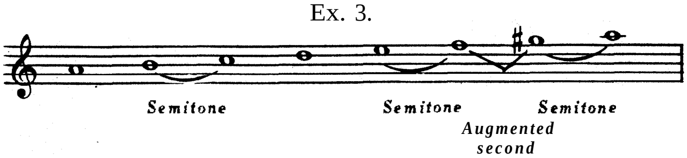
The minor scale has two forms, the "melodic minor" and the "harmonic minor." In the melodic minor the semitones occur between notes 2–3 and 7–8 ascending and between notes 6–5 and 3–2 descending.

Ex. 2.



In the harmonic minor the semitones occur between 2–3, 5–6 and 7–8, with the interval of an augmented second (a tone plus a semitone) between notes 6–7.

Ex. 3.



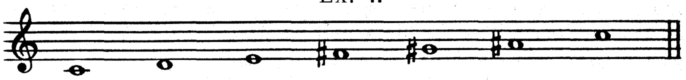
In all forms of the diatonic scale the names given to the degrees of the ascending scale are: 1. tonic; 2. supertonic; 3. mediant; 4. subdominant; 5. dominant; 6. submediant; 7. leading note.

The chromatic scale, which comprises all the 12 semitones in the octave, can be considered as a "colouring" of the diatonic scale. The medieval musician regarded the notes C and C sharp. for example, not as separate notes but as two aspects of one note. This could be written as C and altered in performance "by reason of necessity or of beauty." At a later date, owing to the practice of equal temperament, diatonic scales were built on any of the 12 notes of the octave. In the late 19th century the extreme use of chromaticism (*q.v.*) brought about the partial destruction of diatonic tonality.

The scale of "12-note," or dodecaphonic, music (*see* DODECAPHONY) uses the notes of the chromatic scale but does not permit the establishment of any tonal centre.

The whole-tone scale is often associated with Debussy, although it had been used as early as the 18th century by Mozart (in a sextet called "A Musical Joke"). As its name implies, it is a scale without semitones and consequently consists of only six notes.

Ex. 4.



Other experimental scales have been evolved by 19th and 20th century composers.

See also MUSIC.

SCALE INSECT (SOFT SCALE), the name given to insects belonging to the family Coccidae of the order Hemiptera (*q.v.*). The females are inert wingless creatures usually with reduced legs and antennae. while the males are provided with a single pair of wings and have the legs and antennae well developed. Soft scales include a number of serious plant pests. among the most injurious being the San José scale, the oyster shell scale. the scurfy scale, the purple and red scale of citrus. and the mealy bugs. On the other hand; other species have a commercial value, notably the cochineal (*q.v.*) insect. the lac (*q.v.*). insect and the so-called ground pearls.

SCALES: *see* WEIGHING MACHINES.

SCALIGER, the Latinized name of the Della Scala family. (*See* VERONA.) It has also been borne by two eminent scholars.

1. Julius Caesar Scaliger (1484–1558) was, according to his own account, a scion of the house of La Scala, born in 1484 at the castle of La Rocca on the Lago de Garda At the age of twelve his kinsman the emperor Maximilian placed him among his pages. He remained for seventeen years in the service of the emperor, distinguishing himself as a soldier and as a captain But he was unmindful neither of letters, nor of art, which he studied under Albrecht Durer. In 1512 at the battle of Ravenna, where his father and elder brother were killed, he displayed prodigies of valour, and received the highest honours of chivalry, but no substantial reward, from his imperial cousin. After a brief employment by the, duke of Ferrara, he entered (1514) as a student at the university of Bologna, where he remained until 1519 The next six years he passed in Piedmont, as a guest of the family of La Rovère, until a severe attack of rheumatic gout brought his military career to a close. Henceforth his life was wholly devoted to study. In 152j he accompanied M. A. de la Rovère, bishop of Agen, to that city as his physician. Such is the outline of his own account of his early life. It was not until after his death that his son's enemies first alleged that he was the son of Benedetto Bordone, an illuminator or school-master of Verona; that he was educated at Padua, where he took the degree of M D.; and that his story of his life and adventures before arriving at Agen was a tissue of fables. (*See* below *ad fin*)

The remaining thirty-two years of his life were passed almost wholly at Agen. in the full light of contemporary history. At his death in 1j58 he had the highest scientific and literary reputation of any man in Europe. A few days after his arrival at Agen he fell in love with Andiette de Roques Lobejac, and at forty-five he married Andiette, who was then sixteen The marriage, of which there were fifteen children, was one of almost uninterrupted happiness. In 1531 he printed his first oration against Erasmus, in defence of Cicero and the Ciceronians It is a piece of vigorous invective, displaying an astonishing command of Latin, and much brilliant rhetoric, but full of vulgar abuse, and completely missing the point of the *Ciceronianus* of Erasmus The second is even more abusive, and less successful. The orations were followed by a prodigious quantity of Latin verse, which appeared in successive volumes in 1533, 1534, 1539, 1546 and 1547; of these, a friendly critic, Mark Pattison, is obliged to approce the judgment of Huet, who says, "par ses poésies brutes et informes Scaliger a déshonoré le Parnasse." A brief tract on comic metres (*De comicis dimensionibus*) and a work *De causis linguae Latinae*—the earliest Latin grammar on scientific principles and following a scientific method—were his only other purely literary works published in his lifetime. His *Poetice* appeared in 1561 after his death.

His scientific writings are all in the form of commentaries, and it was not until his seventieth year that (with the exception of a brief tract on the *De insomniis* of Hippocrates) he published any of them In 1556 he printed his *Dialogue* on the *De plantis* attributed to Aristotle, and in 1557 his *Exercitationes* on the work of Jerome Cardan, *De subtzlitate*. His other scientific works, *Commentaries* on Theophrastus' *De causis plantarum* and Aristotle's *History of Animals,* left in a more or less unfinished state, were not printed until after his death. His *Exercitationes* upon the *De subtilitate* of Cardan (1557) is the book by which Scaliger is best known as a philosopher We are astonished at the encyclopaedic wealth of knowledge which the *Exercitationes* display, at the vigour of the author's style, at the accuracy of his observations, but are obliged to agree with G. Naudé that he has committed more faults than he has discovered in Cardan, and with Charles Nisard that his object seems to be to deny all that Cardan affirms and to affirm all that Cardan denies. Yet Leibniz and Sir William Hamilton recognized him as the best modern exponent of the physics and metaphysics of Aristotle. He died at Agen on Oct. 21, 1558.

2. Joseph **Justus Scaliger** (1540-1609), the greatest scholar of his day, was the tenth child of J. C. Scaliger. Born at Agen in 1540, he was sent when twelve years of age, with two younger brothers, to the college of Guienne at Bordeaux. An outbreak of the plague in 1j5j caused the boys to return home, and for the next few years Joseph was his father's constant companion and amanuensis. Julius daily dictated to his son from eighty to a hundred lines of Latin verse, and sometimes more. Joseph was also required each day to write a Latin theme or declamation, though in other respects he seems to have been Ieft to his own devices. He learned from his father to be an acute observer, never losing sight of the actual world, and aiming not so much at correcting texts as at laying the foundation of historical criticism.

After his father's death, he spent four years at the university of Paris, where he began the study of Greek under Turnebus. At the same time he taught himself. He read Homer in twenty-one days, and then went through all the other Greek poets, orators and historians, forming a grammar for himself as he went along. From Greek, at the suggestion of G. Postel, he proceeded to attack Hebrew, and then Arabic; of both he acquired a respectable knowledge, though not the critical mastery which he possessed in Latin and Greek. In 1563 Jean Dorat recommended him to Louis de Chastaigner, the young lord of La Roche Pozay, as a companion in his travels. A close friendship sprang up between the two young men, which remained unbroken till the death of Louis in 1595. The travellers first went to Rome. Here they found Marc Antoine Muretus, who had been a great favourite and occasional visitor of Julius Caesar at Agen. After visiting Italy, the travellers passed to England and Scotland. Scaliger formed an unfavourable opinion of the English. Their inhuman disposition, and inhospitable treatment of foreigners especially impressed him He was also disappointed in finding few Greek manuscripts and few learned men It was not until much later that he became intimate with. Richard Thompson and other Englishmen. In the course of his travels he had become a Protestant. In 1570 he proceeded to Valence to study jurisprudence under Cujas, the greatest living jurist. Here he remained three years.

The massacre of St. Bartholomew induced him to retire to Geneva, where he was appointed a professor in the academy. In 1574 he returned to France, and made his home for the next twenty years with Chastaigner. Of his life during this period we have interesting details and notices in the *Lettres françaises* *inédites de Joseph Scaliger,* edited by *M.* Tamizey de Larroque (Agen, 1881). During this period he published the books which showed that with him a new school of historical criticism had arisen. In his editions of the *Catalecta* (1575), of Festus (1575), of Catullus, Tibullus and Propertius (1577), he was the first to lay down and apply sound rules of criticism and emendation, and to change textual criticism from a series of haphazard guesses into a "rational procedure subject to fixed laws" (Pattison). But it was reserved for his edition of Manilius (1579), and his *De emendatione temporum* (1583), to revolutionize all the received ideas of ancient chronology—to show that ancient history is not confined to that of the Greeks and Romans, and that the historical narratives and fragments of Persia, Babylonia, Egypt and Palestine, and their several systems of chronology, must be critically compared, if any true and general conclusions are to be reached. It is this which places Scaliger immeasurably above any of his contemporaries. His commentary on Manilius is really a treatise on the astronomy of the ancients, and it forms an introduction to the *De emendatione temporum,* in which he examines by the light of modern and Copernican science the ancient system as applied to epochs, calendars and computations of time.

In the remaining twenty-four years of his life he at once corrected and enlarged the basis which he had laid in the *De emendatione.* With incredible patience, sometimes with a happy audacity of conjecture which itself is almost genius, he succeeded in reconstructing the lost *Chronicle* of Eusebius—one of the most precious remains of antiquity, and of the highest value for ancient chronology. This he printed in 1606 in his *Thesaurzis temporum,* in which he collected, restored and arranged every chronological relic extant in Greek or Latin. When in 1590 Lipsius retired from Leyden, the university resolved to obtain Scaliger as his successor. He declined their offer. The next year it was renewed. It was made clear that lecturing would not be required of him, and he would be entirely his own master. About the middle of 1593 he started for Holland, where he passed the remaining thirteen years of his life. He was treated with the highest consideration. His rank as a prince of Verona was recognized. His literary dictatorship was unquestioned. From his throne at Leyden he ruled the learned world; a word from him could make or mar a rising reputation; and he was surrounded by young men eager to listen to and profit by his conversation. He encouraged Grotius when only a youth of sixteen to edit Capella; Daniel Heinsius, from being his favourite pupil, became his most intimate friend.

But Scaliger had made numerous enemies. He hated ignorance, but he hated still more half-learning, and most of all dishonesty in argument or in quotation. His pungent sarcasms were soon carried to the persons of whom they were uttered, and his pen was not less bitter than his tongue. Nor was he always right. He trusted much to his memory, which was occasionally treacherous. The Jesuits, who aspired to be the source of all scholarship and criticism, perceived that the writings and authority of Scaliger whose historical methods had discredited many of their claims were the most formidable barrier in their way. It was the day of conversions. Muretus in the latter part of his life professed the strictest orthodoxy; J. Lipsius had been reconciled to the Church of Rome; Casaubon was supposed to be wavering; but Scaliger was known to be hopeless, and as long as his supremacy was unquestioned the Protestants had the victory in learning.

After several scurrilous attacks by the Jesuit party, in 1607 a new and more successful attempt was made. Scaliger's weak point was his pride. In 1594, in an evil hour for his happiness and his reputation, he published his *Epistola de vetustate et splendore gentis Scaligerae et J. C. Scaligeri vita.* In 1607 Gaspar Scioppius, then in the service of the Jesuits, whom he afterwards so bitterly libelled, published his *Scaliger hypobolimaeus* ("the Supposititious Scaliger"). The main argument of the book is to show the falsity of Scaliger's pretensions to be of the family of La Scala, and of the narrative of his father's early life. To Scaliger the blow was crushing. Whatever the case as to Julius, Joseph had undoubtedly believed himself a prince of Verona, and in his *Epistola* had put forth with the most perfect good faith, and without inquiry, all that he had heard from his father. His reply, *Confutatio fabulae Burdonum,* was not *a* success. Scaliger undoubtedly exposes many pure lies and baseless calumnies; but he could not establish the family's supposed lineage. Scioppius was wont to boast that his book had killed Scaliger. It certainly embittered the remainder of his life. The *Confutatio* was his last work. Five months after it appeared, on Jan. 21, 1609, he died.

Of Joseph Scaliger the standard biography is that of Jacob Bernays (Berlin, 1855). *See* also his *Autobiography, with selections from his letters etc,* trs. with introd. by G. W. W. Robinson (1927). *See* also *J. E.* Sandys, *History of Classical Scholarship,* ii. (1908), 199–204. For the life of J. C. Scaliger *see* the letters edited by his son, and his own writings, which are full of autobiographical matter.

SCALLOP. The popular name for a genus *(Pecten)* of marine molluscs belonging to the class Lamellibranchia. Nearly 300 living species of scallops are known and are found in all seas, from high latitudes to the tropics. Many species are important as human food. The "scallop-shell of quiet" (Sir W. Raleigh) was worn as a badge by mediaeval pilgrims.

Pecten is placed in the second order (Filibranchia) of the Lamellibranchia. This group is characterized by the possession of gills in which the filaments are doubled on themselves. forming reflected lamellae and are joined together by ciliated disks, and by the highly developed byssus. In *Pecten* the foot is rudimentary and the animal is more or less sedentary, the byssus serving to fasten it down to the sea bottom; nevertheless, they are good swimmers. The edges of the mantle are provided with highly developed eyes.

The common scallop of the British Isles (*Pecten opercularis*) is usually found in beds on a bottom composed of shell-debris with a little mud. Some of the largest beds are in the Firth of Forth and in the Irish sea. These beds are usually in water of 5–20 fathoms, though individual specimens are occasionally taken from much deeper water. The United States scallop fishery is centred on the coasts of the northeastern Atlantic states. Representatives of the subgenus *Pseudamussium* are found at greater depths (*e.g., P. neoceanicus* in 2,084 fathoms in the Pacific ocean).

(G. C. R.; X.)

SCALP, in anatomy, the covering of the top of the head from the skin to the bone.

The skin of the scalp is thick and contains a large number of hair follicles. The arteries are remarkable for their tortuosity, which is an adaptation to so movable a part; for their anastomosing across the middle line with their fellows of the opposite side, an arrangement which is not usual in the body; and for the fact that, when cut, their ends are held open by the dense fibrous tissue in which they lie, so that bleeding is more free in the scalp than it is from arteries of the same size elsewhere in the body.

The veins do not follow the twists of the arteries but run a straight course; there is often a considerable distance between an artery and its companion vein. Accompanying the veins are the larger lymphatic vessels. From the forehead the lymphatics accompany the facial vein and usually reach their first gland in the submaxillary region, so that in the case of a poisoned wound of the forehead sympathetic swelling or suppuration would take place below the jaw. From the temple the lymphatics drain into a gland lying just in front of the ear, while those from the region behind the ear drain into glands lying close to the mastoid process. In the occipital region a small gland (or glands) is found about a third of the distance from the external occipital protuberance to the tip of the mastoid process.

The nerve supply of the scalp in its anterior part is from the fifth cranial or trigeminal nerve; behind the ear the scalp is supplied with sensation by the great auricular and the small occipital nerves, while behind these. and reaching as far as the midline posteriorly, the great occipital is distributed.

Beneath the skin and fibrous tissue lies the epicranium, formed by the two fleshy bellies of the occipitofrontalis muscle and the flattened tendon or aponeurosis between them. Of these two bellies the anterior (frontalis) is the larger, and, when it acts, throws the skin of the forehead into transverse puckers. The much smaller (occipitalis or posterior) belly usually merely fixes the aponeurosis for the frontalis to act, though some people have the power of alternately contracting the two muscles and so wagging their scalps backward and forward as monkeys do.

Deep to the epicranium is a layer of very lax areolar tissue constituting a lymph space and allowing great freedom of movement to the more superficial layers; it was this layer which was torn through when an American Indian scalped his foe. So lax is the tissue here that any collection of blood or pus is quickly distributed throughout its whole area. and, owing to the absence of tension as well as of nerves, very little pain accompanies any such effusion.

The deepest layer of the scalp is the pericranium or the external periosteum of the skull bones. This, until the sutures of the skull close in middle life. is continuous with the dura mater which forms the internal periosteum, and for this reason any subpericranial effusion is localized to the area of the skull bone over which it happens to lie. Moreover, any suppurative process may extend through the sutures to the meninges of the brain. *See* also HAIR; SKULL. (F. G. P.)

SCALPING. The common term for the practice of removing, as a trophy, a portion of the skin, "shell" or "sheath," with hair attached, from an enemy's head. The custom was not unknown to the Old World, as it was mentioned by Herodotus as practised by the Scythians. It has been regarded, however, as a prevalent one among the American Indians, yet, contrary to the general belief, not all the tribes practised it by any means. Extended researches by Friederici indicate that in North America it was confined originally to a limited area in eastern United States and the lower St. Lawrence region, about equivalent to the territory held by the Iroquois and Muskhogean tribes and their neighbours. The custom was absent from New England and much of the Atlantic coast region, and was unknown until comparatively recent times throughout the interior and the Plains area; it was not practised on the Pacific coast, in the Canadian North-west nor in the Arctic region, nor anywhere south of the United States with the exception of an area in the Gran Chaco country of South America. Throughout most of America the early trophy was the head itself. The spread of the scalping practice over the greater part of central and western United States was stimulated by scalp-bounties offered by the colonial and more recent governments, the scalp itself being superior to the head as a trophy by reason of its lighter weight and greater adaptability to display and ornamentation.

The operation of scalping was painful, but by no means fatal. The impression that it was fatal probably arose from the fact that the scalp was usually taken from the head of a slain enemy as a trophy of his death, but among the Plains tribes the attacking warrior frequently strove to overpower his enemy and scalp him alive. to inflict greater agony before killing him; and frequently also a captured enemy was scalped alive and permitted to return to his people as a direct defiance and as an incitement to retaliation. The part taken was usually a small circular patch of skin at the root of the scalp-lock just back of the crown. The scalp-lock itself was the small hair braid which hung from the back of the head, as distinguished from the larger side braids. When opportunity offered, the whole top skin of the head, with the hair attached, was removed, to be divided later into smaller locks for decorating the clothing of warriors. The operation was performed by making a quick knife stroke around the head of a fallen enemy, followed by a strong tug of the scalp-lock. The scalper was not necessarily he who had killed the victim; nor was the number of scalps, but rather the number of coups (*i.e.,* "strokes" or acts of bravery in battle), the measure of the warrior's prowess. The fresh scalp was sometimes offered n-ith prayer as a sacrifice to the sun, the nater or some other divinity. When preserved for a time, as was most usual, the scalp was cleaned of the loose flesh and then stretched by means of sinew cords around the circumference within a hoop about six inches in diameter, tied at the end of a rod. When dry the skin side was painted either entirely red, or one half red and the other half black, and the hair was usually carefully braided and embellished with various ornaments. It was carried thus by the women in the triumphal scalp or victory dance on the return of a successful war-party to the home camp, and then, having served its first purpose, was retained as a bridle pendant by the warrior, deposited with the tribal "medicine," or thrown away in some secluded spot. This may be regarded as the typical treatment; but scalp customs varied from tribe to tribe, as likewise did the associated beliefs and rites. The custom is involved with that of decapitation, the severing of parts of the body, such as fingers, etc., as war trophies, and the shrinking of the heads of enemies as among the Jivaro Indians of Ecuador. (F. W. H.)

SCAMMONY, a plant. *Convolvulus scammonia,* native to the countries of the eastern Mediterranean basin; it grows in bushy waste places, from Syria in the south to the Crimea in the north its range extending westward to the Greek islands, but not to northern Africa or Italy. It is a twining perennial, bearing flowers like those of the field or corn bindweed. *Convolvulus arvensis,* and having irregularly arrow-shaped leaves and a thick fleshy root. The dried juice, "virgin scammony." obtained by incision of the living root. has been used in medicine as *scammonium,* but the variable quality of the drug has led to the use of *scammoniae resinu,* obtained from the dried root by digestion with alcohol. The active principle is the glucoside scammonin or jalapin, $C_{34}H_{56}O_{16}$; it is a ponerful purgative.

SCAMOZZI, VINCENZO (1552–1616), Italian architect and architectural theorist of the late Renaissance. was born in Vicenza and trained under his father, a pupil of Sebastiano Serlio, and in the atmosphere of the Accademia Olimpico at Vicenza. He provided designs for Salzburg cathedral, but worked mostly at Venice, Padua and in the Veneto. He designed palaces, villas and churches as well as the permanent classical stage setting for Andrea Palladio's Teatro Olimpico at Vicenza, the ducal theatre at Sabbioneta and the fortress town of Palmanova. He died in Venice in 1616. Through Scamozzi's writings (*L'Idea dell'architettura universale,* 1615) Palladianism (*q.v.*) influenced English architecture from Inigo Jones onward, but Scamozzi's theories differ in certain respects from Palladio's and he may more properly be regarded as the intellectual father of neoclassicism.

The Scamozzi Ionic order is a type of column the capital of which has four identical faces with the volutes meeting at an angle at each corner. Scamozzi was once thought to have invented it, although there are Roman precedents for the design.

See F. Barbieri, *Vzcenzo Scamozzi* (1952). (F. J. B. W.; X.)

SCANDAL, disgrace, discredit, shame, caused by the report or knowledge of wrongdoing, hence defamation or gossip, especially malicious or idle; or such action as causes public offence or disrepute. A particular form of defamation was *scandalum magnatum,* "slander of great men," words, that is, spoken defaming a peer spiritual or temporal, judge or dignitary of the realm. Action lay for such defamation under the statutes of 3 Edw. I. c. 34, 2 Rich. II. c. 5, and 12 Rich. II. c. 11 whereby damages could be recovered, even in cases where no action would lie, if the defamation were of an ordinary subject, and that without proof of special damage These statutes, though long obsolete, were only abolished in 1887 (Statute Law Revision Act).

SCANDINAVIAN CIVILIZATION. At the close of the Ice Age climatic conditions at last allowed man to enter Scandinavia; but authorities differ as to when this occurred, suggestions varying from 10,000 B.C. to 6,000 B.C.

Epipalaeolithic Period.—The earliest civilizations belong to the so-called Epipalaeolithic Period, of which two stages are at present recognised in Denmark, called after their type-stations the Maglemose and Ertebolle Periods. The former is that of a race of fishermen who lived on the shores of the Baltic while it was still a great fresh-water lake (called by geologists Ancylus lake); at Maglemose were found many tools of bone, horn and stone: the most typical being the barbed harpoon of bone or horn and a chipped flint axe known as the tranchec. Pottery was not found. In the following period (Ertebolle) a rise in sea-level had allowed the sea to flow into the Baltic (this Is called by geologists the Littorina sea). The typical remains of this age are usually found in vast rubbish-heaps or kitchen-middens (kjøkkenmøddinger). Bone and horn tools and other objects, *e.g.,* combs were still used, but flint was now the most important material. Pottery had come into use, the commonest form being a wide-mouthed bulging jar with pointed base. It is probable that in Norway and Sweden similar settlements existed, at present less fully known; for instance, remains at Nøstvet in Norway and at Limhamn in Sweden resemble and may be contemporary with those at Ertebolle. With the exception of the dog, domestic animals were unknown at this period, and agriculture was not practised.

Neolithic Period. — In the remoter districts of Norway and Sweden the epipalaeolithic people retained their primitive mode of life for a long time, untouched by the more advanced, neolithic civilizations developing to the south of them.

Our knowledge of these neolithic civilizations is almost entirely gathered from a study of the burial customs of the period. Such dwellings as are known are simple circular mud huts, containing few remains but animal bones, etc. All the more important graves of this period in Scandinavia are megalithic structures, a chronological sequence of three types being recognised (corresponding to Montelius' Periods II., III. and IV.). The earliest form of tomb was the Dolmen (*q.v.*), a small chamber enclosed by three or more rude upright stones, roofed by a single great stone slab, and often still partially covered by a mound. These graves, which usually contained several unburnt bodies, are not very richly furnished, but are characterized by the thin-butted axe (so-called celt) of flint, usually ground and polished, and by pottery, mostly ornamented flasks and vases. From these came the Passage Grave (Chamber-Tomb), a more elaborate structure in which a large megalithic chamber was approached by a passage walled and roofed with stone slabs. Such tombs are often of great size; a typical example figured by Du Chaillu, at Axvalla Heath, near Lake Venern, Vestergotland, Sweden, has a chamber 32×9 ft. and a passage 20 ft. long. These communal tombs sometimes contained as many as 100 skeletons, unburnt, and numerous associated objects. Some of the most typical are the thick-butted axe of flint, sometimes ground and polished; the perforated stone axe; transverse arrowheads and arrowheads with triangular section; oval, thick-butted daggers of chipped flint; amber beads; and pottery, usually angular or round bottomed bowls. The Passage Grave then degenerated into the Long Stone Cist. These graves also contained numerous skeletons, but are scantily furnished, the typical objects being a lunate knife of chipped flint and a beautiful, handled dagger, perhaps the finest achievement of any flint-workers. The pottery was poor and undecorated.

The civilization of the megalith-builders indicates a highly organized society of traders and farmers. Remains of domestic animals (horse, sheep, swine, cattle and dog) and traces of the cultivation of grain (barley, wheat and flax) are found round their huts; animal bones are also found in the mounds covering the tombs. Trade is proved by the occurrence of objects of Scandinavian origin in Britain (*e.g.*, perforated axes and thick-butted dagger-blades of Scandinavian workmanship in graves of the Beaker Period) and in central Europe (*e.g.*, necklaces of Baltic amber in Aunjetitz graves) and vice versa. The graves are most thickly distributed round the coastal districts of Denmark and Sweden, only in the latest (Long Stone Cist) period spreading to Norway and inner Sweden.

Contemporary with the megalithic burials a custom existed (chiefly in Jutland, S. Sweden and some of the Danish Islands) of burying each person in a small separate grave; several of these being covered by one barrow and found at different levels in it, either sunk in the earth, on the ground level or actually in the mound (bottom graves, ground graves and upper graves). These graves have pottery beakers and elaborate perforated stone axes, usually called battle axes. Axes and pottery of this type are widely distributed in Europe and these graves conceivably represent the entrance into Scandinavia of another race, who ultimately merged with the megalith-builders, since in the Long Stone Cist period there is little distinction between the furniture of the megalithic and of the separate graves.

Duration of Neolithic and Bronze Periods. — Prof. Gordon Childe, surveying the various estimates of the duration of the neolithic period in Scandinavia, suggests the following dates: Dolmen Period (Montelius Period II.), 2500–2200 B.C.; Passage-grave Period (Montelius Period III.), 2200–1650 B.C.; Long Stone Cist Period (Montelius Period IV.), 1650–1500 B.C. The last period belongs technically to the Bronze Age, since small objects of metal are occasionally found (copper and bronze pins and gold ear-rings).

Owing to the necessity of importing the metal the Bronze Age began late in Scandinavia; it probably lasted almost until the beginning of the Christian era. Here again much information is derived from burials, but hoards of objects are also of great importance. The dwelling-sites are imperfectly known.

Montelius, in his chronological classification of the Scandinavian Bronze Age, distinguishes two main periods, an Earlier and a Later, each having three subdivisions; but for a general survey the division into two periods is sufficient; the first probably ending about 1000 B.C., the second lasting till a few centuries before the Christian Era.

Earlier Bronze Period. — The sequence of metal types was much the same as in the rest of northern Europe. (See British Museum Guide, Bronze *Age,* Evolution of the Axe, Spear and Sword.) Early in the period the forms were simple, the flat and flanged axe and small knife being the commonest tools; at this time stone was probably in much commoner use than metal. But before long the innate craftsmanship of the Scandinavian asserted itself, and bronze weapons and ornaments were evolved unequalled in northern Europe for utility and elegance. That these were not importations is proved by the discovery of moulds in which such objects were cast and by the difference in technique between these objects and those of other countries.

The typical weapons were: Axes, of various forms, as, the palstave, the socketed and perforated axe; spears with riveted sockets; daggers and swords. The rapier or thrusting type of sword common throughout Europe in the middle Bronze Age was little used, being early replaced before A.D. 1000 by the heavier broad sword (leaf-shaped type), which came into use at an earlier date than in, *e.g.*, Britain. Some archaeologists hold that this type which was widely distributed through Europe, was actually evolved in Scandinavia by smiths who were, through the amber trade with Southern Europe, acquainted with the Italian bronze-handled dagger; others believe that Hungary was the place of origin. Some of the Scandinavian swords have a cast bronze hilt, others a hilt of wood or horn, etc., riveted in slabs on to a flanged bronze tang. The only defensive weapon which has survived is the circular bronze buckler, but such authorities as hold that the famous rock-carvings are of Bronze Age date deduce from these that horned helmets were worn. If the later phase of the Scandinavian Bronze Age was contemporary with the British Early Iron Age, these may well have taken the form of the bronze helmet in the British Museum found in the River Thames.

Personal ornaments were now for the first time abundant. These are usually of bronze but sometimes of gold. They include: Finger-rings, bracelets and torcs of various forms (coiled wire, cast or hammered); tutuli, *i.e.*, conical bosses apparently attached to the belt; pins, frequently disc-headed or with hanging ornaments; and brooches.

Both weapons and ornaments were commonly decorated at this time with incised designs, sometimes of chevrons, etc., but most often of spirals. This spiral ornament is often so marvellously regular as to suggest that some mechanical means was employed.

The distribution of finds suggests that there was at this time a considerable population throughout Southern Scandinavia.

The dead were at this period disposed unburnt in coffins, sometimes in the form of small stone cists but sometimes of wood, roughly hewn from a single tree-trunk. Some of these tree-trunk burials are of great interest as giving examples of the clothing worn. An oak coffin in a barrow (called Treenhøi) at Havdrup in Ribe, Denmark, contained a male skeleton with all his clothes preserved. These were: a high round cap, a wide mantle, a kind of kilt and two small fragments of leg-coverings, all of woven wool, and the remains of leather shoes. The inside of the mantle and a woollen belt which confined the kilt were fringed. A woollen shawl was rolled up to make a pillow. At the left side of the body was a sword in a sheath, and at the foot a wooden box containing a smaller box in which were another cap, a horn comb and a bronze razor. The whole contents of the grave was wrapped in an untanned hide. A complementary find at Borum-Eshoi, near Arhus, also in an oak coffin, produced a woman's dress, consisting of a long under-robe and a sleeved bodice both of woven wool, a cap of netted worsted, a tasseled belt woven of wool and cowhair, and a large mantle of woven wool and cowhair. Another cap was found in the grave, which also contained a bronze brooch, a horn comb, a finger-ring. two bracelets, a torc, three tutli and a horn-handled bronze dagger.

Later Bronze Period.—In this period cremation became general. The burnt bones were at first put in small stone cists, a number being often found under one mound; later the remains were placed in pottery urns, often still placed in cists; sometimes they were simply laid in the ground and covered with a stone. The pottery was usually in the form of plain jars and bowls, sometimes handled. Tomb furniture, especially weapons, became scantier. There is no visible break with the earlier period in the type of weapons; but gradually a new type of decoration was employed, and new kinds of household objects, ornaments, etc., were introduced. These include ornamented bronze vessels of various forms, often for hanging; a new kind of knife (so-called razor); and many personal ornaments. These are decorated with repoussé as well as with incised ornament, sometimes in the form of degenerate spirals, sometimes circles, and frequently wavy ribbon patterns and curves suggesting roughly drawn boats with bird's head terminals. Many of these were imported, being of Italian design; others are local imitations. The ornament is also foreign, being typical of the Hallstatt (earliest Iron Age) civilization of central Europe. The sword pommels are also of Hallstatt types. This period, therefore, although definitely part of the Bronze Age, was strongly influenced by the Iron Age of central and southern Europe, being contemporary with the Hallstatt Period.

At the close of this period a few iron objects of La Tène type, such as swords and brooches, occur in cremation graves otherwise indistinguishable from those of the Bronze Age, and represent the beginning of the use of iron in Scandinavia, probably dating in the first century or two B.C.

Rock Carvings.—On rocks in some districts of Sweden and Norway numerous crude carvings exist, representing scenes of fighting, husbandry, seafaring, etc. If, as most people believe, these belong to the Bronze Age, they throw a flood of light on the daily life of the time. But their dates are as yet unproved.

BOG FINDS

Although Scandinavia was always outside the Roman Empire the influence of that power was strongly shown in contemporary Scandinavian civilization. Very many objects of Roman manufacture were imported, often of good quality, showing that Scandinavia was prosperous and traded freely with the continent. Large numbers of Roman coins have been found, especially in the island of Gotland. Native art shows strong Roman influence.

At this time iron was of course in general use. Much information about the period is derived from hoards found in peat-bogs at Thorsbjerg, Vimose, Nydam and other sites in Jutland and Schleswig. These are supposed to be votive offerings following a battle. The weapons are remarkably fine, and include swords, single and double-edged, and damascened (the double-edged types having hilts resembling the Roman form); spears of various patterns, ornamented and sometimes inlaid on the blade; axes, socketed and perforated; chain-mail; helmets, one of silver; and shield-bosses. Tools of all kinds were found; also personal ornaments. Perhaps the most important find was that of a clinker-built boat 75 ft. long, at Nydam, built of oak and probably dating in the III. century A.D.; another of red pine was found.

Migration Period.—After the collapse of the Roman Empire in the west in the V. century AD. Scandinavian civilization developed gradually in harmony with the Teutonic civilizations to the south of it and in England. Again little is known of the houses of the period; the majority seem to have been four-sided huts. Burials are the chief source of information. Both inhumation and cremation were practised; the tomb furniture was rich, especially in personal ornaments and square-headed and cruciform brooches. These and other ornaments were decorated in a new style common to Scandinavia and the rest of Teutonic Europe at this period, consisting partly of geometric designs, spirals, stars, etc., and partly based on conventionalized and disintegrating animal forms, executed in a variety of techniques. The materials were sometimes bronze, occasionally silver and sometimes gold; the latter was most freely used in Sweden. In Gotland inlaid garnet ornament was popular, a technique which unlike the animal ornament occurs only sporadically in northern Europe. An ornament peculiar to Scandinavia was the bracteate, a disc-shaped gold pendant derived from barbarous copies of late Roman and Byzantine coins. The commonest weapons were the spear and shield. Swords, single and double edged, were not uncommon. Glass and wooden vessels as well as pottery are found.

Viking Period.—In the VIII. century the northern peoples, who had hitherto when restive contented themselves with local warfare and commercial ventures abroad, began to engage in piratical forays overseas. These were at first mere plundering raids resembling those of the Anglo-Saxons on the frontiers of the moribund Roman Empire in the III. and IV. centuries; but (like these) led ultimately to wide-spread colonization in England, northern France, Ireland, Scotland, the Faroes, the Orkneys, Shetland, Sicily and Russia; and to the discovery of Iceland, Greenland and America and the colonization of the two former. Their raids were pushed into almost every corner of Europe and they visited Asia Minor and North Africa.

We are fortunate in being able to examine in detail typical vessels in which they adventured, owing to their custom of burying the dead in their ships, under barrows; and it is not an exaggeration to say that all the finer developments of the sailing-ship were founded on their lines. A typical small war-vessel of the period was found at Gokstad, near Sandefjord in south Norway, and what might be described as a royal pleasure-vessel at Oseberg. Both contained a complete outfit; in the first were the chief's arms, horses, etc.; in the second the queen's bed, sledges, vessels, ornaments, etc. Lest anyone should doubt the seaworthiness of these vessels an exact model of the Gokstad ship was built and sailed across the Atlantic in 1893 and afterwards shown at the Chicago exhibition; it proved an able sea-boat.

In the Sagas, which provide a fund of information about life in those days (see SAGA) the affection of the Vikings for their ships is clearly shown, and they are often referred to by poetical names, such as Sea-skates, Elk of the Fjords, Horse of the Gull's Track, Raven of the Sea, etc.

Apart from warfare, farming was the chief occupation of the Vikings, and for this purpose slaves (thralls) were largely employed; but even kings took an active part in this pursuit. Ale-drinking, story-telling and games occupied the winter, every household having its winter store of dried meat and fish and home-brewed ale. Hospitality was practised on the grandest scale. The vivid description in the sagas of life in the halls of the northmen has been verified by excavation, "Fire-Halls" being found resembling mediaeval tithe-barns.

Typical antiquities of the period are found wherever the Vikings settled. Since paganism prevailed until about AD. 1000 in Norway and Iceland and even later in Sweden, tomb furniture was abundant in the earlier period. There was a great variety of burial customs; both inhumation and cremation were practised and the latter was not confined to the less elaborate tombs; it gradually died out, however, before the spread of Christianity. Men were often buried with a complete outfit of weapons, horse, dogs, harness, etc.; and not infrequently were buried in their boats; women had personal ornaments, household gear, etc. Boat burials were rare in Denmark, and in place of the big ship burials important persons were buried in wooden tomb chambers under mounds.

As might be expected, continual fighting led to the development of far more efficient weapons than had hitherto been known. Although the spear, used for both throwing and thrusting, still played an important part, the axe now reached an importance not seen since the Bronze Age; and the beautiful horned forms evolved (cf. Bayeux Tapestry) attest the skill of the Viking blacksmith. Splendid swords are found in the graves, frequently inlaid with gold and silver. Defensive weapons are represented by the shield, helmet and coat of ring-mail (*brynja*). From the numerous descriptions in the Sagas lve gather that a Viking's weapons were his most esteemed possessions; like the ships they are frequently described in such terms as:—for the sword, the Ice of Battle, the Dog of the Helmet, the Viper of the Host, etc.; for the spear, the Snake of the Attack, the Shooting Serpent, etc.; for the axe, the Witch of the Shield, the Wolf of the Wound; for arrows, the Bird of the Sling, the Twigs of the Corpse, etc.; for shields, the Burgh of the Swords, the Moon of Battle; for the *byrnja,* Gray clothes of Odin, the Woof of the Spear, etc. They also had personal names, as Magnus Barefoot's sword Legbiter, Skarphedin's axe, Ogress of War; and Harald Hardrada's byrnja, Emma.

Most objects are covered with decoration, the style of which at first derived from that of the end of the Migration Period (Vendel Style, conventionalized animal forms); but as a result of foreign intercourse, especially with Ireland and the Carolingian Empire, a new style of a hybrid character developed towards the close of the 8th century. Very good examples of this "Gripping beast" style are to be seen in the Oseberg Find. In the 10th century the Gripping beast style was overshadowed by the Jellinge style, in which animal forms are treated more naturalistically. This style, which in some ways resembles the Vendel style, is usually regarded as the outcome of Irish, English and Carolingian influence. The Jellinge style gave place for a time during the early 11th century to that of Ringerike, characterized by pure interlacing and conventionalized foliage, the animal motive being negligible; but later the interlaced animal of the Jellinge style reappeared in the Urnes style, at the close of which native Scandinavian art was overwhelmed by the bastard Romanesque of the Christian era.

BIBLIOGRAPHY.—For the earlier period (Stone Age to end of Iron Age) see *Reallexikon der Vorgeschiclzte* (ed. by Max Ebert, 1927), vol. ix, article entitled "Nordischer Kreis," with exhaustive bibliographies. Many oi the works mentioned there (*e.g.,* Montelius, *Kulturgeschichte Schwedens* (1906), Rygh, *Norske Oldsager* (1885), Gustaison, *Norges Oldtid* (1906), etc., deal also with the later period (Iron Age to end of Viking period). Consult besides O. Almgren, *Die altere Eisenzeit Gotlands* (1923); C. Engelhardt, *Denmark in the Early Iron Age* (1886); J. Mestori, *Urnenfriedhofe in Schleswig-Holstein* (1886) and *Vorgeschichtliche Alterthümer aus Schleswig-Holstein* (1885); B. Salin, *Die altgermanische Thierornamentik,* trans. by Mestori (1904); Baldwin Brown, *Arts in Early England,* vol. iii, iv and v (1915); P. B. du Chaillu, *The Viking Age* (1889); H. Shetelig, *Vestlandske Graver fra Jernalderen* (1912); H. Shetelig, Hj. Falk and A. W. Brøgger, *Osebergfundet* (1920–28); J. Brøndsted, *Early English Ornament* (1924); J. Petersen, *Vikingetidens Smykker* Stavanger Museum (1927). *See* also *Bergens Museums Aarbog* (Bergen), *Aarsberetninger fra Foreningen til norske Fortidsmindesmaerkers Bevaring* (Oslo), *Aarboger for nordisk Oldhynkighed* (Copenhagen), *Antiqvarisk Tidskrift for Sverige* (Stockholm), the *Manadsblad* of the *Kgl. Vitterhets Historie och Antiqvitets Akademie* (Stockholm), *Fornvännen,* published since 1906 by the same society; *Svenska Fornminnesforeningens Tidskrift* (Stockholm), *Videnskapsselskapetskrifter* (since 1925); *Skrifter utgit av det Norske Videnskaps-Akademi i Oslo* (Stockholm). The guides to Scandinavian museums, the British Museum guides and *London and the Vikings* by W. M. Wheeler London Museum (1926) should also be consulted. (T. C. L.; M. O'R.)

SCANDINAVIAN LANGUAGES. This term is usually limited to the Germanic languages (*q.v.*), of the Indo-European family, spoken. and written in the Scandinavian countries, thus excluding Finnish and Lappish, mhich have most of their speakers in the same area. There are six distinct written languages in Scandinavia: the Danish language (*q.v.*), in Denmark; the Faroese language, in the Faroe Islands, a possession of Denmark; the Icelandic language (*q.v.*), in Iceland; the Norwegian language (*q.v.*), in Norway, split into two norms called Dano-Norwegian and New Norse; and the Swedish language (*q.v.*), in Sweden and Finland (only by about 9% of the population of Finland). Outside Scandinavia there are small areas of Danish speech in northern Germany and of Swedish in Esthonia, as well as among numerous emigrants in the United States and Canada. If these are estimated at about 1,000,000, the total number of Scandinavian speakers around 1950 was just over 16,000,000.

In speech there is a great deal more variation than the number of written norms would indicate. Icelandic has the least dialectal differentiation, while in the Faroes nearly every island has its own dialect

The continental countries all show a typically European cleavage into class and regional dialects. In each country there is an upper-class urban dialect mhich approaches the written norm more closely than do the rest; this is often regarded as a standard, though it varies from city to city, the speech of the capital having the greatest prestige: Oslo, Stockholm, Copenhagen. Closest to it. but by contrast regarded as vulgar, is the speech of the urban working classes; more remote, and often so different as to be mutually incomprehensible, is rustic speech. The rural dialects are divided regionally, reflecting the patterns of communication in medieval and early modern times. Every parish and village may be said to have its own dialect.

It is not known when Indo-European speech entered the north; some believe it may have come with the so-called Battle-Ax people of the Neolithic (c. 2500 B.C.). The earliest linguistic monuments bre about 100 inscriptions in the Germanic alphabet known as the older runic *futhark* (see RUNE). These date from c. A.D. 200 to 900, the earliest of which show a language close to the reconstructed proto-Germanic branch of the Indo-European languages; it may be called either North Germanic (contrasting it with East and West Germanic) or proto-Scandinavian. Between A.D 500 and 700 a radical change in the word forms led to what may be called the common Scandinavian of the Viking age (750–1050). First came a vowel assimilation known as umlaut (mutation), in which the accented vowel was coloured by the quality of the following unaccented vowel; then came a loss of unaccented vonels, ahich greatly shortened the length of the words; e g., *landa,* "land," became land, while its plural landu became *lǫnd;* similarly *katilaz* > *kætilR* > *ketill,* "kettle." Other changes were the loss of initial *j,* for example, in *ár,* "year" (corresponding to German *Jahr*), and of *w* before *u* and o, as in *ull,* "wool," and orb, "word." Our evidence for common Scandinavian consists of about 3,000 inscriptions in the younger runic alphabet of 16 characters, mostly memorial stones.

During this period Scandinavian uas carried also to Normandy, the English Danelagh, the Orkneys, Shetlands and Hebrides, to Ireland and the Isle of Man. to Greenland and the North American continent, as well as to the Swedish kingdoms in Russia; but in these areas the Scandinavian settlers were all absorbed or died out in later centuries.

Although some of the differences within the Scandinavian area undoubtedly date back to an earlier period, they do not become evident until the use of Latin writing after the introduction of Christianity. The native languages were first written in Norway, under the influence of English missionaries, in the late 11th century. From there Anglo-Saxon influences spread to Iceland also. The earliest manuscripts from Iceland and Norway date from c. 1150, while the earliest in Denmark and Sweden are nearly a century later. These show a substantially consistent form, characteristic for each centre of writing, down to about 1350; this may be called the Old Scandinavian period, in mhich fall Old Icelandic, Old Norwegian, Old Swedish and Old Danish, the two former distinguishable 'as Old West Scandinavian (also called Old Norse), the two latter as Old East Scandinavian. In the period from 1350 to 1525 a transition took place to the essentially modern forms of the present-day languages. During this Middle Scandinavian transition the manuscripts show a gradual loss of the old case system in favour of the modern analytic structure. The political and dynastic unions of the Scandinavian countries, under the hegemony of Denmark, spread Danish norms to the other countries, gradually diluting and even supplanting those which had been developing elsewhere.

The language of the royal chancery at Copenhagen eventually supplanted completely the norms of Jutland and Skåne within the Danish realm, as nell as those of Norway, mhich was united with Denmark. The last documents in pure Norwegian were written in the period 1459–1500, and the introduction of the Reformation in 1537 did not lead to a distinct Norwegian translation of the Bible. The authors who wrote in Norway after the Reformation used Danish in their literary composition; the notion of a separate Norwegian language did not arise again until the 18th century but acquired special force after the separation of 1814 In Iceland, on the contrary, the written tradition remained unbroken, though influenced by Danish. The same was true in Sneden, and the establishment of a separate Swedish state in 1525. with Stockholm as its capital, led to a strong and conscious reaction against Danish influences.

The modern Scandinavian era since the Reformation has led to three new norms as the result of modern nationalism: Faroese, established by V. U. Hammershaimb about 1850. New Norse (Landsmål, Nynorsk) by Ivar Aasen in 1853, and Dano-Norwegian (Riksmål, Bokmål), which gradually deviated from Danish in the 19th and early 20th centuries. Icelandic is the language that has most tenaciously preserved the grammar and vocabulary of the common Scandinavian period, with Faroese a not too close second; these languages have therefore become largely unintelligible to other Scandinavians. On the continent, Scandinavians are usually able to communicate with each other by speaking and writing their own languages. This is because of the common developments which the languages have undergone, including an extensive simplification of morphology and the adoption of loanwords from common sources, especially Low German. Danish is phonetically most deviant from the rest but has a large area of vocabulary in common with Dano-Norwegian; the cleavage is therefore greatest between Danish and Swedish.

Attempts have been made to promote communication by approaching the norms to one another, but with little success. Instead, an active program of mutual language teaching has been instituted in the school systems, as well as cultural exchanges under the aegis of the inter-Scandinavian society Norden.

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SCANDIUM (symbol Sc), a metallic element usually classed in the cerium subgroup of rare earths (*q.v.*) and found mainly in rare ores of Scandinavia from which it derived its name. The discovery of its oxide, scandia, by L. F. Nilson in 1879 was of great scientific interest because this and other compounds of scandium had properties corresponding to those predicted by D. Mendeléyev (*q.v.*) in 1869 for the derivatives of a hypothetical element eka-boron which was needed to fill a gap in the periodical classification of the chemical elements (see PERIODIC LAW). Scandium has been found combined in a few uncommon minerals, such as thortveitite (from Saetersdalem, Nor.), wiikite (from Impilako, Fin.) in gadolinite and other rare earth bearing ores. It is also contained in small amounts in many tin and tungsten ores. Spectrographic observations have shown it to be relatively abundant in some of the stars.

Scandium has been successfully separated from the rare earths by solvent extraction of the thiocyanate complex, by anion exchange in strong HCl solutions and by cation exchange using chelating agents such as citric acid. Scandium forms many salts; these are usually colourless, diamagnetic and show scandium in the trivalent state. It .is concentrated in the soluble fractions of the usual bromate separation methods and is easily separated from other soluble salts being the least basic of the whole group.

Scandium crystallizes on the hexagonal close-packed system, $a = 3.309$ A, $c = 5.273$ A. It has an atomic number 21, atomic weight 44.96, stable isotope Sc^{45} (100%), calculated density of 3.016, melts at about 1200°–1600° C. and boils at approximately 2400° C.

SCAPA FLOW, an extensive landlocked anchorage in the Orkney Isles. about 15 mi. in length from north to south and 8 mi. in mean breadth, bounded by Pomona on the north, by South Ronaldshay on the east and southeast, and by Hoy on the west and southwest. The principal entrance is on the south from Pentland firth through Hoxa sound. Hoy sound on the west leads into the Atlantic ocean and three intricate channels on the east lead through Holm sound to the North sea.

Long before 1914 Scapa Flow was frequented by the Channel and Home fleets as its spacious and well-sheltered waters provided an excellent practice ground, and the admiralty planned that the main fleet should work from this base in wartime, to control the North sea. However, although net defenses against destroyer raids were under consideration, nothing had been done by the time war broke out beyond mounting a fen old guns. The strong tides and intricate navigation of the entrances were considered sufficient defense against enemy submarines.

Accordingly, on Aug. 4, 1914, the Grand fleet was at its base in Scapa Flow, which continued to be its base for the greater part of World War I. On Sept. 1, however, as a result of an unfounded report of an enemy submarine having entered the Flow the fleet put to sea, proceeding first to Loch Ewe on the west coast of Scotland and later to Lough Swilly in Northern Ireland. But these places were too far from the danger area so the fleet returned to Scapa Flow early in November. Temporary net defenses were rigged until permanent ones could be installed.

In Nov. 1914 an enemy submarine was destroyed in the outer approaches. Four years later, after the mutiny in the German fleet, one of their U-boats perished in a last desperate attempt to achieve success, but no U-boat managed to enter the Flow during World War I.

The battle cruiser force with its attendant flotillas moved to the Firth of Forth as soon as adequate antisubmarine defenses had been provided and in the latter part of the war Lord Beatty based the whole Grand fleet there.

After the surrender of the German fleet in 1918 the Allies would not agree to Britain's definitely taking over the German vessels but. in spite of Britain's protests, the most important units of what had been the High Sea fleet were interned in Scapa Flow with skeleton German crens on board, but not handed over. They were therefore only under distant observation by the British, and the result was that on June 21, 1919, the ships were scuttled by their German crews and the majority sank. They were later raised, broken up and sold as scrap.

The story of Scapa Flow during 1939–40 bears a striking resemblance to that of 1914–15. Once more the main fleet was at anchor there when war broke out. and once more it had to abandon the base in the early days because of lack of defenses. In 1914 there were none, in 1939 there were only single lines of antisubmarine nets and a few antiaircraft guns. This time. however, the evacuation was due to no false alarm but to the sinking of H.M.S. "Royal Oak" by a German submarine which had entered the Flow through the eastern entrance. where the tide rushes through at a speed of 9 to 12 knots. This disaster was quickly followed by the bombing of the depot ship, and once more the fleet had to move west, farther from the danger zone.

A new defense scheme was immediately prepared and work proceeded with feverish activity. Eighty-eight heavy antiaircraft guns, together with many light ones. and more than 100 searchlights, were mounted. Coast defense artillery was installed and three large controlled mine fields were laid in the entrances. All antisubmarine nets were doubled and additional inner lines were laid. Aerodromes had to be constructed on the most unpromising sites, and there was much anxiety over the gaps continually occurring in the line of block ships closing the eastern entrance. This problem was eventually solved by joining the islands concerned with concrete emplacements, a tremendous engineering undertaking. To the north the defense of Kirkwall as a large convoy assembly port had to be organized, with canteen and recreational facilities—all during a winter of extreme severity, with only six hours of daylight in midwinter. Accommodation difficulties were acute and many men working on the defenses had to be accommodated under canvas.

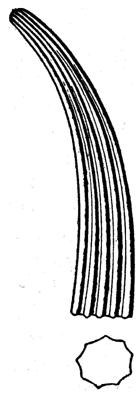
A most farseeing part of the defense was the installation of the first really efficient radar operation near Kirkwall by Sept. 1939. This proved of immense value, and an efficient balloon barrage was installed. Early in 1940 the defenses were sufficiently advanced for the fleet to return.

A successful air attack on the anchorage took place at the end of March 1940 when H.M.S. "Norfolk" was hit by a bomb. Two further air attacks were made early in April, but after this air attacks were never resumed. The efficiency of the defenses was proved by the fact that for five years the fleet's main base, although situated only 250 mi. from enemy aerodromes, was not again attacked. (R. N. BA.)

After World War II little activity took place there except for basic maintenance of the channels and anchorage. The home fleet visited it occasionally and fleet regattas were held there, but it was no longer the busy and important base it had been during World Wars I and II.

In June 1956 the admiralty announced that all naval establishments in the Orkneys would be closed in a program to streamline the naval forces to meet the conditions of nuclear warfare. On March 29, 1957, the Royal Navy ensign was hauled down for the last time and Scapa Flow was abandoned except for an oil storage depot. (X.)

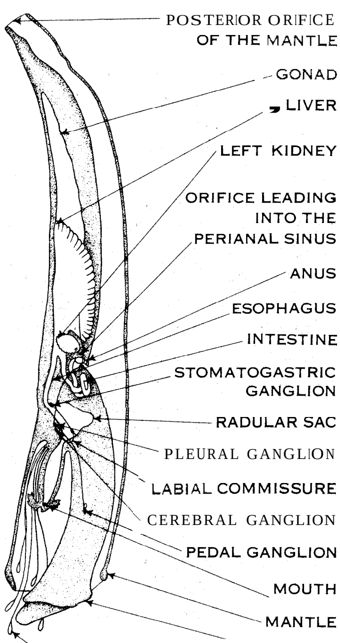
SCAPHOPODA. A group of marine invertebrate animals, popularly called elephant's-tusk or tooth-shells and constituting a class of the Mollusca (*q.v.*). There are four genera (of which *Dentalium* is the most familiar), and more than 350 species. They are the second smallest molluscan class. Their structure is quite distinct from that of other mollusks. They are bilaterally symmetrical, elongate animals, in which the right and left edges of the mantle are joined in the mid-ventral line except at the anterior and posterior ends. The visceral mass is thus enclosed in a tubular sheath open at both ends. The shell secreted by the mantle is correspondingly tubular and has anterior and posterior orifices. The head is imperfectly developed and bears numerous long filaments. The foot is cylindrical, and the animal is devoid of gills.



FROM PILSBRY, "MANUAL OF CONCHOLOGY"

FIG. 1.— TUSKLIKE SHELL OF DENTALIUM ELEPHANTINUM: BELOW. OUTLINE OF CROSS SECTION

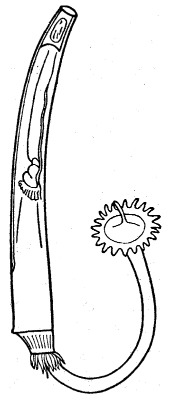
The Scaphopoda are exclusively marine. The foot is adapted for digging and burrowing into sand, in which they lie with the posterior extremity of the shell projecting from the surface. They were originally placed in the same class (Acephala) as the Lamellibranchia; but beyond the conformation of the mantle and the digging foot there is no close resemblance to that group, whereas their possession of a radula, mandible and buccal bulb and of a stomatogastric system in their nervous organization point to affinities with the Gastropoda.



FROM LANKESTER, "TREATISE ON ZOOLOGY"

FIG. 2.—DIAGRAM OF INTERNAL ANATOMY OF DENTALIUM, SHELL REMOVED

Bionomics, Evolution, Etc. —The Scaphopoda are sedentary, and in the adult stage live on the sea bottom, into the surface layers of which they burrow and usually remain with part of the shell projecting from the surface. They are carnivorous and feed upon such small animals as Foramenifera, young bivalves, etc. The majority live in fairly deep water and (*e.g.*) in the North sea are entirely absent in the littoral zone. *Dentalium peruvianum* has been found at a depth of 2,235 fathoms (U.S.S. "Albatross"). Many of the bathyal species are cosmopolitan in distribution. The earliest representatives of the class appear in the Devonian period. about 300 fossil species being known.



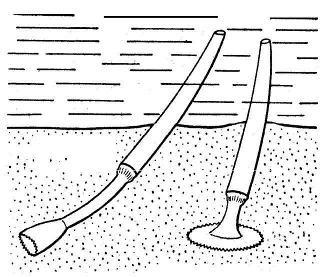
FROM ' VAN BENTHEM JUTTING, "TIERWELT DER NORD-UND OST-SEE"

FIG. 3.—SIPHONODENTALIUM LOFOTENSE SHOWING EXPANDED FOOT AND ANTERIOR END OF SHELL

External Form. — The shell of *Dentalium* is able to contain the whole animal and is elongate, conical and slightly curved. There are two apertures in all the Scaphopod shells, a larger anterior one from which the foot projects and a smaller posterior one. The hinder end bearing this orifice is kept clear of the sand and thus admits water for respiration and allows the excreta and feces to be discharged when the animal is buried. The mantle cavity is continuous from one end of the body to the other. The head and foot lie at the anterior end, the former above the latter. The head is cylindrical and bears two lobes beset with long filaments (captacula). These are mainly sensory but also serve to capture the small organisms on which the animal feeds. The foot is elongated and capable of considerable extension. Its expansible end is of great service in digging.

Internal Anatomy. — All Scaphopoda have a well-developed buccal mass with mandible and radula. From the esophagus the food passes into the stomach, which is little differentiated and receives the ducts of a bilobed liver and a pyloric caecum. The intestine is provided with an anal gland. The circulation and respiratory system is extremely simple. The heart is rudimentary, and there are no proper blood vessels. There are no specialized respiratory organs (gills), and the blood is oxygenated in the inner surface of the mantle. There are two kidneys in the mid-ventral region of the body, which open to the exterior, one on each side of the anus. The nervous system consists of the same pairs of ganglia, with their commissures. as in the Gastropoda. The cerebral and pleural ganglia are joined to the pedal ganglia by a long connective. These animals have only three kinds of sensory organs—the captacula, apparently tactile and olfactory; the subradular organ, probably an organ of taste; and the organs of balance (statocysts), situated in the foot. The sexes are separate. The ovary and the testis are unpaired and open into the right kidney, as in the aspidobranchiate Gastropoda.

Development.—This has been studied in *Dentalium.* The eggs are laid singly, and segmentation is unequal and irregular. A gastrula arises through invagination, as in most Mollusca. and subsequently develops into a floating trochophore larva. A veliger stage succeeds. and after five or six days the velum (girdle of cilia) atrophies and the young *Dentalium* abandons its floating life and starts to creep about on the sea bottom. Interesting experiments have been done on this form.



FROM T VAN BENTHEM JUTTING, 'TIERWELT DER NOR3 UND OSTSEE

FIG. 4.—DIAGRAM OF LOCOMOTION OF SIPHONODENTALIUM LOFOTENSE; (LEFT) FOOT CLOSED. (RIGHT) FOOT EXPANDED

See EMBRYOLOGY, EXPERIMENTAL.

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SCAPOLITE, a group of rock-forming minerals, which are silicates of aluminum with calcium or sodium but containing more or less chlorine, carbonate or sulfate radicals. The name is from the Greek for "rod" and "stone" after the shape of some crystals. Scapolite also is known as wernerite.

Mineralogy.— The species of the scapolite group, ranging from marialite to meionite, must be regarded as variable isomorphous mixtures of the following five components:

Ma = $3NaAlSi_3O_8.NaCl$—chloride-marialite
MaS = $3NaAlSi_3O_8\ Na_2SO_4$—sulfate-marialite
MaC = $3NaAlSi_3O_8\ Na_2CO_3$—carbonate-marialite
MeC = $3CaAl_2Si_2O_8\ CaCO_3$—carbonate-meionite
MeS = $3CaAl_2Si_2O_8\ CaSO_4$—sulfate-meionite

It seems likely that in marialite. NaCl. etc . may be replaced to a limited extent by KOH. and in meionite, $CaCO_3$. etc., may be similarly replaced by CaF_2. The close relation which this group of minerals bears to the plagioclase feldspars is apparent in the formulas indicated above (see FELDSPAR: The *Plagioclases*). The scapolites crystallize in the tetragonal system, the crystals being prismatic hemihedral. The dominant cleavage is (100). The hardness is j–6. while the specific gravity varies with the composition. pure chloride marialite being 2.j60 and carbonate-meionite 2.772. The colour is usually white or gray. Between the end members, marialite and meionite. there are mixtures which have been given definite names. These include dipyre and mizzonite, and may. as in the case of the plagioclase feldspars, be arbitrarily fixed as follows:

marialite $Ma_{100} \rightarrow Ma_{80}$
dipyre $Ma_{80}Me_{20} \rightarrow Ma_{50}Me_{50}$
mizzonite $Ma_{50}Me_{50} \rightarrow Ma_{20}Me_{80}$
meionite $Ma_{20}Me_{80} \rightarrow Me_{100}$

The scapolites show varying resistance to acids, the meionite-rich members being most readily attacked, CO_2 being released by HCl-HF mixtures from the carbonate meionite, while marialite is only slightly attacked. None of the scapolites had been synthesized by the late 1950s. They are destroyed by fusion, the lime-rich members giving plagioclase feldspar on cooling. The commonest alteration products are calcite kaolin, white mica and zeolites. The scapolites are essentially metamorphic minerals, appearing very commonly in metamorphosed limestones.

Well-developed glassy crystals of scapolite occur in the ejected blocks of limestone of Monte Somma. Vesuvius, and large crystals occur in the apatite deposits of Bamle, southern Norway, where they arise from alteration of plagioclase feldspar in gabbro. The mode of occurrence of scapolite is referred to in detail below.

(C. E. T.)

Scapolite **Rocks.**—Scapolites have three principal types of occurrence in rocks:

1. Scapolites are common in crystalline limestones and in calc-silicate hornfelses near igneous contacts. Even marialite, the variety richest in sodium, occurs in this manner as small crystals lining cavities in ejected blocks of limestone at Vesuvius and the Eifel craters in Germany. The scapolite may occur as small inconspicuous grains or as large, well-formed crystals. Minerals found with it in rocks of this sort include calcite: diopside, grossularite garnet, tremolite, wollastonite. sphene and idocrase. In the Pyrenees, scapolite is common in limestone and calcareous shale where these rocks are in contact with diabase and peridotite.

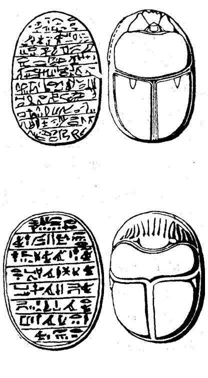
2. Scapolite is also common in beds of marble and calc-silicate granulite associated with gneiss and mica schist. The scapolite is characteristically associated with calcite, diopside. garnet, wollastonite or amphibole. Rocks of this sort have formed by metamorphism. on a regional scale: of impure limestones and calcareous shales. Examples are numerous in the Pre-Cambrian rocks of Canada and Fennoscandia (the Baltic shield) as well as in areas of crystalline schist formed in more recent geologic times. Some scapolite-bearing amphibolites and pyroxene-gneisses are probably metamorphosed igneous rocks. At Bolton, Mass.. coarsely crystalline scapolite and scapolite-quartz rocks occur as dikelike bodies, several feet thick. cutting across dolomitic marble. These masses resemble in texture the pegmatite dikes cutting the adjacent mica schists and their origin may be similar.

3. In gabbros and related rocks: plagioclase feldspars may be wholly or partly converted to scapolite. Excellent examples occur in Norway and Sweden; in the Pyrenees; in Ontario, Can.; and in the Adirondack mountains of New York. The pyroxenes in these rocks are altered in some occurrences to a uralitic hornblende. and the rock may have a spotted appearance with white. rounded patches of scapolite in a granular matrix of green hornblende. Chlorine-bearing apatite is commonly associated with such occurrences and it has been suggested that the scapolitization has been brought about by the action at depth of aqueous solutions rich in chlorides and phosphates, presumably from an igneous source.

(J. B. T.)

SCARAB (Lat. scarabaeus, connected with Gr. *capabos*), literally "a beetle," and derivatively an Egyptian symbol in the form of a beetle. The Egyptian hieroglyph  pictures a dung beetle (*Scarabaeus sacer*), which lays its egg in a ball of dung, and may be seen on sandy slopes in hot sunshine compacting the pellet by pushing it backward uphill with its hind legs and allowing it to roll down again, eventually reaching a place of deposit. Whatever the Egyptians may have understood by its actions, they compared its pellet to the globe of the sun. The beetle is common on both shores of the Mediterranean; the Egyptian name was *kheperer,* kheperi, and the sign spelled the verb *khopi(r)* meaning "become" and perhaps "create," also the substantive "phenomenon" or "marvel." The insect was sacred to the sun-god in his form *kheperi* at Heliopolis, and has been found mummified. A colossal scarabaeus of granite in the British museum probably came from the temple of Heliopolis. The scarabaeus was much used in Egyptian religions, appearing sometimes with outstretched wings or with a ram's head and horns as the vivifying soul. It is often seen in this guise on coffins of the New Kingdom and later. when it also became the custom to place in the bandages of the mummy a large stone scarab engraved with a chapter of the Book of the Dead. This chapter. the 64th, identified the object with the heart of the deceased and conjured it not to betray him in the judgment before Osiris. A winged scarab might also be laid on the breast; and later a number of scarabs were placed about the body. These are often of hard stone and of fine workmanship. Another and even more important class of Egyptian antiquities is in the form of scarabs pierced longitudinally for a swivel or for threading, and having the bases flat and engraved with designs. These were intended principally for seals. but might also be used as beads or ornaments. They are thus found, engraved or plain, strung on necklaces, and amethyst scarabs with plain bases are common articles of Middle Kingdom jewelry. But the employment of scarabs as seals is proved by the impressions found on sealed documents of the Middle and New Kingdoms; on several occasions the impressed clay seals alone have been found hardened and preserved by the fire which had destroyed the archives themselves.

The seal type of scarabaeuses is extremely abundant, and the designs engraved beneath them show endless variety. Some have inscriptions carefully executed, but frequently corrupted by illiterate copying until they became meaningless. The inscriptions are sometimes "mottoes" having reference to places, deities, etc., or containing words of good omen or friendly wishes; *e.g.,* "blemphis is mighty for ever," "Ammon protecteth," "Mūt give thee long life," "Bubastis grant a good New Year," "May thy name endure and a son be born thee." Such are of the New Kingdom or later. Names and titles of officials appear, most commonly in the Middle Kingdom.



FROM PETRIE, "SCARABS AND CYLINDFRS" (HAZELL, WATSON & VINEY)

EGYPTIAN HEART SCARABS OF THE 18TH DYNASTY

Historically the most valuable class is that which bears royal names, ranging from Senusret I of the 12th dynasty to the end of the 26th dynasty. Certain great kings are commemorated on scarabs of periods long subsequent to them. Thus Cheops (Khufu), of the 4th dynasty. appears on examples of the latest Pharaonic age, scarabs having been unknown in his time, and Tuthmosis III is found at all times after the 18th dynasty. But after the 12th dynasty the royal names are of contemporary workmanship. and the differences of style and pattern make it possible to group unknown kings with those who are known historically; the names of the Hyksos kings have been principally recovered from collections of scarab seals. Scarab-shaped seals are traceable as far back as about the 6th dynasty. They became abundant under the 12th and continued until almost the end of the native rule. As seals they took the place of the earlier cylinders and "button-seals." Considering the life history of the scarabaeus and its meaning as a hieroglyph, it may well be that the scarab impressing the clay had a symbolic significance; however that may be, the oval form was well adapted for seal stones and for the bezels of finger rings. In this situation the scarabs were often mounted with a rim of gold or silver round the edge.

Rings of stone, glass or metal. with engraved bezels of the same material, and eventually Greek gem rings, gradually displaced the scarabs.

A series of exceptionally large scarabs was engraved in the reign of Amenophis III, *c.* 1450 B.C., all being inscribed with his name together with that of Queen Tiye and her parentage. At present five varieties are known. The simplest commemorates his queen and the north and south limits of his empire; another dated in the 1st year. a great battue of mild cattle; the third. the arrival of the princess Gilukhipa of Mitanni in the 10th year; the fourth (many specimens), the number of lions slain by the king down to his 10th year; the last, the cutting of the lake of Zarukhe in the 11th year.

Egyptian scarabs were carried by trade to most of the islands and shores of the eastern Mediterranean and to Mesopotamia. The Greeks, especially in their Egyptian colony of Kaucratis, imitated them in soft paste. The finest Etruscan gems of the 6th and 5th centuries B.C. are in the form of scarabs, perhaps suggested by the Egyptian.

See EGYPT.

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(F. LL. G.; H. R. H.)

SCARAMOUCH, properly a buffoon. used later colloquially for a ne'er-do-well. The name was that of a stock character in the 17th-century Italian farce. *Scaramuccia* (*i.e.*, literally. "skirmish"). who. attired usually in a black Spanish dress. burlesquing a "don," was beaten by Harlequin for his boasting and cowardice.

SCARBOROUGH, a municipal borough in the Scarborough and Whitby parliamentary division of the North riding of Yorkshire, Eng., 41 mi. N.E. of York by road. Pop. (1951) 43,985. Area 6.2 sq.mi. It is the largest holiday town on the northeast coast of Yorkshire. where a hammer-shaped peninsula of high land, crowned by a ruined castle, projects eastward, separating the North and South bays. The modern town fringes both bays and extends a considerable distance inland, its southern limits being dominated by Oliver's Mount (said to have been named after Oliver Cromwell) on which the war memorial. a gigantic obelisk, stands. In the southern curve of the peninsula is the harbour, less important than formerly as a fishing centre. The origin of the modern town was the discovery in 1620 of a medicinal spring in consequence of which Scarborough became a much-frequented spa. In 1660 a native of the town. Dr. Wittie, advocated sea bathing and the town added salt-water cures to those of the inland waters and became a very popular health resort. Catering for holiday makers and other visitors is still its chief industry.

There was no direct evidence of early settlements until 1919, when excavations on the seaward side of the castle hill revealed three distinct types of early remains: a late Bronze Age village, a Roman signal station on the castle hill and three chapels. The signal station was one of a series built along the Yorkshire coast about A.D. 370. In the 10th century, Scarborough was founded (and named) as the result of an invasion by a Scandinavian. Thorgils "Skarthi" (hare-lipped). The castle was built by William le Gros. earl of Albemarle, in the 12th century. about 70 years after the town had been raided by Harald Hardrada. Edward I held court there in 1275; it was beseiged in 1312 and five times subsequently. It was damaged in the Civil War, after which it gradually fell into decay. It was in this state when George Fox. the founder of the Society of Friends (the Quakers) was imprisoned in the Charles tower of the castle for more than a year in 1665–66. He suffered great hardships before being released by Charles II. The castle was damaged again in World War I when the German fleet bombarded the town. The present ruins, occupying an area of about 19 ac.. include a lofty Norman keep and a dyke or moat on the landward side. A wall with towers also protected the castle on this side.

The first charter was given to Scarborough by Henry II in 1181 when the town was given the same liberties as those of York. In 1251 Henry III granted a charter for a new port. Authority was also given to Scarborough fishermen to land fish in Sormandy free of toll. Elizabeth I rebuilt the harbour in 1564 and George II enlarged it in 1732 when Vincent pier was built at the end of which was later added a lighthouse. East and West piers were built in 1752 and 1822 respectively. A floating dock was built in 1849 and at the beginning of the 19th century Scarborough was a leading shipbuilding centre on the east coast.

Close to the castle is the parish church of St. Mary, occupying the site of a 12th-century Cistercian monastery. It is transitional Norman and Early English, with later additions. and was much damaged during the siege of the castle in 1644. the tower and other parts having to be rebuilt. In the churchyard is the grave of Anne Bronte (d. 1849). Skirting the foot of the castle hill and serving as a sea-defense work is a marine drive linking the two bays. Old houses are still to be found in Sandside and other steep winding lanes at the back of the harbour which is enclosed by the East and West piers and divided into two basins by the Vincent pier. King Richard III house (1350) is a tall gabled building where the king is said to have stayed in 1484. Running inland south of the harbour is a deep valley crossed by bridges and laid out as Wood End gardens. The house, formerly the home of the Sitwells, is a museum devoted to natural history and including a vivarium; there is also a collection of books. mss.. etc.. connected with the Sitwell family. South of this park are the modern buildings of the spa—the ballroom, theatre, etc.—connected with the promenade above by one of the four cliff tramways. The pump room at the northern end of the present spa promenade is the direct descendant of the original wooden hut and platform which were built over the spring in 1770. There are splendid beaches with bathing and boating in both bays and boating in two of the many beautifully kept gardens and parks. On an island in the lake of Korthstead Manor gardens is the stage of an open-air theatre while the auditorium (for 7,000 spectators) rises up the facing hillside. The stage is illuminated by 40,000,000 candle power. The stewardship of the ancient manor of Northstead, which lies under the lake in the nearby Peasholm gardens. is given alternatively with that of the Chiltern Hundreds to members of parliament who have applied for the latter. There is an annual cricket festival and tennis and golf tournaments, the latter played on the championship course at Ganton. 9 mi. southwest.

Scarborough is the British centre for tunny fishing. the British Tunny club having its headquarters on the Sandside. A residential as well as a holiday town, it has also a number of small industries which include sheet metal and spring works. clothing and hosiery manufactories, motor coach body building, and market gardening. It is a quarter sessions borough and has a separate court of summary jurisdiction.

Scarborough returned two members to parliament from 1295–1885 when the number was reduced to one.

SCARLATTI, ALESSANDRO (1659–1725), Italian musical composer, was born in Sicily in 1659. He is generally said to have been a pupil of Carissimi in Rome, and he probably had some connection with northern Italy, since his early works show the influence of Stradella and Legrenzi. The production at Rome of his opera *Gli equivoci nel sembiante* (1679) gained him the protection of Queen Christina of Sweden, and he became her maestro di capella. In Feb. 1684 he became maestro di capella to the viceroy of Naples, and there he produced a long series of operas, remarkable chiefly for their fluency. In 1702 he left Naples and did not return until the Spanish domination had been superseded by that of the Austrians. In the interval he enjoyed the patronage of Ferdinand III. of Tuscany, for whose private theatre near Florence he composed operas, and of Cardinal Ottoboni, who made him his maestro di capella, and procured him a similar post at the church of S. Maria Maggiore in Rome (1703). After visiting Venice and Urbino in 1707, he took up his duties at Naples again in 1708, and remained there until 1717. It was at the Teatro Capranica in Rome that he produced some of his finest operas (Telemaco, 1718; *Marco* Attilio *Regolo,* 1719; Griselda, 1721), as well as some noble specimens of church music, including a mass for chorus and orchestra, composed in honour of St. Cecilia for Cardinal Acquaviva in 1721. His last work on a large scale appears to have been the unfinished serenata for the marriage of the prince of Stigliano (1723); he died at Naples on the 24th of October 1725.

Scarlatti's music forms the most important link between the tentative "new music" of the 17th century and the classical school of the 18th, which culminated in Mozart. His early operas (Gli *equivoci* nel sembiante [1679]; *L'Honestà negli* amori [1680]; *Pompeo* [1683], containing the well-known airs "O cessate di piagarmi" and "Toglietemi la vita ancor," and others down to about 1685) retain the older cadences in their recitatives. By 1686 he had definitely established the "Italian overture" form (second edition of *Dal* male il bene), and had abandoned the ground bass and the binary air in two stanzas in favour of the ternary or *da capo* type of air. His best operas of this period are La *Rosaura* (1690, printed by the Gesellschaft *für Musikforschung*), and *Pirro* e Demetrio (1694), in which occur the songs "Rugiadose, odorose," "Ben ti sta, traditor." *Mitridate Eupatore,* composed for Venice in 1707, contains music far in advance of anything that Scarlatti had written for Naples, both in technique and in intellectual power. The later Neapolitan operas are *L'Amor volubile* e *tiranno* (1709); La *Principessa* fedele (1712); Tigrane, 1715.

Scarlatti's claim to remembrance rests on the fact that he practically created the language of classical music. He extended the old forms, and filled them with melody unrivalled for purity and serenity, based on a far-reaching foundation of modern harmony and tonality, combined with great power of thematic development.

SCARLATTI, DOMENICO (1685–1757), eldest son of Alessandro Scarlatti, also a composer, was born at Naples on the 26th of October 1685. Presumably he studied first under his father, but he was in all probability also a pupil of Gaetano Greco. In 1704 he remodelled Pollaroli's Irene for performance at Naples. In 1709 Domenico entered the service of Marie Casimire, queen of Poland, then living in Rome, and composed several operas for her private theatre. He was Maestro di Cappella at St. Peter's from 1715 to 1719, and in the latter year came to London to direct his opera *Narciso* at the King's Theatre. In 1720 or 1721 he went to Lisbon, where he taught music to the princess Magdalena Theresia. He was at Naples again in 1725, but in 1729 went to Madrid as music master to the princess, who had married into the Spanish royal house. He is supposed to have died in 1757.

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SCARLET FEVER (Scarlatina) is an acute infectious disease caused by certain types of the haemolytic streptococcus. The first clear description is credited to the German physician. Daniel Sennert (1619), although Michael Doering probably first observed the disease in Breslau, Ger. Thomas Sydenham in 1676 gave a clear differentiation of scarlet fever as follows: "The skin is marked with small, red spots, more frequent, more diffuse, and more red than in measles. These last two or three days. They then disappear, leaving the skin covered with brawny squamulae, as if powdered with meal." The disease appeared in North America about 1735 and was described by Benjamin Rush.

Although many agents have been proposed as the cause of scarlet fever, the streptococcus has been associated with the disease from the early days of bacteriology and is now regarded as the cause. E. Klein, in 1885, in a study of an outbreak of scarlet fever associated with the distribution of milk, isolated an organism which he termed the sfreptococcus scarlatinae. A. Baginsky and P. Sommerfeld, after studying a large group of cases in 1900, stated, "Many points seem to be in favor of the streptococcus being causally related to scarlatina." Ludwig Hektoen in 1903 isolated streptococci from the blood in 12% of a series of cases. C. Krumweide, N. Nicoll and Josephine Pratt in 1914 described a typical case of the disease in a laboratory worker who had accidentally aspirated a suspension of living streptococci into her mouth. In 1923 George and Gladys Dick experimentally reproduced scarlet fever in volunteers by swabbing their throats with suspensions of haemolytic streptococci.

Practically all strains of the organism capable of producing the disease belong to Lancefield's group A and are serologically distinguished from other groups of streptococci on the basis of a specific group antigen, the C substance which is carbohydrate in nature. Within group A many types of haemolytic streptococci have been identified on the basis of their M substance which is protein in nature. In an outbreak of 345 cases at Camp Borden, Ont., in 1943, W. R. Feasby and E. T. Bynoe isolated type 19 in 68%, and type 3 in 22% of the cases. Occasionally scarlet fever is caused by streptococci belonging to a group other than A.

Under suitable growth conditions the haemolytic streptococcus elaborates a number of toxic substances. some of which seem to be important factors in its disease-producing mechanism. These are the erythrogenic toxin, streptocolysin, fibrinolysin, leukocidin, and the spreading factor, an enzyme called hyaluronidase. The erythrogenic toxin causes the toxic manifestations of the disease such as the eruption. rapid pulse, fever and delirium. Injection of a small amount of this toxin into the skin to determine susceptibility to the disease is known as the Dick test. Since fibrinolysin, hyaluronidase and leukocidin are products of freshly isolated strains, they are probably important factors in the septic aspects of the disease.

Symptoms.— The onset of the disease begins from two to seven days after exposure The first symptoms are fever, sore throat, headache and, in children, vomiting. From two to three days later the rash appears as a diffusely fine erythema which begins on the neck, in the arm pits, groins and upon the chest. The face is flushed, with a ring of pallor around the lips. The throat is inflamed and red spots appear upon the palate. The tongue is coated, but the edges are deeply inflamed. After four days the coating on the tongue disappears, leaving a swollen, deeply injected surface with prominent papillae (strawberry tongue).

The eruption lasts for a week or more, and in about one-third of the cases is followed by desquamation, or peeling off of portions of the skin. The glands of the body are usually swollen, those of the neck may be tender and painful to touch. The eruption may be very faint; indeed. it may never occur in persons who have immunity to the toxin (scarlatina sine exanthemata). Such individuals represent important agents in the spread of the disease to others. The fever may last for a week or more.

Various clinical patterns. such as mild, moderately severe, severe, toxic, septic. and malignant scarlet fever have been described. Such classifications merely denote variations in the degree of severity and are a matter of opinion. The clinical manifestations may be regarded as primary and secondary. The primary infection usually occurs in the pharynx; the secondary features are the result of toxic and septic reactions. Toxic reactions include headache. fever, vomiting, rapid pulse, delirium, eruption, and disturbances in the heart and kidneys. The septic reactions result from invasion of the tissues by the haemolytic streptococcus and include cellulitis, swollen glands, infections of the ear, mastoid, sinuses, blood and brain.

Complications are frequent. The sinuses probably are always secondarily involved, frequently remain infected during convalescence and constitute an important focus in which the organism remains to cause the patient to become a carrier. Abscesses of the ear and mastoiditis are common. Infection of the glands of the neck frequently result in abscess formation. In certain instances the streptococcus enters the blood stream and is carried to various parts of the body where localized areas of infection develop. Among the late complications are nephritis (which occurs in 0.5% to 1.0% of all cases), arthritis and rheumatic fever. The urine should be tested frequently during the course of the disease.

Diagnosis is based upon the characteristic symptoms and signs. As a general rule, a child who becomes ill with fever, sore throat, headache and vomiting and who develops a fine generalized rash within 24 to 72 hr. after the onset of symptoms presumably has scarlet fever until proved otherwise. The diagnosis may be confirmed by isolation of the streptococcus from the throat or from some other region of the body, which may be the focus in so-called surgical scarlet fever. When an injection of a small amount of immune serum (0.1 c.c. to 0.3 c.c.) is made into the skin while the rash is at its height, a blanched area results at the point of injection within 18 hr. if the rash in question is caused by scarlet fever toxin. This reaction is known as the Schultz-Charlton test. Another confirmatory test consists in the reversal of the Dick test from positive to negative during the course of the disease.

Second attacks of scarlet fever are relatively rare but the recovered patient may subsequently experience other types of streptococcal infection. Treatment should include bed rest for at least ten days, adequate fluids and a diet commensurate with the patient's desire should be offered.

Penicillin, to which the streptococcus is highly sensitive, was the treatment of choice at mid-20th century. Sulfadiazine was also effective. In addition, the injection of serum, obtained from individuals recently recovered from the disease, or of refined antiserum prepared by injecting horses with the streptococcus or its toxin was beneficial in certain cases. Gamma globulin, prepared from human serum, was also effective.

Epidemiologically scarlet fever is extremely variable in its severity not only in different countries but in different outbreaks occurring in the same country. In the U.S. it is relatively mild, with a mortality rate of less than 1%. In the Balkans and in China severe forms of the disease exist. It is found principally in the temperate zones, rarely in the tropics. It is primarily a disease of childhood; half the cases occur between the ages of two and eight years. Most cases of scarlet fever occur during the winter and spring months, with an increase of incidence in September when schools open. Nonwhite people are less susceptible than white, and slightly more males than females develop the disease. Certain families are especially susceptible, but in general the communicability rate among susceptibles in a given family is between 5% and 15%.

The disease is spread chiefly by droplet infection but may be disseminated by contaminated dust particles and by contaminated hands, food, drinks and fomites. Contaminated milk may give rise to an outbreak. Surgical scarlet fever may result from infected wounds and bums. Convalescent cases and persons harbouring the organism in discharges from infected ears, sinuses and wounds may act as carriers, constituting an important factor in the spread of the disease. Control measures include isolation of the active case and the treatment of carriers, many of whom become free of streptococcus after treatment with penicillin.

In certain institutions active immunization is carried out by the injection of susceptible individuals (those with positive Dick tests) with the toxin of the streptococcus. Persons thus immunized may be protected against the toxic, but not necessarily against the septic, features of the disease. In certain instances the prophylactic administration of sulfadiazine had restricted the spread of the disease to closely exposed contacts; but this procedure sometimes resulted in the particular strain of streptococcus becoming resistant to the drug. Because of the fact that scarlet fever is only one of several related types of infections caused by the haemolytic streptococcus (designated by some as streptococcosis), quarantine and isolation procedures alone did not prove to be adequate measures in the prevention of the disease. (W. L. Bd.)

SCARPANTO: *see* KARPATHOS.

SCARRON, PAUL (1610–1660), French writer whose burlesque poems set him among the wits of the age, whose plays show a gift of lively comedy that immediately foreshadows Molière and whose major novel is a masterpiece of the picaresque genre. The son of a counselor in the *parlement* of Paris, he was baptized July 4, 1610. Becoming an abbé in 1629, he entered the service of Charles de Beaumanoir, bishop of Le Mans, in 1633. After a visit to Rome with him in 1635, Scarron returned to Le Mans and there, in 1638, was attacked by a disease which in 1640 became so much worse that the rest of his life was spent in pain and progressive deformity.

His life up to this point had been dissolute but he now found consolation in the chaste sympathy of Louis XIII's former favourite, Marie de Hautefort (the future maréchale de Schomberg), temporarily exiled at Le Mans. Returning to Paris, he was further troubled by lawsuits with his stepmother after his father's death (1643).

For some time Scarron enjoyed the patronage of the future cardinal de Retz (*q.v.*), and during the Fronde he eventually published a violent pamphlet against Mazarin (early in 1651). In 1652, almost entirely paralyzed, he married a beautiful but poor young girl, Françoise d'Aubigné, who later became world-famous as Madame de Maintenon (*q.v.*). He died in the night of Oct. 6–7, 1660.

Scarron's first book, *Recueil de quelques vers burlesques* (1643; supplemented by *Suite des oeuvres burlesques*, 1644) had some success, but his burlesque epic, *Typhon, ou la gigantomachie* (1644) was less well received. His play *Jodelet, ou le maître valet* (1645), named after the comedian Jodelet for whom the principal role was destined, inaugurated that tradition of developing the valet's role in comedy which Molière was to exploit so brilliantly.

The work for which Scarron was most famous in his own day, *Virgile travesty* (7 books, 1648–53), a parody of the *Aeneid*, seems rather deplorable to modern readers, but his *Roman comique* (*Le Romant comique*, 2 vol., 1651–57, unfinished; 3rd vol. by other hands, 1659) is recognized as of great merit and interest. The desultory story of a troop of strolling actors (in the style of the Spanish picaresque romances), it depicts manners and character in a singularly vivid way that makes it a landmark in the development of the French novel. Scarron's other works include eight more comedies (the most notable was *Don Japhet d'Arménie*, c. 1647) and a series of five tragicomical tales in the Spanish manner (1655–57). Of the latter, Molière drew on *La Précaution inutile* as a main source for *L'École des femmes* and on *Les Hypocrites* to a lesser extent for *Tartuffe*.

Scarron was at the centre of the literary activity of his time. He knew all the young men who were putting new life into the French drama—Jean Mairet, Tristan L'Hermite, Corneille and Rotrou. His own plays show a gift for realistic comedy that is the nearest thing to Molière before 1650. He was moreover a most important representative of the critical strain in French literature. While his burlesque verses parody contemporary epic, the vivid scenes of the *Roman comique* seem to be meant as an antidote to idealistic and pretentious novels. The vigour and wit of his writing reveal a talent as remarkable as the personality that, in the opinion of many who knew him, triumphed over years of pain. A critical edition of Scarron's collected works began with *Le Romant comique*, edited by H. Bénac (1951).

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SCAUP DUCK, a diving duck (*Aythya marila*), so called because it feeds upon scaup (broken shellfish), especially oysters and mussels. This handsome waterfowl winters round the coasts of most of the northern hemisphere; it repairs inland in spring to breed in Iceland, Lapland, Siberia and the fur countries of North America. The scaup has considerable likeness to the pochard (*q.v.*), both in habits and appearance; but it more generally inhabits salt water and the head of the male is black, glossed with green; in North America a smaller species of more southerly distribution is also found, the lesser scaup N. *affinis*. The female scaup can be distinguished from the female pochard by her broad white face. Scaups are expert divers, powerful swimmers and rapid flyers. Because of their dietary (about 50% animal matter), they are not So prized as are the stricter vegetarian ducks.

SCAURUS, MARCUS AEMILIUS, the name of two Roman politicians. father and son.

MARCUS AEMILIUS SCAURUS (c. 162–c. 89 B.c.) was a leader of the Optimates. Having acquired wealth by discreet methods, he turned from business to public life, reaching the consulship in 115 B.C., when he defeated some Alpine tribes and gained a triumph. Chosen *princeps senatus,* he held this position until his death. Sent to check Jugurtha in 112, Scaurus was alleged in 111 to have been bribed by him. but neatly avoided trouble by getting himself selected as one of the presidents of the Mamilian commission appointed to inquire into such allegations (109). In 109, as censor, he constructed a Via Aemilia through Pisa to Dertona and repaired the Mulvian bridge. In 104. as corn commissioner at Ostia he replaced Saturninus. whose sedition in 100 he helped to suppress. Accused of extortion by Caepio in 92. he managed to get the trial postponed. He supported his friend the younger M. Livius Drusus in 91 and was accused in 90 under the Varian commission of intriguing with the Italian allies, but was acquitted. He married Caecilia Metella, later Sulla's wife, and was the father of Aemilia, later Pompey's wife. He wrote three books De vita *sua,* which Sallust may have used in his *Bellum Jugurthinum.* A conservative who moved with the times, Scaurus exercised great influence: Cicero (Pro Fonteio, 24) said that the world was almost ruled by the nod of his head; Sallust gives a less flattering portrait.

See G Bloch, "M Aemilius Scaurus," in *Mélanges* d'hzstoire ancienne (1909); E Pais, *Dalle* guerre *puniche* a Cesare *Augusto,* i, pp. 91 ff. (1918); J. Carcopino, *Histoire* romaine, ii, p 269 (1929)

MARCUS AEMILIUS SCAURUS, son of the foregoing, served as Pompey's quaestor and proquaestor in the third Mithradatic War (66–61 B.C.). Sent to Judaea and Nabataea, in return for large bribes he decided the quarrel between Hyrcanus and Aristobulus in the latter's favour in 64 (Pompey later reversed this) and allowed the king Aretas to retain Nabataea in 62. The settlement nith Aretas was commemorated on a coin which Scaurus issued as curule aedile (58), when he staged public games of unusual magnificence. Having been praetor (56) and propraetor in Sardinia (55), he was accused of provincial extortion in 54, was defended by Cicero and by Hortensius and was acquitted. Accused de *ambitu,* he nent into exile in 52. He married Mucia, formerly Pompey's wife.

See josephus, *Antiquitates,* xiv, 3–5, and *Bellum Judaicum,* 1, 7; Appian, Syriaca, 51, and Bellum *Civile,* ii, 24; Pliny, *Historia Naturalis,* xxxvi, 24; Cicero, Pro Sestio, 54; fragments of Pro *Scauro,* and many references in the Epistulae; Asconius In Scaurianam; E. A. Sydenham, Coinage of the *Roman* Republic, no. 912 (1952)

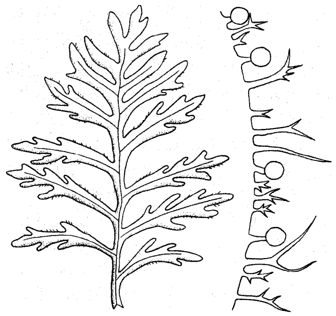
(H. H. SD.)

SCAVENGER'S DAUGHTER (corruption of Skevington's or Skeffington's daughter), an instrument of torture in use during the 16th century in England. It was invented by Sir W. Skevington, lieutenant of the Tower in the reign of Henry VIII. It consisted of a wide iron hoop which by means of screws was tightened round the victim's body until the blood was forced from the nose and ears, and sometimes from the hands and feet.

SCENTED PLANTS. The supreme joyous notes of plant life are colour and fragrance. Colour is shared with many animal groups, among them birds, fishes and butterflies, but fragrance is the openly broadcast gift of plant life. Natural animal fragrances are rare, but it is worth noting that certain floner-visiting butterflies and moths produce a flowery fragrance composed of essential oils, the same group of substances that produces redolence in flowers.

Fragrance and colour. so welcome to the aesthetic sense, have been the practical guideposts to food, consisting of pollen and nectar, for certain insects for thousands of centuries. There are many wind-pollinated and bird-pollinated flowers, none of which possess fragrance, and of the many flowers dependent on insects for pollination, only some are fragrant.

The sweet scents of flowers are nearly always associated with the showy parts of the blossom, being released by the petals or by sepals or bracts when there are no petals, but there are a few plants with small inconspicuous flowers, such as the pussy tvillow and a few others, that are fragrant. In the mint family (Labiatae) the pleasant refreshing scent comes from the green parts of the flower cluster and especially from the leaves and stems.



A LEAF OF LAVENDER (LAVANDULA MULTIFIDA) ABOUT ½ ACTUAL SIZE, WITH OUTLINE OF THE EDGE OF THE SAME LEAF. ENLARGED ABOUT 50 TIMES

Globe-tipped glandular or oil-secreting hairs are present on the edge of the leaf; thousands of smaller glandular organs are on both leaf surfaces

The attractive odours of flowers and foliage are predominantly attributable to the presence of essential oils (*q.v.*). These volatile substances are found in about one plant family out of five. An essential oil is a complex secretion product, apparently a normal part of the functioning of the plant and not an isolated end in itself. The essential oils are rather powerful substances and often appear in minute quantities and perhaps never constitute more than about 2% of the floral plant material. The violet can be taken as an example, 15 tons of the flowers being needed to produce a pound of oil. The essential oils of flowers are more complicated than those of leaves—the former may consist of a dozen components while the simplest of leaf essential oils may have but one.

Both flower and leaf fragrances are much used in the manufacture of perfumes. Outstanding flowers for this purpose are rose, tuberose, hyacinth, jasmine, acacia (Acacia farnesiana), lily-of-the-valley and ylang-ylang (an Asiatic tree, Cananga odovata); leaves (and green sepals) used in perfumery include those of geranium (*Pelargonium* species), lavender, rosemary, patchouli (*Pogostemon* cablin), clary sage and even a few species of grass (of the genus *Cymbopogon*), which produce citronella, lemon grass and palmarosa oils.

Fragrance occurs not only in flowers and leaves but also in fleshy fruits of many kinds. This odour attracts mammals which help disseminate the seeds contained within the fruit. The same scents found in fruits, or very similar ones. are found in flowers and even in leaves of unrelated species. Thus one finds apple-scented (apple mint, sweetbriar rose) among other fruit-scented leaves, and peach, lemon, raspberry and quince odours among others in flowers of plants totally unrelated to those fruits.

The particular sweetness of a flower is usually not the result of the presence of a single chemical compound, but often includes one or more unrelated compounds that closely imitate the dominating odour. The types of compounds which are constituents of the volatile oils are esters, alcohols, aldehydes, ketones, etc. The dominating ester can be accompanied by a closely related set of esters, making for overtones, and the final fragrance results from an intricate combination and proportion of volatile substances characteristic of the species.

The oil secretion of flowers takes place in the epidermal cells of the coloured part, usually on the upper side, but occasionally on both sides. as in the rose. Additional petallike parts, interior to the normal ring of petals, which make for doubling of flowers may also secrete oils, causing many double flowers to have that much more scentedness (violets, roses). Sometimes. however, doubling results in reduction of fragrance over that in single forms of the same kind of flower (lily-of-the-valley, poet's narcissus). In some leaves odours originate in hairs projecting from the surface or recessed in tiny depressions.

In the mint family (lavender, thyme, basil, marjoram, sage, etc.) the short-stalked glandular hairs uhich secrete the oil appear among several other kinds of hairs. They have rounded heads consisting of 1 to 16 or more cells. Other families, such as citrus (Rutaceae), myrtle (Myrtaceae) and laurel (Lauraceae), produce the fragrant oils in tough sacs in the interior of the leaf. These can be readily seen with a hand lens by holding a leaf up against the light.

There has been extensive neglect in maintaining fragrance in a large number of cultivated flowers. It has been customary to think of a flower as being beautiful because of its colour, size and form, and hybridists have been concentrating on this ideal. In the course of extensive hybridization workers have drawn parents from many sources, and when unscented flowers are crossed with scented ones, the progeny will include some without fragrance. As an example, the group of yellow rose species (of Asiatic origin) have no rose scent. When they are bred even with fragrant kinds, many of their progeny will be unscented One large grower of sweet peas finds that after considerable hybridizing his crimson and scarlet kinds are practically devoid of fragrance. It is extremely rare for any flower to lose its scent in nature, as this factor is so fundamental in the maintenance of the species. A fragrant plant introduced into cultivation and given conditions approaching its natural habitat should retain its fragrance.

A pronounced impetus to interest in scented plants has been given by the establishment in several large cities of fragrance gardens for the blind. The first such garden was founded in Exeter, Eng , in 1939; the first in the United States at Lima, Pa., in 1949. Fragrance gardens located in large cities—*e.g.*, one (started in 1955) at the Brooklyn Botanic garden in New York city. and another (started in 1956) at the Lighthouse for the Blind in Chicago—are, because of their locations, much visited. In these gardens the blind can "view" trees. flowers and herbs by their fragrance and texture. Braille markers are placed so that the plants can be readily identified. The gardens are so designed that the sightless can guide themselves through the paths and experience the only realities of plants that are available to them—the furry leaf, the prickly stem, the juice of crushed leaves, the softness and fragility of the petals and above all the faint bouquets and the incense of the unseen blossoms.

Among plants grown for their fragrance and texture—and therefore essential in gardens for the sightless—are those with light and elusive bouquets: wallflower, cottage pink, flowering tobacco, sweet william, alyssum, heliotrope and violet; those with characteristically heavy redolence, hyacinth, rose, tuberose, jonquil, lily-of-the-valley, lilac and mock orange. Plants with pungent piercing scent, to be tasted and bruised with the fingers are thyme, dill, laurel, sage, lemon balm, rosemary, lavender, marigold and the astringent witch hazel and mints; and those to be touched and held in the hand, plants of interesting texture as well as unique odour, the hairy leaves of many herbs (mint, lavender, geranium), the unfolding leaves of the pungent balm-of-Gilead, the apple-scented foliage of sweet brier rose and especially most needle-leaved and some broad-leaved evergreens with their aromatic resins.

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SCEVE, MAURICE (1500?–1564), French poet, was born at Lyons, where his father practised law Besides follo ing his father's profession he was a painter. architect. musician and poet. He was the centre of the Lyonnese group that elaborated the theory of spiritual love, derived partly from Plato and partly from Petrarch. which was enunciated in Antoine Héroet's *Parfaicte Amye*. Scève's chief works are *Délie, objet de plus haulte vertu* (1544); two eclogues. *Arion* (1536) and *La Saulsaye* (1547); and Le *Microcosme* (1562), an encyclopaedic poem beginning with the fall of man. *Délie* (an anagram for *l'idée*) set the fashion of a series of poems addressed to a mistress real or imaginary, followed by Ronsard in *Cassandre* and by Du Bellay in *Olive*. For the Lyonnese school of which Scève was the leader *see* LABÉ, LOUISE CHARLIN PERRIN.

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SCHACHT, (HORACE GREELY) HJALMAR (1877–), German financier, the "German Talleyrand" who occupied high official positions successively under monarchy, the Weimar republic and Naziism, was born at Tingleff, in Schleswig-Holstein, on Jan. 22. 1877. He received his elementary education in the United States, his higher education upon returning to Germany. He became a bank statistician, bank director and then financial administrator of occupied Belgium (until 1916). Appointed president of the *Reichsbank* after World War I, Schacht, as chief German spokesman at reparations conferences. obtained for Germany more money in loans than the country paid in reparations. When in 1930 the Young plan (*see* GERMANY), intended to fund German war indebtedness, came into force, Schacht resigned his official positions in protest. He aided Adolf Hitler's ascent and as economics minister under the Nazi regime forged, by extraordinary methods, the financial sinews of German rearmament. The Nürnberg war crimes tribunal ruled, in 1946. that this central role in German rearmament did not make Schacht a party to Nazi planning for war. After 1950 he advised, among others, the governments of Syria, Indonesia, Iran and Egypt on financial matters. (G. W. Z.)

SCHADOW, a family of German artists.

JOHANN GOTTFRIED SCHADOW (1764–1850), sculptor, was born in Berlin on May 20, 1764. He learned his craft under the court sculptor J. P. A. Tassaert and perfected it in Rome from 1785–87 in the studios of A. Trippel and A. Canova. In Nov. 1787 he returned to Berlin, and a year later succeeded Tassaert as director of the royal school of sculpture.

His first monumental work is the tombstone for Count Alexander von der Mark (1790, Berlin); his best known is the quadriga on the Brandenburger Tor (1793). Among his finest work is the group of the princesses Louise and Frederike of Prussia (1797, Berlin). He was also responsible for the statue of Frederick the Great at Stettin (1793) and the Luther memorial at Wittenberg (1821). From 1800 on Gottfried Schadow was increasingly surpassed by Christian Rauch. After 1807 he executed a series of busts for the Bavarian crown prince's "Valhalla." He was one of the chief representatives of classicism in Germany, but he largely replaced the idealistic by a rigorous realism. In the last three decades of his life his sight became affected; he then stood out primarily for his writings on the theory of art and for his genius as a draftsman. He died on Jan. 27, 1850, in Berlin. The exemplary significance of his work was not recognized during his lifetime.

See H. Mackowsky, *Johann Gottfried Schadow,* with full bibliography (1951).

RUDOLF SCHADOW (1786–1822), eldest son of Gottfried, also a sculptor, was born on July 9, 1786, in Rome and was first taught by his father in Berlin. In 1811 he went to Rome, where he came into contact with the J. F. Overbeck and P. von Cornelius circle. He became the pupil of B. Thorvaldsen and A. Canova and took over C. Rauch's studio in Rome. From 1812 he was a member of the S. Luca academy. Of his youthful, versatile work must be mentioned "The Spinner" (1816, Berlin and Budapest), the "Girl Binding on her Sandals" (1817, Munich) and the model for the monumental group in Berlin "Achilles Defends the Dying Penthesilea" (1821). Rudolf Schadow died in Rome on Jan. 31, 1822.

WILHELM VON SCHADOW-GODENHAUS (1788–1862), painter, founder of the Dusseldorf school, second son of Gottfried, was born in Berlin on Sept. 6, 1788. He was the pupil of his father and later of the painters J. F. Weitsch and W. Wach. He went to Rome in 1811 with his brother Rudolf, becoming a member in 1813 of the "Lukasbund" founded by F. Pforr and J. F. Overbeck. From 1816 to 1817 Wilhelm, together with P. von Cornelius, Overbeck and P. Veit, painted the frescoes in the Casa Bartholdi. From 1819 to 1826 he was professor at the Berlin academy and then succeeded Cornelius as director of the Diisseldorf academy. The Diisseldorf school, which he founded, soon departed completely in its special type of painting and in its anecdotal, religiously-determined realism from the artistic ideas of Overbeck and his Nazarenes. Wilhelm died in Dusseldorf on March 19, 1862. His chief works are: a portrait of Gabriele von Humboldt (1818, Berlin); "Adoration of the Shepherds" (1823, Potsdam); and the fresco of "The Wise and Foolish Virgins" (1842, Frankfurt). He educated a generation of painters, including K. F. Lessing (1808–80).

See Anton Fahne, *Die Düsseldorfer Malerschule in den Jahren 1834, 1835 and 1836,* new ed. (1937); Julius Hiibner, *Schadow und seine Schule* (1869). (J. C. JE.)

SCHAFF, PHILIP (1819–1893), U.S. theologian, church historian and pioneer in church union, was born in Chur, Switz., Jan. 1, 1819. He was educated at the *Gymnasium* of Stuttgart and at the universities of Tubingen, Halle and Berlin. At Berlin he was deeply influenced by the historian J. A. W. Neander, and became *Privatdozent* there in 1842. His brilliant scholarship early attracted favourable attention. In 1844 he became professor of church history and biblical literature in the Theological seminary of the German Reformed Church at Mercersburg, Pa. His inaugural address on *The Principle of Protestantism,* published in both German and English editions, viewed the history of the Christian Church as a divinely appointed development leading to a higher form of church life in which the values of Roman Catholicism and Protestantism would be blended in an evangelical Catholicism. This address, with its prophetic interest in church union, provoked charges of heresy, from which he was exonerated. Schaff, together with the theologian John W. Nevin (1803–86), shaped the Mercersburg theology, which resisted revivalist theology and emphasized the doctrine of the church. In 1864 Schaff began a six-year term as secretary of the New York Sabbath association, becoming a widely known Protestant leader. He became professor at Union Theological seminary, New York city, in 1870, serving until the year of his death. An inveterate traveler, he continued active leadership in Protestant affairs, especially in .the interests of church unity through the Evangelical alliance. He won a secure place as one of America's great theological scholars, both through the quality and remarkable quantity of his work as author and editor.

Outstanding among his many productions are the seven-volume *History of the Christian Church* (1858–92) and the three-volume *Bibliotheca Symbolicae Ecclesiae Universalis: The Creeds of Christendom* (1877). He edited the translation and revision of Lange's massive *Commentary* (1864–80), the great Schaff-Herzog *Encyclopaedia of Religious Knowledge* (1884) and other biblical and historical works. He participated actively in the preparation of the Revised Version of the Bible. He founded the American Society of Church History in 1888 and served as its first president. He was an originator and general editor of the American Church History series.

Schaff's last public address was a remarkable utterance on the reunion of Christendom, delivered at the World's Parliament of Religions.

He died in New York a month later. Oct. 20, 1893.

See David S. Schaff, *Life of Philip Schaff (1897).* (R. T. H.)

SCHAFFHAUSEN, the most northerly Swiss canton. lying almost wholly north of the Rhine, which, in part, separates it from the cantons of Zurich and Thurgau. On the other sides it is surrounded by Baden, portions of ahich separate the canton into three detached portions; the largest is the region near the chief town, Schaffhausen. Southward, the small lowland isolated district of Riidlingen and Buchberg was purchased in 1520, and Zurich. in 1798, ceded a slightly more extensive eastward tract around the old town of Stein. The territory contains two tiny Baden "enclaves." of which the village of Büsingen and the small tract of land surrounding it is the larger and more important. The total area of the canton is 115 sq.mi., of which the high proportion of about 95% is classed as "productive" (forests covering about 45 sq.mi., and vineyards about 1 sq mi.). The dominant land feature is the plateau of Randen—Hohe Randen summit, 2,998 ft., is on the northern boundary—sloping gently southward to the Rhine and intersected by short glens such as Klettgau (west of Schaffhausen) which carry intermittent water torrents. The Rhine 1½ mi. below the capital is a stream 370 ft. wide. interrupted by the famous falls (Laufen), which, though of small height (j6 ft.), are of considerable grandeur; they are exploited for hydroelectric power. The capital is an important railway junction. It is on the main line from Constance to Basel which traverses the canton, and also has normal railway linkages with Friedrichshafen (Lake of Constance), and Zürich (2 lines). Schleitheim (northwest) is connected to it by a light railway.

The population (57,515 in 1950) is devoted chiefly to agriculture and to vine growing; the forests are also a considerable source of revenue. The manufacture of watches and jewelry is also of considerable importance. Schaffhausen (pop. 25,971) is the only large town. Neuhausen (7,969) near the Rhine falls has an important aluminum works. There are six administrative districts containing 36 communes. The Cantonal constitution dates from 1876. The legislature *(Grossrat)* is composed of 76 members elected (by the system of absolute majority) for four years in the proportion of one to every 700 residents. The executive *(Regierungsrat)* of five members is also elected for four years by a popular vote, as are the two members of the federal *Standerat* and the two members of the federal *Nationalrat.* Since 1876, any 1,000 electors have the right of "initiative," both for legislative projects and for the revision of the Cantonal constitution. Since 1895 the "obligatory referendum" for all legislative projects and financial resolutions has prevailed. Taxation is light, for the public cantonal property, *e.g.,* forests, is the most considerable in Switzerland and the area is particularly prosperous.

The canton, admitted into the Confederation in 1501, arose from acquisitions made at various dates by the town; the chief of these were the outlying estates of the ecclesiastical foundations suppressed at the time of the Reformation. Of historical interest in this connection is the little town of Stein am Rhein (pop. 2,352) with its Benedictine monastery (1005–1526)—now restored to form a museum of antiquities—and Hohenklingen—the castle of the feudal lords of Stein—towering above it.

SCHAFFHAUSEN (Fr. SCHAFFHOUSE), the capital of the Swiss canton of that name, situated on rising ground above the right bank of the Rhine, and 31 mi. by rail W. of Constance. The population in 1950 was 25,971. Villa Scafhusun was first mentioned in 1045. About 1050 the counts founded the Benedictine monastery of All Saints, which henceforth became the centre of the town. Perhaps as early as 1190, certainly in 1208, it was an imperial free city, while the first seal dates from 1253. The powers of the abbot were gradually limited, and in 1277 the emperor Rudolf gave the town a charter of liberties. The Habsburgs held the town from 1330 to 1415, its freedom being finally purchased in 1418, while from 1411 the trade guilds ruled the town.

In 1454 the city made an alliance with six of the Swiss confederates, by whom it was received as an ally, being finally admitted a full member in 1501. The Reformation was adopted in 1524, finally in 1529. The town suffered much in the Thirty Years' War from the passage of Swedish and Bavarian troops.

Schaffhausen is a city of contrasts, medieval architecture of the true Swabian type and modern manufactures mingling curiously together. The chief ancient building in the town is the *Münster* (now Protestant) of All Saints, formerly a Benedictine monastery. It was consecrated in 1052, and is a specimen of the sternest and plainest Romanesque. Close to it is deposited the famous 15th-century bell that suggested Schiller's *Song of the Bell* and the opening of Longfellow's *Golden Legend.* The castle of Unnoth, above the town, dates in its present form from the second half of the 16th century. There are a number of factories in the town. At Neuhausen, a suburb, are aluminum works.

SCHAFFNER, JAKOB (1875–1944), Swiss novelist and story writer, was born at Basel on Nov. 14, 1875, was educated in a charity school, and worked as a shoemaker until his 30th year. He won the Schiller prize for the autobiographical novel *Johannes* (1922), followed later by *Die Jünglingzeit des Johannes Schattenhold* (1930), and *Eine deutsche Wanderschaft* (1933). He was a master of the short story, as may be seen in *Die Goldene Fratze* (1912), *Verhangnisse* (1927), and *Föhnwind* (1928). He also published an unconventional and lively *History of Switzerland* (1915), and a collection of poems (Der *Kreislauf,* 1927). His style was marked by freshness, geniality, imagination and humour, often recalling Gottfried Keller (*q.v.*). In later years he wrote favourably of national socialism, though not uncritically *(Volk zu Schiff,* 1936). He died in Strasbourg, France, in Sept. 1944.

SCHAPPE. A term denoting a particular type of yarn spun from schappe waste silk from which the natural gum, termed sericin, has not been entirely removed or discharged either by boiling-off by the English system of degumming raw silk, or by the alternative continental system of fermentation, known as schapping. The waste silk so treated is soft and lustrous, with the fine silk filaments free from each other, yet retaining some of their natural gum. Schappe silk varies from a white to a bright yellow tone according to the amount of gum still present.

Schappe also denotes a particular type of silk fabric sold under that trade name and produced from two-ply schappe spun silk yarn which, before bleaching, has a somewhat yellow tone owing to the presence of the natural gum. A schappe silk fabric is a fairly strong and firm texture of medium weight, woven on the principle of the plain calico weave, but having a slightly fine ribbed effect somewhat similar to that of a fine poplin (*q.v.*) texture but with the ribs or cords much less pronounced. This fine ribbed effect is developed by employing warp yarn of finer denier or counts than that of the weft, and also by inserting a greater number of warp threads than picks of weft, per inch, in the fabric. Thus, one example of schappe silk fabric contains 104 warp threads of 52's/2, and 72 picks of 40's/2 weft, per inch.

These denominations of yarn counts are equivalent to 52's and 40's counts of single cotton yarn respectively. They are produced by folding and doubling together two silk threads each of 50 denier silk (approximately) to produce the 52's/2 silk thread, and two threads each of 65 denier silk (approximately) to produce the 40's/2 silk thread. (H. N.)

SCHARNHORST, GERHARD JOHANN DAVID VON (1755–1813), Prussian general, was born at Bordenau near Hanover, on Nov. 12, 1755. In 1778 he received a commission in the Hanoverian service. He designed, and in part published, a *Handbuch fur Offiziere in den anwendbaren Theilen der Kriegswissenschaften.* He also published in 1792 his *Militiirische Taschenbuch fur den Gebrauch im Felde.* His first campaign was that of 1793 in the Netherlands, in which he served under the duke of York with distinction. In 1794 he took part in the defence of Menin and commemorated the escape of the garrison in his *Vertheidigung der Stadt Menin* (Hanover, 1803), which, next to his paper *Die Ursachen des Glücks der Franzosen in Revolutionskrieg,* is his best-known work. Shortly after this he was promoted to major and employed on the staff of the Hanoverian contingent.

In 1801 he entered the service of the king of Prussia, who gave him a patent of nobility, and the rank of lieutenant-colonel. Scharnhorst was employed at the War Academy of Berlin, where he had Karl von Clausewitz (*q.v.*) as one of his pupils, and he was the founder of the Berlin Military society. In the mobilizations and precautionary measures of 1804 and 1805, and in the war of 1806, Scharnhorst was chief of the general staff (lieutenant-quartermaster) of the duke of Brunswick, and received a slight wound at Auerstedt. He attached himself to Gebhard von Blucher in the last stages of the disastrous campaign, was taken prisoner with him at the capitulation of Ratkau, and, being shortly exchanged, bore a prominent part in the leading of L'Estocq's Prussian corps which served with the Russians. For his services at Eylau, he received the order *pour le mérite.*

Educated in the traditions of the Seven Years' War, Scharnhorst had by degrees divested his mind of antiquated forms of war, and come to realize that a national army and a policy of fighting decisive battles alone responded to the political and strategical situation created by the French Revolution. The steps by which he converted the professional long-service army of Prussia, wrecked at Jena, into the national army, based on universal service, were slow and laboured. He was promoted major-general a few days after the peace of Tilsit, and placed as the head of a reform commission, to which were appointed Gneisenau, Grolman, Boyen and others. Stein himself became a member of the commission and secured for Scharnhorst free access to the king by causing him to be appointed aide-de-camp-general. But Napoleon's suspicions were quickly aroused, and the king had repeatedly to suspend or to cancel the reforms recommended. By direct application to Napoleon, Scharnhorst evaded the decree of Sept. 26, 1810, commanding all foreigners to leave the Prussian service forthwith, but when in 1811–12 Prussia was forced into an alliance with France against Russia and dispatched an auxiliary army to serve under Napoleon's orders, Scharnhorst left Berlin on unlimited leave of absence. In retirement he wrote his *Über die Wirkung des Feuergewehrs* (1813). But the retreat from Moscow at last sounded the call to arms for the new national army of Prussia. Scharnhorst was recalled to headquarters, and was made chief of staff to Bliicher. The first battle, Liitzen or Gross-Gorschen, was a defeat, but a very different defeat from those which Napoleon had hitherto been accustomed to inflict. Scharnhorst was wounded, and died from the effects of his wound on June 8, at Prague, where he had been sent to negotiate with Schwarzenberg and Radetzky for the armed intervention of Austria.

SCHAUMBURG-LIPPE, a former component part of the German empire, from 1922 a free state of the German republic, from 1933 a *Land* of the Third Reich, and from 1945 a district *(Kreis)* of the Lower Saxony *Land* of Germany. It consists of the western half of the old countship of Schaumburg. Area, 131 sq.mi.; pop. (1939) 54,168; (1950) 85,443. Its northern extremity is occupied by a lake named the Steinhuder Meer. The southern part is hilly (Wesergebirge), but the remainder consists of a fertile plain. Besides agriculture the inhabitants practise yarn-spinning and linen-weaving, and the coal mines of the Bückeburg, on the southeastern border, are very productive. The great bulk of the population is Lutheran. The capital is Buckeburg, and Stadthagen is the only other important town.

SCHECHTER, SOLOMON (1847–1915), U.S. Jewish theologian and Talmudist, president (1902–15) of the Jewish Theological Seminary of America and for many years the leading spokesman for Conservative Judaism in the U.S. Born on Dec. 7, 1847, in Fokshan, Rum., he pursued advanced studies in Vienna and Berlin and was one of the first scholars to study the Talmudic literature of Judaism in the light of modern critical research. Schechter's *Some Aspects of Rabbinic Theology,* published while he was still a lecturer in rabbinics at Cambridge university, and other writings led to a sympathetic reappraisal of the teachings of the Pharisees. In 1902 Schechter went to New York city to serve as president of the Jewish Theological Seminary of America, which he developed into a foremost institution for Jewish research and for the training of rabbis and teachers. The United Synagogue of America, which he founded in 1913, had grown, by the early 1960s, from an original membership of 23 Conservative congregations to about 650 congregations.

In 1896 Schechter discovered the Genizah (archive) in the old synagogue in Cairo, containing over 90,000 manuscripts, many of them of great significance for biblical and rabbinic research. Among them was a copy of the original Hebrew text of Ecclesiasticus (*q.v.*), one of the important books in the Apocrypha. Schechter's identification of another manuscript as relating to an ancient Jewish sect in pre-Christian times was confirmed almost 50 years later, by the discovery among the Dead Sea scrolls of the Manual of Discipline, which is very similar in content to what Schechter identified as a Zadokite document. He died on Nov. 19, 1915, in New York city. (M. AT.)

SCHEELE, CARL WILHELM (1742–1786), Swedish chemist, who anticipated by several years Joseph Priestley's discovery of oxygen, was born at Stralsund, the capital of Pomerania, which then belonged to Sweden, on Dec. 9, 1742. He studied the elements of chemistry during his apprenticeship to an apothecary in Goteborg, Swed., with whom he stayed for eight years. In 1765 he took a similar position in Malmo and again in Stockholm in 1768. He read chemistry avidly and experimented constantly during his free time. In 1770 he settled at Uppsala, where he made the acquaintance of Torbern O. Bergman (*q.v.*). A friendship sprang up between the two, and it has been said that Scheele was Bergman's greatest discovery. In 1775, the year in which he was elected into the Stockholm Academy of Sciences, he left Stockholm for Koping, a small place on Lake Malaren, where he became proprietor of a pharmacy. Frederick the Great tried to induce him to accept a chair of chemistry at Berlin, but this flattering offer, as well as one from England, was refused.

He found time for an extraordinary amount of original research, and every year he published two or three papers, most of which contained some discovery or observation of importance. It is said that his unremitting work, especially at night, and in a poorly ventilated laboratory, together with his handling of the most toxic materials and also with the habit of tasting and smelling materials indiscriminately, induced illness which brought about his death in Koping at the age of 43 on May 21, 1786.

Scheele's record as a discoverer of new substances is probably unequaled, in spite of his poverty and lack of ordinary laboratory conveniences. His work touched every province of the chemistry of his time. His first paper was published in 1770 in conjunction with his friend Anders Retzius; it dealt with the isolation of tartaric acid from cream of tartar (see TARTARIC ACID). Analysis of manganese dioxide in 1774 led him to the discovery of chlorine and baryta, to the description of various salts of manganese itself, including the manganates and permanganates, and to the explanation of its action in colouring and decolourizing glass. He showed that iron, copper and mercury exhibit various degrees of oxidation. In 1775 he investigated arsenic acid and its reactions, discovering arsine and Scheele's green (copper arsenite). (See ARSENIC.) Papers published in 1776 were concerned with quartz, alum and clay and with the analysis of calculus vesicae (bladder stones), from which for the first time he obtained uric acid.

Scheele's only book, Air and Fire, was published in 1777 but was written some years before. One of the chief observations recorded in it is that the atmosphere is composed of two gases—one which supports combustion and the other which prevents it. The former, "fire-air," or oxygen, he prepared from acid of nitre, from saltpetre, from black oxide of manganese, from oxide of mercury and other substances, and there is little doubt but that he obtained the gas two years before Priestley. Owing to the delay in the publication of his results he is rarely given credit for this discovery. In all, he described ten methods of preparing oxygen. He showed that it played an essential part in the life processes of aquatic animals and plants. as well as those that live in air. Scheele remained in favour of the phlogiston theory (see CHEMISTRY: History of *Chemistry*) until his death; he apparently thought that hydrogen, which he had obtained by the action of certain acids on iron or zinc, was pure phlogiston.

In 1777 Scheele prepared sulfureted hydrogen by a variety of methods and noted the chemical action of light on silver compounds and other substances. (See SULFUR.) In 1778 he proposed a new method of making calomel and powder of algaroth, and he got molybdic acid from mineral molybdaena *nitens,* which he carefully distinguished from ordinary molybdena (graphite or black lead of commerce). In the following year he showed that graphite consists essentially of carbon, and he published a record of estimations of the proportions of oxygen in the atmosphere, which he had carried on daily during the whole of 1778—three years before Henry Cavendish (*q.v.*). In 1780 he proved that the acidity of sour milk is due to what was afterward called lactic acid, and by boiling milk sugar with nitric acid he obtained mucic acid.

His next discovery, in 1781, was in connection with the mineral scheelite (calcium tungstate), from which he obtained tungstic acid. In 1782 he published some experiments on the formation of ether and in 1783 examined the properties of glycerine, which he had discovered seven years before. About the same time, in the course of some work on Prussian blue, he described the composition, properties and compounds of prussic (hydrocyanic) acid and even ascertained its smell and taste. quite unaware of its poisonous character. In the last years of his life he returned to the vegetable acids. He isolated and investigated citric, malic, oxalic and gallic acids.

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SCHEELITE, a mineral consisting of calcium tungstate, is an important ore of tungsten. Before the development of high-speed tool steels around 1900, the ore had little commercial value. Since then, however, consumption has increased greatly as a source of tungsten for use in the manufacture of alloy steel. Tungsten is also used as a pure metal, in carbides and as filaments in electric lights and electronic equipment, Synthetic sheelite has the same uses. Named after C. W Scheele, a Swedish chemist, it is the mineral in which he discovered tungstic acid. Scheelite is commonly found in heavy, compact and granular masses, but tetragonal, dipyramidal crystals occasionally occur. It is white, yellow, brown or green and has a vitreous to adamantine lustre. The hardness is 4.5 to 5 and the specific gravity 5.9 to 6.1. Most scheelite fluoresces, the colour ranging from blue-white or white to yellow, depending upon the amount of molybdenum present. The formula is $CaWO_4$. $CaO = 19.4\%$; $WO_3 = 80.6\%$. The high density, high lustre and fluorescence are distinguishing characteristics.

Scheelite is found in contact metasomatic deposits, high-temperature veins and in granite pegmatites. Associated minerals include cassiterite, fluorite, topaz, apatite, wolframite and certain sulfides. In the United States scheelite has been mined in quantity in North Carolina, California, Nevada and in smaller amounts in a number of other western states. It also occurs in Cornwall and Cumberland, Eng.; and in Bolivia, New South Wales. New Zealand and Tasmania. See also TUNGSTEN. (A. F. HR.)

SCHEEMAKERS, PETER (1691–1781), a sculptor who worked almost entirely in the classical tradition and may be considered one of the founders of modern sculpture in England, was born at Antwerp in 1691. He studied in the workshop of his father and a orked in Rome. Copenhagen and, about 1720, in London, first with P. D. Plumier and later with F. Bird. After another stay in Rome and at Antwerp he came back to London about 1735 and worked there until about 1770. He spent the last years of his life in Antwerp, a-here he died in 1781.

Scheemakers is responsible for a great deal of work in England, and monuments signed by him are to be found in churches all over the country. His most famous work is the monument to Shakespeare, which was designed by William Kent and erected in Westminster abbey in 1741. (J. A. DR.)

SCHEER, REINHARD (1863–1928), German admiral, who commanded the High Seas fleet at the battle of Jutland (*q.v.*), was born at Obernkirchen, Hesse-Nassau, on Sept. 30. 1863. After serving in the Cameroons and east Africa, in 1903 he was given command of the 1st torpedo division. In 1910 he became chief of staff of the High Seas fleet under Henning von Holtzendorff and in 1913 became commander of a battle squadron. At the outbreak of World War I he was stationed at Kiel with his squadron. Scheer introduced many important improvements in submarine tactics. In Jan. 1916 he was placed in command of the German High Seas fleet, which he led at the battle of Jutland. On July 2, 1918, he succeeded Von Holtzendorff as chief of the admiralty staff. On Nov. 14, 1918, he was placed on the retired list and took up residence in Marktredwitz, where he died on Nov. 26, 1928. Scheer's account of the battle of Jutland appears in his book *Deutschlands* Hochseeflotte *im Weltkriege* (1919).

SCHEFFEL, JOSEPH VIKTOR VON (1826–1886), German poet and novelist, was born at Karlsruhe on Feb. 16, 1826. He studied at Munich, Heidelberg and Berlin, entered the state judicial service, and for four years (1848–52) held an official position at Sackingen. There he wrote his poem Der Trompeter von Sackingen (1853), a romantic and humorous tale which immediately gained extraordinary popularity. It has reached more than 250 editions. In 1854 he quitted the government service and settled at Heidelberg, with the intention of joining the teaching staff of the university. His studies were interrupted by eye disease, and he went to live on the Lake of Constance. There he elaborated the plan of his famous historical romance *Ekkehard* (1857), the scene of which is laid in the monastery of St. Gall in the 10th century; (Eng. trans. by S. Delffs, 1872). The first ideas for this work he got from the *Monumenta* Germaniae. In 1901 *Ekkehard* had reached the 179th edition. Scheffel next returned to

Heidelberg, and published *Gaudeamus, Lieder aus dem Engeren und Weiteren* (1868), a collection of joyous and humorous songs; the matter for which is taken partly from German legends, partly from historical subjects. Scheffel was custodian (1857–59) of the library of Prince Egon von Furstenberg at Donaueschingen; he eventually settled at Karlsruhe, where he died on April 9, 1886.

Scheffel's *Gesammelte Werke* have been published in 6 vol. (1907). *See* also A. Ruhemann, *Joseph Victor von Scheffel* (1887).

SCHEFFER, ARY (1795–1858), French painter of German parentage, was born at Dordrecht, Holland, Feb. 12, 1795; his father was court painter at Amsterdam. He studied in Paris with Pierre Narcisse Guerin and, like his great fellow student Delacroix, painted the defense of Missolonghi. His "Gretchen Spinning" (1831) was the subject of a chapter by Heinrich Heine, and from this time Scheffer devoted himself to romantic narrative and religious paintings. His "Paolo and Francesca" (Wallace collection, London) and "Mount of Olives" (Dordrecht) show his mature style; his early free and bold handling gave place to a manner dependent on precise contour and smooth modeling. Scheffer's best known work in the Louvre is "St. Augustine and St. Monica." He died June 15, 1858, at Argenteuil. He enjoyed immense popularity in his lifetime and was drawing master to the children of Louis Philippe. (D. C. T. T.; X.)

SCHEIDEMANN, PHILIPP (1865–1939), German politician, was born at Kassel on July 26, 1865, the son of a carpenter and upholsterer. He became a printer and later a journalist and editor of Socialist papers. In 1903 he was elected to the *Reichstag* as Social Democratic deputy for Solingen. He became secretary of the Social Democratic party in 1911, and led the party in active support for the war in 1914, a policy he continued to follow as leader of the party in the *Reichstag* after the Independent Socialists, who opposed the war, had broken away, although he demanded a "peace without annexation or indemnities." On Oct. 3, 1918, after some hesitation, he entered Prince Max of Baden's government as secretary of state. He became convinced of the need for the kaiser's abdication; and it was he who, on Nov. 9, proclaimed the republic outside the *Reichstag* building. He joined the provisional government as finance minister, and, together with Friedrich Ebert and Gustav Noske, was active in suppressing attempts at revolution by the Independent Socialists and Communists. He was elected to the national assembly in Jan. 1919, and in February became head of the government, a post he held until June when he resigned because he and some of his colleagues refused to sign the treaty of Versailles. From 1920 to 192j he was *Oberbiirgermeister* of Kassel. He sat in the *Reichstag* from 1920 to 1933 as a deputy for Hesse-Nassau. In 1933 he emigrated to Czechoslovakia and then to Denmark, where he died on Nov. 29, 1939.

Scheidemann published two volumes of recollections, *Der Zusammenbruch* (1921) and *Memoirs of a Social Democrat* (1929). (J. B. Jl.)

SCHELDT (Fr. ESCAUT; Flem. SCHELDE), a river rising near Catelet in France, entering Belgium near Bleharies in Hainaut, and flowing past Tournai, Oudenarde, Ghent and Termonde till it reaches Antwerp. Some distance below Antwerp, in front of the island Beveland, where the river divides into two channels, respectively north and south of the island, both banks belong to Holland. Of the two channels named, the southern, De Hout, which reaches the sea at Flushing, is used for ocean commerce. The Scheldt has a length of 270 mi., of which, by a skillful arrangement of locks, not less than 248 mi. are navigable. Its breadth is 1.640 ft. at Antwerp and 5,905 ft. where it leaves Belgium. The principal tributaries are the Lys, the Dender and the Rupel. By the treaty of Munster in 1648 the Dutch obtained the right to close the Scheldt to navigation, and they clung tenaciously to it for over two centuries. In 1839 on the final dissolution of the kingdom of the Netherlands, Holland gave definite form to this right by fixing the toll, and by obtaining the assent of the powers to the arrangement which fettered the trade of Antwerp. In 1863 after long negotiations Belgium bought up this right—each of the powers interested in the trade contributing its quota—and the navigation of the Scheldt was then declared free.

See also HOLLAND: *History;* BELGIUM: *History.*

SCHELER, MAX (1874–1928), German philosopher, born in Munich on Aug. 22, 1874, began teaching philosophy at Jena in 1902, when he had already come under the influence of Edmund Husserl (*q.v.*). From 1907 to 1910 he taught at Munich. Finally, after some work for the German foreign office in Geneva (1917) and at The Hague (1918), he was in 1919 appointed professor of philosophy at Cologne. He died at Frankfurt am Main on May 19, 1928.

Throughout his work Scheler's method is phenomenological, that is to say, he tries to discover what is essentially involved in mental attitudes and their objects; he differs from Husserl in his readiness to accord an independently real status to the objects of such attitudes.

In ethics Scheler's main work is *Der Formalismus in der Ethik und die materiale Wertethik* (Halle, 1913–16), in which, after severely criticizing the formalistic ethics of Kant, he pleads for a teleological ethics of value not unlike British ideal utilitarianism. Values are ranged in an objective order of higher and lower, which are presented a priori through our feelings: Scheler builds largely on Pascal's "order" or "logic of the heart." In philosophical psychology Scheler's most interesting work is *Wesen und Formen der Sympathie* (1923; Eng. trans. by P. Heath as *The Nature of Sympathy*,.1954). In the work entitled *Vom Ewigen im Menschen* (1921) Scheler gives a penetrating analysis of the religious consciousness (called by him the "religious act") and of the kind of object to which it is essentially directed; *i.e.,* an object self-sufficient, all-performing, holy, etc. The theistic flavour of this work yields to a more pantheistic attitude in the later *Die Stellung des Menschen im Kosmos* (1927, 1928). Scheler's principal contribution to philosophical sociology is *Die Wissensformen und die Gesellschaft* (1926), where he passes criticism and attempts to improve on Marxist and Comtist accounts of the relation of ideas and beliefs to social structure and development.

See the collected *Werke* (1954–); also the special issue of *Philosophy and Phenomenological Research,* vol. 2, *no.* 3 (1942), devoted to Scheler. (J. N. F.)

SCHELLING, FRIEDRICH WILHELM JOSEPH VON (1775–1854), German philosopher who, following a departure from Fichte's ethical philosophy, formulated a system of metaphysics based on the philosophy of nature. He was born on Jan. 2j, 1775, at Leonberg, a small town of Württemberg. He was educated at the cloister school of Bebenhausen, near Tubingen, where his father, an able orientalist, was chaplain and professor. In 1790 he entered the theological seminary at Tubingen. Among his (elder) contemporaries were Hegel and Holderlin. He shared in the revolutionary sentiments common among his fellow students. In 1792 he graduated. Meanwhile he was a close student of Kant, Fichte and Spinoza, more especially of Fichte. Schelling had no sooner grasped the leading ideas of Fichte's amended form of the critical philosophy than he put together his impressions of it in his *Uber die Moglichkeit einer Philosophie überhaupt* (Tubingen, 1795). The more elaborate work, *Vom Ich als Prinzip der Philosophie, oder iiber das Unbedingte im menschlichen Wissen* (Tübingen, 1795), while remaining within the limits of the Fichtean idealism, exhibits a tendency to give the Fichtean method a more objective application and to amalgamate with it Spinoza's more realistic view.

After two years as tutor to two youths of noble family, Schelling was called as extraordinary professor of philosophy to Jena, the centre of the poets and philosophers of the Romantic sch'ool, in midsummer 1798. He had already contributed articles and reviews to F. I. Niethammer's *Philosophisches Journal* (Neustrelitz, 1795–96; Jena. 1797–98), to which his *Philosophische Briefe über Dogmatismus und Kritizismus* (a critique of the ultimate issues of the Kantian system) and his *Neue Deduction des Naturrechts* (the composition of which, in 1795, to some extent anticipated Fichte's *Grundlage des Naturrechts)* had been sent. His studies of physical science bore rapid fruit in his *Ideen zu einer Philosophie der Natur* (Leipzig, 1797) and in the treatise *Von der Weltseele* (Hamburg, 1798); and these were followed by his *Erster Entwurf eines Systems der Naturphilosophie* (Jena and Leipzig, 1799), by the *Einleitung zu dem Entwurf eines Systems der Naturphilosophie* (Jena and Leipzig, 1799), by the *System des transzendentalen*

Idealismus (Tiibingen, 1800), by the *Darstellung meines Systems der Philosophie* (in the *Zeitschrift fur spekulative Physik,* ii, Jena, 1801), by *Bruno, oder uber das natiirliche und gottliche Prinzip der Dinge* (Berlin, 1802) and by the *Vorlesungen iiber die Methode des akademischen Studiums* (Tiibingen, 1803). The philosophical renown of Jena was at its height during Schelling's years of residence there (1798–1803). His intellectual sympathies, moreover, united him closely with some of the most active literary tendencies of the time. With Goethe he was on excellent terms, but he was repelled by Schiller's less speculative philosophy. In Schelling, essentially a self-conscious genius, eager and rash, yet with undeniable power, the Romanticists hailed a personality of the true Romantic type. With August Wilhelm von Schlegel and his wife Caroline, herself the embodiment of the Romantic spirit, Schelling's relations were intimate, and a marriage between Schelling and Caroline's young daughter by a previous marriage, Auguste Bohmer, was perhaps contemplated by both. Auguste's death in 1800 drew Schelling and Caroline together. Schlegel divorced his wife, and in June 1803 she married Schelling. This marriage marks the end of Schelling's life at Jena.

From 1803 to 1806 Schelling was professor at the new university of Wiirzburg. In 1804 he published the essay *Philosophie und Religion* (Tiibingen). During this period, however, he not only broke with Fichte and with Hegel but also embroiled himself with his colleagues and with the government. In 1806, then, he moved to Munich, where he was to remain until 1841. There Schelling enjoyed ease and leisure, thanks to state appointments: he was made an associate of the academy of sciences, secretary of the academy of arts and then secretary of the academy of sciences. These appointments, moreover, did not prevent his lecturing for a short time at Stuttgart and annually over a seven-year period at Erlangen (1820–26). Finally, in 1827, he became professor at Munich. Caroline's death (1809) was followed by his marriage in 1812 to one of her closest friends, Pauline Gotter, in whom he found a faithful companion.

The early years of Schelling's Munich period were marked by several publications. The aphorisms on *Naturphilosophie* in the *Jahrbiicher der Medicin als Wissenschaft* (Tubingen, 1806–08) are for the most part extracts from lectures delivered at Wiirzburg; but the treatise *Uber das Verhältniss der bildenden Kiinste zu der Natur* (Munich, 1807; Eng. trans. by A. Johnson, *The Philosophy of Art,* London, 1845) and the *Philosophische Untersuchungen iiber das Wesen der menschlichen Freiheit* (first published in *Philosophische Schriften,* Landshut, 1809; Eng. trans. by J. Gutmann, Of *Human Freedom,* Chicago, 1936) represent interesting developments in his thought. Subsequently, however, his literary activity came gradually to a standstill. The *Denkmal der Schrift von den'gottlichen Dingen des Herrn F. H. Jacobi* (Tiibingen, 1812) was called forth by the incident of Jacobi's book. The tract *Uber die Gottheiten von Samothrake* (Stuttgart and Tübingen, 181j) was ostensibly part of a great work, *Die Weltalter,* which was frequently announced as ready for publication but which was never finished *(cf.* the fragment trans. by F. de Wolfe Bolman, *The Ages of the World,* New York, 1942).

The dominance of Hegel in the German schools appears to have silenced Schelling. It was only in 1834, after the death of Hegel, that, in a preface to a translation of a work by Cousin, he expressed in writing the antagonism in which he stood to the Hegelian and to his own earlier conceptions of philosophy. The antagonism certainly was not new: it was evidenced in his Erlangen lectures of 1822 on the history of philosophy *(Siimmtliche Werke,* x, 124–125); and Schelling had already begun the treatment of mythology and religion which in his view constituted the true positive complement to the negative of logical or speculative philosophy. The writings of D. F. Strauss. L. Feuerbach and other members of the Hegelian left having alarmed the religious element, Frederick William IV invited Schelling to Berlin in 1841 in the hope that he would lecture at the university and counteract the Hegelians. But the latter were too strongly entrenched, and in 1845 Schelling ceased to lecture. No authentic information as to the nature of the new positive philosophy was made generally available till after Schelling's death, which took place on Aug. 20, 1854, at Ragaz. His Berlin lectures were then printed in the first four volumes (1856–58) of the 2nd section of his collected works, setting forth his "philosophy of mythology" and his "philosophy of revelation."

Philosophy.—Schelling indicated the turning points of his philosophical career as follows: (1) the transition from Fichte's method to the more objective conception of nature — the advance, in other words, to *Naturphilosophie;* (2) the definite formulation, in the *Identitätsphilosophie,* of that which implicitly, as Schelling claims, was involved in the idea of *Naturphilosophie,* that is to say the thought of the identical, indifferent, absolute substratum of both nature and spirit; **(3)** the opposition of negative and positive philosophy, an opposition which is the theme of the Berlin lectures, though its germs may be traced back to 1804.

Schelling's philosophy of nature, though first conceived as a supplement to Fichte's mainly ethical position, soon developed into an entirely different outlook. Whereas Fichte's *Wissenschaftslehre* made the knowing and willing subject the centre of existence altogether, Schelling emphasized the self-existence of the objective world. Nature is not to be understood only from the perspective of empirical observation and scientific theory; it is rather a reality of its own which speculative or intellectual intuition has to interpret. Such an interpretation discloses that nature is a universal organism endowed with a world soul, as Plato taught. In nature as in the human ego the same original tendencies operate: the one finite and material, the other infinite and ideal.

In his system of transcendental idealism (1800) Schelling tried to unite his philosophy of nature with epistemology and ethics, the objective and the subjective aspect of speculation. He subordinated nature to mind, but he denied that morality is the zenith of subjective activity (as Kant and Fichte had assumed). Mind reaches its consummation rather in the creative act of the artist. On the one hand, the genius works as nature does, but consciously and intentionally; on the other, nature works as the genius, but unconsciously and unintentionally. This magnificent solution of the basic problem of reconciling nature and mind to one another corresponded best to the Romantic spirit of the epoch.

But impressive and fascinating as the solution was, it could not fully satisfy the thinking intellect just because it was too Romantic and not rational enough. In 1801 Hegel began his academic career in Jena, and it was probably under the influence of Hegel's more rational thinking that Schelling hastily conceived of a new scheme in which he concentrated upon the original identity of the opposites, the finite and the infinite, the objective and the subjective, the real and the ideal. This identical ground cannot be comprehended in itself, but can be known indirectly by the relative balance of the antagonistic polarity in both the objective and the subjective sphere open to our experience. This scheme was not carried out, but remained a sketch.

The objective tendency, which was dominant in Schelling, soon led him to a Platonic conception of the subjective sphere: he renewed the time-honoured doctrine of the ideas. But the ultimate unity out of which the opposites arise could not be expounded unless the realm of the ideas was understood as being the origin of the finite self and the finite world. Schelling took a new step in 1804 when he wrote his essay *Philosophie und Religion* in order to explain this most hidden relation. Like Coleridge, he longed "to know metaphysically the Spirit of God." The ideas have their absolute unity in that spirit. But since it is the nature of the ideas to be both necessary (objective) and free (subjective), they are able to fall away from their origin and centre. This defection is possible because of the absolute freedom of the ideas; but for the same reason it cannot be accounted for. Schelling here renews the doctrine of Origen. Slowly he is going back to Christian speculation. Through debasing themselves the ideas transform themselves into the phenomenal world in which we live. The original unity of ideas and God can be restored only through the return of man to his creator.

These half-religious, half-speculative conceptions were further modified under the influence of the Catholic Romantic F. X. von Baader (who in turn was inspired by Jacob Boehme) in Schelling's work on human freedom (1809). Schelling now carried the ground of the apostasy of the ideas back into the nature of God himself: in God there is an original abyss, a kind of absolute and non-rational will, which is the ultimate source of the independence and contingency of the finite world, or of its existence in contrast to its divine essence. But the final and definitive form of Schelling's speculation was gained only in the Berlin lectures.

According to these lectures, God cannot be known by any speculative effort whatsoever ("negative philosophy"): God has to be experienced. This position Schelling calls metaphysical empiricism. The experience of the absolute ground of all things is impossible apart from the self-manifestation of God. We learn his nature from the history of myth and revelation. which is at the same time God's own spiritual history ("positive philosophy"), culminating in the Incarnation and Resurrection of Christ. These lectures, which, as has been said, had no success when Schelling delivered them, were to arouse the interest of existentialists in the 20th century.

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(R. KR.)

SCHENECTADY, a city of New York, U.S., is located 16 mi. N.W. of Albany on the Mohawk river, the seat of Schenectady county. It was established in 1661 when the Mohawk Indians sold the title to the wide, flat river plain immediately above the falls of the river to Arent van Curler and his associates. The site was only 14 mi. by easy portage from the seaport of Albany; the place name is of Indian origin. In 1690 the little village was virtually extinguished by the Schenectady massacre, occurring when a war party of French and Indians walked by the snowmen which the overconfident citizens had erected as sentries. About 1700 there was an influx of English settlers. Schenectady was chartered as a borough in 1765 and as a city in 1798. Its location on the portage between the Hudson and Mohawk rivers assured it of a prosperous business in the transshipment of goods. In the period after the American Revolution a vast tide of New England immigrants moved into the Mohawk valley, and Schenectady, being the transfer point, was further stimulated by new business. With the opening of the Erie canal in 1825, however, the canal boats carried their cargoes directly into Albany, and Schenectady suffered a decline. Recovery began with the manufacture of brooms and brushes during the next decade.

New forms of transportation and industry came to Schenectady when the Mohawk and Hudson railroad began to operate in 1831. The railroad was a forerunner of the New York Central, and the consequent demand for locomotives led to the establishment of the Schenectady Locomotive works in 1848. This firm, which has built tanks as well as steam and diesel locomotives, became the American Locomotive company (later Alco Products, Inc.) in 1901.

In 1886 the Edison Machine works were moved to Schenectady and in 1892 mergers created the General Electric company, with its main administrative offices there and later establishing plants manufacturing gas turbines, motor generators and electronic equipment, and experimental laboratories which provided research facilities for many famous scientists, including Charles Steinmetz, Willis Whitney, William David Coolidge and Irving Langmuir. The Atomic Energy commission's Knolls Atomic Power laboratory, established to provide facilities for the investigation of uses of nuclear power, and its nearby establishment at West Milton, Saratoga county, are operated by the company.

Manufactures include varnish, mica products, wire and cable equipment and athletic and sporting goods.

Union college. a private liberal arts college for men, established in 1795. is in Schenectady; the college and its affiliated professional schools in Albany form Union university.

The city has a council-manager form of government, in effect since 1936.

The population of Schenectady in 1960 was 81.682 (for comparative population figures see table in NEW YORK: Population). It is a part of the Albany-Schenectady-Troy standard metropolitan statistical area (see ALBANY). (H. S. PR.)

SCHERER, EDMOND HENRI ADOLPHE (1815–1889), French theologian, critic and politician. was born in Paris on April 8, 1815. After a course of legal studies he spent several years in theological study at Strasbourg, where he graduated doctor in theology in 1843, and was ordained. He held a theological chair in a Protestant seminary at Geneva for a brief period, but developed liberal opinions on religious matters, and eventually settled in Paris as a journalist.

He at once attracted attention by brilliant critical work, at first chiefly on great foreign writers, contributed to the Revue des deux *mondes*. He was elected municipal councillor at Versailles in 1870. deputy to the National Assembly for the department of Seine-et-Oise in 1871 and senator in 1875. He supported the Republican party.

Scherer was for many years one of the ablest contributors to Le Temps. He was a frequent visitor to England, and took a lively interest in English politics and literature. He died at Versailles on March 16. 1889.

Among his works are: *Etudes critiques sur la littdrature contemporaine,* 10 vol. (1863–89), *Études critiques de littdrature* (1876), *Dzderot* (1880), *La Démocratie et la France* (1883), *Etudes sur la littérature au XVIII^e siècle* (1891).

SCHERZO (Italian for "a joke"); in music, a quick movement evolved from the minuet and used in the position thereof in the sonata forms (*q.v.*). The term is also used as a mere character name. Haydn first used it and its adverb scherzando, for the middle movement of an early sonata in C sharp minor, and afterwards in place of the minuet in the set of six quartets known sometimes as "Gli Scherzi," and sometimes as the "Russian quartets" (op. 33). He never used the term again, though his later minuets are often in a very rapid tempo and sometimes on alarger scale than any of the earlier scherzos of Beethoven. Haydn wished to see the minuet made more worthy of its position in large sonata works; but he did not live to appreciate (though he might possibly have heard) the fully-developed scherzos of his pupil, Beethoven.

The formal essence of the minuet and trio lies in their combination of melodic forms with an exact da *capo* of the minuet after the trio. No other movement in the sonata has leisure for so purely decorative a symmetry. Beethoven's typical scherzos purposely exaggerate this quality. He does not follow Mozart's example of minuets with two trios, for the style of his mature scherzos is so continuous that a second trio would give it an elaborate rondo character unlike that of a dance-movement. But after Beethoven's scherzo has run through the stages of scherzo, trio and scherzo da capo, it goes through the same trio and da capo again; and then tries to do so a third time, as if it could not find a way out, so that it has to be abruptly stopped. Modern players and listeners are impatient of these grotesque repetitions; but the art-form is true to its own nature, and we should be the better for leisure to understand it. Apart from the wonderful little A flat bagatelle—No. 7 of the set written at the age of 15 and published (presumably with extensive revision) as op. 33—Beethoven first used the double repetition in his 4th symphony (with a shortening of the last da capo); and his last example is in the C sharp minor quartet (op. 131).

The scherzo of the 9th symphony is so enormous that its main body differs from a complete first movement of a sonata only in its uniformity of texture and its incessant onrush, which not even the startling measured pauses and the changes from 4-bar to 3-bar

Outline of SCHERZO of Beethoven's 7th Symphony.

(The phrasing given here is the most natural; but any phrasing whatever will prove that the themes change their accents in the course of the movement.)

rhythm can really interrupt. Beethoven directs as many repetitions of its subsections as possible, and his coda consists of an attempt to begin the trio again, dramatically cut short. The scherzo of the C minor symphony was originally meant to go twice round; and a certain pair of superfluous bars, which caused controversy for 30 years after Beethoven's death, were due simply to traces of the difference between the *prima volta* and *seconda volta* being left in the score.

Beethoven does not use the title of scherzo unless the music is humorous. Thus in the sonata in E flat (op. 31, No. 3) it is applied to a sonata-form lively movement which is technically the slow movement. while the following slow minuet is the dance-movement. The second movement of the F major quartet (op. 59, No. 1) is a unique example of scherzo-style in a most elaborate sonata-form.

Perhaps this gigantic movement may have been the inspiring source of the Mendelssohnian scherzo, one of the most distinct new types of movement since Beethoven, and quite independent of the notion of an alternating trio. The scherzos in Mendelssohn's *Midsummer Night's Dream* music, in the Scotch symphony and in the string quartets in E minor and E flat major (op. 44, Nos. 2 and 3) are splendid examples. Even Berlioz shows their influence in the "Queen Mab" scherzo of his *Roméo et Juliette.*

Of Brahms' scherzos there are several distinct types, ranging from a quiet allegretto and trio in melodic forms to the sonata-form *Presto giocoso* of the 4th symphony, which within seven minutes accomplishes the most powerful scherzo since Beethoven. Every degree of lyric beauty and dramatic passion is comprised in the various movements that Brahms puts into the position of scherzo in his sonata works.

Chopin produced a new type of independent scherzo; obviously inspired by Beethoven, but with a slightly macabre tendency of his own, except in the very diffuse and light 4th scherzo. The majority of classical scherzos are in a quick triple time with only one countable beat to a bar; and this custom is the last vestige of the derivation of the scherzo from the minuet.

Of modern scherzos there is nothing specific to be said; the term still applies to lively intermediate movements in cyclic instrumental works, and is otherwise a mere character-name.

(D. F. T.)

SCHEVENINGEN (Schāv'nĭng-ẹn), fishing port and watering-place, the Netherlands, on the North sea, province of South Holland, about 2 mi. N. of The Hague, of which it is a part. It is situated in the dunes at the extremity of the woods which separate it from The Hague proper. The development of Scheveningen as a seaside resort dates from modem times, but the fishing village is of ancient origin and once stood farther seaward. To prevent coast erosion a stone wall was built along the sea front in 1896–1900, and below this lies the fine sandy beach stretching for miles on either side. The first bathing establishment there dates from 1818, and was also the first in the Netherlands. There is a large harbour. During the winter of 1942–43 the Germans destroyed large sections of Scheveningen. Pop. (1947) 13,781.

SCHIAPARELLI, GIOVANNI VIRGINIO (1835–1910), Italian astronomer and senator of the kingdom of Italy, was born March 14, 1835, at Savigliano, Piedmont. He entered Turin university in 1850, and graduated in 1854. Two years later he went to Berlin to study astronomy under Encke, and in 1859 was appointed assistant observer at Pulkova, a post he resigned in 1860 for a similar one at Brera, Milan. On the death of Francesco Carlini in 1862, Schiaparelli succeeded to the directorship, which he held until 1900. He died at Milan July 4, 1910.

Schiaparelli possessed exceptional powers as an observer—his first discovery was of the asteroid Hesperia in 1861—and his considerable mathematical ability is shown in his papers. In 1866 he showed the connection between meteor streams and cometary orbits, giving, in particular, the identity of the orbits of the Perseids and Comet III., 1862, and of the Leonids and Comet I., 1866. These discoveries were subsequently amplified in his Le *Stelle cadenti* (1873) and in his *Norme per le osservazioni delle-stelle cadenti dei bolidi* (1896). He observed double stars, and the results of his measures are published in 2 vols., the first containing those made between 1875–85, and the second those between

1886–1900. He made extensive studies of Mercury, Venus and Mars. In 1877 he observed on Mars the peculiar markings, which he called *canali,* the nature and origin of which is still controversial. *(See* MARS.) From his observations of Mercury and Venus he concluded that these planets rotated on their axes in the same time as they revolved about the sun. On his retirement he turned to the astronomy of the Hebrews and Babylonians; his earlier results are given in his *L' Astronomia nell' antico Testamento* (1903), which has been translated into English and German, whilst later ones are to be found in various journals, the last being in *Scientia* (1908).

SCHICHAU, FERDINAND (1814–1896), German engineer and shipbuilder. was born at Elbing, the son of a smith and ironworker, on Jan. 30, 1814. He started works of his own at Elbing in 1834, and was soon employing some 8,000 men. He began by making steam engines, hydraulic presses and industrial machinery, and, by concerning himself with canal work and river or coast improvement, came to the designing and construction of dredgers, in which he was the pioneer (1841), and finally to the building of ships.

His "Borussia," in 1855, was the first screw-vessel constructed in Germany. Schichau began to specialize in building torpedo-boats and destroyers (at first for the Russian Government) at an early date. From 1873 he had the co-operation of Carl H. Ziese, who married his daughter. Ziese introduced compound engines into the first vessels built by Schichau for the German navy, the gunboats "Habicht" and "Möwe," launched in 1879, and also designed in 1881 the first triple-expansion machinery constructed on the continent, supplying these engines to the torpedo-boats built by Schichau for the German navy in 1884, the first of some 160 that by the year 1909 were provided by the Elbing yards. Torpedo-boats were also built for China, Austria and Italy. Meanwhile Elbing had become insufficient for the increased output demanded. In 1889 Schichau established a floating dock and repairing shops at Pillau, and soon afterwards, by arrangement with the Government, started a large yard at Danzig. He died on Jan. 23, 1896.

SCHICKELE, RENÉ (1883–1940), Alsatian writer, was born in Oberehnheim, Alsace, Aug. 4, 1883. He was educated in Zabern and Strasburg, and afterward lived in Paris and Berlin. His first works were poetic; they include the volumes *Sommernachte* (1902), *Der Ritt urns Leben* (1906), *Mein Herz mein Land* (1915). His first prose work was *Der Fremde* (1907). He also wrote dramas. which were of less importance; but *Hans im Schnakenloch* (1916) was performed in both Paris and Berlin during World War I. Schickele was essentially an Alsatian in both style and thought. He blended in his work, which unites warmth with strength in a remarkable degree, the essence of the Germanic and the Latin cultures. His life was largely a revolt against the crushing of Xlsace's individuality by either German or French. Before World War I he was in revolt against Germany. During the war, against which he protested strongly, he lived in Switzerland; but later he made his home in Germany, in the Black Forest. The most notable novels of his maturity were *Wir wollen nicht sterben* (1922), *Maria Capponi* (192j, English trans. 1928), and *Blick auf die Vogesen* (1927). He died Jan. 31, 1940, in Nice, France.

SCHIEDAM, a town and river port of the Netherlands, in the province oi South Holland, on the Schie, near its confluence with the Maas, and a junction station 3 mi. W. of Rotterdam by rail. Pop. (1957 est.) 77,383 (mun.). The public buildings of interest are the Groote or Janskerk, the old Roman Catholic church, the synagogue, the town hall, the exchange, the concert-hall and a ruined castle. Schiedam is famous as the seat of a great gin manufacture, which, carried on in more than three hundred distilleries, gives employment besides to malt-factories, cooperages and cork-cutting establishments, and supplies sufficient yeast to form an important article of export.

SCHIFF, JACOB HENRY (1847–1920), American banker and philanthropist, was born at Frankfurt-on-Main, Germany. Jan. 10, 1847. He studied in the schools of Frankfurt and for a time worked in a bank. In 186; he went to New York city and organized the brokerage firm of Budge. Schiff and Co. In 1875 he was taken into the firm of Kuhn, Loeb and Co., and, on Loeb's retirement in 1885, took his place. In 1897 his house assisted E. H. Harriman in reorganizing the Union Pacific Railway, and in 1901 aided him in his struggle with James J. Hill and J. P. Morgan for the control of the Northern Pacific Railway. In his later years he gave much personal attention to charities. He was a founder and president of the Montefiore Home for chronic invalids, New York city. In 1903 he presented a Semitic museum building to Harvard university. He died in New York city Sept. 25, 1920.

SCHILL, FERDINAND BAPTISTA VON (1776–1809), Prussian soldier, was born in Saxony. Entering the Prussian cavalry at the age of twelve, he was still a subaltern of dragoons when he was wounded at the battle of Auerstadt. At Kolberg he played a very prominent part in the celebrated siege of 1807. After the peace of Tilsit he was given the command of a hussar regiment. In 1809 the political situation in Europe appeared to Schill to favour an attempt to liberate his country from the French domination. Leading out his regiment from Berlin under pretext of manoeuvres, he raised the standard of revolt, and marched for the Elbe. At Dodendorf (May 5, 1809) he had a brush with the Magdeburg garrison, but was soon driven northwards, where he hoped to find British support. With little more than his original force Schill was surrounded by 5,000 Danish and Dutch troops in the neighbourhood of Wismar. He escaped by hard fighting (action of Damgarten, May 24) to Stralsund. The Danes and Dutch soon hemmed him in, and by sheer numbers overwhelmed the defenders (May 31). Schill himself was killed.

See L. K. C. von Liliencron, *Schilliana* (a vols., 1810); Haken, *Ferdinand von Schill* (Leipzig, 1824); Barsch, *Ferdinand von Schill's Zug und Tod* (Leipzig, 1860), and F. *von Schill, ein Charakterbild* (Potsdam, 1860); Francke, *Aus Stralsunds Franzosenzeit* (1890).

SCHILLER, JOHANN CHRISTOPH FRIEDRICH VON (1759–1805), German poet, dramatist and philosopher, was born at Marbach on the Neckar, on Nov. 10, 1759. His father, Johann Kaspar (1723–96), was an army-surgeon, and the vicissitudes of his profession entailed a constant change of residence; but at Lorch and at Ludwigsburg, where the family was settled for longer periods, the child was able to receive a regular education. In 1773 the duke Karl Eugen of Wurttemberg claimed young Schiller as a pupil of his military school at the "Solitude" near Ludwigsburg, where he was obliged to devote himself to law. On the removal of the school in 1775 to Stuttgart, he was, however, allowed to take up medicine. The strict military discipline of the school lay heavily on Schiller, and intensified the spirit of rebellion, which burst out in the young poet's first tragedy. In 1776 some specimens of Schiller's lyric poetry had appeared in a magazine, and in 1777–78 he completed his drama, *Die Rauber.* In 1780 he left the academy qualified to practise as a surgeon, and was at once appointed by the duke as doctor to a regiment garrisoned in Stuttgart. His discontent found vent in the passionate lyrics of this period. Meanwhile *Die Rauber,* which Schiller had been obliged to publish at his own expense, appeared in 1781 and made an impression on his contemporaries hardly less deep than Goethe's *Götz von Berlichingen,* eight years before. The strength of this remarkable tragedy lay, in spite of its inflated tone and exaggerated characterization, in the sure dramatic instinct with which it is constructed and the directness with which it gives voice to the most pregnant ideas of the time. In this respect, Schiller's *Rauber* is one of the most vital German dramas of the 18th century. In January 1782 it was performed in the Court and National Theatre of Mannheim, Schiller himself having stolen secretly away from Stuttgart in order to be present. The success encouraged him to begin a new tragedy, *Die Verschwörung des Fiesco zu Genua,* and he edited a lyric *Anthologie auf das Jahr 1782,* to which he was himself the chief contributor. A second surreptitious visit to Mannheim came, however, to the ears of the duke; he had Schiller put under a fortnight's arrest, and forbade him to write any more "comedies" or to hold intercourse with any one outside Württemberg. Schiller resolved on flight, and took advantage of some court festivities in Sept. 1782 to put his plan into execution. He hoped in the first instance for material support from the theatre in

Mannheim and its intendant, W. H. von Dalberg; but nothing but rebuffs and disappointments were in store for him. He did not even feel secure against extradition in Mannheim, and after several weeks spent mainly in the village of Oggersheim, where his third drama, *Kabale und Liebe,* was in great part written, he found a refuge at Bauerbach in Thuringia, in the house of Frau von Wolzogen, the mother of one of his former schoolmates. Here *Kabale und Liebe* was finished and *Don Carlos* begun. In July 1783 he received a definite appointment for a year as "theatre poet" in Mannheim, and here both *Fiesco* and *Knbale und Liebe* were performed in 1784. In the latter play Schiller's powers as a realistic portrayer of people and conditions familiar to him are seen to best advantage. Although Schiller failed to win an established position in Mannheim, he added to his literary reputation by the publication of the beginning of *Don Carlos* (in blank verse) in his journal, *Die rheinische Thalia* (1785). He had also the opportunity of reading the first act of the new tragedy before the duke of Weimar at Darmstadt in Dec. 1784.

In April 1785 Schiller accepted the Invitation of four unknown friends—C. G. Korner, L. F. Huber, and their *fiancées* Minna and Dora Stock—with whom he had corresponded, to pay a visit to Leipzig. He spent a happy summer mainly at Gohlis, near Leipzig, his jubilant mood being reflected in the *Ode an die Freude;* and in September of the same year he followed his new friend Korner to Dresden. As Korner's guest in Dresden and at Loschwitz on the Elbe, Schiller completed *Don Carlos,* wrote the dramatic tale, *Der Verbrecher aus verlorener Ehre* (1786), and the unfinished novel, *Dcr Geisterseher* (1789). Körner's interest in philosophy also induced Schiller to turn his attention to such studies, the first results of which he published in the *Philosophische Briefe* (1786). *Don Carlos,* meanwhile, appeared in 1787, and added to Schiller's reputation as a poet. It was unfortunate, however, that in seeking a model for this higher type of tragedy he turned rather to the classic theatre of France than to the English drama.

A new chapter in Schiller's life opened with his visit to Weimar in July 1787. Goethe was then in Italy, and the duke of Weimar was absent; but the poet was kindly received by Herder and Wieland. Not very long afterwards he made the acquaintance at Rudolstadt of the family von Lengefeld, the younger daughter of which subsequently became his wife. Meanwhile the preparation for *Don Carlos* had interested Schiller in history, and in 1788 he published the first volume of his chief historical work, *Geschichte des Abfalls der vereinigten Niederlande von der spanischen Regierung.* It obtained for him, on the recommendation of Goethe, a professorship in the university of Jena, and in Nov. 1789 he delivered his inaugural lecture. Schiller's other historical writings comprise a *Sammlung historischer Memoires* and *Geschichte des dreissigjahrigen Krieges* (1791–93). The latter is written for a wider public than his first history, but the narrative is dramatic and vivid and the portraiture is sympathetic.

Before, however, this work was finished, Schiller had turned from history to philosophy. A year after his marriage he had been stricken down by severe illness, from the effects of which he was never completely to recover; financial cares followed, which were relieved unexpectedly by the generosity of the hereditary prince of Holstein-Augustenburg. who conferred upon him a pension of 1,000 talers a year for three years. Schiller devoted the leisure of these years to the study of philosophy. In the summer of 1790 he had lectured in Jena on the aesthetics of tragedy, and in the following year he studied carefully Kant's *Kritik der Urteilskraft,* which had just appeared and appealed powerfully to Schiller's mind. The influence of these studies is to be seen in several essays, as well as in his correspondence with his friend Korner. Here Schiller arrives at his definition of beauty, as "Freiheit in der Erscheinung," which marked the beginning of a new stage in the history of German aesthetic theory. *Uber Anmut und Würde,* published in 1793, was a further contribution to the elucidation and widening of Kant's theories; and in the eloquent *Briefe über die ästhetische Erziehung des Menschen* (179j), Schiller proceeded to apply his new standpoint to the problems of social and individual life. These remarkable letters were published in *Die Horen,* a new journal, founded in 1794, which was the occasion for his gaining the friendship of Goethe. An immediate outcome of the new friendship was Schiller's admirable treatise, *Uber naive und sentimentalische Dichtung* (1795–96). Here Schiller applied his aesthetic theories to that branch of art which was most peculiarly his own, the art of poetry; it is an attempt to classify literature in accordance with an a priori philosophic theory of "ancient" and "modern," "classic" and "romantic," "naïve" and "sentimental"; and it sprang from the need Schiller himself felt of justifying his own "sentimental" and "modern" genius beside the "naive" and "classic" tranquillity of Goethe's.

For Schiller himself this was the bridge that led back from philosophy to poetry. Under Goethe's stimulus he won fresh laurels in that domain of philosophical lyric ahich he had opened with *Die Künstler;* and in *Das Ideal und das Leben, Die Macht des Gesanges, Würde der Frauen,* and *Der Spaziergang,* he produced masterpieces of reflective poetry. These poems appeared in the *Musenalmanach,* a new publication which Schiller began in 1796. Here were also published the *Xenien* (1797), a collection of distichs by Goethe and Schiller, in which the two friends avenged themselves on their critics. The *Almanach* of the following year was even more noteworthy, for it contained a number of Schiller's most popular ballads, *Der Ring des Polykrates, Der Handschuh, Ritter Toggenburg, Der Taucher, Die Kraniclze des Ibykus* and *Der Gang nach dem Eisenhammer; Der Kampf mit dem Drachen* following in 1799, and *Das Lied von der Glocke* in 1800. As a ballad poet, Schiller's popularity has been hardly less great than as a dramatist; his bold and simple outlines, his terse dramatic characterization appealed directly to the popular mind. The supreme achievement of the last period of Schiller's life was the series of master dramas which he gave to the world between 1799 and 1804. Just as *Don Carlos* had led him to the study of Dutch history, so now his occupation with the history of the Thirty Tears' War supplied him with the theme of his trilogy of *Wallenstein* (1798–99). The plan of *Wallenstein* was of long standing, and it was only towards the end, when Schiller realized the impossibility of saying all he had to say uithin five acts, that he decided to divide it into three parts, a descriptive prologue, *Wallensteins Lager,* and the two dramas *Dze Piccolomini* and *Wallensteins Tod.* Without entirely breaking with the classic method he had adopted in *Don Carlos, Wallenstein* shows how much Schiller's art had benefited by his study of Greek tragedy; the fatalism of his hero is a masterly application of an antique motive to a modern theme. The success of *Wallenstein,* with which Schiller passed at once into the front rank of European dramatists, was so encouraging that the poet resolved to devote himself uith redoubled ardour to dramatic poetry. Towards the end of 1799 he took up his residence permanently in Weimar, not only to be near his friend, but also that he might have the advantage of visiting regularly the theatre of which Goethe was director.

Wallenstein was followed in 1800 by *Maria Stuart,* a tragedy, which, in spite of its great popularity in and outside of Germany, is not one of his best. Finer in every way is the "romantic tragedy," *Die Jungfrau von Orleans* (1801) The resplendent mediaeval colouring of the subject, the heroic character of Joan of Arc, gave Schiller an admirable opportunity for the display of his rich imagination and rhetorical gifts; and by an ingenious alteration of the historical tradition he uas able to make the drama a vehicle for his own moral idealism. Between this drama and its successor, *Die Braut von Messina,* Schiller translated and adapted to his classic ideals Shakespeare's *Macbeth* (1801) and Gozzi's *Turandot* (1802). With *Die Braut von Messina* (1803) he experimented with a tragedy on purely Greek lines, this drama being as close an approximation to ancient tragedy as its mediaeval and Christian *milieu* permitted. The introduction of a chorus detracted from the value of the tragedy for the theatre, but it appealed particularly to Schiller's genius. In the poet's last completed drama, *Wilhelm Tell* (1804), he once more, as in *Wallenstein,* chose a historical subject involving wide issues. *Wilhelm Tell* is the drama of the Swiss people; its subject is less the personal fate of its hero than the struggle of a nation to free itself from tyranny. It was an attempt to win for the German drama a new field, to widen the domain of dramatic poetry. Besides writing *Tell*, Schiller had found time in 1803 and 1804 to translate two French comedies by Picard, and to prepare a German version of Racine's *Phèdre*; and in the last months of his life he began a new tragedy, *Demetrius*, which gave promise of being another step forward in his poetic achievement. But *Demetrius* remains a fragment of hardly two acts.

Schiller died at Weimar on May 9, 1805. His last years were darkened by constant ill-health; and indeed it is marvellous that he was able to achieve so much. A visit to Leipzig in 1801, and to Berlin in 1804, were the chief outward events of his later years. He was ennobled in 1802. Schiller's art, with its broad, clear lines, its unambiguous moral issues, and its enthusiastic optimism, has appealed with peculiar force to the German people, especially in periods of political despondency. But since the re-establishment of the German empire in 1871 there has been a certain waning of his popularity, the Germans of to-day realizing that Goethe more fully represents the aspirations of the nation. In point of fact, Schiller's genius lacks that universality which characterizes Goethe's; as a dramatist, a philosopher, an historian, and a lyric poet, he was the exponent of ideas which belong essentially to the Europe of the period before the French revolution.

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(J. G. R.)

SCHILTBERGER, JOHANN or **HANS** (1381–1440?), German traveller and writer, was born of a noble family in 1381, probably at Hollern near Lohof, half way between Munich and Freising. In 1394 he joined the suite of Lienhart Richartinger, and went off to fight under Sigismund, king of Hungary (afterwards emperor), against the Turks on the Hungarian frontier. At the battle of Nicopolis (Sept. 28, 1396) he was wounded and taken prisoner; Sultan Bayezid I. *(Ilderim)* then took him into his service as a runner (1396–1402). During this time he accompanied Ottoman troops to Asia Minor and Egypt. On Bayezid's overthrow at Angora (July 20, 1402), Schiltberger passed into the service of Bayezid's conqueror Timur: he now visited Samarkand, Armenia and Georgia. After Timur's death (Feb. 17, 1405) his German runner became a slave of various successors. He next accompanied Chekre, a Tatar prince living in Abu Bekr's horde, on an excursion to Siberia, of which name Schiltberger gives us the first clear mention in west European literature. He followed Chekre in his attack on the Old Bulgaria of the middle Volga. Wanderings in south-east Russia; visits to Sarai, the old capital of the Kipchak Khanate on the lower Volga and to Azov or Tana, still a trading centre for Venetian and Genoese merchants; travels in the Crimea, Circassia, Abkhasia and Mingrelia; and finally escape (from the neighbourhood of Batum) followed; he lay hid at Constantinople for a time, then returned to his Bavarian home (1427) by way of Kilia, Akkerman, Lemberg, Cracow, Breslau and Meissen. After his return he became a chamberlain of Duke Albert III.

Schiltberger's *Reisebuch* contains not only a record of his own experiences and a sketch of various chapters of contemporary Eastern history, but also an account of countries and their manners and customs. First come the lands "this side" of Danube, where he had travelled; next follow those between the Danube and the sea, which had now fallen under the Turk; then the Ottoman dominions in Asia; last come the regions from Trebizond to Russia and from Egypt to India. Schiltberger is perhaps the first writer of Western Christendom to give the true burial place of Mohammed at Medina; he contributed to fix Prester John, at the close of the middle ages, in Abyssinia.

Four mss. of the *Reisebuch* exist: (1) at Donaueschingen in the Fürstenberg library, No. 481; (2) at Heidelberg, university library, 216; (3) at Nuremberg, city library, 34; (4) at St. Gall, monast. library, 628 (all of 15th century, the last fragmentary). The work was first edited at Augsburg, *c.* 1460; four other editions appeared in the 15th century, and six in the 16th; in the 19th the best were K. F. Neumann's (Munich, 1859), P. Bruun's (Odessa, 1866, with Russian commentary, in the *Records of the Imperial University of New Russia*, vol. i.), and V. Langmantel's (Tübingen, 1885); "Hans Schiltbergers Reisebuch," in the 172nd volume of the *Bibliothek des literärischen Vereins in Stuttgart*. *See* also the English (Hakluyt Society) version, *The Bondage and Travels of Johann Schiltberger . . .*, trans. by Buchan Telfer with notes by P. Bruun (1879); C. R. Beazley, *Dawn of Modern Geography* (1897, etc.) iii. 356–378, 550.

SCHIMPER, ANDREAS FRANZ WILHELM (1856–1901), German botanist best known for his work on the ecology of tropical plants, was born at Strasbourg on May 12, 1856 a member of a celebrated family of botanists. He received his doctorate at Strasbourg in 1878, and afterward studied under H. A. de Bary. From 1880 to 1881 he was a fellow at Johns Hopkins university. Upon returning to Europe he became *Privatdozent* ("official but unpaid lecturer") and professor (1886) at Bonn Botanical institute where he remained until 1898. From 1898 to 1901 he was professor at Basel, Switz. Schimper's botanical travels took him to the West Indies (1881, 1882–83), to Brazil (1886), to Ceylon and Java (1889–90) and to the Canary Islands, Cameroons, East Africa, Seychelles and Sumatra with the "Valdivia" deep-sea expedition (1898–99).

Schimper died on Sept. 9, 1901 at Basel.

Schimper's ecological studies included important papers on epiphytes, strand vegetation and myrmecophilous plants. His *Pflanzengeographie auf physiologischer Grundlage* (1898; 3rd ed., 1935; English trans., *Plant-Geography Upon a Physiological Basis*, 1903), ranks with Johannes Warming's *Plantesamfund* (1895) as one of the foundation works of modern plant ecology. The book is divided into three sections: the first considering factors that affect plant life; the second presenting Schimper's influential classification of world vegetation; and the third containing a systematic account of this vegetation. Schimper was instrumental in the establishment of a truly scientific and comprehensive method of ecological investigation. Apart from ecology, he made significant contributions to other branches of botany. He showed (1881) that starch grains are not formed in cytoplasm as previously maintained, and concluded (1883) that plastids do not arise through anything but the division of pre-existing plastids.

See notice on Schimper, with a bibliography, in *Ber. Dtsch. Bot. Ges.*, xix, pp. 54–70 (1901).
(J. W. Tr.)

SCHINKEL, KARL FRIEDRICH (1781–1841), German architect and city planner, was born near Brandenburg on March 13, 1781. He studied with Friedrich Gilly and at the Academy of Architecture, Berlin. Two years in Italy, 1803–05, completed his studies.

As state architect of Prussia, Schinkel executed many commissions for King Frederick William III and other members of the royal family. His designs were based on the revival of various historical styles of architecture, his Greek revival buildings including the Royal theatre, Berlin, 1818–21, and the Altes museum, Berlin, 1822–30. His design for a monument to Queen Louise, 1810, and the Werdersche church, Berlin, 1824–30, are two of the earliest Gothic revival designs in Europe. The St. Nicholas church, Potsdam, 1826–49, is based on Italian Renaissance prototypes.

The industrial scene in Manchester, Eng., provoked him to inquire why the modern age had not yet developed its own style, and he gave an intimation of his answer in the building he designed for the Bauakademie at Berlin. His work as city planner resulted in new boulevards and squares in Berlin.

Schinkel also is remembered for his paintings of romantic landscape scenes. stage and scenery designs and his designs for furniture, decorative ironwork, etc.

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SCHINZNACH, a small spa in the canton of Aargau, Switz. It is situated 3 mi. from Brugg, in the lower valley of the Aar river. at the southwest foot of the small but steep, well-wooded hill mass of Wülpelsburg (1.683 ft. altitude). The village (1,165 ft alt.; pop.. 1950, 1.083) is famed for its strongly sulfurous and saline medicinal springs (90°–95° F.), and during the period May to September, annually, it is much patronized, principally by French visitors. Other popular spas, such as Mullingen and Birmenstorf, lying eastward in the valley of the Reuss river, are in its immediate vicinity.

The Wulpelsburg is crowned by the ruins of an 11th-century castle. Tradition claims that the count of Altenburg discovered his strayed hawk (Ger, habicht) on the hill summit, and the naturally defended site resulted in its selection for the erection of the castle of Habichtsburg — the first important stronghola of the subsequently famous Habsburg dynasty of Austria.

SCHISM, a division, especially used of a formal separation from a church or religious body; a sect or church formed by such separation

The dispute which led to the separation of the Latin and Greek churches is known as the "Great Eastern Schism." For the Great Western Schism see PAPACY.

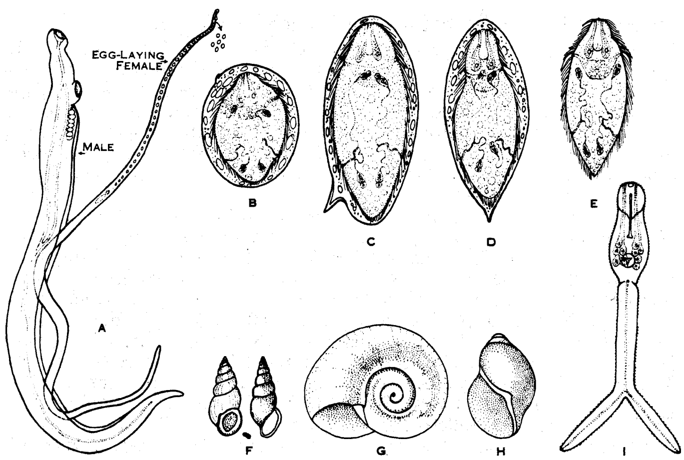
SCHISTOSOMIASIS (BILHARZIASIS), a group of diseases caused by a genus of parasitic microorganisms called blood flukes, produces symptoms primarily referable to the intestine and liver, with associated dysentery, or to the urinary bladder, with passage of blood in the urine.

Oriental schistosomiasis is endemic in Japan, central, west and south China, the Philippines and Celebes. Manson's schistosomiasis occurs in northern Egypt and many other parts of Africa, Yemen and other places in Arabia. Puerto Rico and several islands of the Lesser Antilles, Venezuela, Dutch Guiana and extensive areas in Brazil. Vesical schistosomiasis exists throughout practically all of Africa, the southern tip of Portugal, Cyprus, Palestine, Arabia, Iraq and Iran.

Causative Organisms. — They are commonly called blood flukes or schistosomes because they live in the blood vessels of their definitive host. They belong to the trematodes, a class group of flatworms (Platyhelminthes). The adult blood flukes are delicate, elongated organisms measuring about 10 to 25 mm. in length The sexes are separate. The male holds the delicate female in his ventral sex canal during the long period of egg laying. Oriental (or Asiatic or Japanese) schistosomiasis is produced by Schistosoma japonicum, Manson's (or intestinal) infection by *S.* mansoni and vesical (or urinary) schistosomiasis by S. haematobiurn. The former two reside in the mesenteric-portal venous circulation and S. *haematobium* principally in the vesical and pelvic venous plexuses

The Life Cycle. — Eggs deposited by the female worms in the smaller venules contain rapidly maturing ciliated larvae which secrete digestive substances, aiding the eggs to escape from the blood vessels through the tissues into the lumen of the intestine or urinary bladder. When the fully embryonated eggs reach fresh water they soon hatch and the ciliated larvae (miracidia) actively swim about. In case there are appropriate species of snails near by (species of Oncomelania for *S. japonicum,* Planorbis for *S.* mansoni and Bulinus or Physopsis for *S. haematobium*), the miracidia attack and penetrate the soft tissues of the mollusk and transform into simple hollow sacs (sporocysts). Each of these produces several second-generation sporocysts, which in turn give rise to numerous fork-tailed larvae, the cercariae. Broods of mature cercariae escape at frequent intervals from the snail, swim about in the water and, on contact with mammalian skin, become attached and proceed to penetrate the tissues. Man is the only natural host of S. haernatobium; man and occasionally monkeys are natural hosts of S. mansoni; and almost any mammal is susceptible to infection with *S.* japonicum. Before penetrating exposed skin (or mucous membrane) the cercaria drops its tail. Upon reaching a venule it is passively carried to the pulmonary arterioles, slowly squeezes through the capillaries into the pulmonary venules and passes into the systemic circulation. It will survive only if it reaches a mesenteric artery and proceeds through the capillaries into the portal blood vessels, where it feeds on glycogen in the blood plasma and grows. On reaching adolescence the worms work their way against the venous current: S. *japonicum* migrates to the mesenteric vessels draining the small bowel, S. mansoni to those draining the large bowel and *S.* haematobiurn down the inferior mesenteric venules and through the hemorrhoidal and pudendal anastomoses into the vesical venules. In these localities the worms complete maturity and mate, and the females begin to lay eggs.

From skin exposure until egg deposition the minimum time for *S.* japonicurn is about 4 weeks, for S. rnansoni 6 to 7 weeks and for *S.* haematobiurn 10 to 12 weeks.



BY COURTESY OF DR E C FAUST

STAGES IN THE DEVELOPMENT OF THE THREE SPECIES OF SCHISTOSOMA RESPONSIBLE FOR SCHISTOSOMIASIS

(A) Adult schistosomes in blood vessels (magnified 2.50 times). (B–D) Mature eggs (X 180): *Schistosoma japonicum, Schistosoma mansoni, Schistosoma haematobium.* (E) Miracidium hatched from egg invades snail. (F–H) Snail hosts (X 0.70): Oncomelania (*Schistosoma japonicum*), *Planorbis* (*Schistosoma mansoni*), *Bulinus* (*Schistosoma haematobium*). (I) Cercaria in water invades skin, causing disease (X 90)

Pathogenesis and Symptoms. — There are three recognized clinical stages in schistosomiasis, namely (1) incubation period, (2) acute stage and (3) chronic stage. The incubation period begins with the penetration of the cercariae and is terminated when egg deposition begins. During this time and continuing during the life of the worms (20 or more years if the patient survives) the byproducts of the worms produce local and systemic irritation of an allergic nature. (See PARASITIC DISEASES.) There is inflammation and marked to profound eosinophilia, with a nonproductive cough, late afternoon fever, giant urticaria, together with swelling, pain and tenderness of the liver. In the intestinal types (S. *japonicum* and S. mansoni), diarrhea occurs toward the end of the incubation period. With the beginning of egg deposition the acute stage of the disease is initiated, resulting from trauma caused by eggs escaping from blood vessels through the tissues into the lumen of the intestine or the urinary bladder, typically accompanied by hemorrhages. As the chronic stage gradually develops, eggs become impacted in the walls of the organs and provoke pseudotubercle formation around themselves. This leads to fibrous thickening of the organs, with greatly diminished function. The intestine gradually develops the consistency of an old, nonelastic garden hose, and the bladder becomes impregnated with phosphatic deposits and possesses a gritty surface. Moreover, in the intestinal types, eggs in increasing numbers are carried in the portal current into the liver, filter out and initiate hepatic cirrhosis. This tends to block the flow of blood through the liver, produces abdominal fluid (dropsy) and indirectly causes enlargement of the spleen.

In the vesical type, eggs in the lumen of the bladder become centres for concretions ("stones"); meanwhile the fibrosis extends to the pelvic organs. In all types, eggs are frequently swept through the accessory venous circulation to the lungs where they set up centres of tissue reaction. Occasionally nests of eggs reach the brain and other organs where they produce granulomatous tumours.

Diagnosis and Prognosis.—Diagnosis is accomplished by recovery of the characteristic eggs from the stool or by rectal biopsy (*S. japonicum, S. mansoni)* and from the sediment of the urine or by bladder biopsy (*S. haematohium).*

Prognosis depends on the species of *Schistosoma* involved (*S. japonicum* is most dangerous), on the amount of exposure, on the chronicity of the disease and to a considerable degree on the patient's reactiveness to the infection. Unless exposure is overwhelming, early diagnosis and persistent effective treatment usually provide a good prognosis.

Treatment.—The only drugs which have consistently proved helpful in the eradication of human blood flukes are the antimony compounds. Potassium antimony1 tartrate (tartar emetic), first employed in 1917, proved on the whole satisfactory, although it must be administered intravenously and is rather poorly tolerated in concentrations higher than 0.5%. Certain synthetic antimonials, particularly stibophen and lithium antimony thiomalate, are administered intramuscularly and are better tolerated, but their cure rate is considerably lower than that of tartar emetic. Miracil D is useful in infection with *S. haematohium.*

Prevention.—There is no immunization against schistosomiasis. Theoretically, education in hygiene, and public health measures to keep viable eggs from reaching fresh water constitute first-line prevention. This is impractical, however, both because of social and economic practices and, in *S. japonicum* areas, because the disease would be perpetuated by reservoir hosts. Mass chemotherapy in endemic areas likewise proved unsatisfactory. Concentrated attack on the molluscan host by naturalistic methods and by using copper sulfate in the water was moderately successful in reducing the snail population in endemic spots in Egypt, with a comparable decrease in the incidence of the disease. Molluscicides also showed considerable promise. *See* also FLUKE.

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SCHIST, in geology, a crystalline rock that splits easily. Schists are widely distributed in all major mountain ranges The name is from the German *schizein,* "to split." The ease of splitting is caused by a parallel arrangement of scaly, tabular or prismatic minerals. Nearly all schists are metamorphic rocks, and micas are the most common minerals composing them. Micas are a large family of minerals that have highly perfect cleavage, and tend to form sheetlike crystals. They are hydrous aluminum silicates with various combinations of iron, magnesium, calcium, manganese, lithium, potassium and sodium. Muscovite (white), biotite (brown to black), chlorite (green) and phlogopite (light brown) are the most common micas.

Where the earth's crust is being deformed, physicochemical conditions at depths of a few miles are such as to favour the growth of micas as stable minerals in any rock that has the requisite bulk composition. Elevated temperatures, intense shearing of the rock fabric and solutions circulating through pore spaces are probably the most important factors. Siliceous ashes or lavas (rhyolite), granitic rocks or shales may be converted to schists if the deformation is intense enough. Basaltic rocks and gabbros may be converted into greenish-gray chlorite schists, or hornblende schists, composed of combinations of the minerals hornblende (a prismatic calcium-magnesium-iron-aluminum silicate), epidote, magnetite, garnet, several members of the mica family and other silicates.

However, calcareous shales have a bulk composition similar to that of basalts and gabbros, and can also be converted into chlorite schists or hornblende schists. It may be impossible to determine the parent rock. Igneous rocks high in magnesia and iron but low in silica (peridotites) yield, under metamorphic conditions, aggregates of the fibrous mineral antigorite. Under intensive shear stress, these rocks develop talc and become talc schists. However, certain dolomites (magnesian limestones) may also be metamorphosed to talc or talc-tremolite schists (tremolite is a hydrous calcium-magnesium silicate).

Schists split easily even if mica is a subordinate constituent. Slightly muddy sandstone, metamorphosed and sheared, becomes a quartz-muscovite schist that flakes easily. Slightly muddy limestones turn into calcareous schists, composed of calcite, muscovite, phlogopite or other micas that induce fissility of the rocks. Tabular minerals, such as feldspar, or prismatic minerals like hornblende, tremolite and antigorite may under special conditions arrange themselves in parallel planes and give rise to a crude schistose structure of the rock.

The mineral hematite (ferric oxide) possesses a direction of good cleavage. Larger masses of this mineral, recrystallized under strong shear stress, may slip along the cleavage planes and become schistose (specular hematite, "iron mica"). Some of these rocks contain red jasper beds, and surfaces displaying these scarlet laminae intermixed with the silvery hematite flakes in intricately crumpled beds are extremely beautiful.

Metamorphic processes coarsen the grains of shaly sediments and lead to a series from shale (finest) through slate and phyllite (from the Greek *phyllon,* "leaf, sheet") to schist (coarsest). The grain size of schist averages over one millimetre. If feldspar equals or exceeds the amount of mica, the rock is called a gneiss. Other minerals commonly found in schists are quartz, garnet, tourmaline, feldspar, magnetite, staurolite, hornblende, kyanite, sillimanite, andalusite, epidote and graphite.

The origin and structure of schists discloses many interesting details of rock deformation. Nearly all larger mountain ranges of the earth have gone through a period of preparation during which a major depression in the crust received large volumes of muddy sediment. Subsequently, these large mud-filled depressions have been violently compressed, the strata folded and the folded complex uplifted to form the mountains. At depths of several miles, mud tends to recrystallize into mica aggregates. But simultaneously, the layers are being folded. Thus it can happen that these rocks, having reached their yield strength during the folding, were intimately dissected by slip planes or slip cleavage. If solutions circulate actively along them, the planes will become coated with newly grown mica flakes, extending across the truncated layers of deposition. Along the slip cleavage planes the entire mass of rocks can be further deformed, developing planes of movement unrelated to the layers of deposition. Perhaps some of the longest slip planes in the solid crust of the earth are those that connect major bodies of easily yielding schist.

Unless they contain many nonmicaceous minerals, schists weather readily, and tend to underlie smooth slopes and gentle land forms, yielding fairly good, clayey soils.

Mica crystals in schists are usually too small to be of commercial use. However, the accompanying minerals of some schists (kyanite, sillimanite. andalusite, talc, garnet, graphite and others) are important as raw materials for high-grade ceramic wares, abrasives, lubricants and other nonmetallic mineral industries.

For a more detailed discussion of the metamorphic processes and concepts referred to in this article *see* METAMORPHISM.

(R. BK.)

SCHIZOPHRENIA is a term (replacing the older designation "dementia praecox") to indicate a group of psychological disturbances or mental disorders occurring in different combinations and degrees of symptoms but generally having in common disturbances of feeling, thought and relationship to the outside world. Neither dementia praecox (early progressive insanity) nor schizophrenia (splitting of the mental functions) is entirely satisfactory as a term to cover the various patterns of disturbances usually included in the group. In the 20th century there have been alternating trends to consider the term schizophrenia as denoting a single disease process or a number of similar patterns of psychological reactions to life situations.

Four major types of schizophrenia are generally differentiated. (1) The simple type is characterized mainly by an insidious and gradual reduction in external relationships and interests. Emotions are lacking in depth, ideation is simple and referring to concrete things, there is relative absence of activity, progressively less and less use of inner resources and retreat to simpler or stereotyped forms of behaviour. (2) The hebephrenic type is characterized mainly by shallow, inappropriate affective reactions, silly or bizarre behaviour, false beliefs (delusions) and false perceptions (hallucinations). (3) The catatonic type is characterized mainly by striking motor behaviour. The patient may be in a state of almost complete immobility, often assuming statuesque positions. Mutism, extreme compliance and removal of almost all voluntary actions are also common. This state of inactivity is at times preceded or interrupted by episodes of excessive motor activity and excitement, generally of an impulsive, unpredictable kind. (4) The paranoid type (see also PARANOID REACTIONS), usually arising later in life than the other types, is characterized primarily by unrealistic, illogical thinking, delusions of being persecuted or of being a great person and hallucinations.

Hallucinations, although not constantly found, are perhaps the most conspicuous symptom in the hebephrenic and paranoid types. The commonest are auditory — the patient hears "voices," although nobody is there to say what he hears. The patient, however, does not understand the abnormal character of the voices and believes in their reality. Visual hallucinations are also relatively ccmmon, especially in acute episodes, and olfactory and gustatory hallucinations as well as abnormal bodily perceptions also occur in a smaller number of cases. (See also HALLUCINATION.)

The symptom common to all types, although at times only minimally present and difficult to detect, is a thinking disorder characterized by an impairment in the use of abstract concepts and a withdrawal into a concrete frame of reference, as Kurt Goldstein demonstrated.

These types of schizophrenia are by no means mutually exclusive. Mixtures are to be found especially in the early acute phases but also in some later chronic phases. In the latter also may be found patients who show few of the original symptoms of their earlier phases and whose present symptom picture is indeterminate. In addition to mixtures within schizophrenia itself, there may be mixtures of schizophrenic symptoms with those of other psychoses, notably with those of the manic-depressive group. Such patients are ordinarily referred to as of the "schizo-affective" type.

In the U.S.. schizophrenia is considered the most important of the major psychoses, schizophrenics constituting 20% to 25% of first admissions to public hospitals for mental disease. Because of the relative youth at admittance and the relatively long stay per patient, the group niakes up about 55% of the residual population of these hospitals. It has been estimated that schizophrenics comprise between 2.5 and 3 per 1,000 of the general population. The maximum incidence of first admissions in men comes between the ages of 20 and 24 and in women between the ages of 35 and 39. About 45% of schizophrenics who are admitted to public mental hospitals or clinics recover or improve greatly. Of those patients who are committed and improve, about 80% leave the hospital within the first year of residence.

Causation. — Many theories have been proposed as to the origin of the condition. They vary from anatomical and biochemical to psychological, from hereditary to environmental causes. Probably the best opinion in the 1960s was that the schizophrenic reaction types are faulty adjustment reactions to a variety of underlying conditions which may be either somatic or psychological, or both.

Psychological Theories. — Emil Kraepelin (1856–1926) was the first author who differentiated this mental disorder from the other psychiatric conditions. He gave to it the name dementia praecox (a term which had already been used by the Belgian psychiatrist B. A. Morel in a more restricted sense) and described all the characteristics of the disorder. He held that the varied manifestations of dementia praecox are all different signs of a single disease process, either a degenerative disease of the brain or metabolic disturbances causing autointoxication. He held a rather pessimistic view of the disorder, inasmuch as he believed that all cases end in a dementia1 state.

Eugen Bleuler (1857–1939), early influenced by Freudian ideas, developed more dynamic notions than Kraepelin about the psychological aspects of the disturbance, and it was he who coined the term schizophrenia. Bleuler emphasized the importance of the impairment of association of ideas, and saw most of the symptoms as a direct or indirect result of this impairment. He did not deny, however, the possibility that a toxin may be involved in the causation of this psychosis.

Adolf Meyer (1866–1950) considered schizophrenic reactions to be habit disorganizations resulting from progressive maladaptations. The background for the development of these habit disharmonies and deteriorations he believed could be both physiological and psychological. Meyer emphasized the psychobiological integrity of the organism and preferred not to separate the mental from the physical.

Although Sigmund Freud (1856–1939) was not primarily interested in the study of this psychosis, his psychoanalytic theories and investigations have clarified many aspects of schizophrenia. Many schizophrenic symptoms can be interpreted as symbolic manifestations (similar in form, content and motivation to dreams of normal people) and therefore susceptible of psychoanalytic interpretation. The psychoanalytic view emphasizes also two aspects of schizophrenic behaviour — the regressive and the restitutive. The regressive symptoms are seen as a retreat by the person to less mature levels of the ego (the reality-testing portion of the psyche). The restitutive symptoms are attempts to replace the existing world, from which the patient has retreated, by such phenomena as hallucinations, delusions, world reconstruction phantasies or peculiarity of language.

Carl Jung (1875–1961) thought that schizophrenia is caused by an unusual strength of the unconscious, so that an abnormal number of atavic tendencies do not adjust to modern life. He saw the symptoms not only as the result of the past life of the patient but also as manifestation of the resurging collective unconscious (that is, of that inherited part of the psyche which according to him stores the primordial images, or archetypes, that have been deposited as a result of numerous recurrences of identical situations in previous generations).

Harry Stack Sullivan (1892–1949) considered schizophrenia as a result of faulty interpersonal relations, especially poor parent-child relationship. Anxiety and lack of self-esteem, originating in these early relationships, lead the patient to distortions in his way of living (parataxic distortions), to lack of consensual validation (that is to less and less recognition from others of the patient's way of seeing the world) and finally to schizophrenic panic.

Silvano Arieti (1914–) accepts to a large extent Sullivan's dynamic interpretation of schizophrenia. He emphasizes, however, the importance of the special formal mechanisms that the conflicts and the way of living of the patient must assume. It is especially in the realm of cognition that these special formal mechanisms are found. The patient follows a particular form of logic called by Arieti "paleologic," a different form of causality, of symbolization and of volition. Arieti feels that the schizophrenic process also may be interpreted psychosomatically, inasmuch as intensely disturbing emotional factors may bring about the resurgence of obsolete functional and neuronal patterns.

Biological Theories. — Franz Kallmann, as a result of many investigations, especially on twins, concluded that the cause of schizophrenia is hereditary but that the factor is recessive and therefore manifested only in some cases. According to Robert Heath, schizophrenia is a disorder of metabolism and hinges on the formation of a substance he and his collaborators isolated and called taraxein.

The series of substances which have been thought to engender schizophrenia is very long. Great interest has been shown to the experimental use of some substances, which reproduce a picture similar to schizophrenia. One of them is bulbocapnine, which brings about in experimental animals a picture similar but not identical to catatonia. Mescaline and lysergic acid have reproduced in human beings abnormal perceptions and thought disorders similar to those seen in schizophrenia. (*See* also NEUROPHARMACOLOGY AND PSYCHOPHARMACOLOGY.)

Treatment. — Although at one time there was considerable pessimism about the outlook in schizophrenic cases and in their treatment, this attitude changed markedly, beginning about the fourth decade of the 20th century. Even psychoanalytic therapy, about which Freud himself was skeptical in the treatment of psychoses, began to be applied, after modifications were made on the original orthodox technique. These modifications, mainly introduced by the pioneer work of Paul Federn, Harry Stack Sullivan, Frieda Fromm-Reichmann, John Rosen and Marguerite Sechehaye, include the abolition of the couch, direct intervention with adoption of the symbolic language of the patient and much less reliance on free association. But application of psychotherapeutic techniques to schizophrenia is limited by the fact that relatively few psychiatrists are experienced with this type of treatment.

By far the majority of patients are treated with physical methods, the most important being: (1) insulin therapy, which was devised by Manfred Sakel and consists in the artificial production of comas by administration of large doses of insulin; (2) electric convulsive therapy, which was devised by U. Cerletti and L. Bini, and which consists of the artificial production of convulsions, and (3) drug therapy, which consists in the administration of large doses of pharmaceutical products, called ataractic or tranquilizers, the most important of which are reserpine and chlorpromazine. (*See* also TRANQUILIZING DRUGS.) So-called psychosurgery—separation of certain areas of the brain—has been carried out in the most recalcitrant cases of schizophrenia. The commonest operation, that devised by Antonio Egas Moniz, consists of prefrontal lobotomy, or surgical interruption of bundles of nervous fibres between the thalamus and the frontal lobes. Interest in this type of operation developed especially in the late 1940s, but by the middle 1950s a great decline of interest uas already evident, as less drastic therapies came to be preferred even for the most difficult cases.

Although some cases of schizophrenia are mild and may be treated outside hospitals, the majority of patients diagnosed as schizophrenics are hospitalized, especially during acute episodes. In the hospital the patient may receive various forms of treatment. Whereas almost all psychiatric hospitals are equipped to provide the above-mentioned physical treatments and occupational therapy, only a minority of them provide psychotherapy. In many cases, what seems most important is to provide the patient with an environment in which he is protected and in which he can gradually work through his periods of confusions and disturbance away from the disturbing influences of his ordinary environment.

The success of treatment seems definitely to vary with the stage of the disease in which it is introduced. If the illness has been permitted to go on for a long time, successful treatment is more difficult to attain. Other signs that have been found related to good outcome are acute, sudden onset of a confused, excited kind of disturbance; absence of schizophrenic history in the family; presence of an admixture of symptoms usually found in manic-depressive psychosis; and presence of some fairly clear psychological conflict which precipitated the disturbance. Statistical studies of the effects of therapy indicate in general that shock treatment (insulin and electric convulsive) seems to some extent to improve the prognosis in those cases which already have a good outlook and in some proportion of those with a poor outlook. However, shock treatment is not so generally effective in this disorder as it is in manic-depressive psychosis.

Prevention. — Without a clear-cut understanding of the etiology of the illness, of course, specific preventive measures are not available. A number of authorities, influenced largely by the psychoanalytic points of view, believe that the relationship with the family, particularly the mother, in the early years of life plays a most important role in the development of schizophrenia. Their recommendations for prevention therefore centre largely in the provision of security for the child through warm, understanding relationships in the family.

There seems also to be a relation between the type of society and the incidence of schizophrenia. There are indications that urban areas and in particular the very large cities have a larger incidence of this disorder. An industrial society seems also to predispose to the condition more than an agricultural. Accurate statistical research is difficult because not all patients are hospitalized and because the diagnostic criteria vary in different places. Schizophrenia, however, is found among all cultures and all societies.

See also PSYCHOSES.

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(S. A.)

SCHLEGEL, AUGUST WILHELM VON (1767–1845), German poet, translator and critic, was born on Sept. 8, 1767, at Hanover, where his father, Johann Adolf Schlegel (1721–93), was a Lutheran pastor. He mas educated at the Hanover *Gymnasium* and at the University of Gottingen. Having spent several years as a tutor in the house of a banker at Amsterdam, he nent to Jena, where, in 1796, he married Karoline Michaelis, the widow of the district medical officer Bohmer, and in 1798 was appointed extraordinary professor. There he began his translation of Shakespeare, which was ultimately completed, under the superintendence of Ludwig Tieck, by Tieck's daughter Dorothea and W. H. Baudissin. This rendering is one of the best poetical translations in German, or indeed in any language. At Jena Schlegel contributed to Schiller's periodicals the *Horen* and the *Musenalmanach;* and with his brother Friedrich he conducted the *Athenaeum,* the organ of the romantic school. He also published a volume of poems, and carried on a rather bitter controversy with Kotzebue. The brothers were the leaders of the new romantic criticism. A volume of their joint essays appeared in 1801 under the title *Charakteristiken und Kritiken.* In 1802 Schlegel went to Berlin, where he lectured on art and literature; and in the following year he published *Ion*, a tragedy in Euripidean style, which gave rise to a suggestive discussion on the principles of dramatic poetry. This was followed by *Spanisches Theater* (2 vol., 1803–09), in which he presented admirable translations of five of Calderon's plays; and in another volume, *Blumensträusse italienischer, spanischer und portuguesischer Poesie* (1804), he gave translations of Spanish, Portuguese and Italian lyrics. In 1807 he attracted much attention in France by an essay in the French language, *Comparaison entre la Phèdre de Rncine et celle d'Euripide*, in which he attacked French classicism from the standpoint of the romantic school. His lectures on dramatic art and literature (*Über dramatische Kunst und Literatur,* 1809–11), which were translated into most European languages, were delivered at Vienna in 1808.

Meanwhile, after a divorce from his wife Karoline in 1804, he traveled in France, Germany, Italy and other countries with Madame de Stael, who owed to him many of the ideas which she embodied in her work *De l'Allemagne*. In 1813 he acted as secretary to the crown prince of Sweden. Schlegel was made a professor of literature at the University of Bonn in 1818, and during the remainder of his life occupied himself chiefly with oriental studies, although he continued to lecture on art and literature, and in 1828 he issued tno volumes of critical uritings (*Kritische Schriften*). In 1823–30 he published the journal *Indische Bibliothek* (3 vol.) and edited (1823) the Bhagavad-Gita nith a Latin translation and (1829) the Ramayana. These works mark the beginning of Sanskrit scholarship in Germany. After the death of Madame de Staël, Schlegel married (1818) a daughter of H. E. G. Paulus of Heidelberg; but this union was dissolved in 1821. He died at Bonn on May 12, 184j. As an original poet Schlegel is unimportant, but as a poetical translator he has rarely been excelled.

In 1846–47 Schlegel's *Siimtliche Werke* were issued in 12 vol. by E. Böcking. Editions were also published by the same editor of his *Œuvres écrites en français,* 3 vol. (1846), and *Opuscula Latine scripta* (1848). Schlegel's Shakespeare translations have been often reprinted; the edition of 1871–72 was revised with Schlegel's manuscript by M. Bernays. *See* M. Bernays, *Zur Entstehungsgeschichte des Schlegelschen Shakespeare* (1872); *R.* Genee, *Schlegel und Shakespeare* (1903); J. Koerner, *Romantiker und Klassiker. Die Brüder Schlegel in ihren Beziehungen zu Schiller und Goethe* (1924). Schlegel's Berlin lectures of 1801–04 were reprinted from manuscript notes by J. Minor (1884). A selection of the writings of A. W. and F. Schlegel, ed. by O. F. Walzel, was printed in Kiirschner's *Deutsche Nationalliteratur,* 143 (1892). *See* especially R. Haym, *Romantische Schule,* and the article in the *Allg. deutsche Biographie* by F. Muncker.

SCHLEGEL, FRIEDRICH VON (1772–1829), German poet, critic and scholar, was the younger brother of August Wilhelm von Schlegel. He was born at Hanover on March 10, 1772. He studied law at Gottingen and Leipzig, but ultimately devoted himself entirely to literary studies. He published in 1797 the important book *Die Griechen und Romer,* which was followed by the suggestive *Geschichte der Poesie der Griechen rind Romer* (1798). Goethe and Schiller looked to the Greeks for form and objectivity; Schlegel's Hellenism was romantic and lyrical. At Jena, where he lectured as a *Privatdozent* (official but unpaid lecturer) at the university, he contributed to the *Athenäum* the aphorisms and essays in which the principles of the romantic school are most definitely stated. This journal formed the centre for the first group of romanticists at Jena. There also he wrote *Lzicinde* (1799), an unfinished romance, which is interesting as an attempt to transfer to practical ethics the romantic demand for complete individual freedom, and *Alarcos,* a tragedy ('1802) in which, without much success, he combined romantic and classical elements. In 1802 he went to Paris, where he edited the review *Europa* (1803), lectured on philosophy and carried on oriental studies. some results of which he embodied in *Über die Sprache und Weisheit der Zndier* (1808). In the same year in which this work appeared. he and his wife Dorothea (1763–1839), a daughter of Moses Mendelssohn. joined the Roman Catholic Church, and from this time he became more and more opposed to the principles of political and religious freedom. In 1809 he was appointed imperial court secretary at the headquarters of the archduke Charles at Vienna; later he was councilor of legation in the Austrian embassy at the Frankfurt diet. but in 1818 he returned to Vienna. Meanwhile he had published his collected *Gedichte* (1809) and two series of lectures, *Über die neuere Geschiclzte* (1811) and *Geschichte der alten und neuen Literatur* (1815). After his return to Vienna from Frankfurt he edited *Concordia* (1820–23), and began the issue of his *Samtliche Werke.* He also delivered lectures: which were republished in his *Philosophie des Lebens* (1828) and in his *Philosophie der Geschichte* (1829). He died on Jan. 11, 1829, at Dresden. Friedrich Schlegel's wife, Dorothea, was the author of an unfinished romance, *Florentin* (1801), a *Sammlung romantischer Dichtungen des Mittelalters* (2 vol., 1804), a version of *Lother und Maller* (1805) and a translation of Madame de Stael's *Corinne* (1807–08)—all of which were issued under her husband's name.

Friedrich Schlegel's *Samtliche Werke* appeared in 10 vol. (1822–25); a 2nd ed. (1846) in 15 vol. His *Prosaische Jugendschriften* (1794–1802) were edited by J. Minor (1882; 2nd ed., 1906); also reprints of *Lucinde,* and F. Schleiermacher's *Vertraute Briefe iiber Lucinde, 1800* (1907). *See* I. Rouge, *F. Schlegel et la genèse du romantisme allemand* (1904), *Erläuterungen zu F. Schlegels Lucinde* (1905); M. Joachimi, *Die Weltanschauung der Ronzantik* (1905); *W.* Glawe, *Die Religion F. Schlegels* (1906); *E.* Kircher, *Philosophie der Romantik* (1906); *R.* Volpers, *Friedrich Schlegel als politischer Denker und deutscher Patriot* (1917). On Dorothea Schlegel *see* J. M. Raich, *Dorothea von Schlegel und deren Söhne* (1881); F. Diebel, *Dorothra Schlegel als Schriftsteller im Zusammenhang mit der romantischen Schule* (1905).

SCHLEICHER, AUGUST (1821–1868), German philologist, the first linguist to study an Indo-European language not from texts; but directly from living speakers, was born at Meiningen, on Feb. 19, 1821. He became professor of Germanic and classical philology in Prague in 1850, and in 1857 was appointed to the chair of comparative linguistics at Jena. His *Handbook of the Lithuanian Language* (1856–57) marks an epoch in linguistic history; and his *Compendium of Comparative Grammar of Indo-European* (1861) was the first to emphasize the regularity of phonetic correspondences between the related languages, and the first to attempt reconstructions of proto-Indo-European. His work well sums up the first half century of comparative linguistics, and, methodologically, indicates the direction of much subsequent scholarship.

Schleicher died on Dec. 6, 1868, at Jena. (M. S. Br.)

SCHLEIERMACHER, FRIEDRICH DANIEL ERNST (1768–1834), German theologian and philosopher. one of the most influential thinkers of 19th-century Protestantism, was born in Breslau on Nov. 21, 1768, the son of a Prussian army chaplain of the Reformed confession. He was educated at schools belonging to the Moravian Brethren and was to have become a Moravian pastor. Under the influence of the literature of the time, however. he began to doubt Christianity in its transmitted form; and he exacted from his father permission to study at Halle university, where at the time rationalism reigned.

He early became a student of Kantian philosophy, though from the first a critical one. In 1796 he was appointed chaplain to the Charité hospital in Berlin. He then became influenced by Spinoza and still more by Plato and by Fichte. Entering the circle of the early Berlin romantics. he formed a great friendship with Friedrich Schlegel, whom he defended in his *Vertraute Briefe iiber Schlegels 'Lucinde'* (1800). Schleiermacher established his fame with the *Reden iiber die Religion* (Berlin, 1799; new ed. by R. Otto, 1926) in which he maintained religion to be independent of knowledge and morality. The *Monologen* (1800; new ed. by F. M. Schiele and H. Mulert, Leipzig, 1914) contain the first statements of his ethical system, which does not take a general moral law as its starting point but claims to establish the particularity of the individual.

From 1802 to 1804 Schleiermacher was pastor at Stolp. During these years he began his translation of Plato and published his first strictly philosophical work, the *Grundlinien einer Kritik der bisherigen Sittenlehre* (Berlin. 1803). In 1804 he became professor of theology at Halle; and it was there that. in 1806, he published *Die Weihnachtsfeier,* an important dialogue for his Christology. In the same year appeared the second. heavily revised edition of his *Reden,* already containing his final conception of religion.

From 1809 until his death (Feb. 12, 1834) Schleiermacher lived in Berlin, becoming professor in the newly founded university there in 1810. He took part in the national movement against Napoleon and did much to promote the union of the Lutheran and Reformed churches in the Church of Prussia (1817). His *Kurze Darstellung des theologischen Studiums* (Berlin. 1811; rev. ed, 1830), an encyclopaedia of theological disciplines, already presupposes the final form of his philosophical-theological system, which had built itself up by the independent use of borrowed stimuli (especially from Schelling). His chief theological work, *Der christliche Glaube nack den Grundsätzen der ecangelischen Kirche,* 2 vol. (Berlin. 1821–22), became basic for evangelical theology in the 19th century. Schleiermacher expressed the principles of the second, heavily revised. edition of this work in two letters to his friend Friedrich Liicke (in the periodical *Theologische Studien und Kritiken,* 1829; ed. separately by H. Mulert. 1908); in these he defended his theological position in general and his book in particular. His metaphysic of knowledge, the *Dialektik,* was left incomplete at his death. His lectures on philosophical and theological ethics. as well as those on practical theology, were also printed posthumously.

Theoretical Philosophy.—In Berlin Schleiermacher was overshadowed by Hegel as a philosopher, and the significance of his fragmentary philosophical works was seldom fully appreciated in the century following his death. Although his point of departure was that of the idealist philosophy of identity, he took a critical view of the limits of our knowledge. All knowledge arises from a conflict of thoughts (hence the title Dialektik), as knowledge is the agreement which ends the conflict: but the content of all conflicting thoughts lies between a chaotic multiplicity of sense impressions and the general principles of reason; and only through the unity of real and ideal, that is, through the complete mutual interpenetration of these opposites, could perfect knowledge be attained. In the case of such an absolute knowledge, the one "transcendent cause" of all being. God, mould be simultaneously apprehended. But the reconciliation of the opposites is never more than approximate; our perception of God is likewise confined to various approximate formulas reached by a differential method; and our knowledge remains incomplete. Nonetheless. God as transcendent cause is already presupposed in all partial knowledge. God cannot be comprehended in a definition; but is immanent to all existing beings, constituting their connection with all other existence. In immediate self-consciousness (or, as Schleiermacher calls it, feeling) God is present as the basis of the unity of the self in the transition from thinking to willing and vice versa. Although immanent in all existence, God is not identical with the world but is its origin. As such, He is not conceivable to our thought apart from the world.

Ethics. — The subject of ethics is the striving of the mind to unite physical nature with itself and to fashion that nature into its instrument and symbol. This ethical striving must presuppose that nature and reason are in principle one in the transcendent cause (in God). that nature is preordained to be the organ and symbol of the mind, just as there is an impulse in the mind working toward this same unity. This impulse is not a general moral law but expresses itself differently in each individual. It always leads the individual to participate in society, however—for example in the forms of family, state, school and church.

Theology. — While philosophy, from perception of the world, constructs approximate formulas for the transcendent cause, theology contemplates immediate self-consciousness—or feeling. which mirrors the divine unity. Since man in his self-consciousness knows that he does not exist from himself, he feels himself absolutely dependent. This feeling is the source of all religion. All religious language is its expression, and dogmatic theology states in explicit terms what are actual religious assertions within the religious consciousness. So-called natural religion, or the religion of reason, as something distinct from positive religion, is a pure abstraction. All religion is positive because religious feeling is experienced only in conjunction with sense consciousness, and consequently every religious expression has its own particular character. The great religious communions arise through religious heroes, who awake the religious life in others by communicating their special religious experience and who found religious communities, churches, for the cultivation of this religious life. Christianity belongs to the highest, monotheistic stage of religion and is of the ethical type of religion insofar as it regards every deficiency in consciousness of God as sin and any strengthening of this consciousness as grace. The specific feature of Christianity is the relation to Christ as mediator, in whom the consciousness of God was realized prototypically and superlatively, so that one must speak of "God's being in Him." Christians are conscious of having been redeemed by their experience of Christ's religious perfection from a situation in which their religious consciousness was overpowered by their sense consciousness: they have been transplanted from this condition into one where everything is subordinated to the religious feeling. The work of Christ is now carried on in a natural way by the church; but its founder, Jesus, was a completely new and original factor in the process of religious development and was to that extent, like every new and higher stage of being, a supernatural revelation. Schleiermacher believed that this conception of Christianity overcame both the one-sidedness of rationalism and the contrary one-sidedness of supernaturalism. As he assigned to dogmatic theology the task of justifying all Christian teaching as an expression of Christian consciousness, he nas compelled to exclude from that theology much that does not seem to be a necessary expression of it; *e.g.*, all historical events. the whole of the Old Testament and also the doctrine of the Trinity. Likewise, he had to offer a considerable reinterpretation of the doctrine of sin and justification and of Christological and eschatological teaching.

BIBLIOGRAPHY.—The collected edition of Schleiermacher's works, 30 vol. (Berlin, 1834–64), comprises three groups of writings, (1) theology, (2) sermons and (3) philosophy and miscellanea. To these must be added the *Aesthetik*, ed. by R. Odebrecht (Leipzig, 1931). *See* also the *Dialektik*, new ed. by R. Odebrecht (Leipzig, 1942), in conformity with the lecture of 1822.

F. Ueberweg, *Grundriss der Geschichte der Philosophie*, iv (Berlin, 1923), gives a bibliography of the secondary literature. For more recent works see F. Flückiger, *Philosophie und Theologie bei Schleiermacher* (Zürich, 1947). (W. U. P.)

SCHLESINGER, FRANK (1871–1943), U.S. astronomer, "the father of modern astrometry." was born in New York city May 11, 1871, of Silesian parentage. Upon graduation from City college in 1890, Schlesinger practised surveying four years before preparing for the Ph.D. degree at Columbia (1898). After a period with the International Latitude service in California. he became astronomer at the Terkes observatory (1903–05). There he demonstrated the effectiveness of long-focus telescopes for photographic measurements of distances of stars. His highly accurate method proved epoch making. As others followed his procedure, the number of stars with measured distances increased from a few dozen to over 6.000 during Schlesinger's lifetime, and the measurements became basic to knowledge of the scale of the universe beyond the solar system.

In 1905 Schlesinger accepted the directorship of the Allegheny observatory in Pittsburgh. From 1920 until his retirement in 1941 he was director of the Yale university observatory. For Allegheny he acquired the 30-in. Thaw refractor; for Yale the 26-in. refractor in the southern hemisphere. These instruments contributed a large share of the known stellar distances. He also pioneered in the use of wide-angle cameras for determining photographically positions and proper motions of stars formerly measured by laborious visual methods. Fifteen volumes of Yale Zone Catalogues give results for about 150,000 stars.

Schlesinger's contributions were recognized by many honours: medals, lectureships. election to the National Academy of Sciences and the presidency of the International Astronomical union.

He died in Lyme, Conn., July 10, 1943. (D. BR.)

SCHLESWIG, capital of the former Prussian province of Schleswig-Holstein, and after World War II in the *Land* of the same name, is in the German Federal Republic on the narrow arm of the sea called the Schlei, 30 mi. N.W. of Kiel on the railway from Hamburg to Flensburg. Pop. (1950) 36,247. The town consists mainly of a single street: 3½ mi. long, forming a semicircle round the Schlei. The church of St. Peter (1100), renewed in the Gothic style in the 1jth century, contains a fine carved oak reredos by Hans Brueggemann. The former commercial importance of the town has disappeared, and the Schlei now affords access to small vessels only. Fishing, tanning, flour milling and gardening are the chief industries.

History.—Schleswig (ancient forms Sliesthorp, Sliaswic, *i.e.*, the town or bay of the Slia or Schlei) seems to have been a place of importance in the 9th century, as a medium of trade between the North sea and the Baltic. The first Christian church was built there by Xnsgarius (d. 865), and it became the seat of a bishop about a century later. The town, which obtained civic rights in 1200, also became the seat of the dukes of Schleswig, but its commerce gradually dwindled as a result of the rivalry of Lubeck, the wars in which the district was involved and the silting up of the Schlei. At the partition of 1j44 the old castle of Gottorp, built in 1160 for the bishop, became the seat of the Gottorp line of the Schleswig-Holstein family, which remained there till expelled by the Danish king Frederick IV in 1713.

From 1731 to 1846 Schleswig was the seat of the Danish governor of the duchies.

For later history see SCHLESWIG-HOLSTEIN QUESTION.

SCHLESWIG-HOLSTEIN, a *Land* of the German Federal Republic, formerly a province in the northwest of Prussia, formed out of the once Danish duchies of Schleswig, Holstein and Lauenburg, and of part of the lands of the former free city of Lubeck. Schleswig-Holstein is bounded west by the North sea, north by Denmark, east by the Baltic sea, Lubeck and Mecklenburg and south by the lo er course of the Elbe (separating it from Hanover). It thus consists of the southern half of the Cimbric peninsula. As a result of the plebiscite taken in accordance with the treaty of Versailles in 1920, the northern zone of the existing German province of Schleswig-Holstein was restored to Denmark, while the southern zone remained part of German territory. The boundary line ran just north of Sylt, south of Tønder and north of Flensburg. In addition to the mainland, which decreases in breadth from south to north. the province included several islands, the most important being Fehmarn in the Baltic and Heligoland, Sylt and Fohr in the North sea. The total area of the Land of Schlesmig-Holstein is 6,054 sq.mi.

The more ancient geological formations are seldom found in Schleswig-Holstein. The contrast between the two coast lines of the province is marked. The Baltic coast has generally steep, well-defined banks and is irregular, being pierced by numerous long and narrow inlets (*Föhrden*) which often afford excellent harbours. The North sea coast is low and flat, and its smooth outline is interrupted only by the estuary of the Eider and the peninsula of Eiderstedt.

Dunes or sand hills, though rare on the protected mainland, occur on Sylt and other islands, while the small flat islands called *Halligen* require protection by dikes.

The climate of Schleswig-Holstein is mainly determined by the proximity of the sea, and the mean annual temperature, varying from 45° F. in the north to 49" in the south, is rather higher than is usual in the same latitude. Rain and fog are frequent, but the climate is on the whole healthful. The Elbe forms the southern boundary of Holstein for 65 mi., bpt the only river of importance within the province is the Eider, which rises in Holstein and after a course of 120 mi. falls into the North sea, forming an estuary 3 mi. to 12 mi. in breadth. It is navigable from its mouth as far as Rendsburg. which is on the Riel-Elbe canal, which intersects Holstein. There are numerous lakes in northeast Holstein, the largest of which are the Plöner See (12 sq.mi.) and the Selenter See (9 sq.mi.).

The ordinary cereals are all cultivated with success and there is generally a considerable surplus for export. Rape is groun in the marshlands and flax pn the east coast. while large quantities of apples and other fruit are raised near Altona for the Hamburg and English markets. The marshlands afford admirable pasture, and great numbers of cattle are reared for export. The Holstein horses are also in request. but sheep raising is comparatively neglected. Beekeeping is a productive industry. The hills skirting the bays of the Baltic coast are generally pleasantly wooded, but the forests are nowhere of great extent except in Lauenburg. The fishing in the Baltic is productive; Eckernforde became the chief fishing station in Prussia. The oysters from the beds on the west coast of Schleswig are widely known under the misnomer of "Holstein natives." The mineral resources are almost confined to a few layers of rock salt near Segeberg. The more important industrial establishments, such as iron foundries, machine works, tobacco and cloth factories. are mainly confined to the large towns, such as Rendsburg, Kiel and Flensburg. The shipbuilding of Kiel and other seaports, however. is important. The commerce and shipping of Schleswig-Holstein. stimulated by its position between two seas. as well as by its excellent harbours and waterways, are much more prominent than its manufactures. Kiel is one of the chief seaports of the area. while overseas trade ordinarily is carried on by Flensburg. Kiel (254,449) is the largest town and is the capital of the *Land*. The exports include grain, vegetables, meat, fish and oysters.

The population of the Land in 1950 was 2,594,648. The peninsula of Angeln, between the Gulf of Flensburg and the Schlei, is supposed to have been the original seat of the English, and observers profess to see a striking resemblance between this district and the counties of Kent and Surrey. The peasants of Dithmarschen in the southwest retain many of their ancient peculiarities. The chief educational institution in Schleswig-Holstein is the University of Kiel.

SCHLESWIG-HOLSTEIN QUESTION, the name given to the whole complex of diplomatic and other issues arising in the 19th century out of the relations of the two "Elbe duchies," Schleswig and Holstein, to the Danish crown on the one hand and the German confederation on the other, which came to a crisis with the extinction of the male line of the reigning house of Denmark by the death of King Frederick VII on Nov. 1j, 1863. The central question was whether the two duchies did or did not constitute an integral part of the dominions of the Danish crown, with which they had been more or less intimately associated for centuries. This involved the purely legal question, raised by the death of the last male heir common to both Denmark and the duchies, as to the proper succession in the latter, and the constitutional questions arising out of the relations of the duchies to the Danish crown, to each other, and of Holstein to the German confederation. There was also the national question: the ancient racial antagonism between German and Dane, intensified by the tendency, characteristic of the 19th century, to the consolidation of nationalities. Lastly, there was the international question: the rival ambitions of the German powers involved, and beyond them the interests of other European states, notably that of Great Britain, in preventing the rise of a German sea power in the north.

Early History. — From time immemorial the country north of the Elbe had been the battleground of Danes and Germans. Danish scholars point to the prevalence of Danish place names far southward into the German-speaking districts as evidence that at least the whole of Schleswig was at one time Danish; *i.e.*, place names according to popular usage, not the official names given in German maps (*e.g.*, Haderslev for Hadersleben). German scholars claim it, on the other hand, as essentially German. That the duchy of Schleswig, or South Jutland (Sonderjylland), had been from time immemorial a Danish fief was. indeed, not in dispute, nor was the fact that Holstein had been from the first a fief of the Germano-Roman empire. The controversy in the 19th century raged round the "indissoluble" union of the two duchies, the principle of which had been secured by the charter of Ribe, signed by the Danish king Christian I in 1460, after his election by the respective estates as count of Holstein and duke of Schleswig. The "Eider Danes" (*i.e.*, the party at Copenhagen which aimed at making the Eider, the southern boundary of Schleswig, the frontier of the Danish kingdom proper) claimed Schleswig as an integral part of the Danish monarchy, which. on the principle of the union, involved the retention of Holstein also; the Germans claimed Holstein as a part of Germany and, therefore, on the same historic principle, Schleswig also.

The congress of Vienna, instead of settling the questions involved in the relations of the duchies of Denmark once for all, sought to stereotype the old divisions in the interests of Germany. In 1806, after the dissolution of the Holy Roman empire, the duchies had been virtually incorporated in Denmark. This settlement was reversed by the congress, and while Schleswig remained as before. Holstein and Lauenburg were included in the new German confederation. The opening up of the Schleswig-Holstein question thus became sooner or later inevitable. The Germans of Holstein, influenced by the new national enthusiasm evoked by the War of Liberation, resented more than ever attempts to treat them as part of the Danish monarchy and, encouraged by the sympathy of the Germans in Schleswig, tried to reassert in the interests of Germanism the old principle of the unity of the duchies. The political atmosphere, however. had changed at Copenhagen also; and their demands were met by the Danes with a nationalist temper as intractable as their own. Affairs were ripe for a crisis, which the threatened failure of the male heirs common to the kingdom and the duchies precipitated.

CRISIS OF 1848–49

When Christian VIII succeeded his half-cousin Frederick VI in 1839 the elder male line of the house of Oldenburg was on the point of extinction, the king's only son and heir having no children. To German opinion the solution of the question of the succession seemed clear. The crown of Denmark could be inherited by female heirs; in the duchies the Salic law had never been repealed and, in the event of a failure of male heirs to Christian VIII, the succession would pass to the dukes of Augustenburg. Danish opinion, on the other hand, clamoured for a royal pronouncement proclaiming the principle of the indivisibility of the monarchy and its transmission intact to a single heir, in accordance with the royal law. To this Christian VIII yielded so far as to issue in 1846 letters patent declaring that the royal law in the matter of the succession was in full force so far as Schleswig was concerned. As to Holstein he stated that he could not give so clear a decision, but the principle of the independence of Schleswig and of its union with Holstein were expressly reaffirmed.

An appeal against this by the estates of Holstein to the German diet received no attention. The revolutionary year 1848 brought matters to a head. On Jan. 28 Christian VIII proclaimed a new constitution which, while preserving the autonomy of the different parts of the country, incorporated them for common purposes in a single organization. The estates of the duchies replied by demanding the incorporation of Schleswig-Holstein, as a single constitutional state, in the German confederation. Frederick VII, who had succeeded his father at the end of January, declared (March 4) that he had no right to deal in this way with Schleswig, and, yielding to the Eider-Danish party, withdrew the rescript of January (April 4) and announced to the people of Schleswig (March 27) the promulgation of a liberal constitution under which the duchy, while preserving its local autonomy, would become an integral part of Denmark.

Prussian Intervention. — Meanwhile the duchies had broken out into insurrection; a provisional government had been established at Kiel; and the duke of Augustenburg had hurried to Berlin to secure the assistance of Prussia in asserting his rights. This was at the crisis of the revolution in Berlin, and the Prussian government saw in the proposed intervention in Denmark in a popular cause an excellent opportunity for restoring its damaged prestige. Prussian troops were marched into Holstein and, the diet having on April 12 recognized the provisional government of Schleswig and commissioned Prussia to enforce its decrees, Gen. Friedrich von Wrangel was ordered to occupy Schleswig also. Prussia, as the mandatory of Germany, endeavoured to enforce the principle that the states were independent, indissolubly united and hereditary only in the male line. But the Germans had reckoned without the European powers, which were united in opposing any dismemberment of Denmark, even Austria refusing to assist in enforcing the German view.

Convention of **Malmö**.—Prussia was now confronted on the one side by the German nation urging it to action, on the other side by the European powers threatening the worst consequences should it persist. Frederick William chose the lesser of two evils and, on Aug. 26, 1848. Prussia signed at Malmo a convention which yielded practically all the Danish demands. The Holstein estates appealed to the German parliament, but it was soon clear that this had no means of enforcing its views, and the convention was ratified at Frankfurt.

The convention was only in the nature of a truce establishing a temporary modus vivendi. and the main issues continued to be hotly debated. A conference held in London failed to arrive at a settlement, and on April 3, 1849, the war was renewed. But the European situation, and notably the attitude of the emperor Nicholas I of Russia—who looked on Augustenburg as a rebel and Russia as bound in honour to safeguard the interests of the Danish crown—decided Prussia to conclude peace with Denmark on the basis of the *status quo* ante *bellum*.

Treaty of Berlin, 1850.—The treaty was signed at Berlin on July 2, 1850. Both parties reserved all their antecedent rights; but for Denmark it was enough, since it empowered the king-duke to restore his authority in Holstein with or without the consent of the German confederation. Danish troops marched in to coerce the duchies; but, meanwhile, negotiations among the powers continued, and on Aug. 2, 1850, Great Britain, France, Russia and Norway-Sweden signed a protocol, to which Austria subsequently adhered, approving the principle of restoring the integrity of the Danish monarchy. On Jan. 28, 1852, King Frederick VII issued a royal letter announcing the institution of a unitary state which, while maintaining the fundamental constitution of Denmark, would increase the powers of the estates of the two duchies. This was approved by Prussia and Austria, and by the German federal diet insofar as it affected Holstein and Lauenburg.

The Protocol **of** London, 1852.—The question of the succession was next approached. The main obstacle to an agreement among the powers was removed when, on March 31, 1852, the duke of Augustenburg resigned his claim in return for a money payment. Further adjustments followed. After the renunciation by the emperor of Russia (who represented the elder, Gottorp line) and others of their eventual rights, Charlotte, landgravine of Hesse, sister of Christian VIII. and her son Prince Frederick transferred their rights to the latter's sister Louise, who in her turn transferred them to her husband Prince Christian of Gliicksburg. This arrangement received international. sanction by the protocol signed in London on May 8, 1852, by the five great powers and Norway and Sweden. On July 31, 1853, King Frederick VII gave his assent to a law settling the crown on Prince Christian, "prince of Denmark," and his male heirs. The protocol of London, while consecrating the principle of the integrity of Denmark, stipulated that the rights of the German confederation in Holstein and Lauenburg should remain unaffected. It was, in fact, a compromise which satisfied neither the Danes nor the Germans; and when in Oct. 1855 King Frederick issued a parliamentary constitution for the whole monarchy, its legality was disputed by the two German great powers, on the ground that the estates of the duchies had not been consulted, and the diet of the confederation refused to admit its validity so far as Holstein and Lauenburg were concerned (Feb. 11, 1858).

The question was now once more the subject of international debate; but the situation was no longer so favourable to the Danish view. The Crimean War had crippled Russia, and Nicholas I was dead. France was prepared to sell the interests of Denmark in the duchies to Prussia in return for "compensations" to itself elsewhere. Great Britain alone sided with the Danes; but the action of British ministers, who realized the danger to British supremacy at sea of the growth of German sea power in the Baltic, was hampered by the natural sympathy of Queen Victoria and the prince consort with the German point of view.[1] The result was that the German diet, on the motion of Bismarck, having threatened federal intervention (July 29), Frederick VII abolished the general constitution so far as it affected Holstein and Lauenburg, while retaining it for Denmark and Schleswig (Nov. 6).

CRISIS OF 1863-64

Though even this concession violated the principle of the "indissoluble union" of the duchies, the German diet, fully occupied at home, determined to refrain from further action till the Danish parliament should make another effort to pass a law or budget affecting the whole kingdom without consulting the estates of the duchies. This contingency arose in July 1860, and in the spring of the following year the estates were once more at open odds with the Danish government. The German diet now prepared for armed intervention; but it was in no condition to carry out its threats, and Denmark decided, on the advice of Great Britain, to ignore it and open negotiations directly with Prussia and Austria as independent powers. These demanded the restoration of the union between the duchies, a question beyond the competence of the confederation. Denmark replied with a refusal to recognize the right of any foreign power to interfere in its relations with Schleswig; to which Austria, anxious to conciliate the smaller German princes, responded with a vigorous protest against Danish infringements of the compact of 1852. Lord John Russell now intervened, on behalf of Great Britain, with a proposal for a settlement of the whole question on the basis of

[1] *See* Queen Victoria to Lord Malmesbury, May 1, 1858, in ***Letters,*** iii, 280, pop. ed. (1908). Compare the letters to Palmerston of June 21, 1849, ii, 222, and June 22, 1850, ii, 279, with Palmerston to Russell, June 23, 1850, and Queen Victoria to Russell, ii, zjo.

the independence of the duchies under the Danish crown.[1] This was accepted by Russia and by the German great powers, and Denmark found itself isolated. The international situation, however. favoured a bold attitude, and Denmark met the representations of the powers with flat defiance. The retention of Schleswig as an integral part of the monarchy was to it a matter of life and death; the German confederation had made the terms of the protocol of 1852, defining the intimate relations between the duchies, the excuse for interference in the internal affairs of Denmark: and on March 30, 1863. a royal proclamation was published at Copenhagen repudiating the compacts of 1852, and, by defining the separate position of Holstein in the Danish monarchy, negativing the claims of Germany upon Schleswig.[2]

Danish Constitution of 1863.—The reply of the German diet was a note to Copenhagen (July 9) demanding, on pain of federal execution. the withdrawal of the proclamation and the grant of a constitution based on the compacts of 1852 or on the British note of Sept. 24, 1862. Instead King Frederick VII issued, on Sept. 28, 1863, a new constitution for "our kingdom of Denmark-Slesvig." which. encouraged by the hesitating attitude of the German diet, the Danish parliament passed on Nov. 13. Two days later Frederick VII died.

The "protocol-king." Christian IX, who now ascended the throne, was in a difficult position. The first act he was called upon to perform was to sign the new constitution. To sign was to violate the terms of the very protocol which was his title to reign; to refuse to sign was to defy the sentiment of his Danish subjects. He chose what seemed the remoter evil. and on Nov. 18 signed the constitution. The news was received in Germany with violent manifestations of anger. Frederick, duke of Augustenburg, son of the prince nho in 1852 had renounced the succession to the duchies, now claimed his rights on the ground that he had had no share in the renunciation. In Holstein an agitation in his favour had begun from the first, and this was extended to Schleswig on the terms of the new Danish constitution becoming known. His claim was enthusiastically supported by the German princes and people, and in spite of the negative attitude of Austria and Prussia the federal diet decided to occupy Holstein "pending the settlement of the succession." On Dec. 24 Saxon and Hanoverian troops marched into the duchy in the name of the German confederation and, supported by their presence and by the loyalty of the Holsteiners. the duke of Augustenburg assumed the government under the style of Duke Frederick VIII.

Attitude of Austria and Prussia.—With this "folly"—as Bismarck roundly termed it—Austria and Prussia, in the teeth of violent public opinion. would have nothing to do. for neither wished to risk a European war. It was clear to Bismarck that the two powers, as parties to the protocol of 1852, must uphold the succession as fixed by it. and that any action they might take in consequence of the violation of that compact by Denmark must be so "correct" as to deprive Europe of all excuse for interference. The publication of the new constitution by Christian IX was in itself sufficient to justify a declaration of war by the two powers as parties to the signature of the protocol. As to the ultimate outcome of their effective intervention, that could be left to the future to decide. Austria had no clear views. King William wavered between his Prussian feeling and a sentimental sympathy with the duke of Augustenburg. Bismarck alone knew exactly what he wanted, and how to attain it. "From the beginning," he said later (*Reflections,* ii, 10), "I kept annexation steadily before my eyes."

The protests of Great Britain and Russia against the action of the German diet helped Bismarck to persuade Austria that immediate action must be taken. On Dec. 28 a motion was introduced in the diet by Austria and Prussia, calling on the confederation to occupy Schlesnig as a pledge for the observance by Denmark of the compacts of 1852. This implied the recognition of the rights of Christian IX, and was indignantly rejected; whereupon the diet was informed that Austria and Prussia would act in the matter as independent European powers. The agreement between them was signed on Jan. 16, 1864. One article stated that the two powers would decide only in concert on the relations of the duchies, and that they would in no case determine the question of the succession save by mutual consent.

At this stage, had the Danes yielded to the necessities of the situation and withdrawn from Schleswig under protest, the European powers would probably have intervened, a congress mould have restored Schleswig to the Danish crown and Austria and Prussia, as European powers, would have had no choice but to prevent any attempt upon it by the duke of Holstein. To prevent this possibility Bismarck made the Copenhagen government believe that Great Britain had threatened Prussia with intervention should hostilities be opened, "though, as a matter of fact, England did nothing of the kind." The cynical stratagem succeeded; Denmark remained defiant; and on Feb. 1, 1864, the Austrian and Prussian forces crossed the Eider.

The Danish War.—An invasion of Denmark itself had not been part of the original program of the allies; but on Feb. 18 some Prussian hussars, in the excitement of a cavalry skirmish, crossed the frontier and occupied the village of Kolding. Bismarck determined to use this circumstance to revise the whole situation. He urged upon Austria the necessity for a strong policy, so as to settle once for all not only the question of the duchies but the wider question of the German confederation; and Austria reluctantly consented to press the war. On March 5 a fresh agreement was signed between the powers, under which the compacts of 1852 were declared to be no longer valid, and the position of the duchies within the Danish monarchy as a whole was to be made the subject of a friendly understanding. Meanwhile, honever, Lord John Russell on behalf of Great Britain, supported by Russia. France and Sweden, had intervened with a proposal that the whole question should once more be submitted to a European conference.[3] The German powers agreed on condition that the compacts of 1852 should not be taken as a basis, and that the duchies should be bound to Denmark by a personal tie only. But the proceedings of the conference, which opened at London on April 25, only revealed the inextricable tangle of the issues involved. Beust. on behalf of the confederation, demanded the recognition of the Augustenburg claimant; Austria leaned to a settlement on the lines of that of 1852; Prussia, it was increasingly clear. aimed at the acquisition of the duchies. The first step toward the realization of this latter ambition was to secure the recognition of the absolute independence of the duchies, and this Austria could only oppose at the risk of forfeiting its nhole influence in Germany. The two poners. then, agreed to demand the complete political independence of the duchies bound together by common institutions. The next move was uncertain. As to the question of annexatian Prussia would leave that open, but made it clear that any settlement must involve the complete military subordination of Schleswig-Holstein to itself. This alarmed Austria. which had no wish to see a further extension of Prussia's already overgrown power. and it began to champion the claims of the duke of Augustenburg. This contingency, however, Bismarck had foreseen and himself offered to support the claims of the duke at the conference if he would undertake to subordinate himself in all naval and military matters to Prussia, surrender Kiel for the purposes of a Prussian war harbour, give Prussia the control of the projected North sea canal and enter the Prussian customs union. On this basis. with Austria's support, the whole matter might have been arranged without—as Beust pointed out (*Mem.,* i, 272)—the increase of Prussia's power beyond the Elbe being any serious menace to Austrian influence in Germany. Fortunately, however. for Bismarck's plans. Austria's distrust of Prussia led it to oppose this settlement and at its instigation the duke of Augustenburg rejected it.

Treaty of Vienna, 1864.—On June 25 the London conference broke up without having arrived at any conclusion. On the 24th. in vien of the end of the truce, Austria and Prussia had

[1]Note of Sept. 24, 1862. For the diplomatic correspondence on the duchies see *Parl. Papers,* lxxiv (1863).

[2]For this and later correspondence see *Parl. Papers,* lxiv, p. 40 *et seq.* (1864).

[3]*Parl.* Papers, lxv, 124 *et seq.* (1864). Beust (*Mem.,* i, 252) says that Queen Victoria personally intervened to prevent British action in favour of Denmark.

arrived at a new agreement, the object of the war being now declared to be the complete separation of the duchies from Denmark. As the result of the short campaign that followed, the preliminaries of a treaty of peace were signed on Aug. 1, the king of Denmark renouncing all his rights in the duchies in favour of the emperor of Austria and the king of Prussia. The definitive treaty was signed at Vienna on Oct. 30, 1864. By art. xix a period of six years was allowed during which the inhabitants of the duchies might "opt" for Danish nationality and transfer themselves and their goods to Denmark; and the right of "indigenacy" was guaranteed to all, whether in the kingdom or the duchies, who enjoyed it at the time of the exchange of ratification of the treaty.[1]

SETTLEMENTS OF 1866 AND 1920

The Schleswig-Holstein question from this time onward became merged in the larger question of the general relations of Austria and Prussia. So far as Europe was concerned it was settled by the decisive result of the Austro-Prussian war of 1866. (*See* SEVEN WEEKS' WAR.) It survived, however, as between Danes and Germans, though narrowed down to the question of the fate of the Danish population of the northern duchy.

By art. v of the treaty of Prague (Aug. 23, 1866) Schleswig was ceded by Austria to Prussia with the reservation that "the populations of the North of Schleswig shall be again united with Denmark in the event of their expressing a desire so to be by a vote freely exercised." But the plebiscite never came, and by the treaty of Vienna of Oct. 11, 1878, the clause relating to the plebiscite was formally abrogated.

To incorporate Schleswig in the German empire, however, was one thing; to absorb its people into the German nation quite another. South Schleswig was already German; but for 50 years Germanism, backed by all the weight of the empire and imposed with the weapons of official persecution, had not held its own in north Schleswig. But the scattered outposts of Germanism could hardly be expected to acquiesce without a struggle in a situation that threatened them with social and economic extinction. Fifty years of dominance, secured by official favour. had filled them with a double measure of aggressive pride of race, and the question of the rival nationalities in Schleswig, like that in Poland, remained a source of trouble and weakness within the frontiers of the German empire.

During the years preceding World War I, the efforts to Germanize the Danish inhabitants of Schleswig continued, but only succeeded in strengthening their Danish national consciousness. In Aug. 1914 the effects of this spirit were so feared in Germany that a number of prominent Danes were imprisoned, and during the war the aspirations for union with Denmark were silenced.

On Oct. 23, 1918, however, H. P. Hanssen, a Danish representative, raised the demand for reunion in the German *reichstag;* on the same day the Danish *rigsdag* passed a resolution in favour of a readjustment of the frontier on the principles of nationality. On Nov. 28 the Danish government communicated its wishes to the Allies, and in Feb. 1919 a united Danish north Schleswig delegation was sent to the peace conference in Paris to present the Danish point of view: a plebiscite en *bloc* in north Schleswig (zone 1); a community ballot in central Schleswig and Flensburg (zone 2) and voting rights to all those born in the voting district. The peace treaty presented May 7 further provided for a plebiscite in a third zone, but this was later dropped.

On the treaty coming into force (Jan. 10, 1920) an international commission took charge of the plebiscite district. Zone 1 gave 75,431 votes for Denmark, 25,329 for Germany (Feb. 10); zone 2, 48,148 votes for Germany, 13,029 for Denmark (March 14). The frontier established by the treaty of July j, 1920, gave effect to this verdict, and restored to Denmark that part of Schleswig which lies north of the Flensburg fiord, and of a line drawn approximately west from it. On July 7 the executive power in zone 1 was handed over to Denmark.

Subsequent elections showed the line to be fairly drawn. The Danish vote polled in Germany in 1924 was 7,700—insufficient to return a Danish representative. The German votes for the *rigsdag* in 1921 and 1924 totaled 7,500, returning one member under the system of proportional representation. The treaty of Versailles imposed no special obligations upon Denmark with regard to its German minority, since the Danish constitution offered adequate safeguards; on the same grounds the Danish government declined the proposal for a special treaty with Germany for reciprocal protection of the minorities, as this might lead to interference by the government of one country in the affairs of another. The Danish government, however, offered the German minority every facility to develop its own culture, the school system of north Schleswig being reorganized with this view; parents were allowed to decide whether their children would be educated in German or Danish at primary schools, and German private schools received state grants. (W. A. P.; X.)

[1]The full text of the treaty is in La *Question du Slesvig,* p. 173 *et seq.*

SCHLEY, WINFIELD SCOTT (1839–1911), U.S. naval officer, was born at Richfields, near Frederick, Md., on Oct. 9, 1839. He graduated at the U.S. Naval academy in 1860, and during the Civil War was in active service as a lieutenant until July 1863.

In Feb. 1884 Schley was appointed to command the third Greely relief expedition, and on June 22 near Cape Sabine rescued Greely and six companions. In 1898 he was put in command of the flying squadron, with the "Brooklyn" as his flagship, for service in the war with Spain. The command of the fleet off Santiago de Cuba was taken from Schley by Acting Rear Adm. W. T. Sampson. In the battle of Santiago on July 3, Schley, in Sampson's absence, was the senior officer. In 1901 he retired from active service. At his request, because of charges made against him, a court of inquiry investigated Schley's conduct before and during the battle of Santiago; in 1901 the court pronounced Schley guilty of delay in locating Cervera's squadron, of carelessness in endangering the "Texas" by a peculiar "loop" movement or turn of the "Brooklyn" which blanketed the fire of other American vessels and of disobedience to a departmental order of May 25, but it recommended that no action be taken. He died in New York city, on Oct. 2, 1911.

SCHLICK, MORITZ (1882–1936), German philosopher and leader of the group of neopositivists who composed the Vienna circle, was born in Berlin on April 14, 1882, the son of a manufacturer. After attending the *Realgymnasium* in Berlin, he studied physics at Heidelberg, at Lausanne and at Berlin where, as a pupil of Max Planck, he obtained his doctorate of philosophy in 1904 with a thesis on physics. In 1911 he qualified for a teaching post in Rostock with a dissertation on "The Nature of Truth According to Modern Logic." In 1921 he was appointed to a post in Kiel. In 1922 Schlick went to Vienna as professor of the philosophy of the inductive sciences. His predecessors in this chair included Ernst Mach and Ludwig Boltzmann. In Vienna he gathered around him a group of philosophers, such as Rudolf Carnap, Otto Neurath and Friedrich Waismann, and of mathematicians and scientists, such as Kurt Gödel, Philipp Frank. Karl Menger and Hans Hahn, which met regularly to discuss problems of common interest. The group, the Vienna circle, was characterized by its hostility to metaphysics, by its radical empiricism, by its faith in the techniques of modern symbolic logic and by its belief that the future of philosophy lay in its becoming the logic of science. Claiming to continue the positivist tradition of Mach and Boltzmann, it was much influenced also by Bertrand Russell and by Ludwig Wittgenstein (*q.v.*). Its views were publicized in a series of books. *Schriften zur wissenschaftlichen Weltauffassung* (Vienna, 1928 ff.); and the manifesto *Wissenschaftliche Weltauffassung: der Wiener Kreis* (1929) served to organize it on a more formal basis. Making contact with philosophers of similar tendencies in other countries, it launched the international movement in philosophy which has come to be known as logical positivism. Schlick went to California in 1929 for a short period as visiting professor at Stanford university. On his return he continued to direct the activities of the Vienna circle and wrote regularly for its review *Erkenntnis.* On June 22, 1936, as he was entering the university to give his lecture, he was shot by a demented student and killed.

In his philosophical view Schlick belonged to what may be called the right wing of the Vienna circle. He did not agree with Carnap and Neurath that statements which appeared to be about mental events were all translatable into statements about physical events, nor did he accept their contention that it was metaphysical to talk of comparing statements with reality. On the contrary, he insisted always that the individual's private experience was the ultimate test of the truth of any assertion of fact. To the objection that this made it impossible to account for there being a public language, he replied that while the content of one's experience was incommunicable, its structure was not. He was thus led to the implausible conclusion that all empirical statements, insofar as they are publicly intelligible, are statements about structure. In his early days he was influenced by Kant, but he believed that the discoveries of modern physics, which he was one of the first to interpret philosophically, showed Kant's views of space and time and causality to be untenable. He also appealed to modern physics in support of the fundamental principle of the logical positivists that "the meaning of any statement turns entirely on the possibility of its empirical verification." It was from this principle that he drew the conclusion that metaphysical statements were meaningless. Metaphysics for him did not include ethics; he took a utilitarian view of ethical statements, which allowed them to be empirically verifiable. It did, however, include any attempt to characterize a transcendent reality. The philosopher, therefore, should not try to compete with the scientist. The object of philosophy was not to establish a body of philosophical propositions, but to make other propositions clear.

See also LOGICAL POSITIVISM: *Characteristic Views of the Vienna Circle.*

Schlick wrote a great many essays, of which some were collected in the posthumous *Gesammelte Aufsätze* 1926–36 (1938). His most important books were *Raum und Zeit in der gegenwärtigen Physik* (1917), 2nd ed. (1919), Eng. trans. (1920); *Allgemeine Erkenntnislehre* (1918), 2nd ed. (1925); *Fragen der Ethik* (1930); and the posthumous *Grundziige der Naturphilosophie* (1948) and *Natur und Kultur* (1952). (AD. J. A.)

SCHLIEFFEN, ALFRED, COUNT VON (1833–1913), Prussian soldier, was born on Feb. 28, 1833, in Berlin. He served in the war of 1866 against Austria and in that of 1870–71 against France as a general staff officer. In 1891 he was appointed chief of the general staff of the army. He promoted the training of general staff officers in the leading of armies, urged on technical equipment and threw his energies into the effort to equip the army with mobile heavy artillery.

On his retirement in 1907, Schlieffen put his views in writing. He was a disciple of Clausenitz, nho in his turn had deduced his doctrine of strategy from Napoleon. The essence of their doctrine is that the enemy forces should be not merely defeated but destroyed. To this end it seemed to them necessary that not only the front but the flanks and if possible the rear should be attacked. Schlieffen pushed this system to its logical conclusion. He saw Germany surrounded on all sides by enemies who, together, were far more powerful than itself. It seemed to him that the only salvation lay in opposing one of the enemies with a superior force, inflicting on him a decisive defeat, and then, using a well-developed network of railways and maneuvering on inner lines, turning upon the other enemy against whom until then a defensive attitude would have been maintained.

Schlieffen died in Berlin on Jan. 4, 1913, but in 1914—seven years after his retirement—he still played his part in the world's history; for on retiring, he had bequeathed to his successor, General Moltke the younger, the plan for deployment against France. This plan embodies his strategic convictions. It is at once immensely bold and also simple. Only the bare minimum was to remain facing the Russians; in the West the left flank was to be held back and the troops in Alsace were to withdraw behind the Rhine and face attack on the line Metz-Strasbourg. The bulk of the army was to deploy on the right flank and, pivoting on Metz, to drive forward against the line Dunkirk-Verdun. In this way the strongly fortified east front of France would be turned and the French army forced to give battle with a reversed front. The German army commander of 1914 considerably diluted the Schlieffen plan and, particularly in its execution, followed other courses. And so it was that the inspired scheme of Schlieffen did not bear the fruits which were expected.

How armies are to be handled in the Schlieffen spirit the war on the Eastern front showed. The battle of Tannenberg has very justly been called a super-Cannae, and the campaign of Lodz, the German attack against the Warsaw-Thorn line—the best-conceived operation of the whole War, which was directed solely against the right flank of the Russians—rests upon Schlieffen's ideas. The field marshal's influence on the German leadership in World War I is incontestable.

See Graf Schlieffen, *Gesammelte Schriften (1913)*; *Cannae,* selection from the above (1925). (K. VON O.)

SCHLIEMANN, HEINRICH (1822–1890), German archaeologist, was born on Jan. 6, 1822, at Neu Buckow in Mecklenburg-Schwerin. He made a fortune at the time of the Crimean War, partly as a military contractor. Happening to be in California when made a state of the union, in 1850, he became a U.S. citizen. He took his large fortune to Greece in 1868 and proceeded to visit Homeric sites. In an ensuing *book—Zthaka, der Peloponnes und Troja—he* propounded two theories: that Hissarlik, not Bunarbashi, was the site of Troy, and that the Atreid graves at Mycenae, lay within the citadel wall.

Two years later he took up Calvert's work on the former site, and, convinced that Troy must be on the lowest level, hewed his way down. regardless of the upper strata, wherein lay unseen the remains of which he was really in search. By 1873 he had laid bare considerable fortifications and other remains of a burned city of very great antiquity, and discovered a treasure of gold jewelry. We now know this city to have belonged to the middle pre-Mycenaean period, long prior to the generation of Homer's Archaeans, but Schliemann proclaimed it Troy.

Trying to resume his work in Feb. 1874, he found himself inhibited by the Ottoman government, whose allotted share of the gold treasure had not been satisfactory, and it was not till April 1876 that he obtained a *firman.* During the delay he issued his *Troy and Its Remains* (1875), and betook himself to Mycenae. There in Aug. 1876 he began work in the dome tombs and by the Lion Gate, and opened a large pit just within the citadel. The famous double ring of slabs and certain stone reliefs came to light. Schliemann, thinking it was only a platform leveled as a place of Achaean assembly, paused, and did not resume till November. Then he cleared away some three feet more of earth and stones, and lighted on the five shaft graves.

A sixth grave was found immediately after his departure. The immense treasure of gold, silver, bronze, fine stone and ivory objects. which was buried with the 16 corpses in this circle, is worth intrinsically more than any treasure trove known to have been found in any land, and it revealed once for all the character of a great civilization preceding the Hellenic. The discoverer, publishing his *Mycenae* in English in 1877, had his full share of honours and fame. He had now settled in Athens.

In 1878 he dug unsuccessfully in Ithaca, and in the same year and the following resumed work at Hissarlik, and summed up his results in *Ilios,* upon which a sequel, *Troja* (1884) was a considerable improvement. In 1880 and 1881 Schliemann cleared out the ruined dome tomb of Orchomenus, finding little except remains of its beautiful ceiling; in 1885, with W. Dorpfeld, he laid bare the upper stratum on the rock of Tiryns, presenting scholars with a complete ground plan of a Mycenaean palace.

While Tsountas, for the Greek Archaeological society, picked up his work at Mycenae in 1886, and gradually cleared the Acropolis with notable results, Schliemann tried for traces of the Caesareum at Alexandria, of the palace of Minos at Knossos, in Crete, and of the Aphrodite temple at Cythera (1888); but he was not successful.

In 1889 he entertained at Hissarlik a committee of archaeological experts, deputed to examine Botticher's contention that the ruins represented not a city, but a cremation necropolis. He was planning a new campaign on the site when he became ill at Naples and died on Dec. 25, 1890. (D. G. H.)

SCHLÖZER, AUGUST LUDWIG VON (1735–1809), German historian, was born at Gaggstedt, in the county of Hohenlohe-Kirchberg, on July 5, 1735. He went in 1755 to Stockholm, and afterward to Uppsala; while in Sweden he wrote in Swedish an *Essay on the General History of Trade and of Seafaring in the Most Ancient Times* (1758). In 1759 he returned to Göttingen. From 1761 to 1767 he occupied academic posts in Russia; he returned to Göttingen, retired in 1805 and died Sept. 9, 1809.

Schlözer's most important works were his *Allgemeine nordische Geschichte*, 2 vol. (1772) and his translation of the Russian chronicler Nestor to the year 980, 5 vol. (1802–1809).

SCHLÜSSELBURG (PETROKREPOST), a town of the U.S.S.R. in the Leningrad *oblast*, at the point where the Neva river issues from Lake Ladoga. Opposite the exit of the Neva are two islands, on the larger of which is a fortress, erected after its capture by Peter the Great in 1702. It received its name because Peter considered it the key (*Schlüssel*) to the sea. After the final defeat of the Swedes in his reign, it was converted into a prison for political offenders. Founded by the Novgorodians in 1323, it changed hands many times during the wars between Russia and Sweden, and after its recapture by the Swedes in 1661 was called Noteborg.

SCHLÜTER, ANDREAS (1660–1714), German sculptor, the first important baroque native master and a favourite of the Hohenzollern, was probably born in Danzig in 1660. His most remarkable work is the well-known equestrian monument of the Great Elector in Berlin (1696–1703). The general effect is closely related to the French classical style of the reign of Louis XIV. The motif of the four corner slaves is Italianate and the sculptor might have derived the ideas for their attitudes from figures of Michelangelo and Bernini. The most famous example of his religious work is the pulpit in the Marienkirche (1703) in Berlin. The sarcophagi of King Frederick I (1713) and his queen (1705) in the cathedral are also monumental works of Schlüter's who finished them with extraordinary dispatch. A good deal of room decoration in a style bordering between the baroque and rococo is attributable to Schlüter. Schlüter, who was also an architect, designed the old post office in Berlin (1701/2–04) which was torn down in 1889. He died at St. Petersburg in 1714.

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SCHMIDT, BERNHARD VOLDEMAR (1879–1935), Estonian optical instrument maker whose invention of the telescope named after him was an outstanding development in astronomical optics for the increase in dimension which it gave to the useful field and for its fine image definition (*see* PHOTOGRAPHY, CELESTIAL: *Photographic Telescopes*). Schmidt was born on the island of Naissaar near Reval (Tallin), Estonia, on March 30, 1879. After little schooling, he worked until 1898 as a telegraph operator, photographer and designer, meanwhile continuing independent studies and experiments with increasing interest in astronomy and optics. After a short period at the Chalmers institute in Goteborg, Swed., he went in 1901 to the engineering school at Mittweida in Germany for a few terms' study, but remained until 1926, installing a small workshop and observatory there. The parabolic mirrors which he made during this period and his 16-in. horizontal telescope of 1909 established his reputation as an optical technician, and he obtained several patents. In 1926 Schmidt joined the staff of the Hamburg observatory at Bergedorf. During the far eastern solar eclipse expedition of 1929, he conceived the idea of a coma-free mirror system, and after initial difficulties, the first 14-in. Schmidt telescope (1:1.75) was begun at Bergedorf in 1930 and completed in 1932. *See* his "Ein lichtstarkes Komafreies Spiegel-system," *Mitteilungen der Hamburger Sternwarte in Bergedorf*, no. 36 (1931). Schmidt died at Bergedorf on Dec. 1, 1935. His optical system has proved its efficiency in various technical fields, including that of television projection.

See A. A. Wachmann, "From the Life of Bernhard Schmidt," *Sky and Telescope*, vol. xv, no. 1 (Nov. 1955). (A. A. WN.)

SCHMIDT, WILHELM (1868–1954), German Roman Catholic priest and anthropologist, the leader of an influential school of ethnology, was born, Feb. 16, 1868, in Horde, Westphalia. He was educated at a seminary in the Netherlands and at the universities of Berlin and Vienna. A member of the Society of the Divine Word, Father Schmidt taught ethnology and linguistics at St. Gabriel's seminary at Wien-Mödling, Aust., 1895–1938, and at the universities of Vienna and Fribourg (Switz.). He began his career in linguistics and soon broadened it to include ethnology, joining the culture-historical (*Kulturkreis* or "culture circle") movement founded by F. Ratzel, F. Graebner and B. Ankermann, of which he eventually became leader. Schmidt vigorously opposed the evolutionism of L. H. Morgan, E. B. Tylor and H. Spencer. Following the lead of Andrew Lang, Schmidt challenged the evolutionists' theory of the development of religion, and maintained in *Der Ursprung der Gottesidee* ("The Origin of the Idea of God," 12 vol., 1912–55), his principal work, and in *The Origin and Growth of Religion* (1931), that the most primitive peoples believed in a supreme being. In 1906 he founded the Anthropos institute and its journal, *Anthropos*. His philosophy of ethnology was expounded in *The Culture Historical Method of Ethnology*, translated by S. Sieber (1939).

Schmidt died on Feb. 10, 1954, in Fribourg, Switz.

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SCHMIDT-ROTTLUFF, KARL (1884–), German painter and graphic artist and an important figure in the Expressionist movement, was born in Rottluff near Chemnitz on Dec. 1, 1884. Originally a student of architecture, Schmidt-Rottluff turned to painting in Dresden where he became one of the founders of *die Brücke* ("the bridge")—an influential group of artists in the initial years of Expressionism. His finest work is characterized by a dynamism of brilliant colour and boldness of cubic form. His religious woodcuts, done immediately after World War I, were inspired by African sculpture. They are characterized by a power of religious statement that could not have been achieved with traditionalistic liturgical art forms.

See Will Grohmann, *Karl Schmidt-Rottluff* (1956). (P. H. S.)

SCHMITT, FLORENT (1870–1958), French composer, known for his orchestral works, was born at Blâmont, Meurthe-et Moselle, Sept. 28, 1870. He studied at Nancy and in 1889 entered the Paris Conservatoire, where he was a pupil of Massenet and Fauré. In 1900 he won the Prix de Rome with his lyric scene *Sémiramis* and later traveled throughout Europe. His reputation was established with the *Psaume XLVI* (1906) for chorus and orchestra, the ballet, *La Tragédie de Salomé* (1907) and a piano quintet (1908). Between 1894 and 1950 he wrote many orchestral works, showing a bold sense of orchestral colou., and including *Antoine et Cléopâtre* (1920), *Mirages* (1924) and *Salammbô* (1927). Among his piano works, several of which he orchestrated, are the *Reflets d'Allemagne* (1905). He wrote unaccompanied choral works and chamber works, including the *Suite en rocaille* (1935), *A tour d'anches* (1947), quartets for woodwind instruments and for brass, and a sextet for clarinets. He died, Aug. 17, 1958, at Neuilly-sur-Seine.

See Yves Hucher, *Florent Schmitt* (1953).

SCHMOLLER, GUSTAV VON (1838–1917) noted German economist, was born in Heilbronn, Württemberg, June 24, 1838. He taught successively at the universities of Halle, Strassbourg and Berlin and became the leader of the "younger historical school," which emphasized empirical research and the historical background of contemporary economic phenomena, wanting to give economics an ethical foundation. He stood in contrast to the neoclassical school that emphasized deductive reasoning, searched for timeless economic laws and refrained from making value judgments. Moderately liberal in his views on policy, Schmoller criticized the socialists while asserting that the socialist movement must be understood as a reaction to the evils of unregulated capitalism. As an academic teacher, Schmoller inspired a great deal of valuable research, especially in economic history; on the other hand, his influence was largely responsible for the neglect of economic theory at German universities up to the 1920s. Next to economic history, Schmoller's favourite object of research was the administrative technique of the Prussian state. Schmoller was a co-founder and guiding spirit of the largest professional organization of German economists, the Verein für Sozialpolitik ("Association for Social Welfare Policy"). He was also a member of the Prussian Academy of Sciences and of the upper chamber of the Prussian diet. He died in Bad Harzburg on June 27, 1917.

Among Schmoller's numerous writings are the following: *Zur Geschichte der deutschen Kleingewerbe im 19. Jahrhundert* (1869); "Zur Methodologie der Staats- und Socialwissenschaften" (against Menger) in *Jahrbuch für Gesetzgebung und Verwaltung* (1883); *Über einige Grundfragen der Sozialpolitik und der Volkswirtschaftslehre,* a collection containing the article against von Treitschske (1898); *Grundriss der allgemeinen Volkswirtschaftslehre* (1901). He was co-editor of *Acta Borussica.*

See Richard Bahr, *Gustav Schmoller* (1909). (C. L.)

SCHMUCKER, SAMUEL SIMON (1799–1873), U.S. theologian, a leading theologian of the American Lutheran Church during the period of the development of an indigenous type of liberal Lutheranism, was born at Hagerstown, Md., on Feb. 28, 1799. He was educated at first under private tutors and then at the University of Pennsylvania and at Princeton seminary. Schmucker fostered a strongly pietistic emphasis, moving on to a prophetic ecumenical spirit. He was a pioneer in the establishment of a first united Lutheran Church of district synods in America, the General Synod (1820); he became the first theological professor in Gettysburg seminary, an institution he helped to promote; and he founded a classical school that later became Gettysburg college.

Constitutions for churches and district synods, liturgies, hymnbooks and editions of Luther's catechisms (with his own freer interpretations) were only a few of his numerous works. In 1834 appeared his *Elements of Popular Theology,* a first systematic treatment in English of Lutheran theology in America. In 1838 was published his *Appeal to the American Churches,* outlining a plan of church fraternity, a forerunner of the Federal Council of Churches which came years later. When the Evangelical Alliance was organized in 1846 he played a major role.

What has been called the crisis in American Lutheran theology centred about Schmucker's name, particularly in an anonymous pamphlet which he caused to circulate entitled *Definite Synodical Platform* in 1855. This document proposed an amended and abridged form of the Augsburg Confession as a confessional statement for the American Lutheran Churches. The incentive to its publication lay in the pressure groups of conservative Lutheran immigrants, who, in increasing numbers, began to flood the American scene, calling for a return to a stricter allegiance to the Lutheran Confessions of the 16th century. Schmucker went down to defeat, and with him the tender plant of "American Lutheranism," the term given to the liberal movement he had so strongly nurtured. He died on July 26, 1873. (V. F.)

SCHNABEL, ARTUR (1882–1951), Austrian-born pianist and composer, known for his masterly interpretations of Beethoven, was born at Lipnik, near Bielitz-Biala, Aust., April 17, 1882. From about 1892 to 1897 he studied the piano with T. Leschetizky and theory with E. Mandyczewski in Vienna. His first performance was given in 1893 at Bielitz. After giving recitals in Vienna and Berlin he became the accompanist of the singer Therese Behr, whom he married in 1905. From 1919 to 1933 he taught at the Hochschule für Musik at Berlin. During this period his performances throughout Europe and the United States of the works of Beethoven, particularly the late sonatas, became known for their intellectual grasp of Beethoven's forms. His repertory also included Mozart, Schubert, Schumann and Brahms. He settled in London in 1934 and moved to the United States in 1939, becoming naturalized five years later. His own compositions, which show the influence of Schoenberg, include three symphonies, an orchestral rhapsody, five string quartets and some piano pieces. He also edited Beethoven's sonatas and published books on musical aesthetics. He died at Axenheim, Switz., on Aug. 15, 1951.

See C. Saerchinger, *Artur Schnabel* (1957).

SCHNEIDEMÜHL (Polish PILA), the capital town of the former Prussian province of Grenzmark, Ger., now in state of Poznan, Pol., on the Cüddow, 60 mi. N. of Posen and 145 mi. N.E. of Berlin on the main line to Königsberg, and at the junction of lines to Stargard and Thorn. Pop. (1950) 21,100. Schneidemühl has a trade in wood, grain and potatoes and possesses iron foundries, a brewery and machine shops, and manufactures cement, starch and bricks. It is the seat of the provincial law courts.

SCHNITZLER, ARTHUR (1862–1931), Austrian playwright and novelist, was born in Vienna on May 15, 1862. He took a medical degree, and practised for a time as a physician. Schnitzler's first and one of his most characteristic pieces was his *Anatol* (1893, Eng. trans. 1911), a series of sketches of the love adventures of a rich young Viennese. Nearly all Schnitzler's gifts are revealed in this series: a limpid style, a strong but never exaggerated sense of humour, an inimitably light touch and above all, a gift of characterization. Other plays in the same style are *Liebelei* (1895, Eng. trans. 1914) and *Freiwild* (1896), each striking a more tragic note in the fate of the "sweet little girl" round whom Viennese romance centres, and *Reigen* (1920), a series describing Viennese amours in great detail. The best of his early stories are *Sterben* (1895), describing the decline of a tubercular, and *Leutnant Gustl* (1901), portraying the kindly but stupid soul of the Austrian subaltern with deadly accuracy. His one long novel *Der Weg ins Freie* revealed his limitations, still more marked in his long romantic play *Der junge Medardus* (1920). Notable are the stories *Die griechische Tänzerin* (1904), *Casanovas Heimfahrt* (1918, Eng. trans. 1922) and *Fräulein Else* (1924, Eng. trans. 1925) and the play *Professor Bernhardi* (1913). In his later period, Schnitzler at times left Vienna to deal with such subjects as the life and adventures of Casanova, but he remained happiest in describing his Viennese. His verse, while polished and brilliant, gives less scope to his talents than his prose. Among his later works are *Beatrice* (Eng. trans. 1926), *Buch der Sprüche und Bedecken* (1927) and *Daybreak* (Eng. trans. 1928). (C. A. M.)

SCHNORR VON CAROLSFELD, JULIUS (1794–1872), German painter, was born on March 26, 1794, at Leipzig, where he received his earliest instruction from his father, Hans Veit Schnorr (1764–1841), a draftsman, engraver and painter. In 1818 he followed the founders of the new school of German Pre-Raphaelites in the general pilgrimage to Rome. This school of religious and romantic art abjured modern styles and set itself to recover fresco painting and "monumental art." Together with Cornelius, Overbeck and Veit, Schnorr received a commission to decorate the entrance hall of the Villa Massimi with frescoes after Ariosto. In 1825 he left Rome, settled in Munich, entered the service of King Ludwig and transplanted to Germany the art of wall painting learned in Italy. Schnorr published a pictorial Bible, with about 200 pictures, in 1852–60; it does not bear comparison with Raphael's Bible. He also made designs, carried out in the royal factory at Munich, for windows in Glasgow cathedral and in St. Paul's cathedral, London. He died on May 24, 1872.

His son, LUDWIG SCHNORR VON CAROLSFELD (1836–1865), was a singer, well known for his interpretation of Wagnerian parts. He created the role of Tristan.

SCHOBER, JOHANN (1874–1932), Austrian politician, was born and educated in upper Austria, entering the Imperial Austrian police service as a young man, and became the Austrian president of police in 1918, some months before the revolution. On the proclamation of the Austrian republic (Nov. 12, 1918), Schober immediately placed his force at the disposal of the new government, and by this action and by his moderate conduct in general did much to ensure a peaceful and bloodless change of regime. At the same time, he succeeded in securing the safety of the ex-imperial family, whose departure from Vienna he supervised. During the two years of social democratic government which followed, Schober's force was reproached by extremists with being reactionary, quite unjustly, as he aimed at strict impartiality. his administrative ability, and above all, his conspicuous honesty, gained him the confidence of all moderate opinion in Austria, and especially of the inter-allied missions and advisers. Because he was known to enjoy this confidence it was expected that if he were chancellor, the Allied and Associate Powers would be willing to grant the loan necessary to restore Austria's chaotic finances, and he was selected to form a non-party ministry in June 1921. He took the first step toward establishing friendly relations between Austria and its neighbours when he concluded the pact of Lana with Czechoslovakia on Dec. 16, 1921 (*see* AUSTRIA). This move aroused the hostility of the pan-Germans, who formed a part of the Government coalition, and resented any pact with Czechoslovakia as putting difficulties in the way of the ultimate *Anschluss* with Germany. They withdrew from the Government coalition. The Christian Socialists were not strong enough to govern alone against the opposition of the Social Democrats. On May 24, 1922, Schober resigned the chancellorship and returned to the post of president of police.

Sre O. Kleinschmied, *Schober* (Wien, 1930).

SCHOBERT, JOHANN (*c.* 1720–1767), German composer and harpsichord player, was brought up at Strasbourg but settled in Paris in 1760, where he held an appointment under the Prince de Conti. He was one of the most popular players of the harpsichord of his time, and is praised by Mozart and by Grimm. He left a large number of agreeable "sonatas" for harpsichord, with and without the accompaniment of other instruments; also six "sinfonies" for clarinet and two horns. These were published and much played in London as well as in Paris. A selection is included in vol. xxxix., of *Denkmäler deutscher Tonkunst* (1909).

See also the article *Jean Schobert* by Georges de Saint-Fois in the *Revue musicale* of Aug 1922.

SCHOFIELD, JQHN MCALLISTER (1831–1906), American soldier, was born at Gerry, Chautauqua county (N Y.), on Sept. 29, 1831. He graduated at West Point in 1853, served for two years in the artillery. and was an assistant professor of philosophy at West Point in 1855–60. When the Civil War broke out he became a major in a Missouri volunteer regiment and served as chief of staff to Maj.-Gen. Nathaniel Lyon until the death of that officer. In 1864, as commander of the Army of the Ohio, he took part in the Atlanta campaign under Maj -Gen. W. T. Sherman. In Oct. 1864 he was sent to Tennessee to join Maj.-Gen G. H. Thomas in opposing Gen. J. B. Hood, and on Nov. 30 he fought with Gen. Hood the desperate indecisive battle of Franklin He was awarded the rank of brigadier-general (Nov. 1864) and the brevet rank of major-general (March, 1865) in the regular army. He co-operated with Sherman in North Carolina in the spring of 1865 with great skill and distinction.

After the war he was sent on a special diplomatic mission to France, on account of the presence of French troops in Mexico. From June 1868 to March 1569 he served as secretary of war under President Andrew Johnson, after the retirement of E. M. Stanton (*q.v.*). From 1876 to 1881 he was superintendent of the Military Academy at West Point, and from 1888 until his retirement in 1895 he was commanding general of the United States Army He died at St. Augustine (Fla.) on March 4, 1906. Gen. Schofield published *Forty-Six* years in *the Army* (1897).

SCHOLASTICISM, the name usually employed to denote the most typical products of mediaevai thought, and commonly employed with differing shades of meaning down to modern times when its application has become fixed in accordance with the latest views of modern philosophy. These views are so far-reaching and complicated that the present article will be confined to an historical sketch of Scholasticism merely, and the reader is referred to the bibliography for details of modern publications on the subject.

After the centuries of intellectual darkness which followed upon the closing of the philosophical schools in Athens (529), and the death of Boetius, the last of the ancient philosophers, the first symptoms of renewed intellectual activity appear contemporaneously with the consolidation of the empire of the West in the hands of Charlemagne. He endedvoured to attract to his court the best scholars of Britain and Ireland, and by imoerial decree (787) commanded the establishment of schools in connection with every abbey in his realms. Peter of Pisa and Alcuin of York were his advisers, and under their care the opposition long supposed to exist between godliness and secular learning speedily disappeared. Besides the celebrated school of the Palace, where Alcuin had among his hearers the members of the imperial family and the dignitaries of the empire as well as talented youths of humbler origin, we hear of the episcopal schools of Lyons, Orleans and St. Denis, the cloister schools of St. Martin of Tours, of Fulda, Corbie, Fontenelle and many others, besides the older monasteries of St. Gall and Rcichenau. These schools became the centres of mediaeval learning and speculation, and from them the name Scholasticism is derived (*cf.* Sandys, *Hist. of Class. Schol.*, i. 471, 1906). They were designed to communicate instruction in the seven liberal arts which constituted the educational curriculum of the middle ages (*See* TRIVIUM) The name *doctor scholasticus* was applied originally to any teacher in such an ecclesiastical gymnasium, but gradually the study of dialectic or logic overshadowed the more elementary disciplines, and the general acceptation of "doctor" came to be one who occupied himself with the teaching of logic. The philosophy of the later Scholastics is more extended in its scope; but to the end of the mediaeval period philosophy centres in the discussion of the same logical problems which began to agitate the teachers of the 9th and 10th centuries.

Chronological Limits.—Scholasticism in the widest sense thus extends from the 9th to the end of the 14th or the beginning of the 1 jth century—from Erigena to Occam and his followers. The belated Scholastics who lingered beyond the last mentioned date served only as marks for the obloquy heaped upon the schools by the men of the new time. Erigena is really of the spiritual kindred of the Neoplatonists and Christian mystics rather than of the typical Scholastic doctors, and, in fact, the activity of Scholasticism is mainly confined within the limits of the 11th and the 14th centuries. It is divisible into two well-marked periods—the first extending to the end of the 12th century and embracing as its chief names Roscellinus, Anselm, William of Champeaux and Abélard, while the second extended from the beginning of the 13th century to the Renaissance and the general distraction of men's thoughts from the problems and methods of Scholasticism. In this second period the names of Albertus Magnus, Thomas Aquinas and Duns Scotus (qq *v.*) represent (in the 13th century and the first years of the 14th century) the culmination of Scholastic thought and its consolidation into system.

Prnntl says that there is no such thing as philosophy in the middle ages; there are only logic and theology. The remark overlooks two facts—firstly that the main objects of theology and philosophy are identical, though the method of treatment is different, and secondly that logical discussion commonly leads up to metaphysical problems, and that this was pre-eminently the case with the logic of the Schoolmen. But the saying draws attention to the two great influences which shaped mediaeval thought—the tradition of ancient logic and the system of Christian theology. Scholasticism opens with a discussion of certain points in the Aristotelian logic; it speedily begins to apply its logical distinctions to the doctrines of the church; and when it attains its full stature in St. Thomas it has, with the exception of certain mysteries, rationalized or Aristotelianized the whole churchly system. Or we might say with equal truth that the philosophy of St. Thomas is Xristotle Christianized. The Schoolmen contemplate the universe of nature and man not with their own eyes but in the glass of Aristotelian formulae Their chief works are in the shape of commentaries upon the writings of "the philosopher" (Aristotle). Their problems and solutions alike spring from the master's dicta—from the need of reconciling these with one another and with the conclusions of Christian theology.

Reason and Authority.—The fact that the channels of thought during the middle ages were determined in this way is usually expressed by saying that reason in the middle age is subject to authority. It has not the free play which characterizes its activity in Greece and in the philosophy of modern times. Its conclusions are predetermined, and the initiative of the individual thinker is almost confined, therefore, to formal details in the treatment of his thesis. To the church, reason is the handmaid of faith (*ancilla fidei*). But this principle of the subordination of the reason wears a different aspect according to the century and writer referred to. In Scotus Erigena, at the beginning of the Scholastic era, there is no such subordination contemplated, because philosophy and theology in his work are in implicit unity. "Conficitur inde veram esse philosophiam veram religionem, conversimque veram religionem esse veram philosophiam" (De *divina praedestinatione,* Proem). Reason in its own strength and with its own instruments evolves a system of the universe which coincides, according to Erigena, with the teaching of Scripture. For Erigena, therefore, the speculative reason is the supreme arbiter; and in accordance with its results the utterances of Scripture and of the church have not infrequently to be subjected to an allegorical or mystical interpretation. But this is only to say again that Erigena is more of a Neoplatonist than a Scholastic. Hence Cousin suggested in respect of this point a threefold chronological division—at the outset the absolute subordination of philosophy to theology, then the period of their alliance, and finally the beginning of their separation. In other words, we note philosophy gradually extending its claims. Dialectic is, to begin with, a merely secular art, and only by degrees are its terms and distinctions applied to the subject-matter of theology. The early results of the application, in the hands of Berengarius and Roscellinus, did not seem favourable to Christian orthodoxy. Hence the strength with which a champion of the faith like Anselm insists on the subordination of reason. To Bernard of Clairvaux and many other churchmen the application of dialectic to the things of faith appears as dangerous as it is impious. Later, in the systems of the great Schoolmen, the rights of reason are fully established and acknowledged. The relation of reason and faith remains external, and certain doctrines—an increasing number as time goes on—are withdrawn from the sphere of reason. But with these exceptions the two march side by side; they establish by different means the same results. For the conflicts which accompanied the first intrusion of philosophy into the theological domain more profound and cautious thinkers with a far ampler apparatus of knowledge had substituted a harmony. "The constant effort of Scholasticism to be at once philosophy and theology" seemed at last satisfactcrily realized. But the further progress of Scholastic thought consisted in a withdrawal of doctrine after doctrine from the possibility of rational proof and their relegation to the sphere of faith. Indeed, no sooner was the harmony apparently established by Aquinas than Duns Scotus began this negative criticism, which is carried much farther by William of Occam. But this is equivalent to a confession that Scholasticism had failed in its task, which was to rationalize the doctrines of the church. The Aristotelian form refused to fit a matter for which it was never intended; the matter of Christian theology refused to be forced into an alien form. The end of the period was thus brought about by the internal decay of its method and principles quite as much as by the variety of external causes which contributed to transfer men's interests to other subiects.

BIBLIOGRAPHY.—Besides the numerous works quoted in articles on the individual philosophers, *see* Haureau, *Histoire de la philosophie scolastique* (2 vols., 1850; revised and expanded in 1870 as *Histoire de la phil. scol.),* Kaulich, *Geschichte d. schol. Philosophie* (1863); Stockl, *Gesch. der Phil. des Mittelalters* (3 vols., 1864–66); Karl Werner, *Die Scholastik des spateren Mittelalters* (4 vols., 1881–87); and, on a smaller scale, de Wulf's *Histoire de la phil. médiévale* (1900; 5th ed., 1924–25). Supplementary details are given in Hauréau's *Singularités historiques et litte'raires* (1861) and in R. L. Poole's *Illustrations of the History of Mediaeval Thought* (1884), while much light is thrown upon the minuter history of the period by the *Chartularium Universitatis Parisiensis* edited by Denifle and Chatelain in 1894, by Hauréau's *Notices et extraits de quelques MS. latins de la Bibliothlque Nationale* (6 vols., 1890–1895) and by the *Beiträge zur Geschichte d. Phil. d. Mittelalters.* The accounts of mediaeval thought by Ritter, Erdmann, Ueberweg and Windelband are very good. There are also notices of the leading systems in Milman's *History of Latin Christianity* (6 vols., 1854–55). The psychology of the Scholastic writers is ably dealt with in Siebeck's *Die Psychologie von Aristoteles bis zu Thomas von Aquino* (1885). Jourdain's *Recherches critiques sur l'âge et l'origine des traductions latines d'Aristote* (1819; 2nd ed. 1843); Rousselot's *Études sur la philosophie dans le moyen âge* (1840–1842), Cousin's Introduction to his *Ouvrages inédits d'Abélard* (1836), and Prantl's *Geschichte der Logik im Abendlande* (4 vols., 1855–1870) are invaluable aids in studying the history of mediaeval thought. For modem views *see* C. Baeumker, *Abhandlungen zur Geschichte der Philosophie des Mittelalters* (1923); G. Ritter, *Studien zur Spätscholastik* (1921, etc.); A. C. A. Schneider, *Die Erkenntnislehre bei Beginn der Scholastik* (1921); H. O. Taylor, *The Mediaeval Mind,* 2 vols. (1925); O. Wichmann, *Die Scholastiker* (1921); N. de Wulf, *Histoire de la philosophie médiévale* (1924, etc.).

SCHOLIUM (to be distinguished from *Scolium,* an after-dinner song), the name given to grammatical, critical and explanatory notes, extracted from existing commentaries and inserted on the margin of the m.s. of an ancient author. These notes were altered by successive copyists and owners of the m.s. and in some cases increased to such an extent that there was no longer room for them in the margin, and it became necessary to make them into a separate work. The name of "the first scholiast" has been given to Didymus of Alexandria (see DIDYMUS CHALCENTERUS), and the practice of compiling scholia continued till the 15th or 16th century A.D. The word σχόλιον itself is first met with in Cicero (Ad Att. xvi, 7). The Greek scholia we possess are for the most part anonymous, the commentaries of Eustathius on Homer and Tzetzes on Lycophron being exceptions. Although frequently trifling, they contain much information not found elsewhere, and are of use for the correction and interpretation of the text. The most important are those on Homer (especially the Venetian scholia on the *Iliad,* discovered by Villoison in 1781 in the library of St. Mark), Hesiod, Pindar, Sophocles, Aristophanes and Apollonius Rhodius; and, in Latin, those of Servius on Virgil, of Acro and Porphyrio on Horace, and of Donatus on Terence.

SCHOMBERG, FRIEDRICH HERMANN (or FREDERIC ARMAND), DUKE OF (1615–1690), marshal of France and English general, was born Dec. 6, 1615, at Heidelberg, Ger.. the son of Hans Meinard von Schonberg (1582–1616) and Anne Sutton. daughter of the 5th Lord Dudley. He was educated by various friends, among whom was the "Winter King." Frederick V of the Palatinate. in whose service his father had been. He began his military career under Frederick Henry prince of Orange. and entered about 1633 into the Swedish service, and that of France in 1635. After a time he retired to his family estate at Geisenheim on the Rhine, but in 1639 he re-entered the Dutch army, in which he remained until about 1650. He then rejoined the French army as a volunteer in May 1652, served under Marshal Turenne in the campaigns against the prince of Condé, and became a lieutenant general in 1655.

After the peace of the Pyrenees (1659) Schomberg was sent as military adviser to Lisbon to assist the Portuguese in their struggle for independence from Spain. He nent with the secret approval of Charles II of England and Louis XIV, who, in order not to infringe the treaty just made with Spain, deprived Schomberg of his French offices. By winning the victory of Montes Claros on June 17. 1665, over the Spaniards under the prince of Parma he assured the independence of Portugal. He then helped to depose the reigning king in favour of his brother Dom Pedro, and then returned to France, became a naturalized Frenchman and bought the lordship of Courbet near Paris. In 1673 he was invited by Charles to England and was appointed lieutenant general to Prince Rupert. He soon returned to the French service. In 1674 his operations in Catalonia were unsuccessful because of the disobedience of subordinates and the rawness of his troops, but he retrieved this failure by retaking Bellegarde in 1675. For this he was made a marshal in the promotion that followed the death of Turenne.

The tide had now set against the Huguenots, and Schomberg's merits had been long ignored on account of his Protestantism. The revocation of the edict of Nantes (1685) compelled him to quit France, and he became in 1687 general in chief of the forces of the elector of Brandenburg. At Berlin he was the acknowledged leader of the Huguenot refugees.

In 1688. with the elector's consent, he joined the prince of Orange on his expedition to England, as second in command to the prince. The following year he was made a knight of the garter, took the naturalization oath, was created successively baron, marquess and duke in the English peerage, was appointed master general of the ordnance, and received compensation for the loss of his French estates. of which Louis had deprived him. In Aug. 1689 he commanded the expedition to Ireland against James II. After capturing Carrickfergus he marched unopposed through a country desolated before him to Dundalk, but decided not to risk a battle with his undisciplined troops, and entrenching himself at Dundalk declined to be drawn beyond the circle of his defenses. Shortly afterward pestilence broke out, and when he retired to winter quarters in Clster his forces were severely shattered. His conduct was criticized in ill-informed quarters, but the facts justified his inactivity. In the spring he began the campaign with the capture of Charlemont, but no advance southward was made until the arrival of William. At the Boyne (July 1. 1690) Schomberg gave his opinion against the determination of William to cross the river in face of the opposing army. In the battle he commanded the centre, and while riding through the river without his cuirass to rally his men. was killed by Irish horsemen. (R. B. WM.)

SCHOMBURGK, SIR ROBERT HERMANN (1804–1865), British explorer and surveyor whose "Schomburgk line" marked the boundary of British Guiana from 1841 to 1895 (*see* GUIANA: *British* Guiana), was born at Freiburg, Lower Saxony, Ger., on June 5, 1804. In 1829 he went to the United States and from there in 1831 visited Anegada, one of the British Virgin Islands. He surveyed it and noted the frequency of the wrecks, particularly of U.S. ships. which occurred upon it. In 1835 the Royal Geographical society sent Schomburgk to explore British Guiana. On this trip he discovered the giant water lily, *Victoria regia,* and in 1840 produced his *Description* of *British* Guiana. In 1841 he surveyed the colony and fixed its boundary, being knighted on his return to England in 1844. He continued his geographical surveys as British consul to Santo Domingo, non the Dominican Republic (1848), and to Bangkok (1857). Schomburgk died at Berlin on March 11, 1865.

SCHÖNBEPN, CHRISTIAN FRIEDRICH (1799–1868), German-Swiss chemist who discovered ozone, guncotton and collodion, was born at Metzingen, Swabia, on Oct. 18. 1799, and died at Sauersberg, near Baden-Baden, on Aug. 29, 1868. After studying at Tübingen and Erlangen. he taught chemistry and physics, first at Keilhau, Thuringia, and then at Epsom, Eng., but most of his life was spent at Basel, where he began to lecture on chemistry and physics in 1828 and was appointed full professor in 183j. His name is chiefly known in connection mith ozone (*q.v.*), which he discovered in 1839; with guncotton, which he prepared and applied as a propellant in firearms early in 1846; and with his discovery of collodion (1846). He also worked on the passivity of iron. the properties of hydrogen peroxide and catalysis. He was a most prolific writer. 364 papers appearing under his name in the Royal society's *Catalogue.*

Many of his letters together with a life will be found in G. W. A. Kahlbaum, *Monographien aus der Geschichte der Chemie,* vol. iv and vi (1899 and 1901). *See* also E. Farber, essay, in G. Bugge, *Buch der grossen Chemiker* (1955).

SCHÖNBERG, ARNOLD (1874–1951), Austrian composer, was born in Vienna on Sept. 13, 1874. He began to study violin and cello at an early age and to compose chamber music. In musical theory he was practically self-taught. His earlier works include songs, the string sextet, *Verklarte Nacht,* opus 4 (revised later for string orchestra with six soloists), the symphonic poem *Pelléas et Mélisande* and the *Gurrelieder,* a ballad cycle for chorus and full orchestra (first produced in Vienna 1912–13), written under the influence of the Wagner tradition.. Schonberg then came into touch with Kokoschka and other leaders of the new movement in art and literature, and entered upon an experimental period in which he put romanticism behind him and went back to Bach and the earlier polyphonic writers for inspiration. With the 2nd chamber symphony and particularly the 2nd string quartet (1908), into the last two movements oi which he introduces a soprano part to words by Stephan George, he definitely broke away from tradition; and with the piano pieces, opus 11, his mature period may be said to begin, although he continued to strike out new paths with each successive mork. In 1911 he went to live in Berlin and in the same year produced his *Harnzonielehre* (rev. ed., 1922). (*See* also HARMONY.)

An eventful performance was that of *Pierrot Lunaire* in Berlin in 1923 with Xlbertine Zehme in the spoken part. This cycle of 21 poems for recitation with piano, flute, clarinet, violin, and violoncello in constantly changing combinations, is, after the *Gurrelieder,* his best-known mork. In 1918, having returned to Vienna, Schonberg founded there a society for private musical performances. A revival of *Die glückliche Hand,* opus 18, at Breslau, Ger., in 1928 aroused much interest. This dramatic piece was, in spite of its early date, perhaps the most daring of Schonberg's experiments and that in which his psychology finds its clearest expression. He wrote the libretto and ordered every detail of the staging. Essentially a pioneer, he never made concessions to the ordinary listener, but the tenseness and extreme compression of this work make quite unprecedented demands on the concentrative powers of his audiences. In all his later writing the combination of a tersely dramatic and fragmentary style with complete atonality leaves an impression of complication and strain. He was, nevertheless, sincerely striving toward simplicity and compactness, and his reversion to a smaller or chamber orchestra led to a general adoption of this medium by younger composers. He also adopted a simplified method of scoring, in which duplication of parts is avoided and the whole is compressed onto a few staves. He went to the U.S. in Oct. 1933 and mas professor of music at the University of California at Los Angeles, 1936–44. He died near Los Angeles, July 13, 1951.

Other important works are: 6 songs with orchestra, opus 8 (1911); chamber symphony for 15 solo instruments, opus 9 (1912); serenade ior clarinet, bass clarinet, mandolin, guitar, three strings and (low) male voice, opus 24 (1924); *Thenze and Variations,* opus 43b (1943); *Fantasie* for violin and piano (1949). *See* E. Wellesz, *Arnold Schonberg,* Eng. tr. by W. H. Kerridge (1925); René Leibowitz, *Schoenberg and His School,* Eng. tr. by Dika Newlin (1949).

SCHÖNEBECK, a town of Germany, in the district of Magdeburg, on the left bank of the Elbe, 9 mi. S. of the city of Magdeburg by the railway to Halle and Leipzig. Pop. (1950) 46,426. It contains manufactories of chemicals, machinery, bicycles, rubber, explosives and various other articles, but is chiefly noted for its extensive salt works. Its harbour on the Elbe and factories were objects of aerial bombardment in World War II.

SCHÖNEBERG, an administrative district of Berlin, Ger., which it adjoins on the southwest. Pop. (1950) 189.260. The foundation of Alt-Schoneberg is ascribed to Albert the Bear, margrave of Brandenburg, in the 12th century, while Neu-Schöneberg was founded by Frederick the Great in 1750 to accommodate some Bohemian weavers exiled for their religion. Its chief manufactures are railway material, cigars, soap, paper and chemicals.

SCHONGAUER, MARTIN (called MARTIN SCHÖN and HIPSCH [Hubsch] MARTIN) (1445/50–1491), German engraver and painter of the early German school, was born in Colmar, Alsace, a son of the goldsmith. Caspar Schongauer from Augsburg, where the family, originally from Schongau. had been prominent for two centuries. Dates of his birth proposed in German literature after 1941, range from 1425 to 1453. In 1465 he was registered at the University of Leipzig. but apparently remained there only one semester. In view of the variance of opinion on his age, it is not clear whether he was there as a student or as a visiting artist, enjoying the university's protection from interference of the local painters' guild. That he was a student appears more likely because no work of his has ever been discovered which could with certainty be dated earlier than 1469, and because the wide distribution of his work did not get under way until the late 1470's, judging from the flood of copies mhich are dated. In 1469 his name is mentioned for the first time in the Colmar register of property. The same date appears also on three of his drawings, all obviously early works, but these dates and signatures were added by Albrecht Dürer, who may have received them from Schongauer's brothers when he arrived in Colmar the year after Martin's death. In 1488 Schongauer left Colmar and moved to Breisach, Baden. He died a bachelor in Breisach on Feb. 2. 1491, being survived by three brothers, the goldsmiths Jorg and Paulus and the painter Ludwig.

According to contemporary sources, Schongauer was a prolific painter, whose panels were sought in many countries. Few paintings by his hand survive. Among them the "Madonna in a Rose Garden" of 1473, altarpiece of the church of St. Martin in Colmar, ranks first in importance. This work strikingly combines monumentality with tenderness and is the only painting in which Schongauer approached the heights of the great Flemish painter Rogier van der Weyden by whom he was so profoundly influenced Other paintings by Schongauer include two wings of the Orliac altar (Colmar museum); six small panels among which the "Nativity"

(Berlin) and the "Holy Family" (Vienna) are the most mature; and finally the murals of the "Last Judgment" in the cathedral of Breisach, probably his last work (uncovered in 1932). The 24 panels depicting the "Joys of Mary" and the "Passion of Christ." painted for the church of the Dominicans (Colmar museum), appear to be mainly the work of his assistants.

As an engraver, however, Schongauer stands without rival in northern Europe in his time. His engraved work, consisting of about 115 plates, all signed with his monogram, is a final, highly refined and sensitive manifestation of the late Gothic spirit. Technically he brought the art of engraving to maturity by expanding its range of contrasts and textures, thus introducing a painter's viewpoint into an art which had been primarily the domain of the goldsmith's shop. The larger and more elaborate engravings,. such as the "Temptation of St. Anthony" or the "Death of the Virgin," belong to his earlier period. In his later years, he preferred smaller plates, even for subjects as the "Passion of Christ," a set of twelve engravings. Some of his most eloquent plates are single figures, such as the "Madonna in a Courtyard" or "St. Sebastian." Within the diversity of trends in German art in this period, Schongauer represents the most idealistic and aristocratic element. devoting his art mainly to Christian subjects and shunning the gross and often bawdy humorous realism of some of his fellow engravers. The sensitive grace of his work became proverbial even in his lifetime and gave rise to such names as "Hübsch Martin" or "Schon Martin" ("Bel Martino" in Italian), whereby the adjective "Schon" became often confused with the artist's real family name. Schongauer's engravings are well represented in the print rooms of the larger museums of Europe as well as numerous C.S. museums (New York, Boston, Chicago, Cincinnati, Cleveland and Washington, D.C.).

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(H. JM.)

SCHÖNHERR, KARL (1867–1943), Austrian dramatist, was born at Axams, Tirol, Feb. 24, 1867. His first works were published in 1895. These were dialect poems of an unassuming nature and short stories; in 1897 he turned his attention to drama and the stage with *Der Judas von Tirol* (revised in 1927). Schonherr stood midway between realism and symbolism and expressed himself in a vigorous and original style. His accomplished technique, applied frequently to peasant or medical life, enabled him to evolve successful dramas with a limited number of characters. In his plays simple emotions and the problems and crises arising out of them are presented with inexorable consistency. His most famous drama *Glaube und Heimat* (1910), dealing with the time of the Counter-Reformation, and also *Der Weibsteufel* (1914), aroused religious controversy. Schonherr's other important works include *Die Bildschnitzer* (1900); *Erde* (1908); *Volk in Not* (1915); *Frau Suitner* (1916); *Vivat academia* (1922); *Es* (1923); *Hungerblockade* (1925). Most of his dramas were first produced in the Burgtheater and in the Deutsches Volkstheater in Vienna. Later dramas included *Der Armendoktor* (1927), *Passionsspiel* (1933) and *Die Fahne weht* (1938). His tales and sketches, *Caritas* and *Aus meinem Merkbuch,* express much the same trend of thought and motif as his dramas. His *Gesammelte Werke* appeared from 1928 onward. He died in Vienna March 16, 1943.

SCHOOL ADMINISTRATION. School administration deals with the control, management and direction of all matters affecting the school, including organization, finances, policies, personnel, curriculum and methods, standards and related areas.

In this article school administration is treated under the following headings: types of administration; national systems; local systems; joint local and national systems; sectarian systems; political party control; and trends. For information concerning school administration in various countries, states and provinces, etc., not treated here, *see* the articles on those political divisions. *See* also EDUCATION, HISTORY OF.

Types of Administration.—The schools of the world are organized and administered for the most part by four agencies functioning separately or in combination: the church, the state, the political party and the private group. Of these, the church and private groups have become less powerful. In fact, the last named is now concerned almost exclusively with private schools.

Most school systems of the world are centralized; that is, they are administered by the national government. Decentralized types of administration may be classified under such headings as provincial (state), county, township, community, etc. In Communist countries much administration is determined by local or regional cultural preference. but over-all policy is governed by directives issued from party headquarters in accordance with the prevailing political philosophy.

Administration differs also with the level of education. In centralized systems of education much responsibility for the early stages of schooling is granted to local authorities, whereas secondary education tends to gravitate toward centralized control. Higher education defies generalization. Publicly controlled universities in the United States and Canada may be either local or state in nature; at the same time they are supported to a very small degree, if land-grant colleges, by the federal government. In Great Britain both private and civic universities are dependent upon public funds but remain autonomous. Governmental influences are strong in French, Spanish, Italian and Latin-American universities, while in countries similar to the Soviet Union, universities are controlled by the Communist party, trade and professional unions, and various governmental departments.

National *Systems.* — *France.* — *The* classic example of a national system of education is that of France. Its administrative structure was originated by Napoleon in 1802. The country is divided into politico-educational units decreasing in size from *académies* to *départements* to communes. Each of the 17 *académies* is headed by a university. The chief administrator of both the university and the *acade'mie* is called a rector, who is appointed from the ranks of university professors by the president of France on recommendation of the national minister of education. He is responsible primarily for secondary and higher education within his *académie;* he nominates candidates for administrative positions in his area, appoints examination committees, supervises examination content and procedures and presides over a sort of personal cabinet called an academic council. Unlike political divisions in such countries as Australia, Canada, the United States and west Germany, the *académies* have little power or authority of their own; rather, they are administrative arms of the national ministry of education; they represent a devolution rather than a delegation of power from the central government. The 97 *départements* are likewise administrative units governed by prefects who are appointed in Paris. The prefect heads the elementary school system, acting in a manner similar to the rector. The prefect, too, has an advisory council, appointive in nature, and by no means equivalent to local boards of education in such countries as the United States and Canada. *Départements* are empowered to levy subsidiary school taxes as approved by the national government; in the early 1960s about half the cost of *département* schooling was met by local taxation. *Départements* are also permitted to provide further school services, on approval of higher authorities, including additional emoluments for teachers. There are about 38,000 communes, varying in size from the smallest community to the city of Paris. The chief officer of the commune is the mayor, who is likewise the president of the commune school board. Again, these school boards are largely advisory in nature; they also see to it that national and *département* educational procedures and policies are carried out in their particular area; they have only minor administrative responsibilities and can initiate very little school legislation and practice. In practice, the *département* prefect assumes much of the control over education in the commune, as such control is derived from higher authorities.

The French educational system is also characterized by a pyramid of bureaus which reach their apex in the ministry of national education in Paris. As in all national systems, even including Great Britain, the minister of education is a political appointee of the prime minister, and he usually falls when his government falls. Practical control is exercised by a powerful and permanent civil service, which remains relatively unaffected by political changes. The ministry of education consists of five directorates: general administration; elementary; secondary; technical; and higher education. The minister is assisted by a higher council of national education, consisting of 56 members appointed in part by the president of the republic and the minister of education and elected in part by the universities and representatives of elementary and secondary education. Although its primary function is advisory in nature, the higher council is really a sort of educational parliament, in that the minister is required to consult its members and secure their approval in nearly all major matters of educational policy and procedure. A corps of inspectors general. appointed by the ministry of education, reports on progress and needs in all areas. Although some determination of school practices is allowed local governments, especially in matters involving purely internal conduct. the responsibility for education is actually not delegated, as in such countries as the United States. Great Britain and Canada. Administration is a sort of "line and staff" arrangement ordered in such a way that directives may readily be executed by subordinate officers.

Other National Systems.—National systems of education prevail in Belgium, the Netherlands. Greece. Scandinavia and other countries where centralized controls are geographically practical and strategic; the middle east (Turkey, Iraq, Syria. Egypt. etc.); most Latin-American countries; and other political systems not federal in nature. In most national systems, however, local control over educational administration increased after World War II.

An example of a different type of centralized control is Uruguay. The highest administrative agency is the ministry of public education and social welfare. but the ministry concerns itself primarily with welfare services. Educational administration falls within the province of four national autonomous educational councils: the Xational Council for Primary and Teacher Education; the National Council for Secondary and Preparatory Education; the Higher University council; and the National Council for Industrial Education, which occupies itself with agricultural, vocational and industrial schools of all types. but it is divorced from the political and ideological overtones which characterize labour educational administration in such a country as Mexico. The coexistence of these four councils in one sense illustrates a form of decentralization; since the councils operate on a national basis, however, and since their functions interlock, the resulting organization might be conceived as a type of pluralistic centralized control.

Local Systems. — Included in local systems are state. provincial. county and community types of school administration. Local emphases in administration are to be found in countries where public schooling originated in grass roots or separatist movements, or where political unity was achieved out of a confederation of sovereign states. In some instances of federalization. as in Italy and to some extent Switzerland, a central ministry has been granted administrative as well as advisory power. As a rule, however, cultural and political units have jealously guarded their control over education. Characteristics of local control may be generalized thus: (1) weak central ministries or bureaus of education. which are largely advisory in character; (2) financial support for education locally derived. aid from central authorities being mostly in the form of supplementary or emergency funds accepted with a minimum amount of control; and (3) administrative power lodged in local boards of education, sometimes appointed. sometimes elected. In countries like Canada. west Germany and Australia. where the separate states are sovereign, state ministers of education are appointed and state systems of inspection prevail. In the United States the state executive officer of education becomes either a commissioner of education (if appointed) or a state superintendent of schools, each with less power than his counterpart abroad.

United States. — The United States is an outstanding example of local control on state, county and community levels. The decentralization of education characteristic of U.S. schooling is a source of bewilderment to foreign observers. who seek to understand not only the many different types of state-controlled education but yet another system in the District of Columbia, administered by the federal government.

The whole is complicated by the myriads of local county, township or community units of education, by types of schooling directly supported and controlled by the federal government, and by the great variation among the states as regards internal administration and relations with local organizations. Some states, like Delaware: tend toward centralization. Massachusetts is an example of decentralization. Even in the support of education. the amount of funds provided can vary from the practice in such a state as Nebraska; where in 1955, for example, about 90% of expenditures were underwritten by local authorities, to states like New Mexico where, in the same year, state rather than local revenues paid for most public schooling. In addition to the various state public-school systems, there exist, outside these systems, parochial schools which are administered by church groups and a large variety of privately supported schools.

Although no mention is made of education in the United States constitution, the federal government has been mindful of the need to support formal schooling. exemplified in the Land ordinances of 1785 and 1787, by which part of the national domain was set aside for school purposes. and in the numerous federal statutes which have supported types of education (technical, military, agricultural, etc.) necessary to national welfare. The earliest federal statutes, enacted in accordance with traditional educational practices, gave control of lands and resources to local townships: but by 1804, with the Ohio Territory act, the states had accepted custodianship and assumed control of school endowments.

Education in the United States mas originally conceived as a private or local affair. If not undertaken by the family or the church, schooling became the concern of charity groups. Hence, education was considered a matter of public welfare. But the federal government did not relinquish its responsibility; acting by authority of the "general welfare clause" of the constitution (sec. 8. art. i), it required of all states joining the union that satisfactory provision for public education be stipulated in the state's constitution. By a series of supreme court decisions the federal government settled local educational disputes and in part guided the course of education in its national implications. The federal government has also supervised the educational welfare of territories. trusts and dependencies. and assumed the responsibility for educational agencies supplying the federal government with the kind of personnel and services it requires. Included in this category are the various academies and institutes which train officers and specialists for such areas as national defense, diplomacy. internal security and technology. The federal government has also supported educational relief programs, such as the National Youth administration and the Civilian Conservation corps in the 1930s.

The United States office of education was established by congress in 136;. In 1939 it was transferred from the department of the interior to the Federal Security agency. It became a branch of the department of health. education and welfare when that department was established in 1953. It is not an administrative agency in essence. although it has assumed control over certain projects supported by the federal government. such as certain programs of vocational education, exchange of students and teachers with other countries, certain aspects of land-grant college administration and the general promotion of educational thought and practice throughout the country. Specifically, its functions involve the collection, interpretation, publication and dissemination of factual information on education, not only in the U.S. but abroad. Its specialists may be drawn upon for counsel by any educational group in the country. Similar agencies exist in India, Canada. Australia, west Germany and other nations where federated governments and local controls determine educational administration.

Responsibility for education in the United States rests with the individual states. The states delegate this responsibility to the local communities, not simply as a devolution of power. as in France and other centralized systems, but as a matter of self-determination under fairly liberal state school codes. It is commonly claimed that the three levels of educational organization and administration in the U.S.—federal, state and local—are in matter of fact actually interdependent rather than hierarchic. Hence, a system of checks and balances is said to prevail in educational as well as other governmental matters. In practice. however, administration rests heavily on the shoulders of local communities and operates in accordance with local decisions, assuming such decisions accord with federal and state statutes.

On the state level. educational administration generally is headed by a state board of education, sometimes appointed by the governor or the state legislature, sometimes elected. As a rule, state boards of education are less powerful than state ministries of education in other countries, largely because local communities in the United States assume much more administrative responsibility.

However, the board of education of the state of New York, for example, exercises powerful control over educational standards through a system of state-wide examinations. The extensive ramifications of its operations are seen in the fact that its staff consists of over 500 full-time professionals. State boards range in size from 3 to 19 members. They are largely composed of laymen but in some instances professional educators may become members.

Again, the duties of these state boards vary from state to state, but in general they all concern themselves with the distribution of state or federal funds (allotted to the states), the enforcement of educational statutes, the determination of basic courses of study, the adoption or recommendation of textbooks. the certification of teachers, the approval of building and maintenance standards, the provision of library services and the operation of teachers' colleges. State boards likewise interest themselves in the improvement of education as a function of government. the equalization of educational opportunity, the provision of educational leadership and the improvement of local operations. The functions of state departments of education were defined by the White House Conference on Education, Nov. 1955, in which general agreement was reached on the following recommended types of services to be provided local districts: (1) establishment of minimum standards for an adequate educational program; (2) advisory or consultative services in such areas as population trends, transportation, school construction, financial planning. curriculum development and special services; (3) research and statistical studies of a nature to assist in long-term planning; (4) certification of teachers and professional staffs; (5) provision of "dynamic" leadership. Included in a minority report were the following recommended types of services: (1) provision of scholarships for qualified students in financial need; (2) establishment of a sound, equitable tax base among administrative units; (3) assumption of desirable services above or beyond the capabilities of local districts to provide,

Inspection of local schools and school systems by inspectors responsible to state boards or other authorities is found in many states but is not so highly developed as in most other countries. School and classroom supervision is provided by local systems through specialists who do not function as inspectors but rather "helping teachers." In one state they are officially so designated.

The genius. but also the weakness, of the U.S. educational system lies in its more than 60.000 school districts, each exercising an amount of freedom unequaled in any other country. Administrative authority is assumed by a local board of education, which in about 90% of cases is elected by the people. Boards of education are usually independent of other agencies of local government; in fact, school funds voted by boards of education are for the most part not subject to rejection by other bodies. In cases of dispute over budgets between boards of education and boards of finance, the courts have ruled almost exclusively in favour of the former. In most communities, school taxes have first priority; usually they are independent of other sources of revenue.

The duties of a local board of education are limited to community needs. The local board selects the superintendent of schools, who in turn recommends personnel for appointment by the board. In nearly all cases. boards of education have the power directly to appoint nonteaching employees. The local school board also determines the educational policy for the district, acting usually on professional advice, secured by way of the superintendent of schools and in accordance with the wishes of the community at large. The board assists the superintendent in the preparation of the budget. approval of which obligates the local board to see that tax funds are provided.

India.—India may be used as an example of local control strongly exercised by the various provinces under provincial or state ministries of education. Unlike the United States constitution, the Indian counterpart of 1947 states that the federal government will endeavour to provide free, compulsory education for all children till they reach the age of 14. Partly because the central government did not have sufficient funds to implement this ideal and partly because of the natural diversity of India's population, considerable responsibility for education has been delegated to the states. The functions of the Indian ministry of education approximate those of the United States office, but whereas the United States commissioner of education is appointed by the president, the Indian minister of education is elected by parliament and is directly responsible to that body. The state ministry of education has five divisions: (1) administration and cultural relations; (2) bureau of development; (3) general education; (4) technical education; and (5) scholarships. Delegation of authority by the states to the local communities is restricted to elementary education, as is the case in most countries. while secondary education is subject to state control. State ministers of education. like their federal counterparts, are both elected and appointed and are responsible to state legislative bodies. Indian state governments are responsible for educational policy, the local units being conceived largely as administrative and taxation units. Control over education is exercised through an inspection system.

Advising the Indian state minister of education is the director of public education, who is a permanent executive head of the ministry. He controls the inspectorial staff, the teachers and the government-recognized private schools, and is responsible for executing the policies of the ministry of education, principal among which is the inculcation of basic education through productive activity and local crafts to all children between the ages of 6 and 14.

There are great inequalities of educational opportunity in India, where population distribution, linguistic diversity and the caste system aggravate an already difficult educational situation. The Indian central government has confessed its inability to assist adequately in fostering school development, not for want of desire but from sheer financial inability. It has confined its efforts to supporting higher education and technical education, research in the interest of national welfare, experiments in educational methods, the production of suitable literature. the training of specialized personnel and the translation of important works into Indian languages. The administrative problem in India is therefore not one of where control ideally may be located but of securing the kind of educational organization and administration which will best serve a country which is as yet economically undeveloped, and where the many religions and sects insist upon tying public education to their own particular beliefs.

West Germany.—West Germany (the German Federal Republic) is another example of decentralization of administration. Art. 7 of the Basic law of the German Federal Republic (1949) places schools under the supervision of the respective states (Lander). The various states exercise fairly complete control over all schools and commit themselves to a program of close supervision in major activities. Local boards of education function everywhere. but with less power than in the United States. Again, as in similar systems, the highest administrative agency is the state ministry of education, headed by a minister of education (*Kultus*-minister), who is a political appointee. The state minister of education might be compared with the state superintendent of schools in the United States, but he also absorbs some of the duties reserved for the U.S. local superintendent of schools, exemplified by his right of control and jurisdiction over internal school practices. Co-ordination among the state school systems is achieved in part by the Conference of Educational Ministers which meets several times a year in Bonn. In 1953 a federal educational council was established to advise the Conference of hlinisters. The west German local school superintendent is appointed by the state minister of education on recommendation of the *Kultusminister*. Local school boards are not elected but are chosen by local legislatures; they are responsible only for those phases of school administration not assumed by the state. External university administration, including certain financial, academic, examination and other aspects, is exercised by the division of higher education of the state ministry of education, though the universities enjoy a large amount of autonomy.

Joint Local and National Systems.—Examples of national and local systems working co-operatively, or in partnership, are to be found in England and. to some extent, Japan.

Great Britain.—Educational administration in England was fixed by the Education act of 1944, which lodged final authority in the central ministry of education but which placed immediate administrative responsibility upon local educational authorities (L.E.A.s). (See EDUCATION, HISTORY OF: *Great* Britain *and the* Commonwealth *of Nations:* The 1944 *Act.)* The Education act sets the structure of administration and control but allows local authorities to interpret policies in accordance with local need, preference. and internal school conditions. Central authority is vested in three bodies: the ministry, the central advisory councils and the civil service: representing the political. the advisory and the professional elements of education respectively. The minister of education. appointed by the prime minister, is responsible for broad educational policy and practice within the framework of existing legislation as approved by parliament. The two Central Advisory councils (for England and Wales) advise the minister on internal matters of administration. The civil service is responsible for the communication and interpretation of broad policy at the local level. The permanent education secretary guarantees continuity of policy and operations. The "eyes and ears" of the ministry are her majesty's inspectors, better known as H.M.I.s, who are members of the civil service. The H.M.I.s have four major duties: (1) to ensure that government appropriations are being spent wisely; (2) to see that educational legislation is being complied with; (3) to act as missionaries disseminating enlightened educational thought; and (4) to keep the ministry informed on what transpires at the grass roots of education.

The L.E.A.s are not elected directly by popular vote but are appointed by county and borough councils. which are in turn elected directly by the people. Actual supervision is, however, delegated to education committees, which are appointed by the L.E.A.s out of their own membership plus a minority of non-L.E.A. members who are interested in education. One of the committee's functions, like that of a local board in the United States, is to appoint a chief education officer, usually called a director of education. The director of education enjoys less power and independence of action than the U.S. superintendent of schools, his chief function being to present proposals to his committee for decision and action, to record decisions and to carry them out. On the other hand, the headmaster of an English school, especially on the secondary level, is a more powerful and influential person than his U.S. colleague; he is given wide latitude in the formulation and execution of internal policy. As the power of the headmaster increases. it is natural that the power of the director of education decreases. Nevertheless, with the aid of a corps of local inspectors and advisers, the director of education commands a post of considerable weight, which takes on added importance in view of the director's responsibility to the national ministry of education, as well as to his local education committee.

In general. it may be said that in contrast with other leading nations, England presents an educational system which not only operates co-operatively on both local and national levels but unites with private endeavour and voluntary organizations to spread the responsibility for control throughout the entire political and social structure of the nation.

Japan.—After World War II, in Japan educational administration tended to follow directives issued by the United States as the occupying power. Organization is on three levels: national; prefectural or county: and local community. The central ministry of education, though stripped of much of its power, is still, as in England. the chief administrative authority. The ministry has a secretariat and five divisions: elementary and secondary education: higher education and science; social education; research; and administration. Advice on general policy is afforded by 18 councils on education, including a central council for education. The national ministry of education is entitled to draft laws in the interest of national educational standards but its power to instruct local boards is limited by parliament. Since the ministry allots much financial aid to local systems. especially for school buildings, considerable indirect control is added to that which may be exercised directly. In consideration also of the weakness of local boards, due in part to educational tradition in Japan and in part to insufficient funds for vigorous programs at the local level, the ideal of a weak central ministry of education advocated by the United States educational mission failed to materialize. Concrete evidence is seen in such developments as the assumption by the central ministry of responsibility for the nine years of compulsory schooling and the security of teachers' salaries and emoluments. Also, the recommended transfer of university control to local authorities has failed, so that since 1954 universities have fallen within the province of the national educational administration.

Unlike England, the roots of local self-determination, especially in educational matters, are not deep in Japan, so that local controls are in a stage of growth rather difficult to delineate. Local boards of education are responsible. legally, for the establishment and maintenance of elementary and lower secondary schools; while the county (prefectural) board of education administers upper secondary and special schools, the certification of teachers, certain aspects of private schools and the choice of textbooks. Originally. too, these boards were supposed to be elected, but because educated and desirable Japanese people did not wish to run for the office (or could not afford campaign expenses), and because the Japanese themselves did not feel a strong affinity for the elective process, board members became appointive. Another difficulty with implementing the ideal of local controls in Japan has been the traditional method of collecting taxes. It has not been possible to establish a system of special school taxes, so that local boards must depend upon general local revenues, supplemented by allotments from the central ministry. Although the trend is back to a centralized administration in Japan, local authorities still exercise far more control than before the war, so that a modified type of partnership in educational administration may therefore be said to prevail in Japan, in principle if not always in practice.

Sectarian Systems.—Religious and denominational influences control school administration in Spain, Ireland, certain provinces in Canada and certain Latin-American countries. The Spanish state guarantees the teaching of the Catholic religion as a regular and compulsory subject in all educational institutions, whether state controlled or not, and no matter what their level and purpose. Publications of any type may be banned or suppressed if contrary to Catholic dogma and morals. Also, in tests for the selection of teachers, for example. examining boards are composed of five members, three of whom, including the chairman, must be church officers. In Ireland local boards of education, hence local school systems, are controlled by the prevailing local religious denomination.

Canada.—For the most part, educational administration in Canada is similar to that of the Cnited States. The national government delegates the responsibility to the provinces and local communities. In the provinces of Quebec and Newfoundland, administration is sectarian in nature, but the schools are otherwise "public." Education is free and compulsory but children must attend the school of their denomination, unless an "outsiders fee" is paid. Control of schooling in Quebec dates from 1826, when the province was divided into two distinct groups: the Protestant English and the Catholic French, each group demanding the right to educate its members. There is no minister of education in Quebec, as in other provinces. Instead, the titular head of the department of education is the superintendent of education, appointed by the government, who is chairman of a council of education which is divided into two committees, Catholic and Protestant, each having a secretary. School districts may be organized by minorities in any community, if there are a sufficient number of pupils to justify the procedure and a sufficient number of taxpayers capable of assuming the responsibility. This principle of "dissent" is guaranteed by law. Individual taxpayers may also designate the school system to which their taxes must be paid. The French-speaking school districts in Quebec are generally coterminous with the Catholic parishes; otherwise, it is obvious that political districts and school districts are not necessarily identical.

In Newfoundland, where early settlement took place along denominational lines, nearly every local community has a majority of one or another of the various denominations. This situation has produced a sectarian system of education, whereby the churches of the various groups have built and in large part control their own schools. Directors of education are nevertheless responsible to the provincial ministry of education. Increasingly the schools of Newfoundland are becoming consolidated, however, especially at the secondary level, reflecting a national trend.

Certain general observations may be made about the rest of Canada. There is neither a central ministry of education, as in England, nor an office of education, as in the United States. Instead, the dominion bureau of statistics publishes an *Annual* Survey of Education in Canada; the Canadian Education association collects and pubiishes research studies and disseminates information on procedures and practices in the various provinces; and a national research council assists materially in advanced research and investigation at the university level. The dominion government is not without authority, however, in educational matters. For one thing, it is empowered to overrule any act of a provincial government. It protects the educational rights of minorities; it has provided crown lands for the support of education; it is responsible for the operation of schools within the territories, it grants a limited amount of aid for vocational and higher education; it supports research and other types of educational investigation; it provides special grants to increase staff salaries in universities; it supports school broadcasts. (Pressures upon the dominion government to support education at the federal level are similar to those in the United States.)

The provincial departments of education exercise control over such matters as courses of study. teacher education, examinations, textbooks, school buildings and legislative grants. The provincial minister of education is a member of the provincial legislature and hence of the political party in power, and he is responsible to the legislature in matters involving broad educational policy. The deputy minister of education (called the superintendent of education in Quebec and by other titles in other provinces) is the chief permanent officer of the provincial department of education.

The most persistent administration problem in Canada is how to find the means of providing larger and more efficient units of organization and administration, at the same time preserving local control of schooling in a sparsely settled, widely diversified, heterogeneous nation.

Political Party Control. — The Soviet Union and its satellites, Communist China and, to a limited extent, Spain, are examples of educational administration as controlled by a single political party.

U.S.S.R.—Art. 121, revised, of .the U.S.S.R. constitution reads as follows:

All citizens of the U.S.S.R. have the right to education. This right is insured by universal compulsory seven-year schooling, by extensive developments of secondary education, by the fact that all forms of education, both secondary and higher, are free of charge, by a system of state stipends for students who have distinguished themselves in higher schools, by education in the schools in the students' native language, and by organization at plants, state farms, machine tractor stations, and collective farms of free, technical, industrial, and cultural training for the working people.

The Soviet Union resembles India and China in its multiplicity of cultural, national and linguistic groups. There are nearly 200 such groups incorporated into the union; more than 100 different languages are spoken. Under such circumstances, the U.S.S.R. could not help but organize as a federal state; indeed, one secret of Soviet success may be traced to the willingness of the central government to cater in part to national and cultural differences, including instruction in vernacular languages at primary and secondary levels, with Russian the compulsory second language. After World War II the union consisted of 16 union republics, 16 autonomous republics, 9 autonomous regions and 10 national areas, listed in order of size of population and area. The Russian Soviet Federated Socialist Republic, with Moscow as its capital, is by far the largest union republic; within its boundaries are no less than 100 cultural and linguistic groups.

In the Soviet Cnion, as in other federated political systems, education is the responsibility of the individual republic. The U.S.S.R. goes one step further in providing no central ministry of education, relying instead upon ministries of education of the various republics to unify their activities in accordance with educational directives emanating from Communist party headquarters and the central government in Moscow. There is, however, a central ministry of higher educational institutions, which is part of the ministry of culture; and this agency controls all universities, most of the secondary schools (technicumr) and most of the teachers' institutes. Another sample digression occurs in the fact that the national ministry of labour reserves is in charge of the factory schools and certain vocational institutes, even though it does not contribute materially to their support. Budgets are drawn up by local agencies and the ministries of education of the republics for approval by central authorities, who, in turn, advance direct grants for specified areas and make up deficits. Despite the apparent decentralization of administration. uniformity is guaranteed, as no decision of any consequence, certainly none contravening party directives, is made at levels lower than the republican ministry of education. Policies may originate locally, but they have to be submitted to the republican ministry for approval, or, if of sufficient importance, to the council of ministries for general agreement. The philosophy underlying all agreements and hence all policy and practice is that of the Communist party and party principles are the same for the entire nation. Under the sixth five-year plan (1956–60), for example, the goal in all republics was ten years of compulsory education for ages from 7 to 1;.

Control by the Communist party is guaranteed by the central government, which administers the entire economy and the fiscal policies of the nation. In a planned economy, education becomes simply another agency of government and national life, so that all school practices must be co-ordinated with activities planned for other phases of the country's existence. Freedom is allowed only when no directives exist to the contrary. Though directives are many and detailed, the individual republics have been able to exercise a number of prerogatives which give the air of self-determination. In Georgia, for example, the compulsory study of Russian (in addition to the Georgian vernacular) was found to interfere so greatly with the time allotted to other subjects that primary schooling was extended one more year.

Because they are tied to other segments of the government, the republican ministries of education are far more complex in organization than counterparts in other nations. For one thing, the minister of education is also a member of the union republic council of ministers. so that, contrary to practice in other nations, he belongs not only to his republic but also to the central government. He therefore has a multiplicity of divided duties to perform. The following departments exist in a Soviet republican ministry of education: organization and administration (including teacher training, buildings, finance. elementary and secondary educational methods, etc.) ; vocational education; adult education; social and polytechnic education; literature and publications; science and art institutes; research agencies; and certain commercial trusts. such as the state publishing house, the state motion-picture enterprises and the state supply board. An inspectorial system, under control of the ministry, interests itself in the improvement of teaching and classroom management. Although inspectors must see that party policies are carried out, in practice, they interest themselves primarily in modern pedagogical methods and in supervision; they also teach demonstration classes. Inspectors co-operate closely with school principals; they do not "rate" teachers, except to recommend awards or special honours for particular tasks well done.

Local school boards are appointed by local executive committees of the local council (soviet) concerned. The local director of education is likewise appointed. by the executive committee of the council. School principals are, however, named by local school boards and principals in turn select the teachers, subject to approval of the school board. The school principal is also in charge of school purchases; but he must buy all supplies from government houses. The internal duties of local school boards resemble those of most countries but they must look to higher authorities for the determination of over-all policy and practice and have no authority to levy taxes. Each school is guided by a council consisting of parents, teachers, Communist party members and others connected with school life, including clerks and janitors. These councils occupy themselves vigorously with the ongoing activities of the school, uniting with parent-teachers associations in physical (as well as ideational) projects, such as cleaning and redecorating classrooms and providing benefits and perquisites not forthcoming from governmental sources.

The Communist party not only establishes policy but also determines who may be elected to office. Education therefore has the task of preparing future leaders, for whom special party schools are established. In all schools the party exerts its influence in the organization of pupils in various types of political youth leagues. from Pioneer groups for ages 9 to 14 to the Komsomol, or Young Communist league for youth over 14. Members of these youth groups are specially chosen for their loyalty to party principles and their actual or potential capacity for leadership. In sum, administrative policies in the Soviet Union may originate in local areas but to become effective they must be approved at the top. Approved policy then sifts down through the various levels and its enactment is overseen by party members or affiliates, who penetrate every phase of public and educational life.

Communist China.—Similar practices prevail in China. In fact, following World War II Chinese schools were reorganized under the aegis of Russian counselors and modeled after the educational ideals of the Soviet Union. Art. 41 through 47 of ch. v of the Common Program contain the core of Chinese educational policy. Education, according to this program, shall be "national, scientific, and cultural." It shall promote the five "loves": fatherland, people, labour, science and public property. Education and politics become inseparable, so that educational leaders are either members of the Communist party or pledged to support its principles. The entire nation is organized under such centralized ministries as finance, trade, labour, heavy industry, fuel industry, textiles, foods, light industries. railways, communications, agriculture, conservation, forestry and land reclamation. The listing of these ministries is not merely a verbal duty; it reveals the nature of Communist China; and the school system is charged with providing trained personnel for all these ministries.

Contrary to the Soviet Union, China has a central ministry of education, which concerns itself not only with elementary and secondary education but also with the establishment and administration of institutes of higher learning. Hence. it might be said that China is an example of an educational system which is controlled not only by a political party but also by highly centralized administrative agencies. School administration is said to be democratized by the organization of educational councils, in which teachers, students and workmen enjoy equal voting status. The democratic way is also said to be practised in all kinds of meetings and discussion groups, findings of which are transferred for action to higher authorities, on the basis of "discussion by the many but decisions by the few." Heading these educational discussions, or influential in their operation, are members of the party. When one compares two such highly nationalized systems as China and France, political preference is readily discerned as perhaps the chief agent for ordering educational ends, even though the means of administration are similar.

Trends. — While trends in educational administration differ among nations, certain generalizations may be made:

(1) Nationalized or centralized systems (France, Mexico, India, etc.) are advocating the assumption of greater responsibility at the local level; conversely, local school systems (the United States, Canada, Great Britain, etc.) are looking toward centralized authorities for assistance in the support of schools. Thus, a greater co-operation among all governmental groups is becoming evident, influenced by two forces: more liberal sociopolitical democratic practices and the need to derive the cost of schooling from more and wider sources of revenue. (2) School-leaving ages are being raised, so that few countries remain in which children are allowed to leave school before the age of 14; only financial and material limitations prevent the fullest application of laws on compulsory education. (3) Administration is rapidly being democratized, largely in co-ordination with greater democratic practices in other phases of a culture, as evidenced in the breakdown of hierarchic controls, in less rigid forms of student selectivity, in the establishment of single-ladder (open to all regardless of class) school systems, in the insistence upon basic education for all children up to school-leaving age and in provisos for secondary education for more and more young people. (4) State interest in the education of all citizens is resulting in greater provisions for scholarship help to those in economic need, so that meritorious students will be afforded the necessary impetus to continue their education at state expense. (5) The single-ladder system of school organization is slowly gaining favour, though in countries like France and Germany. where entrance to secondary school has traditionally been highly selective, the *école unique* and the *Einheitsschule* are meeting considerable opposition, partly in reaction to general reforms of a socializing nature and partly because of the power of the universities over secondary school policy. Otherwise, secondary education for all, wherever physically possible, is becoming fundamental to educational progress. (6) Although more and more money is being spent on education year by year, and although more and more students are attending the world's schools, the proportion of most government budgets allotted to education is either static or actually decreasing. Teachers' salaries have not increased commensurately with the rising cost of living and with salaries paid in other professions or vocations. Problems of administration are everywhere aggravated by the lack of funds and of suitably trained, talented personnel. *See* ELEMENTARY EDUCATION; SECONDARY EDUCATION. *See* also Index references under "School and Curriculum" in vol. 24.

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(G. F. KR.)

SCHOOL AND CURRICULUM. Prior to the opening of the 20th century, traditional curricula were accepted in the United States without serious question. During the colonial period they were dominated by British practices and traditions. Textbooks used in the United States were printed in England, and British courses of study were only slightly modified for use in American schools. Even when America began to print its own textbooks following the American Revolution. their content was not materially changed until the 20th century.

In the first two decades of the 20th century. the term curriculum was used interchangeably with course of study. It later became generally agreed, however, that the curriculum consists of all the experiences of the pupils under the guidance of the school. The teachers' guide or course of study is an aid to be used voluntarily by teachers, not a prescribed syllabus to be followed rigidly.

Logically organized subject matter formulated by scholarly specialists resulted in the subdivision of knowledge into smaller units. This accounted for the expansion of elementary subjects after

1890 in the following sequence:

1890: Drawing, civics, history, language and grammar, reading, spelling, writing, arithmetic, nature study, geography, music and physical exercises.

1900: Hygiene, literature, sewing and manual training.

1925: Instrumental music, health and safety.

1950: Social studies, art, crafts and science.

The typical U.S. child learns to read, write and figure in the first six grades. In most schools developmental reading is supplemented by reading for pleasure in books borrowed from a classroom or a school library. Spelling is learned separately from books in which the words appear in context as well as in an isolated list. The children begin manuscript (print) writing in the first grade and change to cursive writing toward the end of the second grade. The addition, subtraction, multiplication and division of integers are learned in the first four grades in the order of difficulty. Fractions are learned in grade five and decimals in grade six. The applications of numbers to real situations have been increasingly used in the classroom and in the textbooks.

At mid-20th century there was still considerable variation from school to school in the content of the social studies. The first three grades were usually devoted to the study of home and community life. The pupils studied state and local history and geography most commonly in grade four; U.S. history and geography in grade five; and European backgrounds and world geography in grade six. Elementary science, usually taught in the middle grades, was undergoing a transition from nature study to the broader phases of science. The topics of study were being drawn from the physical and biological environment to include the heavenly bodies, the earth. living things, simple phenomena and man's use of the soil, power and minerals. Health and physical education were being taught incidentally in the first three grades and somewhat more directly in the upper three elementary grades. Art, studied both separately and as an outgrowth of other studies, had broadened to include the crafts.

The number of subjects in the high school curriculum also multiplied rapidly after 1890. At the turn of the 20th century, the high schools reported 18 subjects to the United States office of education. At mid-century, 70 common subjects were listed on the official blank of the same agency. The appearance of new subjects is most conveniently shown in the follo ing sequence:

1890: Latin, Greek, French, German, algebra, geometry, physics, chemistry and history (U.S., ancient, mediaeval, modern).

1898: Trigonometry, astronomy, physical geography, geology, physiology, rhetoric, English literature and civics.

1922: Spanish, zoology, botany, agriculture, home economics, general biology, industrial training, drawing, vocal music, bookkeeping, typewriting, shorthand, office practice, social studies, shop subjects, hygiene, general science, economics and physical education.

1934: World history, problems of democracy, United States government, military drill, art appreciation, band and orchestra.

1950: Music appreciation, general shop, sheet and art metal, printing, machine shop, electrical work, auto mechanics, aeronautics, general mathematics, general business education, consumer economics, retailing and home management.

In 1934 the typical high school youth completed a course of fairly conventional subjects. In the seventh and eighth grades a pupil studied English and social sciences; he took one year of mathematics and perhaps a second year; he studied science and music for one year and may have taken drawing for one year. A girl took at least one year of home economics and a boy one year of shopwork. As the youth progressed through the four remaining years of the secondary school he studied three years of English, three years of social science, two years of science, two years of commercial work, two years of mathematics, two years of physical education and one year of music. The girl took one year of home economics and she also may have taken a year of industrial training; the boy was likely to have taken a year of shop or industrial work.

During the years following World War II the pattern of education underwent a few changes. The pupil in the seventh and eighth grades added one year of general science and two years of physical education. In grades 9-12 the youth had one more year of English and three more years of physical education. He was required to take one year of United States history in grades 7 and 8 and another year in grades 9–12. He probably elected one year of art or music. In addition to these courses the student chose two years of commercial education, two years of industrial education or two years of homemaking, depending upon his field of specialization.

Influences on U.S. Curriculum Development. — In teaching the school subjects the textbook remains the most dominant influence in the life of the classroom. The course of study is frequently built before selecting a textbook, but as it actually works out in the classroom, the textbook and not the course of study determines what is learned by the children.

One must not conclude that all schools require their pupils to follow a program of isolated subjects. Over a period of years, there is evidence of considerable effort to reduce the number of unrelated studies and to unify learning. When the junior high school movement began in 1910 it gave impetus to a wave of fused or broad courses such as general mathematics, social studies, general science and general language.

In a nation-wide study of representative schools in 1944, about 25% of the elementary schools reported social studies for grades three to eight, an indication of the trend toward fusion of related subjects. About half of the schools had combined two or more subjects into broader areas, the language arts and social studies being the most frequently combined fields. Arithmetic, art, language, geography, handnriting, health, music, reading, science and spelling stood out predominantly as separate subjects in all grades.

Another step in overcoming the limitations of organized knowledge was to functionalize it, that is, to make it useful in life. A large number of practical subjects such as social and economic mathematics. consumer science, everyday physics and living chemistry made, their appearance. The introduction of practical courses led to a more lifelike organization of content. For example, the conventional outline of physics is: matter, force, heat, sound, light, magnetism, electricity, etc. The organization of the same subject for the improvement of living would be based upon problems of living such as water, fuels, weather, transportation and home equipment.

The still potent influence of the college preparatory requirements was gradually breaking down at mid-20th century. Studies made in 1948 showed that the high school was exerting a groaing independence from the domination of the college. There was a sharp decline in the number of colleges requiring a specific number of units for college entrance. For example, 61% of the colleges in nine states required no units of foreign languages and 48% required no units of mathematics. Conversely, the high school requirements were more rigid than the college entrance requirements. For example, 45% of the high schools in the nine states studied required three or four units in mathematics and science although no college imposed this requirement in science and only 2% had prescriptions in mathematics.

Interested groups outside of the schools were exerting pressure on the curriculum through direct influence on the teacher and by school legislation. Nearly every subject in the curriculum had been regulated in some way by state legislation. A study of legislative control in the northwest made in 1948 showed that the number of curricular prescriptions increased from 233 in 1900 to 5j2 in 1947. These prescriptions pertained most frequently to health and safety, state and national history and vocational education. Many of the materials advocated by pressure groups had been of fundamental educational value. A number of educational foundations had made generous grants for the advancement of wise use of resources, better intergroup relations and the improvement of health

Curriculum-Making Movement. — For convenience, the curriculum-making movement may be said to have begun with the first of the reports on minimal essentials made by the National Society for the Study of Education in 1915. In 1920, spurred by the leadership of this organization, the department of superintendence of the National Education association appointed a curriculum commission which produced a series of five successive yearbooks. These brought the need for curriculum revision forcibly to the attention of more than 5,000 superintendents of schools in the U.S. and led to the most phenomenal output of courses of study in the history of public education to that date. While the improvement of the curriculum was most extensively organized in the local schools. nearly all the states also conducted elaborate long-range programs of curriculum development.

The first ten years of the curriculum-making movement were marked by the appearance of several important germinal books, the most significant of which was Franklin Bobbitt's *The* Curriculum. The principal contribution of the universities at that time was to encourage investigators to study what should be learned. Several thousand curriculum studies were produced as a result and helped to transform the content of the common school subjects.

The principle of selection with which the schools of the United States were experimenting was that of usefulness. But to U.S. thought the concept of usefulness was given a meaning sufficiently broad to include aesthetic, social, moral and intellectual, rather than merely vocational and financial uses. Utility was not always of major importance in curriculum construction. For centuries educators assumed that the organized fields of knowledge—grammar, history, botany, mathematics and the like—were appropriate for instructional purposes. The practical value of these courses of study was based upon the doctrine of transfer of training, expounded by John Locke in the 17th century. In 1901 and 1902, Edward Thorndike's studies on the transfer of training appeared, causing educators to question the adequacy of the text materials to train students in abilities useful outside school.

The exploration of the concept of usefulness had taken several directions in the United States. One approach was through activity analysis; another was by way of the long-familiar organized fields of knowledge. The investigators interested in discovering the activities, needs, problems or interests of the persons to be educated were divided into two groups, one interested in exploring children's activities and the other adult activities. The former group, which asserted that the school is life, not preparation for life, to use John Dewey's phrase, more or less consciously analyzed child activities and interests to discover the most important of these; and upon them they based the curriculum. Numerous studies of children's spelling vocabularies, their errors in language, their use of mathematics, etc., were made. A second group, which assumed that the school is an agency established by the state to teach the young the patterns of behaviour which a good citizen should follow, analyzed the activities, interests and problems of adults. and based the selection of their curriculum on the results of such analyses, with adaptation of the material to children's interests and activities. Careful studies were made by this group of adult vocabularies and errors, of the use of mathematics, geography, history and the like. The second group was interested also in the analysis of vocations as a basis for the selection of materials for vocational curricula. Analyses of the activities of pharmacists, secretaries! machinists and a wide variety of other occupations were made in constructing a curriculum for each.

As the concept of usefulness was developed further, theories of learning introduced from psychology were utilized. With the acceptance of the theory that purposeful learning in solving problems felt to be valuable by pupils is superior to the learning of systematized information, the usefulness of which is not appreciated, the project had been evolved. The project curriculum is one in which significant problems, as nearly like life situations as may be, were selected as units of instruction, and such subject matter as was needed was drawn from the organized fields of knowledge in a form appropriate to the completion of the project.

Interest in the project as a learning unit gave rise to a number of experimental centres commonly referred to as activity schools. These contributed largely to a better understanding of children and to a somewhat more general introduction of purposeful learning in an informal atmosphere. The teachers were given more freedom to adjust their work to the interests and needs of the learners. Creative expression in art, music, literature, drama and the dance were encouraged. Pupils worked together in small groups toward the achievement of the goal which the class had chosen and accepted as its own. As centres of experimentation increased in number, many schools were induced to pioneer in breaking down the barriers between subjects.

Interest in curriculum research continued for the next two decades. New techniques of research developed and extensively applied in the 1920s were concerned with the discovery of the objectives of subjects and areas of living. The study of social and civic deficiencies was accelerated during the depression years of 1929–33. This gave rise to a wave of elaborate studies on the social basis of the curriculum. Extensive experimentation was carried on with various plans of reorganization of the curriculum in which broad areas of social experience replaced the conventional subjects.

The years immediately preceding entry of the United States into World War II were notable for experimentation with activity and core curricula. The war dealt a harsh blow to these frontier programs and led to a decline in significant curricular research. During the war period the investigation~in secondary education were centred on the study of the needs and interests of youth. The critical problems revealed by the war led to increased research in curriculum planning and to a renewal of interest in curriculum change.

Basic Reorganization of Curriculum.— Dissatisfaction with a classroom procedure in which subjects were taught with little relation to each other and in short, disconnected periods of time led to a search for a more satisfactory organization of learning. It was natural to turn to life for learning experiences which possessed unity. This led to the formulation of the concept of the unit of work.

A unit of work is a large ongoing experience having a purpose which the pupils have accepted as their own. It is a purposeful learning enterprise in which the pupils work together to solve a problem of individual or community living. The pupils have a part in deciding in what direction their learning shall move. They help to outline the inquiry and, therefore, step by step, they know where they are going. It is a continuing and developing enterprise which goes more deeply into the problem which the learners have set for themselves.

The basic skills of reading, writing and figuring were learned as needed in solving the learners' problem. Additional periods were provided daily for acquiring the tool subjects and for practice in attaining mastery of the skills in reading, writing, speaking and figuring.

The unit of learning was the smallest subdivision of the curriculum. The sequence of units over a period of years derived unity and coherence by continuous reference to broad areas of living and to the progressive stages of child growth. These furnished the framework of the curriculum.

Many schools and school systems departed from tradition and accepted areas of living instead of systems of knowledge as fundamental to the development of the new curriculum. They represented a unity of design and a continuity of purpose which gave clear direction to all the work of the school.

Generally speaking, the proposals for basic reorganization of the curriculum were built on one axis showing the areas of living, and on a second axis showing the progressive levels of child development. Together they formed the framework of the curriculum. The areas of living had been identified by many working groups and put into practice by a considerable number of schools and school systems. The specific areas of living varied from group to group but the following pattern is suggestive of the most common practice: protecting life and health, engaging in recreation, expressing aesthetic impulses, communicating and transporting goods and people, producing and consuming goods and services, making a home, governing and getting a living.

The levels of maturation furnished the sequence of learning activities year by year. These were more difficult to isolate, and therefore the available suggestions were fewer in number. The grade centres or themes were committee generalizations made to simplify and to facilitate the planning of the curriculum. The most common grade themes proposed were:

Grades 1–2: the immediate environment
Grades 3–4: the expanding environment

Grades 5–6: invention and discovery
Grades 7–8: adjustment to physical and biological environment
Grades 9–10: adjustment to social and economic institutions
Grades 11–12: building a democratic society.

Education for Good Living.— During the 20 years ending in mid-century, the expansion of interest in the improvement of the curriculum resulted from a number of long-term projects of several nation-wide commissions. The Commission on Relation of School and College of the Progressive Education association. established in 1930, made agreements with institutions of higher learning which freed 30 experimental schools from the rigid requirements for college entrance. The so-called eight-year study demonstrated that the traditional patterns of prescribed courses were not essential and that secondary schools could be given greater freedom in planning the curriculum. The work of the commission, ending in 1942, led the way to about a dozen other regional and state projects, all of which resulted in some adjustments of the curriculum to the needs of youth.

In 1936 the American Association of School Administrators took the initiative in organizing the Educational Policies commission which represented the full scope of public education in the United States. The commission proceeded to prepare several significant reports on the purposes, structure and content of education which had great influence on the plans and policies of the schools.

An intensive study of the social aspects of democratic living yielded four major objectives of education: the development of the learner; the improvement of home. family and community life; fulfilment of economic needs; and performance of civic and social duties. This led to formulation of a detailed program of education for living which was issued in a volume entitled *Education for All American Youth.* The commission recommended that the secondary school curriculum should be divided into four major divisions: (1) personal and individual interests; (2) vocational preparation; (3) common learnings in personal and social living, and (4) health and physical fitness.

In co-operation with the National Association of Secondary-School Principals. the Educational Policies commission gave wide circulation to what was called the ten imperative needs of youth. These goals indicated the direction which the scope of secondary education was taking. Briefly stated and roughly following the language of the commission, all youth need: to develop salable skills; to develop good health; to understand the significance of the family; to purchase and use goods and services intelligently; to understand the influence of science on human life; to enjoy literature, art, music and nature; to use leisure time well; to develop respect for other persons; and to grow in the ability to think rationally.

Core **Curriculum.**—The area of common learnings correspondcd to the core curriculum which was an outgrowth of the eight-year study of the Progressive Education association. Together they constituted a phase of widespread interest in general education which is that part of the curriculum designed to meet the common needs of good living in a democracy. In 19jo the United States office of education reported that 3.5% of the nation's approximately 24.000 public high schools had adopted a core curriculum in some form.

The transition to the core mas usually made by scheduling English and social studies in two successive periods. Thus a larger block of time was devoted daily to the study of the problems of living. Information from several subjects was drawn upon as needed. The students took a part in selecting the goal and in planning the learning activities: working in groups and coming together from time to time to share their findings.

The core was prescribed for all pupils but the special interests were most commonly organized as elective courses and voluntary activities. The block of time devoted to them increased from year to year as the pupil progressed from the 1st to the 12th grade. The special interests included college preparatory courses, vocational studies, creative and expressive arts and informal activities. The latter were usually voluntary, self-governing groups called, in common parlance, extracurricular activities.

In 1948 the Educational Policies commission turned its attention to the education of children on the assumption that elementary education was entering a period of significant change. Its report. *Education for All American Children,* recommended that all school faculties should engage in continuous curriculum improvement. This process was designed to keep pace with changing social demands and to introduce new learnings built upon familiar backgrounds. drawing upon experiences in the local community as starting points for broader understandings. This was a downward extension of the core curriculum to the elementary grades.

Impact of World War **II** on the U.S. **Curriculum.**—The trend for some time prior to World War II was to make the study of mathematics courses elective. At the same time social and economic arithmetic was introduced into the junior high school and a somewhat more advanced course of a similar nature was offered in the senior high school. The advent of World War II temporarily reversed this trend. Some schools rashly added required courses in algebra, geometry and trigonometry. At mid-century the pendulum began to swing back to the prewar policy of making pure mathematics elective and prescribing functional and useful mathematics.

The war brought new emphasis on science which continued in the postwar period. Pure science had always had sufficient emphasis as a college preparatory subject but the application of physics, chemistry and biology to problems of everyday living had been neglected. Physical science courses for noncollege preparatory students were spreading rapidly until they were temporarily displaced by the courses given prior to induction into the armed services. but later such courses began once more to increase in number. The mobilization of industry gave greater impetus to rapidly expanding opportunities for vocational education. Yocational schools were established in industrial centres and all new high schools added the shops and equipment for training in a variety of industrial occupations.

Greater attention was given to understanding the free institutions of democracy. Racial and religious tolerance was stressed in many schools. On the high school level, particularly, the school continued to function as a little community in which the self-governing activities offered the most effective apprenticeship in citizenship. In the postwar years the emphasis upon development of a global outlook was continued.

Curriculum Development in School Systems.— In the first quarter of the 20th century there was a strong tendency to assign the task of educational planning to the expert, particularly as it applied to the curriculum. Although this survived in practice in many places, professional leadership completely repudiated the old view in favour of broad participation of teachers in group planning.

Experience in co-operative programs of curriculum development had demonstrated that the greatest amount of individual growth comes from active participation in planning, experimenting with and evaluating teaching and administration. This discovery revolutionized the process of curriculum development. Indeed, it accounted for adoption of the term curriculum development instead of curriculum making which had been in vogue during the 1920s.

Co-operative effort continued to characterize long-term curriculum development in state and local school systems. The program usually begins with a period of study which leads to the acceptance of the need for a fundamental approach to instructional improvement. The teachers working as a group develop a common educational point of view; they study the needs of the children and the community; they formulate the broader goals of education. The teachers continue their study and experimentation with a balanced curriculum, a more fundamental framework and large ongoing learning units. A tentative course of study is prepared which stimulates widespread experimentation with improved learning activities. The curriculum is continually adjusted to the changing needs of good living. The production of the course of study is one of a series of steps in the ongoing process of curriculum development.

The emphasis upon curriculum development as a process is reflected in the contents of courses of study which show that policies are made by committee procedure. Varied and lifelike activities are suggested. The importance of formulating meaningful goals is recognized. Units of work are organized around social experiences or lifelike interest centres and integration of courses begins to emerge as a significant trend.

Following the interruption caused by World War II a number of U.S. states and cities resumed long-range programs for instructional improvement. In the southeast and northwest, regional groups were organized with special emphasis upon the development of the human and natural resources. Several significant reports produced during the war years portended a renewal of study of the total pattern of the curriculum.

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GREAT BRITAIN

A curriculum is a course of study laid down for students of a university or school or for schools of a certain type; *e.g.,* primary, secondary. In Great Britain education is compulsory between the ages of 5 and 15. The primary stage, for children up to 11 years of age, includes nursery schools for children between 2 and 5 years old. The secondary stage, while compulsory for pupils between 11 and 15, can be continued up to the age of 18 or 19.

The Primary Stage—It is usual to regard this stage as consisting of three parts—nursery, infants and junior, although because of the exigencies of accommodation or small numbers two or three parts are often combined in one school. The nursery school has a long history if the nurseries and kindergartens set up in the 19th century may be regarded as prototypes. They were established mainly as an antidote to bad housing conditions or to assist mothers going out to work; and nurseries were later widely used in wartime to meet the needs of women warworkers. The true nursery school, however, bears little relation to such expedients and owes its origin rather to pioneers like Rachel and Margaret Macmillan who, concerned about the falling birth rate and high infant mortality, sought to bring about a more enlightened conception of our responsibility to very young children. The purpose of the nursery school is not only to make good deficiencies in the home but especially to co-operate with the parent so as to ensure for the child the best possible early upbringing. The Education act of 1944 made it a duty of the local education authority to make provision for these younger children, where it is likely to be needed, by means of nursery schools or, where such schools are considered to be inexpedient, by means of nursery classes.

The aims of the nursery school are to provide the medical care which such young children need, to afford a training in good habits and right behaviour and to supply an environment in which children can learn the things appropriate to their age. It would be difficult to define the curriculum of a nursery school. The physical needs of the child demand a balanced diet, adequate rest and sleep, play within doors and in the open air, suitable clothing and careful training in healthy habits. An important part of the curriculum consists in helping children to adjust themselves to their environment and to behave socially; and a great deal depends upon the quality of the teacher, her influence with the parents and her guidance within the school. Although there is no curriculum in the ordinary sense, the child's day is carefully planned in stages to secure a balance of rest and of activities, the child himself being, of course, unaware of this: as the Scottish Advisory council's report observed: "The child is taught; the objects he handles, the things he sees, the projects he plans. the actions he performs, the companionship he shares, the atmosphere of affection and security by which he is surrounded—all these are his teachers." The infant school (ages 5–7) has forged for itself a certain tradition; and it has been claimed that as an institution it is peculiar to Britain. The first school in Great Britain founded specially for the teaching of infants was established at New Lanark by Robert Owen in 1816 and his aim was that the children should grow up happily in a healthy environment. By making school attendance compulsory at five, a lower age than that adopted in any other country, the legislation of the 1870s perpetuated a type of school already in existence: and as a nation therefore the British have had a long experience of infant teaching. Although the history of the infant school contains many bad patches, it is true to say of it that Robert Owen's keynotes of health and happiness predominate. But it is difficult to speak with precision about the curriculum at the infant stage, for as the consultative committee in their report on infant schools remarked: "It would be entirely inappropriate to translate it [the life of the school] into any rigid or logically ordered curriculum." It is characteristic of children at this age that their interests emerge during play, and that is why the "play-way" constitutes an important element in the teaching of infants. Opportunities are thereby provided for children to discover by their own experiences answers to the questions which arise in their minds as they play. For this reason many individual occupations are arranged for them and they are also encouraged to engage in co-operative "work" in small groups. Thus in any good infant school can be seen children doing things together most energetically and freely talking and puzzling about the business in hand. That is how they learn to think, and how the desire to read, write, measure and count grows. The curriculum usually embraces: (1) natural activities, including physical exercises, open-air life, rest and play; (2) expression training, comprising speech, dancing, singing, handwork and drawing; and (3) in the later age groups, formal instruction in the three R's. Opinions differ as to when formal instruction should begin but Sir Cyril Burt's view, that there should be little or no formal teaching before the age of six, came to be widely adopted.

The important junior stage (7–11) formerly fared badly. Too often it had formed part of an all-age school or, when the seniors had been removed as a result of reorganization (*i.e.,* the establishment of a separate senior school as recommended in the Hadow report), the juniors had been left to make the best of it in the old building. It suffered also from the intense competition for admission to grammar schools, serving as a preparatory establishment, although about 90% of its pupils never entered the grammar school. This had an adverse influence on its curriculum, and for this and other reasons it became difficult for the junior school to become an entity with a soul of its own. Because of the inevitable delay in giving effect to the Education act of 1944, these handicaps remained but the sense of frustration and despair was less evident when it was appreciated that as the act came into effective operation the junior school would acquire a new status. One function assigned to it was that of assessing the aptitude and ability of children, all of whom were expected to pass forward to an appropriate secondary education. If then the junior stage had been a Cinderella of the educational system, it now had a bright prospect before it. "The junior school," to quote the ministry of education, "is at the beginning of its history. Its tradition has yet to be made, and all those who care for young children have a part to play in the making. It is our task to create in our time a junior school not only with fair buildings, not only with small classes, but giving a happy and healthy growth to all children from seven to eleven." Thus the junior school was visualized as a little commonwealth of children mainly between the ages of 7 and 11, but some might continue to the end of the term in which they reach 12 while there would also be bright children going forward to the secondary stage from about 10½ years old onward.

To some extent: therefore, the curriculum and methods of the junior school had to be thought out afresh, taking full advantage of the experience gained by enterprising teachers of juniors. The Scottish Advisory Council for Education urged strongly that "curriculum and methods should follow the child's natural line of development." and that "we should not destroy or needlessly impair those primitive powers and graces, those qualities of initiative, curiosity, ingenuity, and self-dependence" that are an essential part of a child's heritage. This also expressed the opinion prevailing in other parts of the United Kingdom; the general tendency was for the curriculum of this junior stage to move rapidly away from the former restrictive influences. In place of this emphasis on the three R's the aim was to awaken interest and create alertness by the stimulus of activity and experience. The curriculum was therefore devised not only as a means of imparting knowledge or facts to be stored but also as a source of opportunities whereby the child might grow in mental, moral and physical stature through the media of activity and experience. In addition to religious education, the main phases of the curriculum are English, especially spoken English; art and various crafts; music; counting and measuring; physical exercises including. of course, games and dancing. "We regard," the Scottish Advisory council remarked?"hand-and-eye training not as a 'frill' but as forming along with oral expression ('tongue-ear-and-eye training') the core of the primary curriculum." An intensely active education of this kind makes a considerable demand upon the teacher; much depends in the application of the curriculum upon his or her sympathetic understanding of children 'at this vital junior stage.

Here it may be well to note that in all stages of education the co-operation of the home is of crucial importance if full value is to be derived from the curriculum: and among the techniques of education it became more and more realized that one of the most effective is that of finding ways of knowing parents and attracting their support.

The Secondary Stage.—The Education act of 1944 gave a new meaning to the term "secondary school." Formerly it was applied only to public, grammar and high schools, but now became a generic expression embracing every kind of school attended by pupils of 11 and over. The educational world was therefore confronted with an entirely new concept of secondary education, and as required by the act was engaged in the difficult task of evolving courses of study appropriate to the "different ages, aptitudes and abilities" of the pupils, bearing in mind also the "different periods for which they may be expected to remain at school." This process of reconstruction was still in the experimental stage at mid-20th century and it would be premature to indicate as standard any of the numerous courses of study being followed at that time.

The problem of providing secondary education for all children is fundamentally different from that of providing a particular kind of secondary education for a few selected children. The task of those concerned with secondary education was not, therefore, one of giving to all children the education previously available for a fen-, but rather one of mapping out a variety of alternative courses so as to ensure that different aptitudes and abilities would be catered for. Nor indeed was it as straightforward as that, for the educational needs of children vary greatly; and it is also impossible to regard aptitude or range of ability as a constant factor during the school life of any individual pupil.

The concept of secondary education for all had received long years of consideration before its acceptance by parliament, and the decision to provide it with due regard to age, aptitude and ability was a direct consequence of recommendations made in various official reports—the Hadow report on the education of the adolescent (1926), the Spens report on secondary education (1938) and the Norwood report on curriculum and examinations (1943). In all these reports emphasis was laid on the importance of ensuring that the curriculum fitted the pupil and on the inadequacy of an educational system which in its provision of secondary education met the needs only of the pupil with an academic bent. Indeed the first official warning that a secondary education which ignored the nonacademic pupil was ill-conceived was given as early as 189j by the influential Bryce Commission on Secondary Education; "no definition of technical instruction," it contended, "is possible that does not bring it under the head of secondary education."

The regulations for secondary education prescribed under the Education act of 1902 disregarded the opinion of the Bryce commission, enunciating a curriculum that was mainly academic. Criticizing them, the Spens committee observed that "they failed to take note of the comparatively rich experience of secondary curricula of a practical and quasi-vocational type which had been evolved in the higher grade schools, the organized science schools and in the technical day schools. The new regulations were based wholly on the tradition of the grammar schools and the public schools." Under these secondary regulations the admirable service of grammar and high schools was built up to a high level, but apart from a comparatively few junior technical schools all other postprimary education was administered under the regulations for elementary schools. Fortunately many central and senior schools succeeded in providing much excellent teaching of a nonacademic character within the elementary school system, some of them reaching a high standard in spite of the discouraging auspices under which they worked. It remained true however that in providing secondary education for all the major task was to establish on a nation-wide basis schools that would adequately meet the needs of pupils—the great majority—for whom the academic curriculum of the grammar and high schools is inappropriate.

Much consideration had been given as to how this should be done before the Education act of 1944 gave statutory sanction to the principle of secondary education for all. The Hadow committee envisaged secondary education as consisting of two broad types: grammar (with an academic bias) and modem (with a practical bias). The Spens committee added a third type, the technical high school, while the Norwood committee confirmed this tripartite division. "Such, then." said the White Paper on *Educational Reconstruction* submitted to parliament in 1943, "will be the three main types of secondary schools to be known as grammar. modern, and technical schools. It would be wrong to suppose that they will necessarily remain separate and apart. Different types may be combined in one building or on one site as considerations of convenience and efficiency may suggest. In any case the free interchange of pupils from one type of education to another must be facilitated." Wide differences of opinion as to the best way of organizing secondary education revealed themselves as soon as the act became law and its implementation a practical issue. These found expression in the development plans prepared by local education authorities in pursuance of the act, some preferring the tripartite arrangements, others one type of comprehensive school, others a multilateral school; while several sought a solution by means of the establishment of bilateral schools; *e.g.*, grammar and technical or modern and technical. The London county council came out strongly in favour of a comprehensive school catering for all abilities and aptitudes. The upshot of all this divergency of view was a reorientation of official policy with the result that when the ministry of education published its leaflet on The *New Secondary Education* (1947), the stress was laid on variety. flexibility and experiment.

Meanwhile the Scottish Advisory Council for Education had been considering how the problem could best be resolved in Scotland, having regard to its educational history and tradition. The tripartite organization was found to be unsuitable for Scotland because: (1) it was unrelated to the existing system; (2) the age of 12 was considered too early to distinguish grammar, technical and modern types; (3) evidence was lacking that the "modern" school would have adequate status; and (4) the segregation of types at 12 would be opposed to the conception of school as community. One difficult question yet to be determined was that of size; *e.g.*, could a school foster a sense of community if it were large? On this the ministry of education made this comment: "In order to ensure that a school providing secondary education for all the senior children in a given area offers proper scope and opportunity for all its pupils, it will have to be a very large school. It is doubtful whether a school with less than a ten-form or eleven-form entry (that is, a total of 1.500 to 1,700 pupils) is capable of offering the necessary variety of suitable courses."

The future of the curriculum was largely bound up with that of organization, and so far the tendency had been to give precedence to a consideration of the latter. Some, however, maintained that by doing so the cart had been put before the horse. One reason for the emphasis on organization was the optimistic belief that the new schools would be built fairly soon and accord with the development plans; and there was a tacit assumption that once the organization had been settled the curriculum would be made to fit. The prolongation of economic difficulties, however, thrust the idea of the rapid completion of a vast building program into the background and as a result problems of organization lost their original urgency. Consequently the issue of the curriculum began to assume priority; and much thoughtful research and experiment was undertaken in colleges and schools as to what kind of secondary education was best suited to children of different ages, aptitude and ability.

Official opinion as to the content of the secondary curriculum was clearly expounded in the ministry of education's pamphlet *The New Secondary Education*, the needs of grammar, modern and technical schools being dealt with separately. The grammar-school course was then represented as a whole, covering the years 11 to 18, and it was regarded as incomplete if it ended at 16 and lacked two years future study in the sixth form. In the general course up to 16 "the treatment of all subjects and groups of subjects, but notably languages (classical and modern), mathematics and science, follows a predominantly logical development" and the subsequent intensive course in the sixth form covers "a narrower range of subjects, which for many boys and girls leads naturally on to studies at the university level." The distinguishing feature of the grammar-school curriculum lies in its length, the scholarly treatment of its content and the intellectual discipline that it affords. The duration of the modern school course was to be four or five years. From April 1, 1947, school attendance was compulsory up to 15 and it was official policy that as soon as practicable it would be raised to 16. As modern schools developed it was to be expected that the tendency for children to remain at school beyond the compulsory age would increase, but meanwhile the normal modern school course would extend from 11 to 15 with provision for those who remained at school longer.

The modern school curriculum includes English (or English and Welsh), mathematics, history, geography and science. In many modern schools a modern language is taught, and there is a growing interest in social studies. Art, music, handicraft, housecraft and various kinds of crafts are strong features of the curriculum and, wherever possible, gardening and animal husbandry. Physical education has an important place throughout the secondary stage, and the teaching of health principles is assuming more and more a positive quality.

The technical secondary school had behind it the tradition and experience gained by the junior technical schools established from 1905 onward; but the latter were handicapped by their truncated age range, normally from 12 or 13 to 15 or 16. The technical secondary school would have its pupils from 11 to 16, and after the age of 16 there would be various lines of development open to keen pupils; *e.g.*, combination of training in industry with part-time attendance at a college for further education, or full-time study at such a college, or in some technical secondary schools courses at the sixth-form level with some degree of vocational specialization. The curriculum of these schools would, however, during the first two years not differ much from that of other secondary schools; in the third year some vocational teaching might be included, introducing applications of basic principles. In the fourth and fifth years the bias would be increased and the work more deliberately related to a future vocational purpose.

Religious Instruction.— It should be noted that under the Education act of 1944 it was a requirement that in all primary and secondary schools the school day should begin with a corporate act of worship and that religious instruction should be given. The former provision in previous acts, restricting religious instruction in elementary schools to the beginning and end of the school session, no longer applied; and now the instruction might be given at any time during the session One consequence of this was that it became possible in many schools, formerly prevented from doing so by the timetable restriction, to arrange for the religious teaching to be given by a teacher who had made it a special study.

In the voluntary aided schools a syllabus appropriate to the particular denomination is followed and in the county schools use is made of an "agreed syllabus" drawn up by a conference of biblical scholars and teachers convened by the local authority in each area. Much care has also been taken in many areas in the preparation or selection of suitable service books.

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(W. 0. L. S.)

SCHOOL AND THE HOME: *see* PARENT EDUCATION.

SCHOOL ARCHITECTURE: *see* EDUCATIONAL ARCHITECTURE.

SCHOOLCRAFT, HENRY ROWE (1793–1864), U.S. ethnologist and explorer, one of the earliest of important writers on the American Indian. was born on March 28, 1793, in Albany county, New York. He was educated at Union and Middlebury colleges, where he showed a predilection for mineralogy. His *View of the Lead Mines of Missouri* (1819) was based upon a collecting trip through the Indian country of Missouri and Arkansas and led to his appointment as topographer on the Lewis Cass expeditions to the upper Mississippi and Lake Superior copper regions, where he became increasingly interested in Indian life. In 1822 he was appointed Indian agent to the tribes of the Lake Superior region and shortly afterward married a girl of Chippewa extraction. Her tribe became the subject of his special study. From 1836 to 1841 he was superintendent of Indian affairs for Michigan; in this capacity he supervised the treaty of March 28, 1836, by which the Chippewa ceded much of northern Michigan to the United States. Schoolcraft's contribution to ethnology was made in his *Historical and Statistical Information Respecting the History, Condition, and Prospects of the Indian Tribes of the United States*, 6 vol. (1851–57). Repetitious and disorganized, the work nevertheless remains an invaluable source of information gathered by the author from Indians, missionaries, traders and agents. The publication of F. Nichols' *Index to Schoolcraft's "Indian Tribes of the United States"* by the Bureau of American Ethnology (1954) greatly enhanced the value of the original volumes.

Schoolcraft continued his exploratory trips, the most important of which was in 1832, when he discovered Lake Itasca, the source of the Mississippi. Among many books was *Algic Researches* (1839; 1856 ed., *The Myth of Hiawatha),* which Longfellow used for *Hiawatha.* He died on Dec. 10, 1864, in Washington, D.C.

See also Chase S. Osborn and Stellanova Osborn, *Schoolcraft-Longfellow-Hiawatha* (1942). (V. Kz.; X.)

SCHOOL HYGIENE AND PHYSICAL EDUCATION form important branches of public hygiene in the United States. The school, since practically all the children are collected there, furnishes the great opportunity for caring for the health of all the people.

School Hygiene.— School hygiene may be divided into four main branches: (1) Sanitation of schoolhouses and school grounds. (2) The hygiene of the school child. including prevention of contagious and other diseases, health examinations both physical and mental, the prevention and treatment of defects and positive training for the development of habits of health. (3) The hygiene of school teachers. (4) The hygiene of school instruction together with mental hygiene.

The Schoolhouse.—This branch of school hygiene is concerned first of all with the best conditions of workshop for growing children occupied in brainwork. Architectural and artistic considerations, although usually considered important, are secondary. First of all the health of the workers should be considered. For example, the unit in a schoolhouse is the schoolroom and the size of the room should be determined by consideration of the average limits of normal sight and hearing, etc.

Hygiene of the School Child.—Child hygiene is based upon the character of the child's body and the laws of growth. It seeks to determine the needs and to avoid the dangers of each stage of development. Among its important contributions have been many scientific studies of development, the diseases and abnormalities of school children, the defects of the sense organs, the incidence of disease by years, seasons, months of the school year, the relation of defects to school progress and studies also in detecting and controlling contagious diseases.

Hygiene of Teachers—A new branch of school hygiene relates to the health of teachers. The few studies made emphasize the great importance of the health of the great army of teachers. It appears that the members of the teaching profession are prone to respiratory diseases and to nervous disorders. Thus it is seen to be a matter of importance to make conditions healthful for the work and the life of the teachers as well as of the pupils.

Hygiene of Instruction.—This emphasizes the hygienic importance of the mental habits formed by education, the secondary effects of instruction; and it studies every educational principle and method, the relations of teacher and pupil, the problems of the period of study, from the point of view of hygiene.

The importance of this newer field of school hygiene is seen when one considers the fact that an important means of cure for nervous and mental disorder is re-education, the development of healthy habits of mental activity—wholesome interests, habits of attention, self-control and orderly association—in fact, the very habits that are essential for hygienic school work. More and more scientific investigation and observation are showing the hygienic importance of mental hygiene both for pupil and teacher.

School Legislation.—The development of school hygiene is shown by the growth of medical inspection as well as by the training of teachers, the legislation in regard to the health of children and the sanitation of school buildings. By mid-20th century most states had laws making medical examination of school children practically compulsory. There was a wide divergence in practice, however; some of the states required annual examinations, some biennial or even less frequent, and some specified no definite period.

Most U.S. cities likewise had laws requiring annual health examinations of children, and many had adopted mental hygiene programs as well. Increased attention had been paid to physical defects as well as to contagious disease, and health inspection had been placed largely under the direction and control of the educational authorities.

Physical Education.—Physical education in the school may be divided as follows: (1) General physical exercise including play and training in health habits; (2) systematic physical training, gymnastics (*q.v.*), callisthenics, and the like; (3) athletics (see ATHLETIC SPORTS); (4) the higher aims of physical education. Special treatment of gymnastics, athletics and mental hygiene is given under separate articles. Only general aspects of the subject are discussed here.

The importance of physical education in relation to health has been emphasized in recent years in a twofold way: first, because of its significance for the normal development of children and the maintenance of general physical health; second, because of its significance for mental health. The minimum amount of physical exercise for the maintenance and development of physical health has been suggested by Hetherington as follows: Four hours of muscular activity at the age of 5 years, five hours from the ane of 7 to 9, six hours from 9 to 11, five hours from 11 to 13, four hours from 13 to 16, three hours from 16 to 18, and two hours daily from 18 to 20.

The slogan of physical education from the days of the Greeks until the present has been *mens* sana in *corpore sano* (the sound mind in the sound body), with the implication that the sound body is a condition of mental sanity. In modern times, under the influence of the great teachers of physical training in Europe, Johann Christoph Friedrich Guts-Muths, Friedrich Ludwig Jahn and others in Germany, Pehr Henrik Ling and the founders of Swedish gymnastics, the training has naturally centred much more upon physical education. While the mental factor in this twofold aim has often been neglected, in recent times the emphasis has been placed largely on the mental aspects of physical training. In a report of a special committee to the Society of Directors of Physical Education in Colleges made in 1921 the committee emphasized right mental attitudes, self-sacrifice, loyalty and co-operation, and mentioned some of the more generic of these mental attitudes as their first group of aims. Thus by mid-20th century there was growing the theory that physical education affords opportunity for important training in mental hygiene as well as for physical health. While no claim was made, like that of Plato, that God gave men music and gymnastics for mental culture alone, emphasis was placed on the development of healthy mental attitudes and interests as the culminating value of such training.

With the development of physical education in relation to somatic and mental health, it became a subject ior scientific research as well as a practical art, as indicated by recent literature. In the practice of hygiene the best schools supplemented instruction by actual training in health habits; and in the colleges the highest ideal was the acquisition of health intelligence as demonstrated by health habits. (See also PHYSICAL EDUCATION, and for English legislation on the subject see EDUCATION, HISTORY OF.) (W. H. B.)

SCHOOLS, ANCIENT. This article deals with the history of Greek and Roman schools, from which modern schools are derived. For modern schools see SCHOOL AND CURRICULUM and for a general historical sketch see EDUCATION, HISTORY OF.

GREEK SCHOOLS

First Phase.—The term and the institution date, not from the great or what may be called the Hellenic age of Greece, but from the later Macedonian or Hellenistic period. The account given by K. I. Freeman in his *Schools* of *Hellas* (1907) may be summed up in the statement, "There were no schools in Hellas." That is, there were no schools in the modem sense, where, during boyhood and youth, boys spent their whole time in a continuous course of instruction. There were professional teachers of three kinds: (1) the grammatistes, who taught reading, with writing and perhaps arithmetic, in the grammateion; (2) the *citharistes,* who taught music, *i.e.,* playing and singing to the cithara; (3) the paedotribes, who taught gymnastic, wrestling, boxing, running, jumping, throwing the javelin, etc., in the *palaistra.* To these teachers the boys were taken by slaves, called boy-leaders (παιδαγωγοί, whence our pedagogues), as single pupils, and were not taught in classes.

Roughly, the age for the grammar-school and song-school was 7 to 14, for the gymnastic school 12 to 18. A certain amount of literature was imparted, and especially in the song-school, Homer and other early poets, the very Bibles of Hellas, were learnt by heart. In later days, under the Sophists, and Socrates, "the greatest of the Sophists," 450–400 B.C., something approaching secondary education was developed. But it was wholly unorganized. The itinerant orators or rhetoricians taught oratory, and the learning that was considered necessary to the political orator, a smattering of Greek history, constitutional law and elementary logic. The philosophers, such as Protagoras, discoursed vaguely on natural science, "things in the heavens above and the earth beneath," and divinity, "whether there are gods or not," mathematics and ethics, or any subject which attracted them, while the lawyers, in the same unsystematic way, taught what law was necessary in a State where the Constitution was at the mercy of chance majorities in a sovereign assembly of 30,000 people, and trials at law were settled by 600 jurymen-judges.

Second **Phase.—In** the next generation, the orators and the philosophers, by settling down in fixed places, began to establish something more like schools. Plato, though like his master Socrates he taught without asking fees, was the first to give a regular educational course extending over three or four years, and in a fixed place, the Academy. The gymnasium was originally a parade or practice ground for the militia or conscript army of the State, which derived its name from the exercises being in that climate performed naked (γυμνός). At the age of 15 or 16 the boys left the palaestra, or private gymnasium, for this public training school, maintained at the public expense, preparatory to their admission as youths (ἔφηβοι), to take the oath of citizenship and undergo two years' compulsory training in regiments on the frontier. After those two years were over, they still required continuous exercise to keep themselves in training; consequently men of all ages, from 16 to 60, were to be iound in the gymnasium. Though the gymnasium was free, the teachers and trainers in gymnastics were paid, and as the poorer citizens had to earn their own living, the Athenian gymnasium, like the modem university, was for educational purposes chiefly frequented by the well-to-do. So the Academy became a fashionable lounge, and here developed the walking and talking clubs, which became the Platonic or Academic Schools. Logic and ethics, built on a foundation of geometry and mathematics, seem to have been the staple subjects. An inner circle met, and dined together in Plato's private house and garden, close to the Academy. Plato devised the house and garden to his successor Speusippus, who passed them on to Xenocrates. They thus became the first endowment of the first endowed college, which grew very rich and lasted till the disestablishment and disendowment of the old learning by Justinian in A.D. 529. Aristotle, a pupil of Plato for 20 years, set up a school of his own in the Lyceum, another public gymnasium, where he lectured twice a day, in the morning esoterically to the inner circle of regular attendants, in the afternoon to the public. From these two institutions three nations of Europe have derived three different terms for a school, the Germans their gymnasium, the French their lycée, and the Scotch their academy. Yet none of the originals was a school in any real sense of the word. In the days of their founders they were like discussion forums; at the most, courses of lectures. In later years, the gilded youth whb flocked to Athens from the whole Graeco-Roman world were enrolled among the ephebi, and the so-called "university of Athens" was evolved.

Third Phase.—It is to the Alexandrines, either to Antiodorus or to Eratosthenes, c. 250 (J. E. Sandys, *Hist.* of Classical *Scholarship,* 7), that grammar, as a term and a science, which included literary criticism and scholarship, and the grammar school are due. The earliest extant treatise on grammar is by Dionysius of Thrace (born c. 146), a pupil of the Homeric critic, Aristarchus. It defines grammar as "the practical knowledge of the usage of writers of poetry and prose" and includes exegesis or explanation of the author in the widest sense as well as mere verbal or syntactical grammar. It was from the term thus understood that the grammar school (*scola* grammaticalis), the term which described the typical secondary school from that day to 1869, derived its denotation and its connotation. Throughout the 13 centuries which intervened between Dionysius Thrax and Dr. Kennedy, Dionysius's grammar was the standard work and the foundation, directly or indirectly, of all other grammars, while the grammar school has always meant, and, in the hands of the better class of teachers, has always been, not a gerund-grinding machine, but a place for the training and exercise of the mind by the study of literature. The word "school," as well as the word "grammar," seems to be due to Alexandria. The first known use of it in that sense seems to be in Dionysius Halicarnassus' Letter to Ammaeus, *c.* 30 B.C. But as Plautus (c. 210) uses the corresponding Latin term, ludus *literarius,* some two centuries earlier, we may safely infer that he used it as a translation of grammar school.

ROMAN SCHOOLS

First Stage.—At Rome schools began under influence of the Greeks. According to Suetonius. the emperor Hadrian's secretary, who wrote *The* School *Masters* (De *grammaticis*) about A.D. 140, literary teaching and the science of grammar began with Livius Andronicus, a Greek from Magna Graecia in the south of Italy, who, being brought to Rome as a slave in 272 B C, became a freedman, translated the Odyssey into Latin, and taught both Greek and Latin. Ennius, the first Latin poet, was also half-Greek, and came to Rome in 209 B C, where he also taught both languages. According to Plutarch (Quaest. Rom 59) the first grammar school (*grammatodidaskaleion*) was opened by Spurius Carvilius, a freedman of Carvilius, about 230 B.C. According to Suetonius, Crates, who about 169 B C came to Rome as ambassador from Attalus, king of Pergamum, a great centre of learning, and was kept there by a broken leg, occupied himself in giving lectures His example was soon followed by Romans. Schools of grammar, in which, even as late as Cicero's time, the Laws of the Twelve Tables were the chief text-book and were learnt by heart, were kept by Greeks or freedmen. These seem to have been of the nature of elementary schools. But at Rome, as at Athens, the working-classes were for the most part slaves; and elementary schools were like English preparatory schools rather than public elementary schools. Schools of rhetoric, which were more like secondary schools, were also opened after the model of that of Isocrates at Athens In 92 B C schools of Latin rhetoric were put down as an innovation. Yet among the treatises written by Cato, the praiser of the past at the expense of the present, was one on public speaking, the chief rule in uhich was "take care of the sense. and the sounds will take care of themselves." Neither the gymnasium or palaestra, nor the music school, flourished at Rome. As at Athens, so at Rome the boys were sent to school in charge of a slave, a *pedagogus,* comes or *custos.* But it would seem that at Rome the pedagogus generally a Greek slave, often himself gave elementary instruction In Varro's much-debated phrase, "Educat nutrix, instituit pedngogus, docet magister," "the nurse brings up, the pedagogue instils the elements. the master teaches" *Magister*, which in English became "maister" and then "master," remained the term for the teacher of the public school from that day to this, though attempts were made at the time of the Reformation to introduce the Greek word *didascalus* in its place

The Roman school was very much like the modem school. All the methods of torture which have made the service of the Muses for most boys a veritable slavery were in full vogue. Instruction was now in a foreign language, and grammar became prominent. Early rising, loud speaking and hard flogging were in the ascendant. The staple of instruction in the Roman schools was the works of the poets, Greek and Latin, Homer and Virgil, Hesiod and Aesop, Menander and Terence. Horace says (*Ep.* i. 19. 40) "that he was not thought worthy of going the round of the schoolmasters' desks"; but it was a fate not long delayed, and the writings of the poets of the silver age, Lucan and Statius, became school-books in their own lifetimes.

Our knowledge of the Roman curricula is mainly due to Quintilian's *Institutio* oratoria, C. A.D. 91. Fabius Quintilianus, born on the banks of the Ebro, was not only the son of a man who kept a rhetoric school, but himself kept one, and is said by St. Jerome to have been the first who kept a public school, in the sense that he was the first who received a stipend from the emperor. In endeavouring to create the perfect 'orator, Quintilian discusses the whole of education from the cradle upwards.

Second Stage.—The first definitely endowed school we hear of is one founded by Pliny the younger, a pupil of Quintilian, at his native place Como. Later historians say that the emperor Antoninus Pius (138–161) assigned offices and salaries (honores et *salaria*) for rhetoricians throughout the provinces; and that Alexander Severus did the same, and also established exhibitions for poor boys, with the limitation, curiously repeated a thousand years later in the statutes of All Souls College and of Eton, modo *ingenuos, i.e.,* provided only that they should be free-born.

There were complaints that the masters were ill-paid. Quintilian made a fortune by his school, but Juvenal calls him in this respect a white crow.

Later Schools.—Grammar and rhetoric schools spread throughout the Roman world and continued substantially unchanged in method and subject to the days of Gregory the Great and Augustine the apostle of the English. The Confessions of St. Augustine of Hippo, a schoolmaster at Carthage, Rome and Milan, before his baptism in the year 387, and the poems of his contemporary Ausonius, educated in the grammar school at Toulouse, and himself a schoolmaster at Bordeaux before becoming prefect of Illyria and of Gaul, show that the schools were much the same in the 4th century as in the first. Ausonius celebrated in verse all the Bordeaux schoolmasters, some coming from schools at Athens, Constantinople, Syracuse and Corinth, one the son of a Druid at Bayeux, others schoolmasters from Poitou, Narbonne, Toulouse, who went to Lerida and other places in Spain. Ausonius had for his pupil the emperor Gratian, who in 376 established a legal tariff for schoolmasters' salaries. "In every town which is called a metropolis, a noble professor shall be elected" The rhetoric master (rhetor) was to have at least 24 annonae (an annona being a year's wages of a working man); while the grammar masters were to receive half that. But at Trier, then the capital of the Western empire, the rhetor was to have 30, the Latin grammarian 20, and the Greek grammarian, if one could be found, 12 annonae (Cod. *Theod.* xiii. 3. 11). The same century saw Priscian, a schoolmaster at Constantinople, compose the Latin grammar which, itself for the most part a mere translation from Greek, reigned without a rival till the Reformation. and is represented by over 1,000 mss.

Venantius Fortunatus, educated in the grammar school at Treviso, wrote in 570 a life of St. Martin of Tours in three books of hexameter verse, and lives of saints and bishops. His era was one of transition, and marks the passing of the schools from secular to ecclesiastical control. His contemporary Pope Gregory in a letter to Desiderius, "bishop of Gaul." at Vienne commends the monks whom Gregory was sending with Laurence the priest and Mellitus the abbot to Augustine of Canterbury, thus bringing the grammar-school-teaching bishop into direct connection with the conversion of the English, and the foundation of the first English school.

SCHOOLS, EVENING, schools open in the evening to enable those working during the day to continue their education. Evening schools in Great Britain are discussed under ADULT EDUCATION and TECHNICAL EDUCATION. The following article describes the work in the United States.

Evening schools in the United States for apprentices and others were opened in New York (1833) and Louisville, Ky. (1834). Ohio (1839) enacted legislation requiring towns to provide evening schools for males over 12 years of age. Massachusetts (1847) permitted towns to appropriate money for instructing adults in reading, writing, English grammar, arithmetic and geography.

By 1862 Cincinnati, San Francisco, St. Louis, Chicago, New Orleans and other cities to the number of at least 15 had conducted free public evening schools. Thirty-two cities reported such schools in 1881, and the report of the United States bureau of education for 1887–88 showed a total enrolment in cities of 8,000 or more of 135,654. Thereafter the growth was even more rapid, enrolment being approximately 1,400,000 at mid-20th century.

Classes are maintained in Americanization work, elementary, high school and vocational subjects. The objectives of Americanization work are to teach immigrants to speak, read and write English, to aid them to get an understanding of American institutions and to prepare them to take out citizenship papers. Many employers co-operate helpfully in this work, and sometimes pay part or all of the expenses of these classes. Elementary classes are for those who wish to obtain further instruction in subjects usually covered in day grade schools. High school classes enrol pupils who wish to pursue work of high school grade in English, history, mathematics, science and classical or modern languages, and also offer courses in such fields as choral singing, dancing, art work and business law. Vocational courses range from work which appeals to an avocational interest in fancy work or manual arts to specific vocational training for office workers, housekeepers and apprentices and journeymen in the industrial trades. Of the total evening school enrolment of 1,475,104 provisionally reported for 1951 by the U.S. office of education, 319,096 students were taking agricultural courses. 228,173 courses in distributive occupations, 659,551 courses in home economics and 268,284 courses in trades and industry.

Pupils usually attend evening school two hours per night for two or three evenings per week, from Oct. 1 to April 1. By increasing the time allotment, Cincinnati, Chicago, Boston, Philadelphia and other cities offered an evening school diploma equivalent to that of the day high school. Rural evening schools also developed large enrolments. This work is essentially for adult men, and is strictly vocational.

The evening school in the United States, excepting Americanization classes, is chiefly for young working people. The pupils average about 19 years in age and are about equally divided as to sex. (O. D. E.; X.)

SCHOOLS OF ART. As institutions, art schools are comparatively recent. The first signs of organization were perhaps in the middle ages when the arts and trades were controlled by guilds. Courses of instruction, promotions, competitions and general advisory councils were in existence at that time in the more important art centres of England, France, Germany and, especially, Italy.

However, such organizations did not take the place of personal instruction by the masters of the arts, fine and applied. It was to the great artists that pupils looked for supervision, and the term "school" as applied to these masters (such as the school of Michelangelo) had no connection with organized institutions. The 19th and early 20th centuries saw the birth and development of innumerable art schools, especially in countries where the government made appropriations for such educational work. The development of art schools saw the evolution of the art teacher, a phenomenon new to the 19th century, since he was a man trained to teach art as distinct from the artist who only taught incidentally.

In recent times there has been a marked tendency to encourage an individual approach among students. There is less emphasis on the teaching of traditional techniques and more on making students aware of contemporary idioms and ways of expression, but this advancement did not mean the obliteration of personal instruction under pre-eminent artists. It is not uncommon to find students who have never attended an art school. This "personal supervision" system of study has its weaknesses, the chief among which is the tendency toward imitation oh the part of the student.

With the development of museums where design could be studied from the collections of art work, more importance was given to observation classes. In many of the municipal museums, especially in the U S., an art school was established in connection with the museum. For those wanting industrial arts. most schools have branches for technical instruction in that field, such as interior design, graphic design and dress design Since 1934, in Great Britain, there has been an attempt to restrict the industrial subjects offered at individual art schools to the special requirements of the main industries of the area in which the schools are situated.

Public exhibitions. local and international. were perhaps the greatest stimulus in the development of art schools in Europe and the United States. About the middle of the 19th century considerable competition in the industrial arts was started among the European countries, and later spread to the United States, making itself manifest also in local exhibitions in the larger cities.

UNITED STATES

Schools of art which provide opportunities for specialized study in one or more of the various areas of art in the U.S. are set up largely on the postsecondary level. Most high schools of sufficient size to employ specialized teaching personnel, however, offer major programs in art. Such an arrangement enables talented or interested students to enroll in art courses continuously throughout their secondary schooling, usually for one period a day. although occasionally more. Sometimes these courses are highly specialized and of a terminal nature.

On the postsecondary level, schools of art are numerous. The *American Art Directory*, compiled by the American Federation of Arts, includes a listing of almost 600 institutions offering professional training. With few exceptions, these fall into three categories: professional art schools, colleges and universities and the schools of individual artists who conduct classes of professional standards. Only those colleges and universities were included that offered a major in art, including the fields of architecture and landscape architecture. In many instances, one university may have several independent departments and colleges where various major curriculums can be pursued.

New York state headed the list with more than 100 different institutions offering professional training. California, Massachusetts and Pennsylvania each had more than 30.

In addition to the institutions listed by the American Federation of Arts, there are hundreds of other colleges and universities that offer courses in art, either as a minor subject or as an essential part of the training of students (for example, to elementary teachers) or as an elective that does not have "minor" status. A very large number of communities, through such agencies as museums or school systems, offer instruction in art to interested adults and children on afternoons, evenings and Saturdays. There are also many artists who carry on private instruction or who conduct an occasional class in art. Although the art instruction covered in this paragraph is not set up as professional instruction, it generally includes some individuals who have a professional interest. But, more important, it exerts an enormous influence in maintaining a widespread interest in art.

There is great diversity among the art schools in practically all the factors which characterize them. A large number have no entrance requirements, being open to any interested student. Entrance requirements on both academic background and art ability and achievement are set up by those schools that offer programs of study over a period of several years leading to diplomas or degrees. Many are set up around one man, generally an artist of distinction who gives instruction to small groups of students. In such cases the character of instruction and the reputation of the school itself are dependent on the reputation and the stature of the artist who conducts the school.

Many art schools have large and permanent faculties and offer programs of study in varied fields. A goodly number, such as the Brooklyn Museum Art school, are connected with museums of art. One, the Massachusetts School of Art, Boston, is state supported. Some, such as the Art Students league of New York city, are best known for their training in painting. as the staff of that organization includes many gifted contemporary artists. Others. such as the art school of Pratt institute. also in New York city. are best known for their courses in such fields as advertising design. illustration and industrial design. Many art schools. particularly the small ones. enroll only part-time students. Most enroll both full-time and part-time students.

There has been a strong trend among the large and established art schools to become degree-granting institutions. This development has been the result of the continued increase in numbers of college graduates in all fields and the increasing status of college degrees generally, but also to meet the competition from regularly established colleges and universities where. increasingly. courses in studio work in the various fields of art are counted toward a degree along with academic subjects.

For the art schools this has meant offering the liberal arts courses themselves that are required for the degree; or working out some arrangement with a nearby college or university as. for example, the Rhode Island School of Design. Providence. with Brown university. or the Pennsylvania Academy of the Fine Arts. Philadelphia, with the University of Pennsylvania; or accepting academic work from any accredited institution where the student wishes to take it. A number of art schools, such as the school of the Art Institute of Chicago and the Kansas City Art institute. offer master's as well as bachelor's degrees.

A partial list of other outstanding art schools. besides those already mentioned, includes the Cleveland School of Art; Cooper union of New York city, which is tuition-free; the Art Center school and the Chouinard Art institute. both of Los Angeles; Parsons School of Design in New York city; and the Moore Institute of Art. Science and Industry in Philadelphia.

Colleges and universities are all degree-granting institutions and the colleges, schools and departments of art that are within them are governed hy the same general policies as other sections of the institution. The staffs of the art departments, in most instances, however, have considerable freedom in determining the character and direction of the art program.

A large number of colleges and universities offer art programs, either for the preparation of professionals in such fields as painting, sculpture, architecture, advertising art and industrial design, or as a cultural subject for interested students.

Although art history and aesthetics were at one time considered the only kinds of art courses academically acceptable at the college level, there is an increasing acceptance of studio work toward meeting degree requirements. Bachelor's degrees in a wide variety of art fields are common. Many institutions offer either master of fine arts or master of arts degrees for students specializing in such fields as painting, sculpture or education. In a few institutions, as, for example, Teachers college. Columbia university, and the State University of Iowa. Iowa City, doctor's degrees are ofiered which include courses in studio work toward meeting the degree requirements. In fact. the considerable expansion and acceptance of productive work in the arts in higher education during the 20th century is a most significant development in art. The presence of art departments in the college and university milieu is of great educational and cultural importance.

The placement and organization of art departments within higher education varies considerably from one institution to another. In some large universities offerings in art appealing to differing groups of students are available in a number of places. At Columbia university, for example. there are six separate departments offering courses and programs of art. These include such fields as art education, art history. painting and medical illustration. In other universities the various art offerings have been brought together. Yale. for example, has a school of fine arts with departments of architecture, drama, design and history of art. The department of design offers curriculums in painting. sculpture and graphic arts. In some universities, such as the University of California at Los Angeles and the University of Illinois. Urbana, the various art departments form a college.

Most frequently, the art departments are placed in the college of liberal arts, such as at the University of Minnesota, Minneapolis. and the State University of Iowa. At Ohio State university, Columbus, however. the school of fine and applied arts, which does not include architecture and landscape architecture, is placed within the college of education.

A partial list of the other universities with important art programs includes: the universities of Arkansas, Fayetteville, and Nebraska. Lincoln. Syracuse university, N.Y., and the Carnegie Institute of Technology. Pittsburgh, Pa.

Although one or more college degrees are necessary for many art teaching positions in colleges and universities, professional accomplishment alone is a basis for employment in a considerable number of instances.

In the teaching of the arts in the U.S., emphasis is being placed on the development of individual expression. Basic courses are offered, but in them. also. experimentation and the development of unique and personal interpretation are encouraged. The role of the instructor is to guide and develop the student rather than to encourage imitation. (See also ART EDUCATION.) (E. Z.)

GREAT BRITAIN

Apart from one or two small private academies of the early 18th century, the first British art school was that which still forms a part of the Royal Academy of Art, founded in 1768. This school gives instruction to an average of 60–70 students in painting, sculpture and architecture at Burlington house.

In 1835 a parliamentary commission was appointed to inquire into "the best means of extending a knowledge of the arts and of the principles of design among the people (especially the manufacturing population) of the country." The immediate outcome of the commission's report was the establishment, in London, of the Normal School of Design, later to be called the Royal College of Art. A radical reorganization of this college was undertaken in 1948, as a result of which it became for the first time the main centre in the country for the training of industrial designers. It also has departments of painting, sculpture. stained glass, engraving and graphic design.

A further result of the report of the commission of 1835 was the foundation of other schools of design—the first in 1842—which were to become the foundation of the British system of public art education. By 1890 there were 200 such schools of art, and in 1902 their work became a part of the national system of higher education.

Immediately after World War II the number of art students increased, but dropped after a few years. Consequently the ministry of education, in consultation with local authorities, carried out an active policy of closing art schools in many parts of the country. In the late 1950s there were about 200 art schools in England and Wales recognized by the ministry. The ministry of education administers its own system of art examinations.

The universities of Oxford, London, Reading and Durham and University college. Aberystwyth also maintain schools of art, of which the most famous is the Slade School of Fine Arts, of London university. Another London school of considerable importance is the London county council's Central School of Arts and Crafts, founded in 1896. This had some influence on the development of art education on the continent of Europe in the early years of the 20th century.

There are, besides, a number of private schools, mainly in London: for example, the Byam Shaw school and Heatherley's.

CONTINENT OF EUROPE

Germany.— It has been in Germany that many important experiments in art education have taken place since the beginning of the 19th century. It was the Nazarene painters such as Peter von Cornelius, for example, who made the first serious attack upon the authority and curriculum of academies and who put forward the idea of *Meisterklassen,* training based upon the talents and personality of outstanding teachers with whom the student could enter into a more intimate and inspiring relationship than had been possible under the academic system of fixed instruction. Between the 1890s and the end of World War I much was done to prepare the way for a reunion of the fine and applied arts and to consider the particular problems of industrial design.

This movement found its fulfillment in the work of Walter Gropius; his Bauhaus, established at Weimar in 1918 and later moved to Dessau, aimed, in its instruction, to achieve a union of all the branches of art. This fruitful amalgamation of the fine and applied arts was also achieved in the 1920s at the Berlin Hochschule der Freien Kiinste. Most of the main centres of Germany have their *Kunstakademien, Kunstgewerbeschulen* or *Werkakademien.*

France. — In the 17th century France created the most famous and the most influential of all art academies, the Académie Royale de Peinture et Sculpture. It established the form of art education in Europe for many generations. In modern times the official art schools of France are administered by the Ministère de l'Instruction Publique et des Beaux Arts; there are not only the many municipal schools maintained by the state throughout the country but also those at Lyons and Dijon modeled directly upon the chief state school, the École Nationale des Beaux Arts in Paris.

Italy. — In Italy, where the first academies of art were established in the 17th century, no public system of art education existed until the time of the Fascist state. The fine arts are catered for in the *licei artistici;* and for more advanced studies there are *accademie di belle arti* in Rome, in Bologna, in Florence, in Milan, in Naples, in Palermo, in Turin and in Venice.

Training in arts and crafts is given in *scuole d'arte,* in *istituti d'arti* and in *istituti superiori per le arti industriali,* the last being found in Venice, in Florence, in Naples and in Palermo.

(B. Tr.)

SCHOONER, a sailing vessel having two or more masts and only fore-and-aft rigged sails. The masts have the same names as those of square-rigged ships and the sails forward of the foremast are similar to those of a square-rigged ship. Each mast carries a single gaff-headed sail which takes the name of the mast supporting it; gaff topsails may be carried above these sails. *(See* also RIGGING ; SAILS.)

In two-masted schooners the mainmast is higher and carries more sail than the foremast. In schooners having more than two masts the masts are the same height and carry nearly equal sail areas.

Modern schooners are generally used as yachts and have but two masts. The sails on the after side of the masts of schooner yachts are triangular in shape and slide up and down the mast on metal tracks. (M. R. D.)

SCHOPENHAUER, ARTHUR (1788–1860), German philosopher. primarily important as the exponent of a metaphysical doctrine of the will in immediate reaction against Hegelian idealism, was born at Danzig on Feb. 22, 1788, the son of a merchant, Heinrich Floris Schopenhauer, and of his wife Johanna. H F. Schopenhauer was a liberal-minded man who disliked authoritarian and absolutist governments and moved to Hamburg in 1793 when Danzig surrendered to Prussia; he was also cultivated and cosmopolitan in his tastes and acquainted with French and English literature. Johanna shared her husband's literary interests and herself wrote novels; but otherwise they seem to have been temperamentally unsuited, and the marriage was not a happy one.

Arthur Schopenhauer's education was intermittent. After spending two years (1797–99) at Le Havre to learn French, four years in a private school at Hamburg and another two years traveling in England, France. Switzerland and Austria, he entered a merchant's office at Hamburg

After the unexpected death of Heinrich Floris in 1805 (he fell, or threw himself, into a canal), Johanna Schopenhauer moved to Weimar. Schopenhauer eventually joined her there and studied classical literature until 1809. when he entered the University of Gottingen, reading first medicine and then philosophy. The pears 1811–13 he spent at the University of Berlin, attending the lectures of J. G. Fichte, for whose philosophy he was later to express considerable contempt.

At the time of the uprising of the German states against Napoleon, Schopenhauer, who disliked all forms of militarism and was not much moved by appeals to national sentiment, retired to Rudolstadt, where he published his doctoral thesis, *Uber die vierjache Wurzel des Safzes vom zureichenden Grunde* (1813; Eng. trans.. *On the Fourfold Root oj the Principle of Sufficient Reason,* London. 1889).

After his thesis had appeared Schopenhauer returned to Weimar, where in his mother's salon he met the orientalist F. Mayer, who introduced him to Indian philosophical literature. He also met Goethe. The latter having in 1810 published an essay on colours, Schopenhauer took up the same subject and sent his manuscript "On Vision and Colours" (*Über das Sehn und die Farben,* Leipzig, 1816) to Goethe in 1815; it was not, however, very enthusiastically received.

Schopenhauer had meanwhile left Weimar for Dresden, having quarreled with his mother (May 1814); they were never to see one another again. At Dresden he wrote his principal work, *Die Welt als Wille und Vorstellung* (Leipzig, 1819; Eng. trans., *The World as Will and Idea,* 3 vol., London! 1883.) Schopenhauer expected that this would at once be recognized as a book of first-class importance; but neither was it well-received nor did it sell. More successful at this time were his efforts to save the family fortunes when the firm in Danzig in which they had been invested went bankrupt.

After the publication of his book, Schopenhauer started lecturing in the University of Berlin (1820), but this too was a failure. Philosophy in Berlin was dominated by Hegel, and Schopenhauer's disdain for Hegelian ideas met with a poor response. He went to Italy in 1822 and to Munich in 1823; there he stayed for nearly a year. sick and isolated. From 1825 to 1831 he lived in Berlin, partly in order to defend himself against a seamstress who was suing him for injuries sustained when Schopenhauer, annoyed by her chatter, had driven her downstairs from a landing outside his room. He was eventually condemned to pay her regularly a certain sum of money until her death. which took place in 1841.

In 1831 Schopenhauer settled in Frankfurt-am-Main. He seems to have lived very well there: he enjoyed food and wine; he was fond of the theatre and music (he himself played the flute); and he read widely in French, Italian and English literature. Happy, however, he was not. By'nature misanthropic, he was also by this time profoundly embittered by lack of recognition, and his bitterness was only exacerbated by his contempt for the official Hegelian philosophy. He expressed his opinions on this score with great vigour. both in *Uber den Willen in der Natur* (Frankfurt, 1836; Eng. trans., "On the Will in Nature," in *Two Essays,* London, 1889) and in his preface to the second edition (1844) of *Die Welt als R'ille und Vorstellung:* he regarded Hegel as a charlatan who had corrupted the minds of an entire generation with bombastic sophistry and meaningless verbiage. Nor was his resentment alleviated when an essay of his, the sole entry for a competition instituted by the Danish academy of science, received no award. This essay was subsequently published in *Die beiden Grundprobleme der Ethik* (Frankfurt, 1841; Eng. trans., *The Basis of Morality,* London, 1903).

Schopenhauer's later writings added little that was new to what he had already written. In the second edition of his main work he added 50 supplementary chapters. including a section on sexual love in which there is only a suggestion of the misogynistic sentiment that coloured his later well-known essay "On Women."

With the publication of *Parerga und Paralipomena, 2* vol. (Berlin. 1851; selective Eng. trans., *Essays From the Parerga and Paralipomena,* London. 1951), a collection of essays on a variety of topics. Schopenhauer at last began to acquire fame. Articles on his system appeared in English. French and Italian as well as German periodicals; in 1856 the University of Leipzig offered a prize for the best exposition and criticism of his ideas; and by 1857 his doctrines were the subject of lectures at Jena, Bonn and Breslau. His reputation quickly spread beyond the confines of the academic field, and he gradually became the object of a kind of cult, with admirers in England, Russia and the U.S. He died at Frankfurt on Sept. 21, 1860.

PHILOSOPHY

The main philosophical influence upon Schopenhauer, and one that he freely acknowledged, was undoubtedly Kant. But although he never questioned Kant's greatness, *Die Welt als Wille und Vorstellung* contains a long "Criticism of the Kantian Philosophy" in which Kant's theories are subjected to a severe analysis. Other influences were Plato (particularly noticeable in Schopenhauer's references to eternal "ideas" in his account of artistic experience), Schelling, oriental philosophy and, to a lesser extent, the British empiricists: Schopenhauer speaks with respect of Locke and shared Kant's admiration for Hume.

Theory of **Knowledge.**—Schopenhauer accepted the Kantian distinction between the phenomenon, or the appearance that a thing presents to the perceiving mind, and the noumenon, or the thing as it is in itself. Thus in perception the mind is aware only of phenomena: what lies behind them, being beyond all possible experience, is unknowable; and the pretensions of traditional metaphysics to provide knowledge of a supra-empirical kind must accordingly be rejected. Again. Schopenhauer derived from Kant his view that the mind makes an important contribution to the general nature of our experience. The human sensibility is such that sense-data can only appear to us as spatially and temporally ordered; further, all phenomena are subject to the a priori category of cause and effect. Time, space and causality. Schopenhauer declares, are "nothing more than functions of the brain."

Schopenhauer went on to argue that we reflect upon and communicate our experience through concepts, or general terms. By means of these we are able to classify together different things in virtue of those common features which are of interest or importance to us. The function of conceptual thinking is thus essentially practical: without it what we learn from our experience could not be retained or put to use. But it is impossible to dissociate it—as some philosophers have tried to do—from the perceptual experience on which it is based: "Conceptions and abstractions which do not ultimately refer to perceptions are like paths in the wood that end mithout leading out of it." In saying this, Schopenhauer acknowledged his debt to the English empiricist philosophers.

Metaphysical theories that profess to be able to describe the nature of the world a priori and without reference to observed facts "move in the air without support." In the end they do no more than elicit by deductive steps the implications of the highly abstract concepts from which they start. and such a procedure can yield no more than a system of tautologies. Schopenhauer regarded Hegel's work as a prime example of such "trifling and paltry" philosophizing.

Metaphysics. — The basic tenets of Schopenhauer's theory of knowledge would seem to impugn the validity of all metaphysical speculation considered as a source of information about the world. He felt. however, a deep dissatisfaction with the purely empirical type of knowledge represented by the natural science of his time. Scientific explanation. he believed, always ultimately presupposes what is itself inexplicable in scientific terms: it may tell us how things as a matter of fact behave under certain conditions, but it cannot in the final analysis explain why things happen as they do and not otherwise; it is like "a sum which never comes out." Thus metaphysics has, after all, a genuine function, viz., to resolve certain fundamental problems which, although necessarily beyond the scope of science, seem naturally to arise. But how are these problems to be tackled in the light of what Schopenhauer, following Kant. has already said concerning the limitations of human knowledge?

The answer, for Schopenhauer, lay in the nature of our own intimate experience of ourselves. Although, from one point of view, I am as much a "phenomenal" object as a rock or a tree, self-consciousness reveals that I am more than this. For, apart from my awareness of myself as a perceivable bcdy, occupying space, enduring through time and causally responding to stimuli, I also know that in my overt behaviour I express my will. And just as my own activity is ultimately only explicable as the expression of my will, so it is with everything else in nature. Will is the concept in terms of which all that exists and manifests itself in the world can finally be understood. In this way Schopenhauer believed that he had arrived at a fundamental metaphysical truth by a method which escaped Kant's objections, although the reasons for his confidence are not very clear.

The picture which Schopenhauer thus drew of the inner character of the world was not—and was not intended to be—a pleasant or consoling one. For him the "real" was not, as it was for Hegel, the rational, but the irrational: the metaphysical will is "blind," an insatiable force without conscious purpose or direction. Human beings may deceive themselves into thinking that they are acting from considerations dictated by reason alone, but this is never in fact the case: the function of the intellect is only to assist the will to achieve its ends. From this the conclusion is drawn that all participation in the world is to be avoided. Schopenhauer's final remedy being not, as might be expected, suicide. but quietism.

Theory of Art. — The importance that Schopenhauer assigned to artistic experience is understandable in the light of his general theory. The scientist's attitude to the world is practical: he is concerned with phenomena only with a view to discovering the laws which govern their behaviour; and the sole value of his findings lies in the use to which they can be put in securing the objectives of the will. By contrast, the concern of art is with what Schopenhauer calls "contemplation," or "will-less" perception: the aesthetic frame of mind is characterized by a complete absence of desire or practical interest. What is perceived in artistic apprehension and what the artist strives to communicate through his works are certain archetypal "ideas," described as "the permanent essential forms of the world and all its phenomena." These "ideas" are not to be confused either with concepts or with the objects of everyday perceptual awareness to which concepts are applied: they occupy, in fact, an intermediate place in Schopenhauer's system between phenomenal appearances and the underlying noumenal reality of will. The position is further complicated by the fact that a different account is provided of music, which is regarded as directly exhibiting the inner workings of the will itself. Yet. whatever obscurities surround his theory of the ideas, the general significance of Schopenhauer's discussion of art is plain: the Romantic conception of the artist, as one who can withdraw from the material exigencies of life and reveal aspects of the world to which those dominated by considerations of practical interest are blind, could not fail to appeal to him; and the "knowledge" so achieved seemed to him to be correspondingly superior to any that could be acquired in response to the demands of the will.

Psychology and **Ethics.**—Schopenhauer's deterministic theory of human action and motivation is consistent with the rest of his system. Whatever a man does is necessarily an expression of his inner will, and this is fixed and unalterable. The knowledge of what we are comes to us as a result of seeing what we do: a man cannot "resolve to be this or that, nor can he become other than he is; but he *is* once and for all, and he knows in the course of his experience *what* he is." The common-sense belief in the freedom of the will is consequently an illusion: in our so-called "free" choices we merely exhibit the nature of our innermost unchangeable character. This belief did not, however, prevent Schopenhauer from distinguishing on moral grounds between different sorts of action. A wrong act is an act by which a man, in expressing his own will, "denies" or inhibits the will of another. Moreover, if justice consists in refraining from such injurious acts, goodness consists in treating the welfare of others as being as important as one's own: thus the good man acts from motives of benevolence and sympathy.

Influence and **Originality.**—Schopenhauer's philosophy achieved a wide popularity on the continent of Europe in the latter half of the 19th century: both Friedrich Nietzsche and Richard Wagner, for instance, were in different ways profoundly impressed by his ideas. In England. however, his influence on philosophical thinking was small: the dominant school of "absolute idealism," for example, was largely inspired by Hegel's doctrines, against which Schopenhauer had directed his most bitter attacks; and little attention was paid to his writings by British philosophers in the first half of the 20th century, when belief in the validity of metaphysical speculation was declining.

Such neglect is somewhat unjustified. Schopenhauer was not a rigorous thinker, and his theory lacks the tight, connected structure and logical ingenuity characteristic of the systems of men like Spinoza and Leibniz. Yet he compares favourably in a number of ,respects with other 19th-century metaphysicians — Hegel and his followers. for instance. He recognized, as they did not, the force of Kant's criticisms of metaphysics, and he had a much clearer conception of the relations holding between language and the world and, consequently, of the limitations of a priori knowledge. Moreover, he wrote with great distinction and style and with a natural clarity of expression that prevented him from camouflaging his inconsistencies beneath obscure phraseology and jargon. He showed acute psychological insight, particularly into the metaphysical urge; and his doctrine of the will foreshadowed, in metaphysical form, new categories of thought that were to emerge with advances in the nonphysical sciences — especially psychology. His avowed dissatisfaction with science can in fact be seen — partially at least — as a dissatisfaction with the mechanistic models of explanation and interpretation which theorists of the 17th and 18th centuries, fascinated by the achievements of physics. had sought to extend to all departments of human life and experience. Both here and in his rejection of the optimistic rationalism of the Enlightenment, Schopenhauer showed an originality and a prescience which it is difficult to ignore.

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SCHORL, in mineralogy the name given to coarse black varieties of tourmaline (*q.v.*). Schorl was originally a mining term applied both to black tourmaline and to hornblende.

Schorl rocks are crystalline aggregates of quartz and tourmaline and occur almost always in association with tourmaline-bearing granites or pegmatites. They originate by the action of gases and vapours on granites, porphyries and other rocks. Sometimes direct pneumatolytic derivatives of the granite itself, they are also frequent as replacement products of the country rock into which the granite is intruded (*see* also Greisen). The altered granite known as luxullianite, from its occurrence near Luxullian, a village in Cornwall. is a tourmalinized granite in which a progressive replacement of biotite and feldspar by quartz and tourmaline can be traced. The rock still contains pink feldspars in large porphyritic feldspars set in a dark tourmaline matrix, giving polished specimens a handsome appearance. By impregnation with boron-bearing vapours, the slates and sandstones surrounding granites are locally converted into schorl rock, schorl schist or tourmaline hornfels consisting almost wholly of quartz and tourmaline. Banding, lamination or cleavage of the original slates, etc. is frequently preserved. (C. E. T.)

SCHOULER, JAMES (1839–1920), U.S. lawyer and historian of Scottish descent, was best known as a legal writer and for his seven-volume history of the United States. Born in West Cambridge (now Arlington), Mass., on March 20, 1839, he graduated at Harvard in 1859, taught a year at St. Paul's school in Concord, N.H., studied law in Boston and was admitted to the bar in 1862. His legal practice was interrupted by service in the Union army, and in 1869 he moved to Washington, where he opened a branch office and for several years published the *United States Jurist.*

After his return to Boston, he devoted himself to office practice and to literary pursuits, lecturing also at Boston university, the National university law school, Washington, D.C., and Johns Hopkins university, Baltimore, Md. In 1896–97 he was president of the American Historical association. He died at Intervale, N.H., on April 16, 1920. His legal publications include treatises on domestic relations (1870), bailments (1880) and wills (1887).

Schouler is best known, however, as a historian, his most important work being a *History of the United States Under the Constitution* (1880–1913) covering events from 1783 to 1877. Among his other publications are *Historical Briefs* (1896), which contains his biography up to that period; *Constitutional Studies* (1897); lives of Thomas Jefferson (1893) and Alexander Hamilton (1901); *Americans of 1776* (1906); and *Ideals of the Republic* (1908).

SCHREINER, OLIVE (1855–1920), pen name of Mrs. Cronwright-Schreiner, was born in Basutoland, the daughter of a German missionary. In 1881 she brought to England the manuscript of her first novel, *The Story of an African Farm,* a vivid and penetrating study of the life. she knew well, and submitted it to George Meredith, then reader for Chapman and Hall. It was published in 1883 by this firm over the pseudonym "Ralph Iron," and proved an immediate success, entirely surpassing any of her subsequent writings in literary merit. Her later work included *Dreams* (1891); *Trooper Peter Halkett of Mashonaland* (1897), a much-criticized attack on the first settlers in Rhodesia; *An English South African's View of the Situation* (1899); and *Woman and Labour* (1911), a fragment of an earlier manuscript which had been burned during the South African war. She died at Cape Town, U. of S.Af., in Dec. 1920. She had married in 1894 S. C. Cronwright. a member of the Cape parliament. who afterward took the name of S. C. Cronwright-Schreiner. He wrote *The Life of Olive Schreiner,* which appeared in 1924.

SCHREINER, WILLIAM PHILIP (1857–1919), was born in the district of Cape Colony. After studying law at Cape Town, and at Cambridge and London universities, he was called to the bar (Inner Temple) in 1882 and on returning to South Africa in the same year was admitted as an advocate of the Cape supreme court.

He was for many years leader of the Cape bar; in 1887 he entered Cape politics as attorney general in the second Rhodes ministry. He was prime minister on the outbreak of the South African war (1899). In 1914 he was appointed high commissioner for the Union in London, and he died at Llandrindod Wells, Wales, on June 28, 1919.

SCHREYER, ADOLF (1828–1899), German painter, especially esteemed as a painter of horses, of peasant life in Wallachia and Moldavia, and of battle incidents, was born at Frankfurt am Main on May 9, 1828. He studied art first at the Staedel institute in his native town and then at Stuttgart, Munich and Diisseldorf; but he formed his style in Paris, while he found his favourite subjects in his travels in the near east. In 1862 he settled in Paris, but returned to Germany in 1870, settling at Cronberg near Frankfurt, where he died in 1899. Schreyer's work may be seen at the Museum of Art in Toledo, O., at the Metropolitan Museum of Art, New York city, and at other galleries.

SCHRODER, FRIEDRICH LUDWIG (1744–1816), German actor, manager and dramatist, was born in Schwerin on Nov. 3, 1744. In 1764 he appeared with the Ackermann company (K. E. Ackermann was his stepfather) in Hamburg, playing leading comedy parts; but his most famous performances were in the tragic roles of Hamlet. Lear and Philip in Schiller's *Don Carlos.* After Ackermann's death in 1771 Schröder and his mother took over the management of the Hamburg theatre, and he began to write plays — largely adaptations from the English, making his first success with the comedy *Die Arglistige.* In 1780 he left Hamburg, and after a tour with his wife, Anna Christina Hart, accepted an engagement at the Court theatre in Vienna. In 1785 Schroder again took over his Hamburg management and conducted the theatre with marked ability until his retirement in 1798. In 1811 he returned to it for one year. He died on Sept. 3, 1816.

As an actor Schroder abandoned the stilted style of former tragedians; as a manager he first brought Shakespeare before the German public. Schroder's *Dramatische Werke,* with an introduction by Tieck, were published in four volumes (1831).

See B. Litzmann, Friedrich Ludwig Schroder (Hamburg, 1890–94); R. Blum in the *Allgemeines* Theater-Lexikon (1842); and Brunier, Friedrich Ludwig *Schröder* (Leipzig, 1864).

SCHRODINGER, ERWIN (1887–1961), Austrian physicist who, with Paul A. M. Dirac (*q.v.*), was awarded the Nobel prize for physics in 1933 for work on wave mechanics and its applications to atomic structure. His discoveries agreed with those made independently by Werner Heisenberg (*q.v.*).

Schrodinger was born in Vienna on Aug. 12, 1887. He was educated at the University of Vienna, Aus., and was subsequently professor of physics in Stuttgart, Ger., Breslau, Pol., and Ziirich, Switz. He succeeded Max Planck as professor of physics at the University of Berlin in 1927. and in 1940 he became professor at the Institute for Advanced Studies in Dublin. Ire. He returned to Vienna in 1956 and died there on Jan. 4, 1961.

His work. which was mainly in the field of mathematical physics and especially in the physics of the atom, was an extension of the ideas of Louis de Broglie (see BROGLIE, DE). Niels Bohr (*q.v.*) had pictured the atom as consisting of a nucleus about which electrons rotated in fixed orbits, radiation being absorbed or emitted only when an electron changed from one orbit to another, the energy change involved being therefore discrete! and the atom regarded as being in a series of what were called "stationary states." De Broglie's theory of wave mechanics, or matter waves, had modified this by supposing that a wave, with a wave length an exact submultiple of the length of the orbit, is associated with the electron circulating about the nucleus. Schrodinger extended these ideas further to the problem of atomic structure by supposing that such waves could be superposed on each other. The emission and absorption frequencies were thus related to the orbital frequencies and were represented by the differences of the frequencies of two standing waves. The mathematical application of these ideas was confirmed by experimental observations of spectral lines. Schrodinger wrote several works on wave mechanics and also developed a new field theory. (D. McK.)

SCHUBERT, FRANZ PETER (1797–1828), Austrian composer, was born on Jan. 31, 1797, in the Himmelpfortgrund, a small suburb of Vienna. His father, Franz, son of a Moravian peasant, was a parish schoolmaster; his mother, Elizabeth Fitz, had before her marriage been cook in a Viennese family. Of their 14 children nine died in infancy. The father, a man of worth and integrity, possessed some reputation as a teacher, and his school, in the Lichtenthal, was well attended. He was also a fair musician.

At the age of five Schubert began to receive regular instruction from his father. At seven he was placed under the charge of Michael Holzer, the Kapellmeister of the Lichtenthal Church. Holzer's lessons seem to have consisted mainly in expressions of admiration, and the boy gained more from a friendly joiner's apprentice, who used to take him to a neighbouring pianoforte warehouse and give him the opportunity of practising on a better instrument than the poor home could afford.

In Oct. 1808 he was received as a scholar at the Convict, which, under Salieri's direction, had become the chief music-school of Vienna, and which had the special office of training the choristers for the Court Chapel. Here he remained until nearly 17, profiting little by the direct instruction, which was almost as careless as that given to Haydn at St. Stephen's, but much by the practices of the school orchestra, and by association with congenial comrades. Many of the most devoted friends of his after life were among his schoolfellows: Spaun and Stadler and Holzapfel, and a score of others who helped him out of their slender pocket-money, bought him music-paper which he could not buy for himself, and gave him loyal support and encouragement.

EARLY COMPOSITIONS

Meanwhile his genius was already showing itself in composition. A pianoforte fantasia, 32 close-written pages, is dated April 8–May 1, 1810: then followed in 1811, three long vocal pieces written upon a plan which Zumsteeg had popularized, together with a "quintet-overture," a string quartet, a second pianoforte fantasia and a number of songs. His essay in chamber-music is noticeable, since we learn that at the time a regular quartet-party was established at his home "on Sundays and holidays," in which his two brothers played the violin, his father the violoncello and Franz himself the viola. It was the first germ of that amateur orchestra for which, in later years, many of his compositions were written. During the remainder of his stay at the Convict he wrote a good deal more chamber-music, several songs, some miscellaneous pieces for the pianoforte and, among his more ambitious efforts, a Kyrie and Salve Regina, an octet for wind instruments — said to commemorate the death of his mother, which took place in 1812—a cantata, words and music, for his father's name-day in 1813, and the closing work of his school-life, his first symphony.

At the end of 1813 he left the Convict, and, to avoid military service, entered his father's school as teacher of the lowest class. For over two years he endured the drudgery of the work, which, we are told, he performed with very indifferent success. There were, however, other interests to compensate. He took private lessons from Salieri, who annoyed him with accusations of plagiarism from Haydn and Mozart, but who did more for his training than any of his other teachers; he occupied every moment of leisure with rapid and voluminous composition. His first opera —*Des* Teufels Lustschloss — and his first Mass — in F major — were both written in 1814, and to the same year belong three string quartets, many smaller instrumental pieces, the first movement of the symphony in B flat and 17 songs, including such masterpieces as *Der* Taucher and Gretchen am *Spinnrade*. But even this activity is far outpaced by that of the *annus* mirabilis 1815. In this year, despite his school-work, his lessons with Salieri and the many distractions of Viennese life, he produced an amount of music the record of which is almost incredible. The symphony in B flat was finished, and a third, in D major, added soon afterwards. Of church music there appeared two Masses, in G and B flat, the former written in six days, a new Dona *nobis* for the Mass in F, a *Stabat* Mater and a Salve Regina. Opera was represented by no fewer than five works, of which three were completed —*Der Vierjährige Posten,* Fernando and Claudine von Villabella — and two, Adrast and Die *beiden Freunde von Salamanca,* apparently left unfinished. Besides these the list includes a string quartet in G minor, four sonatas and several smaller compositions for piano, and, by way of climax, 146 songs, some of which are of considerable length, and of which eight are dated Oct. 15, and seven Oct. 19.

In the winter of 1814–15 Schubert made acquaintance with the poet Mayrhofer: an' acquaintance which, according to his usual habit, soon ripened into a warm and intimate friendship. They were singularly unlike in temperament: Schubert frank, open and sunny, with brief fits of depression, and sudden outbursts of boisterous high spirits; Mayrhofer grim and saturnine, a silent man who regarded life chiefly as a test of endurance.

As 1815 was the most prolific period of Schubert's life, so 1816 saw the first real change in his fortunes. Somewhere about the turn of the year Spaun surprised him in the composition of Erlkonig — Goethe's poem propped among a heap of exercise-books, and the boy at white-heat of inspiration "hurling" the notes on the music-paper. A few weeks later Von Schober, a law-student of good family and some means, who had heard some of Schubert's songs at Spaun's house, came to pay a visit to the composer and proposed to carry him off from school-life and give him freedom to practise his art in peace. The proposal was particularly opportune, for Schubert had just made an unsuccessful application for the post of Kapellmeister at Laibach, and was feeling more acutely than ever the slavery of the class-room. His father's consent was readily given, and before the end of the spring he was installed as a guest in Von Schober's lodgings. For a time he attempted to increase the household resources by giving music lessons, but they were soon abandoned and he devoted himself to composition. "I write all day," he said later to an inquiring visitor, "and when I have finished one piece I begin another."

The works of 1816 include three ceremonial cantatas and two new symphonies, No. 4 in C minor, called the Tragic, with a striking andante, No. 5 in B flat, as bright and fresh as a symphony of Mozart; some numbers of church music, fuller and more mature than any of their predecessors, and over a hundred songs, among which are comprised some of his finest settings of Goethe and Schiller. There is also an opera, *Die Burgsckajt*, spoiled by an illiterate book.

All this time his circle of friends was steadily widening. Mayrhofer introduced him to Vogl, the famous baritone, who did him good service by performing his songs in the salons of Vienna; Anselm Hiittenbrenner and his brother Joseph ranged themselves among his most devoted admirers; Gahy, an excellent pianist, played his sonatas and fantasias; the Sonnleithners, a rich burgher family whose eldest son had been at the Convict, gave him free access to their home, and organized in his honour musical parties which soon assumed the name of Schubertiaden. The material needs of life were supplied without much difficulty. No doubt Schubert was entirely penniless, for he had given up teaching, he could earn nothing by public performance, and, as yet, no publisher would take his music at a gift; but his friends came to his aid with true Bohemian generosity—one found him lodging, another found him appliances, they took their meals together and the man who had any money paid the score. Schubert was always the leader of the party and was known by half-a-dozen affectionate nicknames, of which the most characteristic is *"kann er 'was?"* his usual question when a new acquaintance was proposed.

The year 1818, though, like its predecessor, comparatively unfertile in composition, was in two respects a memorable year. It saw the first public performance of any work of Schubert's—an overture in the Italian style written as an avowed burlesque of Rossini, and played in all seriousness at a Jäll concert on March 1. It also saw the beginning of his only official appointment, the post of music-master to the family of Count Johann Esterhazy at Zelesz, where he spent the summer amid pleasant and congenial surroundings. On his return to Vienna in the autumn he found that Von Schober had no room for him, and took up his residence with Mayrhofer. He made his first public appearance as a song-writer on Feb. 28, 1819, when the *Schäfers Klagelied* was sung by Jager at a Jall concert. In the summer of the same year he took a holiday and travelled with Vogl through Upper Austria. At Steyr he wrote his brilliant piano quintet in A, and astonished his friends by transcribing the parts without a score. In the autumn he sent three of his songs to Goethe, but, so far as we know, received no acknowledgment.

MATURITY

The compositions of 1820 are remarkable, and show a great advance in development and maturity of style. The unfinished oratorio *Lazarus* was begun in Feb.; later followed, amid a number of smaller works, the 23rd Psalm, the *Gesang der Geister,* the quartettsatz in C minor and the great pianoforte fantasia on *Der Wanderer.* But of almost more biographical interest is the fact that in this year two of Schubert's operas appeared at the Karnthnerthor theatre, *Die Zwillingsbrüder* on June 14, and *Die Zauberharfe* on Aug. 19. Still, however, publishers held obstinately aloof, and it was not until his friend Vogl had sung *Erlkönig* at a concert in the Karnthnerthor (Feb. 8, 1821) that Diabelli hesitatingly agreed to print some of his works on commission. The first seven opus-numbers (all songs) appeared on these terms; then the commission ceased, and he began to receive the meagre pittances which were all that the great publishing houses ever accorded to him. Much has been written about the neglect from which he suffered during his lifetime. It was not the fault of his friends, it was only indirectly the fault of the Viennese public; the persons most to blame were the cautious intermediaries who stinted and hindered him from publication.

The production of his two dramatic pieces turned Schubert's attention more firmly than ever in the direction of the stage; and towards the end of 1821 he set himself on a course which for nearly three years brought him continuous mortification and disappointment. *Alfonso und Estrella* was refused, so was *Fierrabras; Die Verschworenen* was prohibited by the censor (apparently on the ground of its title); *Rosamunde* was withdrawn after two nights, owing to the badness of its libretto. Of these works the two former are written on a scale which would make their performances exceedingly difficult (*Fierrabras,* for instance, contains over 1,000 pages of manuscript score), but *Die Vsrschworenen* is a bright, attractive comedy, and *Rosamunde* contains some of the most charming music that Schubert ever composed. In 1822 he made the acquaintance both of Weber and of Beethoven, but little came of it in either case, though Beethoven cordially acknowledged his genius. Von Schober was away from Vienna; new friends appeared of a less desirable character; on the whole these were the darkest years of his life.

In the spring of 1824 he wrote the magnificent octet, "A Sketch for a Grand Symphony"; and in the summer went back to Zelesz, when he became attracted by Hungarian idiom, and wrote the *Divertissement à l'Hongroise* and the string quartet in A minor. Most of his biographers insert here a story of his hopeless passion for his pupil Countess Caroline Esterhazy; but whatever may be said as to the general likelihood of the romance, the details by which it is illustrated are apocryphal, and the song *l'Addio,* placed at its climax, is undoubtedly spurious. A more debatable problem is raised by the grand duo in C major (op. 140) which is dated from Zelesz in the summer of this year. It bears no relation to the style 'of Schubert's pianoforte music, it is wholly orchestral in character, and it may well be a transcript or sketch of the "grand symphony" for which the octet was a preparation. If so, it settles the question, raised by Sir George Grove, of a "symphony in C major" which is not to be found among Schubert's orchestral scores.

Despite his preoccupation with the stage and later with his official duties he found time during these years for a good deal of miscellaneous composition. The Mass in A flat mas completed and the exquisite "Unfinished Symphony" begun in 1822. The *Müllerlieder,* and several other of his best songs, were written in 1825; to 1824, beside the works mentioned above, belong the variations on *Trockne Blumen* and the two string quartets in E and E flat. There is also a sonata for piano and arpeggione, an interesting attempt to encourage a cumbersome and now obsolete instrument.

The mishaps of the recent years were compensated by the prosperity and happiness of 1825. Publication had been moving more rapidly; the stress of poverty was for a time lightened; in the summer there was a pleasant holiday in Upper Austria, where Schubert was welcomed with enthusiasm. It was during this tour that he produced his "Songs from Sir Walter Scott," and his piano sonata in A minor (op. 42), the former of which he sold to Artaria for £20, the largest sum which he had yet received for any composition. Sir George Grove, on the authority of Randhartinger, attributes to this summer a lost "Gastein" symphony which is possibly the same work as that already mentioned under the record of the preceding year.

From 1826 to 1828 Schubert resided continuously in Vienna, except for a brief visit to Graz in 1827. The history of his life during these three years is little more than a record of his compositions. The only events worth notice are that in 1826 he applied for a conductorship at the opera, and lost it by refusing to alter one of his songs at rehearsal, and that in the spring of 1828 he gave, for the first and only time in his career, a public concert of his own works. But the compositions themselves are a sufficient biography. The string quartet in D minor, with the variations on the song *Der Tod und das Mädchen,* was written during the winter of 1825–26, and first played on Jan. 25. Later in the year came the string quartet in G major, the "Rondeau brilliant," for piano and violin, and the fine sonata in G which, by some pedantry of the publisher's, is printed without its proper title. To these should be added the three Shakespearian songs, of which *Hark! Hark! the Lark* and *Who is Sylvia?* were written on the same day, the former at a tavern where he broke his afternoon's walk, the latter on his return to his lodging in the evening. In 1827 he wrote the *Winterreise* songs, the fantasia for piano and violin, and the two piano trios; in 1828 the *Song of Miriam,* the C major symphony, the Mass in E flat, and the exceedingly Beautiful *Tantum Ergo* in the same key, the string quintet, the second Benedictus to the Mass in C, the last three piano sonatas, and the collection of songs known as *Schwanengesang.* Six of these are to words by Heine, whose *Buch der Lieder* had recently appeared. Everything pointed to the renewal of an activity which should equal that of his greatest abundance, when he was suddenly attacked by typhus fever, and after a fortnight's illness died on Nov. 19 at the house of his brother Ferdinand. He had not completed his 32nd year.

HIS ACHIEVEMENT

Some of his smaller pieces were printed shortly after his death, but the more valuable seem to have been regarded by the publishers as waste paper. In 1838 Schumann, on a visit to Vienna, found the dusty manuscript of the C major symphony and took it back to Leipzig, where it was performed by Mendelssohn and celebrated in the *Neue Zeitschrift*. The most important step towards the recovery of the neglected works was the journey to Vienna which Sir George Grove and Sir Arthur Sullivan made in the autumn of 1867. The travellers rescued from oblivion seven symphonies, the *Rosamunde* music, some of the Masses and operas, some of the chamber works, and a vast quantity of miscellaneous pieces and songs. Their success gave impetus to a widespread public interest and finally resulted in the definitive edition of Breitkopf and Härtel.

Schubert is best summed up in the well-known phrase of Liszt, that he was "le musicien le plus poète qui fut jamais." In clarity of style he was inferior to Mozart, in power of musical construction he was far inferior to Beethoven, but in poetic impulse and suggestion he is unsurpassed. He wrote always at headlong speed, he seldom blotted a line, and the greater part of his work bears, in consequence, the essential mark of improvisation: it is fresh, vivid, spontaneous, impatient of restraint, full of rich colour and of warm imaginative feeling. He was the greatest song-writer who ever lived, and almost everything in his hand turned to song. In his Masses, for instance, he seems to chafe at the contrapuntal numbers and pours out his whole soul on those which he found suitable for lyrical treatment. In his symphonies the lyric and elegiac passages are usually the best, and the most beautiful of them all is, throughout its two movements, lyric in character. The standpoint from which to judge him is that of a singer who ranged over the whole field of musical composition and everywhere carried with him the artistic form which he loved best.

Like Mozart, whose influence over him was always considerable, he wrote nearly all the finest of his compositions in the last ten years of his life. His early symphonies, his early quartets, even his early Masses, are too much affected by a traditional style to establish an enduring reputation. It is unfair to call them imitative, but at the time when he wrote them he was saturated with Mozart, and early Beethoven, and he spoke what was in his mind with a boy's frankness. The andante of the Tragic symphony (NO. 4) strikes a more distinctive note, but the fifth is but a charming adaptation of a past idiom, and the sixth, on which Schubert himself placed little value, shows hardly any appreciable advance. It is a very different matter when we come to the later works. The piano quintet in A major (1819) may here be taken as the turning-point; then come the Unfinished symphony, which is pure Schubert in every bar; the three quartets in A minor, D minor and G major, full of romantic colour; the delightful piano trios; the great string quintet; and the C major symphony which, though diffuse, contains many passages of surpassing beauty.

His larger operas are marred both by their inordinate length and by their want of dramatic power. The slighter comedies are pretty and tuneful, but, except as curiosities, are not likely to be revived. We may, however, deplore the fate which has deprived the stage of the *Rosamunde* music. It is in Schubert's best vein; the *entr'actes*, the romance, and the ballets are alike excellent, and it is much to be hoped that a poet will some day arise and fit the music to a new play.

Of his pianoforte compositions, the sonatas, as might be expected, are the least enduring, though there is not one of them which does not contain some first-rate work. On the other hand his smaller pieces, in which the lyric character is more apparent, are throughout interesting to play and extremely pleasant to hear. A special word should be added on his fondness for piano duets, a form which before his time had been rarely attempted.

His concerted pieces for the voice are often extremely difficult, but they are of a rare beauty which would well repay the labour of rehearsal.

Of the songs it is impossible, within the present limits, to give even a sketch. They number over 600, excluding scenas and operatic pieces, and they contain masterpieces from the beginning of his career to the end. *Gretchen am Spinnrade* was written when he was 17, *Erlkönig* when he was 18; then there follows a continuous stream which never checks or runs dry, and which broadens as it flows to the *Müllerlieder*, the Scott songs, the Shakespearian songs, the *Winterreise*, and the *Schwanengesang*. He is said to have been undiscriminating in his choice of words. Schumann declared that "he could set a handbill to music," and there is no doubt that he was inspired by any lyric which contained, though even in imperfect expression, the germ of a poetic idea. But his finest songs are almost all to fine poems. He set over 70 of Goethe's, over 60 of Schiller's.

In his earlier songs he is more affected by the external and pictorial aspect of the poem; in the later ones he penetrates to the centre and seizes the poetic conception from within. But in both alike he shows a gift of absolute melody which, even apart from its meaning, would be inestimable. Neither Händel nor Mozart—his two great predecessors in lyric tune—have surpassed or even approached him in fertility and variety of resource. The songs in *Acis* are wonderful; so are those in *Zauberflöte*, but they are not so wonderful as *Litanei*, and *Who is Sylvia?* and the *Ständchen*. To Schubert we owe the introduction into music of a particular quality of romance, a particular "addition of strangeness to beauty"; and so long as the art remains his place among its supreme masters is undoubtedly assured.

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SCHÜCKING, WALTER (1875–1935), German jurist, was born on Jan. 6, 1875, at Munster, Westphalia. He taught at the universities of Breslau and Marburg 1900–21, and in 1921 was appointed a professor at the Berlin commercial high school. In 1919 he was appointed a member of the National Assembly and chief German delegate to the Peace Conference at Versailles. In 1919 he became a member of the permanent court of arbitration at The Hague. In 1920 and again in 1924 he was elected to the Reichstag and became one of the leaders of the German Democratic party.

His works include: *Das Küstenmeer im internationalen Recht* (1897), "Die Verwendung von Minem im Seekrieg" (in Niemeyer's *Zeitschrift*, vol. 16), *Die Organisation der Welt* (2nd ed. 1909), *Der Staatenverband der Haager Conferenzen* (1912) (Eng. trans. 1918), *Neue Ziele der staatlichen Entwicklung* (3rd ed. 1913), *Internationale Rechtsgarantien* (Hamburg, 1918), *Die Satzung des Völkerbundes* (2nd ed. 1924), *Garantiepakt und Rüstungsbeschränkung* (1924), *Das Genfer Protokoll* (1924).

SCHULZE-DELITZSCH, FRANZ HERMANN (1808–1883), German economist, was born at Delitzsch, in Prussian Saxony, on Aug. 29, 1808. The suffix Delitzsch was added in 1848 to distinguish him from other Schulzes in the National Assembly. He studied law at Leipzig and Halle, became an assessor in the court of justice at Berlin in 1838, and three years later was appointed *Patrimonialrichter* at Delitzsch. Entering the parliament of 1848, he joined the Left Centre, and, acting as president of the commission of inquiry into the condition of the labourers and artisans, became impressed with the necessity of co-operation to enable the smaller tradespeople to hold their own against the capitalists. He was a member of the Second Chamber in 1848–49; but a quarrel with the minister of justice led him to throw up his public appointments in October 1851, and withdraw to

Delitzsch. Here he devoted himself to the organization of co-operative societies, and of Vorschussvereine (people's banks). In 1859 he promoted the first *Genossenschaftstag,* or co-operative meeting, in Weimar, and founded a central bureau of co-operative societies. In 1861 he again entered the Prussian Chamber. The next few years were given to the formation of local centres, and the establishment of the Deutsche Genossenschafts-Bank, 1865.

The spread of these organizations led to legislation on the subject, and this too was chiefly the work of Schulze-Delitzsch. As a member of the Chamber in 1867 he was mainly instrumental in passing the Prussian law of association, which was extendec! to the North German Confederation in 1868, and later to the empire. Schulze-Delitzsch also contributed to uniformity of legislation throughout the states of Germany, in 1869. by the publication of *Die Gesetzgebung über die privatrechtliche Stellung der Erwerbs- und Wirthschaftsgenossenschaften,* etc. His remaining years were spent in consolidating his work. He died on April 29, 1883, at Potsdam.

His works include: *Kapitel zu einem deutschen Arbeiter-Katechismus* (1863); *Soziale Rechte und Pflichten* (1867); and *Die Entwicklung des Genossenschaftswesen in Deutschland* (1870). *See* also A. Bernstein, *Schulze-Delitzsch* (1879); B. Rampal, *Esquisse Biographique* (1874).

SCHUMANN, **ROBERT** ALEXANDER (1810–1856), German musical composer, was born on June 8, 1810, in Zwickau, Saxony, the son of a publisher. He tells us that he began to compose before his seventh year. At fourteen he wrote an essay on the aesthetics of music and also contributed to a volume edited by his father, entitled *Portraits of Famous Men.* While still at school in Zwickau he read, besides Schiller and Goethe, Byron (whose *Beppo* and *Childe Harold* had been translated by his father) and the Greek tragedians. But the most powerful and permanent of the literary influences exercised upon him, however, was that of Jenn Paul Richter. This influence may clearly be seen in his youthful novels *Juniusabende* and *Selene,* of which the first only was completed (1826). In 1828 he left school, and after a tour, during which he met Heine at Munich, he went to Leipzig to study law. His interest in music had been stimulated when he was a child by hearing hfoscheles play at Carlsbad, and in 1827 by the works of Schubert and Mendelssohn. But his father, who had encouraged the boy's musical aspirations, had died in 1826, and neither his mother nor his guardian approved of a musical career for him. Nevertheless, both at Leipzig and at Heidelberg, whither he went in 1829, he neglected the law for the philosophers, and began composing songs. At Easter 1830 he heard Paganini at Frankfurt. In December 1830 he returned to Leipzig, taking piano lessons with his old master, Friedrich Wieck. In his haste to acquire a perfect execution he permanently injured his right hand. His ambitions as a pianist being thus suddenly ruined, he began a course of theory under Heinrich Dorn, conductor of the Leipzig opera. About this time he contemplated an opera on the subject of *Hamlet.*

The fusion of the literary idea with its musical illustration, which may be said to have first taken shape in *Papillons* (op. 2), is foreshadowed in an essay on Chopin's variations on a theme from *Don Juan,* which appeared in the *Allgemeine musikalische Zeitung* in 1831. Here the work is discussed by the imaginary characters Florestan and Eusebius (the counterparts of Vult and Walt in Jean Paul's novel *Flegeljahre*), and Meister Raro (representing either the composer himself or Wieck) is called upon for his opinion. By the time, however, that Schumann had written *Papillons* (1831) he had gone a step farther. The scenes and characters of his favourite novelist had now passed definitely and consciously into the written music, and in a letter from Leipzig (April 1832) he bids his brothers "read the last scene in Jean Paul's *Flegeljahre* as soon as possible, because the *Papillons* are intended as a musical representation of that masquerade." In the winter of 1832 Schumann visited his relations at Zwickau and Schneeberg, when the first movement of his symphony in G minor mas performed. In Zwickau the music was played at a concert given by Wieck's daughter Clara. then only thirteen. The death of his brother Julius and of his sister-in-law Rosalie in 1833 affected Schumann with profound melancholy. By the spring of 1834, however, he started *Die neue Zeitschrift fur Musik,* the paper in which appeared the greater part of his critical writings. The journal effected a revolution in the taste of the time, when Mozart, Beethoven and Weber were neglected, and the genius of Chopin and of Berlioz unappreciated.

During the summer of 1834, Schumann became engaged to Ernestine von Fricken, a girl of sixteen, the adopted daughter of a rich Bohemian, from whose variations on a theme in C♯ minor Schumann constructed his own *Études symphoniques.* The engagement was broken off by Schumann, for reasons which have always remained obscure. In the *Carnaval* (op. 9=1834), Schumann commenced nearly all the sections with the musical notes signified in German by the letters that spell Asch, the town in which Ernestine was born, which also are the musical letters in Schumann's own name. By the sub-title "Estrella" to one of the sections in the *Carnaval,* Ernestine is meant, and by the sub-title "Chiarina" Clara Wieck. In the *Carnaval* Schumann went farther than in *Papillons,* for in it he himself conceived the story of which it was the musical illustration. On Oct. 3, 1835, Schumann met Mendelssohn at Wieck's house in Leipzig, and his appreciation of his great contemporary was shown with the generous freedom that distinguished him in all his relations to other musicians.

In 1836 Schumann's acquaintance with Clara Wieck, already famous as a pianist, ripened into love, and a year later he asked her father's consent to their marriage, but was met with a refusal. The series of *Phantasiestücke* for the piano (op. 12) once more illustrates the fusion of literary and musical ideas as embodied conceptions in such pieces as "Warum" and "In der Nacht." In the *Kreisleriana,* written in 1838, the composer's realism is again carried a step farther. Kreisler, the romantic poet brought into contact with the real world, was a character drawn from life by the poet E. T. A. Hoffmann (*q.v.*), and Schumann used him as a mouthpiece for the recital in music of his own personal experiences. The *Phantasie* (op. 17), written in the summer of 1836, is a work of the highest quality of passion. With the *Faschingschwank aus Wien,* his most pictorial work for the piano, written in 1839, after a visit to Vienna, this period of his life comes to an end. As Wieck still withheld hi: consent to their marriage, Robert and Clara dispensed with it, and were married on Sept. 12 at Schonefeld, near Leipzig.

Until now Schumann had written almost solely for the pianoforte, but in 1840 he wrote about a hundred and fifty songs. Schumann's biographers represent him as caught in a tempest of song, the sweetness, the doubt and the despair of which are all to be attributed to varying emotions aroused by his love for Clara. Yet it would be idle to ascribe to this influence alone the lyrical perfection of "Friihlingsnacht," "Im wunderschonen Monat Mai" and "Schone Wiege meiner Leiden." His chief song-cycles of this period were his settings of the *Liederkreis* of J. von Eichendorff (op. 39), the *Frauenliebe und Leben* of Chamisso (op. 42), the *Dichterliebe* of Heine (op. 48) and *Myrthen,* a collection of songs, including poems by Goethe, Riickert, Heine, Byron, Burns and Moore. The songs "Belsatzar" (op. 57) and "Die beiden Grenadiere" (op. 49), each to Heine's words, show Schumann at his best as a ballad writer, though the dramatic ballad is less congenial to him than the introspective lyric. As Grillparzer said, "He has made himself a new ideal world in which he moves almost as he wills." But in his lifetime the sole tokens of honour bestowed upon Schumann were the degree of Doctor by the University of Jena in 1840, and in 1843 a professorship in the Conservatorium of Leipzig In 1841 he wrote two of his four symphonies. The year 1842 was devoted to the composition of chamber music, and includes the pianoforte quintet (op. 44). In 1843 he wrote *Paradzse and the Peri,* his first essay at concerted vocal music. He had now mastered the separate forms, and from this time forward his compositions are not confined during any particular period to any one of them. In Schumann, above all musicians, the acquisition of technical knowledge was closely bound up with the growth of his own experience and the impulse to express it. The stage in his life when he was deeply engaged in his music to Goethe's Faust (1844–1853) was a critical one for his health. The first half of the year 1844 had been spent with his wife in Russia. On returning to Germany he had abandoned his editorial work, and left Leipzig for Dresden, where he suffered from persistent nervous prostration. As soon as he began to work he was seized with fits of shivering, and an apprehension of death which was exhibited in an abhorrence for high places, for all metal instruments (even keys) and for drugs. He suffered perpetually also from imagining that he had the note A sounding in his ears. In 1846 he had recovered, and in the winter revisited Vienna, travelling to Prague and Berlin in the spring of 1847 and in the summer to Zwickau.

To 1848 belongs his only opera, Genoveva. It is interesting for its attempt to abolish the recitative, which Schumann regarded as an interruption to the musical flow. The music to Byron's *Manfred* is pre-eminent in a year (1849) in which he wrote more than in any other. The insurrection of Dresden caused Schumann to move to Kreischa, a village near the city. In August, on the occasion of the centenary of Goethe's birth, such scenes of Schumann's Faust as were already completed were performed in Dresden, Leipzig and Weimar, Liszt as always giving unwearied assistance and encouragement. The rest of the work was written in the latter part of the year, and the overture in 1853. From 1850 to 1854 the text of Schumann's works is extremely varied. In 1850 he succeeded Ferdinand Hiller as musical director at Düsseldorf; in 1851–1853 he visited Switzerland and Belgium as well as Leipzig. In January 1854 Schumann went to Hanover, where he heard a performance of his Paradise and *the* Peri. Soon after his return to Diisseldorf, a renewal of the symptoms that had threatened him before showed itself. Besides the single note he now imagined that voices sounded in his ear. One night he suddenly left his bed, saying that Schubert and Mendelssohn had sent him a theme which he must write down, and on this theme he wrote five variations for the pianoforte, his last work. On Feb. 27 he threw himself into the Rhine. He was rescued by some boatmen, and taken to a private asylum in Endenich near Bonn, where he remained until his death on July 29, 1856.

His wife, CLARA SCHUMANN (1819–1896), extended her own reputation as a pianist beyond the borders of Germany, and it was thanks to her efforts that Schumann's compositions became generally known in Europe. From 1865 onward she was a regular visitor in London. In 1878 she was appointed teacher of the piano at the Hoch Conservatorium at Frankfurt, a post which she held until 1892, and in which she contributed greatly to the modern improvement in technique. As an artist she is remembered, together with Joseph Joachim, as one of the first executants who really played like composers. She was herself the composer of a few songs and of some charming music, mainly for the piano, and the authoritative editor of her husband's works for Breitkopf and Härtel.

The following are the chief compositions of Robert Schumann.

Pianoforte Works.

Papillons (op. 2)	1829–31
Etudes symphoniques (op. 13)	1834
Carnaval (op. 9)	1834–35
Sonata in F sharp minor (op. 11)	1835
Sonata in G minor (op. 22)	1833–35
Kinderszenen (op. 15)	1836
Fantasia in C (op. 17)	1836
Fantasiestücke (op. 12)	1837
Kreisleriana (op. 16)	1838
Novelletten (op. 21)	1838
Faschingschwank aus Wien (op. 26)	1839

Songs and Choral Works

Songs:—"Liederkreis" (Heine), nine songs (op. 24)	1840
"Myrthen," twenty-six songs (4 books) (op. 25)	1840
"Liederkreis" (Eichendorff), twelve songs (op. 39)	1840
"Frauenliebe und Leben" (Chamisso), eight songs (op. 42)	1840
"Dichterliebe," sixteen songs from Heine's *Buch der Lieder* (op. 48)	1840
"Belsatzar," ballad (Heine) (op. 57)	1840
Song, "Tragödie" (Heine) from op. 64	1841
Ballad, "Der Handschuh" (Schiller)	probably 1851
Songs from Wilhelm Meister and Requiem for Mignon for chorus (op. 98)	1849
Spanische Liebeslieder (op. 138)	1849
Choral *and* Dramatic Works:—"Paradise and the Peri," for solos, chorus and orchestra (op. 50)	1843
Faust music	1844–1853
"Genoveva," opera	1848
Manfred music	1849
"Der Rose Pilgerfahrt" (Moritz Horn), for solos, chorus and orchestra (op. 112)	1851
"Der Königssohn" (Uhland), for solos, chorus and orchestra (op. 103)	1851
"Des Sängers Fluch" (Uhland) for solos, chorus and orchestra (op. 139)	1852
Mass for four part chorus and orchestra (op. 148)	1852
"Vom Pagen und der Königstochter," four ballads (Geibel) for solos, chorus and orchestra (op. 135)	1852
"Das Gliick von Edenhall," ballad (Uhland), for solos, chorus and orchestra (op. 143)	1853
Festival overture on the *Rheinweinlied* for orchestra and chorus (op. 123)	1853

Chamber Music

Three quartets for strings in A minor, F and A (op. 41)	1842
Quintet for pianoforte and strings in E flat (op. 44)	1842
Quartet for pianoforte and strings in E flat (op. 47)	1842
Fantasiestucke for pianoforte, violin and violoncello (op. 88)	1842
Andante and variations for two pianofortes (op. 46)	1843
Trio for pianoforte and strings in D minor (op. 63)	1847
Trio for pianoforte and strings in F (op. 80)	1847
Fantasiestucke for clarinet and pianoforte (op. 73)	1849
Five "Stiicke im Volkston" for piano and violoncello (op. 102)	1849
Three Romances for oboe and piano (op. 94)	1849
"hlarchenbilder" for pianoforte and viola (op. 113)	1851
Sonata for pianoforte and violin in A minor (op. 105)	1851
Trio for pianoforte and strings in G minor (op. 110)	1851
Sonata for pianoforte and violin in D minor (op. 121)	1851
"Marchenerzahlungen," four pieces for clarinet, viola and pianoforte, probably written in	1853

Orchestral *Works*

B flat Symphony (op. 38)	1841
Fourth Symphony in D minor (op. 120)	1841
Overture, Scherzo and Finale	1841
Second Symphony in C (op. 61)	1846
Third or "Rhenish" Symphony in E flat (op. 97)	1850

Concertos *and* Concert-Stucke

For Pianoforte in A minor (op. 54)	1841–1845
Concert-stiick for four horns (op. 86)	1849
Introduction and Allegro-appassionato for Pianoforte (op. 92)	1849
concerto for Violoncello (op. 126)	1852

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SCHUMANN-HEINK, ERNESTINE (1861–1936), contralto, was born at Leiben, near Prague, June 15, 1861. After making her début as Azucena, Oct. 13, 1878, at the Court theatre, Dresden, she was engaged at the Stadt theatre, Hamburg, where she remained until she went to the Royal theatre, Berlin. After appearing with success at Bayreuth, in 1896, she made her American début in *Lohengrin,* at Chicago in 1898. Her London début was at Covent Garden, in Das *Rheingold,* 1902.

See Mary Lawton, *Schumann-Heink* (1929).

SCHUMPETER, JOSEPH ALOIS (1883–1950), economist whose work bridges the static equilibrium theory of Léon Walras and modern dynamics (see ECONOMICS: The Marginal Utility Analysis), was born in Triesch, Moravia (now in Czechoslovakia), on Feb. 8, 1883. In Vienna he was a pupil of Friedrich von Wieser and Eugen Bohm-Baaerk and he taught at Czernoaitz, Graz and Bonn (1909–32) when he went to the U.S. where he taught at Harvard university until his death.

Schumpeter's *Theorie der wirtschaftlichen Entwicklung* (1912; Eng. trans., *The Theory of Economic Development*, 1934) contained the seeds of his later work. The central idea is that of the creative entrepreneur whose activities as an "innovator" prevent the capitalist system from settling down into the monotonous circular flow of a static state. The phenomena of interest, held to be nonexistent in a static economy (a view for which he was much criticized), and profit emerge as the results of dynamic change. Business cycles are also the indirect product of innovation, and the capitalist system generates the forces of its own decline into socialism. Schumpeter was consistently hostile to Keynesian economics. He exalted mathematics in economic theory and was a founder of the Econometric society. He died in Taconic. Conn.. Jan. 8, 1950; his monumental *History of Economic Analysis* (1954) was published posthumously.

See for bibliography of Schumpeter's writings *Quarterly Journal of Economics* (Aug. 1950); evaluations of his work are in *Schumpeter, Social Scientist*, ed. by Seymour Harris (1951). (E. H. Cn.)

SCHURMAN, JACOB GOULD (1854–1942), U.S. educator and diplomat. was born at Freetown, P.E.I.. on May 22. 1854, of Dutch descent, his loyalist ancestors having left New York in 1784. He secured his B.A. and M.A. degrees at the University of London (1877 and 1878) and studied for several years in Paris, Edinburgh and Germany. After teaching appointments at Acadia, Wolfville, N.S., (1880–82) and Dalhousie, Halifax. N.S., (1882–86) colleges. he went to Cornell university as professor of philosophy. He became dean of the Sage school of philosophy in 1891 and president of the university in 1892, holding that post until 1920. Like his predecessor. Andrew Dickson White (*q.v.*), he united a diplomatic with an educational career. He was president of the first U.S. Philippine commission in 1899; he served as minister to Greece and Montenegro and to China. becoming in 1925 ambassador to Germany. He edited the *Philosophical Review* (of which he was a cofounder) and wrote *Kantian Ethics and the Ethics of Evolution* (1881), *The Ethical Import of Darwinism* (1888), *Belief in God* (1890), *Agnosticism and Religion* (1896), *The Balkan Wars, 1912–1913* (1914) and *Why America Is in the War* (1917). He died on Aug. 12. 1942.

SCHURZ, CARL (1829–1906), German-American statesman and reformer, was born in Liblar. near Cologne, on March 2, 1829, the son of a school-teacher. He studied in the Jesuit gymnasium of Cologne in 1840–46, and then entered the University of Bonn, where he became a revolutionary and assisted Gottfried Kinkel, professor of literature and history, in editing the *Bonner Zeitung*. On the outbreak of the revolution of 1848 he took the field. but when Rastatt surrendered he escaped to Ziirich. In 1850 he returned secretly to Germany, rescued Kinkel from prison and helped him to escape to Scotland. Schurz went to Paris. but the police forced him to leave France on the eve of the *coup d'état*, and until Aug. 1852 he lived in London, making his living by teaching German. He married in July 1852 and removed to America. living for a time in Philadelphia.

In 1856 after a year in Europe he settled in Watertown, Wisconsin, and immediately became prominent in the Republican Party. In the Illinois campaign of the next year between Abraham Lincoln and Stephen A. Douglas he took part as a speaker; and later in 1858 he began to practise law in Milwaukee. In the State campaign of 1859 he made a speech attacking the Fugitive Slave Law and in the same year he delivered in Faneuil Hall, Boston, an oration on "true Americanism," which coming from an alien was intended to clear the Republican Party of the charge of "nativism." In the Republican national convention of 1860 Schurz was chairman of the delegation from Wisconsin. Lincoln sent him in 1861 as minister to Spain. He returned to America in Jan. 1869, was commissioned brigadier-general of volunteers in April. and in June took command of a division under Frémont, and then in Sigel's corps, with which he took part in the second battle of Bull Run. He was promoted major-general of volunteers on March 14, and was a division commander at Chancellorsville of the 11th Corps, under Gen. O. O. Howard. He was at Gettysburg and at Chattanooga and was then put in command of a corps of instruction at Nashville; he was with Sherman's army in North Carolina in the last months of the war and resigned immediately after the close of hostilities. In 186j President Johnson sent him through the South to study conditions; but Schurz's valuable report, suggesting the readmission of the States with complete rights and the investigation of the need of further legislation by a Congressional committee, n·as not heeded by the president. In 1866–67 he was chief editor of the Detroit *Post* and then became editor and, joint proprietor with Emil Praetorius (1827–1905) of the *Westliche Post* of St. Louis.

In 1869–75 he was U.S. senator from Missouri, and made a great reputation by his speeches on financial subjects. During this period he broke with the administration: he started the Liberal Republican movement in Missouri in 1870 and in 1872 he presided over the Liberal Republican convention. He opposed Grant's Santo Domingo policy, his Southern policy, and the Government's selling arms and making cartridges for the French army in the Franco-Prussian War. But in 1875 he campaigned for Hayes, as the representative of "sound money," in the Ohio gubernatorial campaign. In 1876 he supported Hayes in the contest for the presidency, and Hayes made him in 1877 his secretary of the interior. Upon his retirement in 1881 he removed to New Tork city, and from 1881 to 1883 was editor-in-chief and one of the proprietors of the *New York Evening Post*. In 1884 he was a leader in the Independent (or Mugwump) movement against the nomination of James G. Blaine for the presidency and for the election of Grover Cleveland. In 1892 he succeeded George William Curtis as president of the National Civil Service Reform League and held this office until 1901. He succeeded Curtis as editorial writer for *Harper's Weekly* in 1892–98, in which he did much for civil service reform and for Cleveland's nomination and election in 1892. He opposed W. J. Bryan for the presidency in 1896, speaking for sound money; in 1900 on the anti-imperialism issue he supported Bryan. He died in New York city on May 14, 1906.

Schurz published a volume of *Speeches* (188j); *Henry Clay* (1887) in the "American Statesmen" series; *Abraham Lincoln* (1889); and *Reminiscences* (1907–08).

SCHUYLER, MONTGOMERY (1843–1914), U.S. journalist. writer and architectural critic. an exponent of modern American architecture. was born in Ithaca, N.Y.. Xug. 19, 1843. and died in New Rochelle. N.Y., July 16. 1914. Schuyler spent 42 years on the staffs of the *New York World* (1865–83) and the *New York Times* (1883–1907) and was also managing editor of *Harper's Weekly* (1885–87). His editorials and features were urbane. dignified and punctuated with sophisticated literary allusions. Schuyler's architectural criticism was no less accomplished than his editorials. though grace and elegance of phrasing were sometimes replaced by polemics and ridicule. He helped found the *Architectural Record* (1891) and from then on his architectural writings had an increasing effect on the architectural profession. *Studies in American Architecture* (1892). a collection of his earlier architectural writings, contains a magnificent essay on the Brooklyn bridge. Though late in life Schuyler praised skyscraper Gothic, he was among the first to recognize and evaluate the significance of the works of Louis Sullivan and Frank Lloyd Wright.

His other published works include *Westward the Course of Empire* (1906), a collection of descriptive essays, and *The Woolworth Building* (1913).

See E. R. Smith, "Montgomery Schuyler and the History of American Architecture," *Architectural Record* (Sept. 1914), for a bibliography of Schuyler's architectural writings. (H. Mn.)

SCHUYLER, PHILIP JOHN (1733–1804), American soldier, mas born at Albany, N.Y., on Nov. 11, 1733. The Schuyler family was established in the new world by Philip Pieterse Schuyler (d. 1683), who migrated from Amsterdam in 1650, and whose son, Peter (1657–1724), was the first mayor of Albany. The family was one of the wealthiest and most influential in the colony and was closely related by marriage to the Van Rensselaers, Van Cortlandts and other representatives of the old Dutch aristocracy. Philip Schuyler served in the Provincial army during the Seven Years' War, first as captain and later as major, taking part in the battles of Lake George (1755), Oswego river (1756), Ticonderoga (1758) and Fort

Frontenac (1758). From 1768 to 1775 he represented Albany in the New York assembly, and he was closely associated with the Livingston family in the leadership of the Presbyterian or Whig party. He was a delegate to the Second Continental congress in May 1775, and on June 19, was chosen one of the four major generals in the Continental service. Placed in command of the northern department of New York, he made preparations for an invasion of Canada. Soon after the expedition started he was prostrated by rheumatic gout, and the actual command devolved upon Gen. Richard Montgomery. On the death of Montgomery and the failure to take Quebec the army retreated to Crown Point, and its commander, Gen. John Sullivan, was superseded by Gen. Horatio Gates. Gates claimed precedence over Schuyler and, on failing to secure recognition, intrigued to bring about Schuyler's dismissal. The necessary withdrawal of the army from Crown Point in 1776 and the evacuation of Ticonderoga in 1777 were magnified by Schuyler's enemies into a retrograde movement, and, on Aug. 19, 1777, he was superseded. A court martial appointed in 1778 acquitted him on every charge. He resigned from the army in April 1779. In 1788 he joined his son-in-law Alexander Hamilton, John Jay and others in leading the movement for the ratification by New York of the federal constitution. He served in the United States senate as a Federalist in 1790–91 and mas again elected in 1797. He was also active for many years as Indian commissioner and surveyor general and helped to settle the New York boundary disputes with Massachusetts arid Pennsylvania. In 1792–96 he carried to a successful conclusion a project for connecting the Hudson with Lake Ontario by way of the Mohawk, Oneida lake and the Onondaga river. He died on Nov. 18, 1804.

SCHWANN, THEODOR (1810–1882). German physiologist known as one of the originators of the cell theory, and the first to use this term, was born at Neuss in Rhenish Prussia on Dec. 7, 1810. After studying at Cologne, Bonn and Würzburg, he graduated in medicine at Berlin in 1834. There he assisted Johannes Peter Muller (*q.v.*) with his experimental work in physiology. Schwann in 1838 was called to the chair of anatomy at the University of Louvain. and in 1847 went as professor to Liège, where he continued until his death, at Cologne, on Jan. 11, 1882. While working with Müller, Schwann's attention was directed to the physicochemical basis of life. Between 1825 and 1837 several workers demonstrated that yeasts of beer and wine are cells that multiply by budding.

In 1839 Schwann was the first to observe internal spores of yeasts, and demonstrated the necessity to digestion of the presence of a ferment which he called pepsin. In 1837 he began to investigate the laws of muscular contraction, discovering the striated muscle in the upper part of the esophagus, and, later, the myelin sheath, covering the peripheral axons, which now bears his name (*see* REGENERATION: *Nerve Regeneration*). Schwann's *Microscopic Investigations on the Accordance in the structure and Growth of Plants and Animals* (1839; Eng. trans., 1847) set forth his hypothesis that both animal and vegetable tissues are to be traced back to cells and that the cells of each are identical in character. His cell theory was taken up by Rudolf Virchow (*q.v.*), who disproved Schwann's hypothesis of the discontinuity of cell formation.

SCHWANTHALER, LUDWIG VON (1802–1848), German sculptor, who was in style a belated neoclassicist, m s born in Munich on Aug. 26, 1802. He studied in Munich and in Rome, where he adopted the neoclassical manner. After 1834 in the new palaces and museums built in Munich by Ludwig I he was probably kept so busy doing pediments, friezes and the like that he had no opportunity to fulfill his real capabilities. Some of his work was on a colossal scale, *e.g.*, a 60-ft. figure of Bavaria, and twelve 10-ft, bronze figures. He supplied the Alte Pinakothek with 25 marbles commemorative of painters. Outside Munich he executed groups for both pediments of the Walhalla in Ratisbon, and also numerous portrait statues, including those of Mozart, Jean Paul Richter and Goethe. Schwanthaler died at Munich on Nov. 14, 1848, and left to the Munich academy his models and studies (about 200), which now form the Schwanthaler museum.

(A. K. McC.)

SCHWARZENBERG, FELIX, PRINCE. ZU (1800–1852), Austrian statesman, was born on Oct. 2, 1800.

After six years' service in the Austrian army, Felix espoused a diplomatic career at the instance of Metternich, and underwent a period of probation (1824–48) at various European courts, which confirmed his aristocratic aversion to popular government. In 1848 he took an active part in the war against Piedmont and the insurgents in Vienna. On Nov. 21, 1848, he was appointed head of a reactionary ministry, at the instance of his brother-in-lam, Prince Windischgratz. Himself a soldier, he aimed at the restoration of the absolute monarchy by means of the army. He supervised the abdication of Ferdinand and proclamation of Francis Joseph as emperor, and although at first he held out prospects of constitutional government, he dissolved the Kremsier *reichstag* at the earliest opportunity (March 7. 1849) and late in November called in the Russians to end the war in Hungary. He then turned his attention to Germany. His refusal to incorporate only the German provinces of the monarchy in the proposed new German empire had thrown the German parliament into the arms of Prussia. His object was to restore the *status quo ante* of the confederation, with the old predominance of Austria. His success in this respert was partly due to exterior circumstances, notably the mistimed exaggerations of the German revolutionists, but largely to his diplomatic skill, unscrupulousness and iron tenacity of purpose with which the weakness of Frederick William IV and his ministers was unable to cope. His triumph came with the restoration of the old federal diet in May 1850 and the signature of the convention of Olmütz Nov. 29, 1850 (*See* GERMANY *History.*) Schwarzenberg was also mainly responsible for Francis Joseph's suspension of the last remnants of the constitution on Dec. 31, 1851. He died on April 5, 1852.

See Berger, *Felix, Fürst zu Schwarzenberg* (1853); A. Beer, *Fürst Schwarzenberg's Deutsche Politik bis zu den Dresdener Konferenzen* (Historisches Taschenbuch, 1891); A. Schwarzenberg, *Prince Felix zu Schwarzenberg, Prime Minister of Austria* (1946).

SCHWARZENBERG, KARL PHILIPP, PRINCE ZU (1771–1820), Austrian field marshal, was born on April 15. 1771, at Vienna. He entered the imperial cavalry in 1788, fought in 1789 under Count Lacy and Baron von Loudon against the Turks, distinguished himself by his bravery and became major in 1792. At Cateau Cambresis in 1794 his brilliant charge at the head of his regiment, vigorously supported by 12 British squadrons, earned him the cross of the Maria Theresa older. After taking part in the battles of Amberg and Würzburg in 1796 he was promoted major general, and in 1799 lieutenant field marshal At Hohenlinden in 1800 his promptitude and courage saved the right wing of the Austrian army from destruction, and he afterward commanded the rear guard. In 1805 he commanded a division under Mack, and when Ulm was surrounded by Napoleon in October he was one of the brave band of cavalry, under the archduke Ferdinand, which cut its way through the hostile lines.

In 1808 he was sent on a mission to St. Petersburg (Leningrad) but returned in time to take part in the battle of Wagram, and was soon afterward promoted general of cavalry. After the peace of Vienna he was sent to Paris to negotiate the marriage between Napoleon and the archduchess Maria Louisa The prince gave a hall in honour of the bride on July 1, 1810, which ended in the tragic death of many of the guests, including his own sister-in-law, in a fire. Napoleon held Schwarzenberg in great esteem, and it was at his request that the prince took command of the Austrian auxiliary corps in the Russian campaign of 1812. In 1813 Schwarzenberg, recently promoted field marshal, was appointed commander in chief of the allied Grand Army of Bohemia against France. As such he was the senior of the allied generals who conducted the campaign of 1813–14 to the final victory before Paris and the overthrow of Napoleon. He died at Leipzig on Oct. 15, 1820.

SCHWARZSCHILD, KARL (1873–1916), German astronomer,. whose researches were of great range and versatility, was born on Oct. 9. 1873, at Frankfurt am Main, Ger. His exceptional ability in science was evident in a paper on the theory of celestial orbits he wrote at the age of 16. As a student, Schwarzschild came under the inspiration of the astronomer Hugo von Seeliger at Munich. In 1901 he became professor and director of the observatory at the University of Gottingen. leaving in 1909 to become director of the Astrophysical observatory at Potsdam. He served actively in World War I, during which he contracted an illness of which he died on May 11, 1916, at Potsdam.

Schwarzschild's contributions to physical science are significant in several fields. In observational astronomy, he was the first to introduce and apply precise methods in photographic photometry; the first to employ a coarse grafting in front of the telescope objective for photometric and astrometric work; and he developed certain basic methods of analysis of solar spectra taken during eclipses. In theoretical astronomy Schwarzschild introduced the concept of radiative equilibrium in astrophysics and was the first clearly to recognize the role of radiative processes in the transport of heat in the atmospheres of the stars. He also initiated some basic mathematical methods for the treatment of these problems.

Schwarzschild laid the foundations of modern statistical methods in astronomy, and also made the most important contributions, after Carl Friedrich Gauss, to geometrical optics and the theory underlying the design of optical instruments.

Although generally considered an astronomer, Schwarzschild also made fundamental contributions to theoretical physics and to relativity. In the former, he was one of the great pioneers in developing Niels Bohr's theory of atomic spectra. In a great paper, the proofs of which he read on his deathbed, Schwarzschild developed (independently of Arnold Sommerfeld) the so-called general "rules of quantization" and gave the complete theory of the Stark effect and initiated the quantum theory of molecular spectra. Similarly, in developing the general theory of relativity, Schwarzschild gave the first exact solution of Einstein's general gravitational equations leading to the discovery of what is now called Schwarzschild's line element describing the geometry of space in the neighbourhood of a mass point. (Su. C.)

SCHWEINFURT, a German town of Bavaria, on the Main, 27 mi. N.E. of Wiirzburg. Pop. (1950) 46,140. Schweinfurt is mentioned in 790, and in the 10th century was the seat of a margrave. Receiving civic rights in the 13th century, it maintained its independence as a free imperial city with few interruptions until 1803, when it passed to Bavaria. In the Thirty Years' War it was occupied by Gustavus Adolphus, who erected fortifications, remains of which are extant. The chief manufactures are paint, beer, sugar, machinery, ball bearings, bicycles, brushes, soap and other drysalteries, basketwork and vinegar. Schweinfurt is the seat of an important sheep and cattle market.

SCHWEINFURTH, GEORG AUGUST (1836–1925), German botanist and traveler who made his name as the explorer of the Bahr el Ghazal region of the west Nile basin, was born in Riga on Dec. 29, 1836, the son of a German wine merchant who had settled in Riga. He studied botany at Heidelberg and Berlin and early became interested in the plants of Africa. In 1863 he traveled down the Red sea to Suakin and overland to Khartoum, botanizing as he went. On his return to Berlin in 1866 he interested the Royal Academy of Science in the botanical exploration of the hitherto little-known region watered by the Bahr el Ghazal, for which he received a grant from the Humboldt institute. Arriving at Suakin in Sept. 1868 and at Khartoum in Jan. 1869, he ascended the White Nile and traveled westward by way of Lake No with a party of ivory traders.

Primarily a botanist, Schweinfurth had also a good knowledge of zoology and ethnology; he spent nearly three years in the region, visiting the Niam-Niam, the Bongo and the Mangbettu peoples; and his is the first authoritative account of the Congo pygmies. Crossing the Nile-Congo watershed he reached, in March 1870, the westward-flowing Uele, later discovered to be an affluent of the Congo. He received the Royal Geographical society's Founder's medal for 1874. his discovery of the Uele having helped toward a final estimate of the extent of the Nile System.

From 1875 to 1888 Schweinfurth lived in Cairo, traveling each winter, notably to the Lebanon in 1880, Socotra in 1881 and the Yemen in 1888, interesting himself in botany. geology, paleontology and archaeology. In 1876 he attended the African conference summoned to Brussels by King Leopold, and in 1888 moved to Berlin where his herbarium was housed. Until 1914 he went to Africa frequently, visiting Eritrea three times between 1891 and 1894. He died in Berlin on Sept. 19. 1925. Schweinfurth was a keen observer and an accurate and humorous recorder; *The Heart of Africa* (1873) is excellent reading and a reminder of the part played by German explorers in African discovery.

See S. Passarge, *Mitteilungen der Geographischen Gesellschaft in Hamburg*, vol. 37 (1926); and an unsigned obituary in *Geogr. J.* vol. 67 (1926). (D. Mn.)

SCHWEITZER, ALBERT (1875–), philosopher, theologian, musician, mission doctor and winner of the Nobel peace prize of 1952, was born on Jan. 14. 1875 the eldest son of the Lutheran pastor of Kaysersberg in Upper Alsace. He studied at the universities of Strasbourg. Paris and Berlin.

Schweitzer's first original academic work was a treatise *Die Religionsphilosophie Kants* (1899), which gained him a doctorate of philosophy at the age of 24. Already however his mind was turning to the problems of the Synoptic Gospels and to that independent line of investigation into the life of Jesus which. despite a multiplicity of other labours, he has pursued ever since, unmoved by controversy. In 1901 appeared *Das Abendmahlsproblem auf Grund der wissenschaftlichen Forschung des 19. Jahrhunderts und der historischen Berichte* and *Das Messianitäts-und Leidensgeheimnis Jesu* (Eng. trans., *The Mystery of the Kingdom of God*, 1914), preparing the way for the publication in 1906 of *Von Reimarus zu Wrede: eine Geschichte der Leben-Jesu-Forschung* (Eng. trans., *The Quest of the Historical Jesus*, 1910), which at once established Schweitzer as a world figure in theological studies. In these two books he made a radical and exhaustive demonstration of the eschatological view of Our Lord's life, the view that Jesus' whole ministry was dominated by His knowledge of His Messiahship and of the imminent end of the world. In two books on Paul and in later and briefer writings he continued to expound the hypothesis that the New Testament is pervaded by eschatological expectation.

Having achieved the second of his three doctorates, in theology, and being already engaged upon *Von Reimarus zu Wrede,* Schweitzer in 1902 agreed to write for his organ instructor, the renowned C. M. Widor of Paris, a study of the life and art of J. S. Bach. Widor recognized in the young Schweitzer not only an unusually gifted organist hut also a Bach interpreter of rare and original perception. As so often in Schweitzer's literary undertakings, an intended essay grew into a substantial book, *Jean Sébastien Bach: le musicien-poète* (1905), written while he was lecturing and preaching in German at Strasbourg. Its publication brought him immediate acclaim from the highest musical circles in France and Germany. Called upon for a German translation, Schweitzer instead entirely rewrote the book in German and at twice the length, and it was from this edition (1908) that the English translation was made (1911). Following his usual practice, he gave the reader a thorough historical and analytical background of the subject, of the origins of the chorale, of the cantata and of the Passion music; he reviewed the forms of music and art within the philosophy of the history of thought and presented Bach as a deeply religious mystic whose music was impersonal and unselfconscious, as cosmic as the forces of nature. In a literary style matching his theme, he described the composer as a musician-poet and the supreme pictorial artist in sound; and he gave detailed and copiously illustrated instructions for the playing of his works. His *J. S. Bach* remains the classic study, for the depth and breadth of its interpretation and for its rich spiritual content.

In 1905, principal of the theological faculty at the university and a pastor in Strasbourg, a scholar and an organist of more than continental repute with an unbounded academic future before him, Schweitzer made known to his protesting friends his intention to realize a decision made on the threshold of manhood. He resigned his university appointments and became a humble medical student to qualify himself as a mission doctor to the primitive natives oi equatorial Africa. Later, in *Zwischen Wasser und Urwald* (1921; Swedish text 1920; Eng. trans., *On the Edge of the Primeval Forest*, 1922), he explained that he had found his simple motive in the parable of Dives, the white man endowed with all the benefits of culture and science, and Lazarus, the Negro exploited and oppressed and lacking even medical treatment for his disease and pain. With characteristic thoroughness he took the full six years' course in medicine and surgery, continuing meanwhile with almost superhuman energy some of his major literary work. In 1912 he married Hélène Bresslau, daughter of a well-known Strasbourg historian and herself an accomplished scholar, who became a trained nurse to share her husband's renunciation and adventure in discipleship. In 1913 they went out to the Gabon province of French Equatorial Africa. The site for Schweitzer's hospital at Lambaréné on the forested banks of the Ogowe river was provided by the Paris Missionary society, which had declined his services because of his unorthodox theological views; but in all else his was an entirely independent enterprise. He established, equipped and maintained his hospital from the proceeds of organ recitals and lectures on his occasional visits to Europe and irom royalties on his books (later also irom unsolicited gifts and grants from private individuals and foundations in many countries).

Building his hospital with his own hands and native help, operating far into the night under the most primitive conditions and entering his long fight with leprosy, with sleeping sickness and with the host of tropical diseases, Schweitzer began at the same time to turn his ever-active intellect to the problem of world civilization. Opportunity for the development of his thought was given by the brief internment at Lambarene in 1914 of himseli and his wife as German subjects, and he continued to work more intensively on his thesis when brought back to a prison camp in Prorence. The outcome was the publication in 1923 of the first two volumes of his *Kulturphilosophie*. The first, *Verfall und Wiederaufbau der Kultur* (Eng. trans., *The Decay and the Restoration of Civilization*, 1923), is a brief introduction, while the second, *Kultur und Ethik* (Eng. trans., *Civilization and Ethics*, 1923), is a brilliant review of the history of ethical thought leading to his own original and positive contribution of reverence for life as the true and effective basis for a civilized world.

Early in 1925 Schweitzer returned to Africa to rebuild his derelict hospital and to renew its work. Famine, pestilence, floods and lack of adequate help made this fresh start even more formidable than the first beginning, and after a couple of years he decided to move to a better site about two miles further up the Ogowe. Here his impressive practical powers of planning and building were devoted to the creation of a larger and more efficient hospital. For more than a quarter of a century the hospital village grew under his hand and, with the discovery of new drugs for the treatment of leprosy, a large leper colony came into being near by.

Beside this principal preoccupation, Schweitzer published *Die Mystik des Apostels Paulus* (1930; Eng. trans., *The Mysticism of Paul the Apostle*, 1931), more massive and mature than his previous pieces of original New Testament scholarship, and *Die Weltanschauung der indischen Denker: Mystik und Ethik* (1935; Eng. trans., *Indian Thought and its Development*, 1936), a book that grew from a single chapter of the draft of the continuation of his *Kulturphilosophie*. He returned for a number of brief visits to his home at Günsbach and to give lectures and organ recitals in Germany, Great Britain, the Netherlands, Scandinavia and France and accepted an invitation to take a leading part in the Goethe bicentenary celebrations at Aspen, Colo., in 1949; and he made gramophone recordings and resumed his editing of Bach's music begun with Widor in 1911. Intermittently he returned to the third volume of the *Kulturphilosophie*, which he was reluctant to publish until he thought its iorm and content satisfactory and world conditions iavourable ior its effective acceptance.

Schweitzer's astonishing capacity for arduous physical and mental labour all his life and into old age was supported by a physique of exceptional strength. Tall and broad, of relentless energy and acute concentration, his iace at once iorceful and strikingly compassionate, his charm ior all who met him proved immediate and magnetic. A peasant shrewdness is evident in his business arrangements and administration of his hospital settlement, together with an almost patriarchal feeling in his retention of control over every detail of its work and management. The practical thoroughness underlying his powers of creation and interpretation is reflected no less clearly in his passion for the building and repair of organs than in his exhaustive mastery of the work of his predecessors in theology and philosophy. He can be regarded as above all an artist striving with humility to become as nearly perfect as possible in his Christian discipleship and in all the manifestations of his many-sided genius.

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SCHWENKFELD, KASPAR (1490–1561), of Ossing, German theologian, entered the service of the duke of Liegnitz, over whom he had great influence. In 1522 he visited Wittenberg, where he made the acquaintance of Andreas Carlstadt and Thomas Münzer. On his return to Liegnitz he helped to spread the principles of the Reformation in the principality and in Silesia, while warning his colleagues against the abuse of the doctrine of justification by faith. The controversy on the Eucharist (1524) revealed his disagreement with Luther on that critical point. He sought to establish a via *media* between the doctrines of Luther and Zwingli, and vainly hoped to obtain for it Luther's acceptance. He as vainly sought to secure Luther's adoption of a strict rule of church discipline, after the manner of the Moravian Brethren. Meanwhile the Anabaptists obtained a footing in Silesia, and suspicions of Schwenkfeld's sympathy with them were aroused. Letters and writings of his own (1527–1528) proved him to hold strongly anti-Lutheran views, and both Catholics and Lutherans urged the duke of Liegnitz to dismiss him. He voluntarily left Liegnitz in 1529, and lived at Strasbourg for five years amongst the Reformed clergy there. In 1533, in an important synod, he defended against Martin Bucer the principles of religious freedom as well as his own doctrine and life. But the heads of the church carried the day, and Schwenkfeld left Strasbourg for a time. The publication (1j39) of a book in proof of his most characteristic doctrine — the deification of the humanity of Christ —led to active persecution by the Lutherans and his expulsion from the city of Ulm. The next year (1540) he published a refutation of the attacks upon his doctrine with a more elaborate exposition of it, under the title Grosse Confession. The book emphasized the differences between the Lutherans and Zwinglians on the doctrine of the Eucharist at a moment when efforts were being made to reconcile them. An anathema was accordingly issued from Schmalkald against Schwenkfeld (together with Sebastian Franck); his books were placed on the Protestant "index"; and he himself was made a religious outlaw. Schwenkfeld went into hiding. He and his followers withdrew from the Lutheran Church, declined its sacraments, and formed small societies of kindred views. He died at Ulm, on Dec. 10, 1561.

Schwenkfeld left behind him a sect (who were called subsequently by others Schwenkfeldians, but who called themselves "Confessors of the Glory of Christ") and numerous writings to perpetuate his ideas. His writings were partially collected in four folio volumes, the first of which was published in the year 1564, containing his principal theological works. His adherents were to be found at his death scattered throughout Germany. In Silesia they formed a distinct sect, which persisted. In the 17th century they were associated with the followers of Jacob Böhme, and were undisturbed until 1708, when an inquiry was made as to their doctrines. In 1720 a commission of Jesuits was despatched to Silesia to convert them by force. Most of them fled from Silesia into Saxony, and thence to Holland, England and North America. Frederick the Great of Prussia, when he seized Silesia, extended his protection to those who remained in that province. Those who had fled to Philadelphia in Pennsylvania (1734) formed a small community under the name of Schwenkfelders; and Zinzendorf and Spangenberg, when they visited the United States, endeavoured, but with little success, to convert them to their views. This community still exists in Pennsylvania and their views appear to be close to those of the Quakers.

Schwenkfeld distinguished between an outward word of God and an inward, the former being the Scriptures and perishable, the latter the divine spirit and eternal. In his Christology he departed from the Lutheran and Zwinglian doctrine of the two natures by insisting on what he called the Vergotterung des Fleisches Christi, the deification or the glorification of the flesh of Christ. His peculiar Christology was based upon profound theological and anthropological ideas, which contain the germs of some recent theological and Chiistological speculations.

See Arnoldt, *Kirchen- und Ketzer-Historie* (Frankfort, ed. 1700); Salig, *Historie der Augsburg. Confession; W. H.* Erbkam, *Gesch. der prot. Sekten* (1848); Dorner, *Gesch. d. prot. Theol.* (1867); also R. H. Griitzmacher's article in Hauck-Herzog's *Realencyklopadie;* Robert Barclay's *Inner Life of the Religious Societies of the Commonwealth* (1876); *C.* Beard's *Hibbert Lectures* (1883); H. W. Kriebel, "The Schwenkfelders in Pennsylvania," *Pa.-German Soc. and Addresses*, vol. xiii. (1904); and S. K. Brecht, *The Geneological Record of the Schwenkfelder Families* (1923).

SCHWERIN, KURT CHRISTOPH, Count von (1684–1757), Prussian general field marshal, was born at Löwitz, Pomerania. He served in the Dutch army and then in the Mecklenburg-Schwerin armies during the War of the Spanish Succession. In 1713 he was with Charles XII. of Sweden in his captivity at Bender, and in 1718 was made major-general. In 1719 he opposed the Hanoverian army which invaded Mecklenburg (in the course of which he fought a brilliant action at Walsmühlen on March 6, 1719), and in 1720 entered the Prussian service. In 1730, as a major-general, he was a member of the court-martial which tried the crown prince of Prussia (afterwards Frederick the Great) for desertion, and in 1733, at the head of a Prussian army, conducted with great skill the delicate and difficult task of settling the Mecklenburg question. Frederick promoted Schwerin to the rank of general field marshal and made him a count. At the battle of Mollwitz (April 10, 1741) his brilliant leading converted a doubtful battle into a victory. In the Second Silesian War (1744–1745) Schwerin commanded the army which, marching from Glatz, met the king's army under the walls of Prague and contributed 'to the capture of that place. In the first campaign of the Seven Years' War (1; j6) he conducted the war on the Silesian side of Bohemia; and in 1757, following the same route as in 1744, again joined Frederick at Prague. On May 6, leading on a regiment of the left wing to the attack with its colour in his hand, the old field marshal was shot dead.

See Varnhagen von Ense, *Biographische Denkmale*, vol. vi. (3rd ed., Leipzig, 1873), and *Leben Schwerins* (Berlin, 1841).

SCHWERIN, from Jan. 22. 1953, chief town of a district in the German Democratic Republic, at the southwest corner of the Lake of Schwerin 129 mi. N.W. by rail of Berlin. Population: (1925) 48,157; (1950) 93,576. Schwerin is mentioned as a Slavonic stronghold in 1018, its name (*Zwierin*) signifying "game preserve." The town. founded in 1161 by Henry the Lion in opposition to this Slavonic fortress, received civic rights in 1166. From 1167 to 1648 it gave name to a bishopric; and it was also the capital of the duchy of Schwerin, which formed the western part of the grand duchy of Mecklenburg-Schwerin.

Destructive fires. the hardships of the Thirty Years' War and the removal of the court to Ludwigslust in 1756 seriously depressed the town.

The town is closely surrounded and hemmed in by a number of lakelets. Though Schwerin is the oldest town in Mecklenburg, its aspect is comparatively modern, a fact attributable to destructive fires which swept away most of the ancient houses. The most conspicuous of the many fine buildings is the former ducal palace built in 1844–57 in the French Renaissance style. It stands on a small round island between Castle lake and the lake of Schwerin, formerly the site of a Slavonic fortress and of a later mediaeval castle.

The older palace, the government buildings and the museum all stand in the "old garden," an open space at the end of the bridge leading to the new palace. Among the other secular buildings are the former palace of the heir apparent and the library. The cathedral was originally consecrated in 1248, though the present building—a brick structure in the Baltic Gothic style, with an unfinished tower—dates for the most part from the 15th century.

The chief industry is the making of furniture, and there are also some manufactures of dyes, pianos, wool yarn, sugar, cement and soap.

SCHWERTE, a to n in North Rhine-Westphalia, Ger., 7 mi. N.E. of Hagen, at the junction of the lines Aachen-Holzminden and Schwerte-Münster. Pop. (1950) 22,940. Schwerte received civic rights in the 12th century.

It has a Romanesque church. with a carved altar of 1523 and stained glass of the 14th and 15th centuries; and there is a 16th-century toun hall.

The industries are practically confined to the manufacture of iron and steel goods.

SCHWIEBUS or SWIEBODZIN, a town formerly in the Prussian province of Brandenburg. Ger.. 47 mi. E. of Frankfurt-on-Oder by the railway to Posen. It was incorporated into Poland in 1945. Pop. (1946) 6,144.

The territory originally belonged to the principality of Glogau, and in the 16th and 17th centuries mas a bone of contention betneen the electors of Brandenburg and the emperors. In 1686 the elector received the lordship of Schwiebus on renouncing his claims to certain other principalities. Frederick III, however, restored Schwiebus to the emperor Leopold I in 1695, receiving £40,000 in exchange. By the peace of 1742, Frederick the Great regained Schwiebus with the rest of Silesia. The town is still in part surrounded by its medieval wall, and has an old market place, a castle and many old houses.

Cloth, machinery and bricks are manufactured, and there are flour mills, breweries and lignite mines.

SCHWIND, MORITZ VON (1804–1871), Austrian painter and engraver, remembered mainly for his illustrations, was born in Vienna on Jan. 21, 1804. His early art training was rudimentary, and at 17 he entered the circle of artists who gathered around Schubert in Vienna and became a friend and admirer of the composer.

In 1827 Schwind went to Munich, where he came under the influence of Schnorr and Cornelius, and in 1834 was commissioned to decorate Ludwig II's new palace with wall paintings after Tieck. Later he also designed the wall paintings for the castle of Hohenschwangau in the Bavarian Tirol and for the Wartburg. The revival of art in Germany was favourable to the development of his fanciful genius, and he became popular through his illustrations of Goethe and other poets. From 1844–47 he lived in Frankfurt, where he painted the "Singers' Contest in the Wartburg" (1846), made the designs for the Goethe celebrations and did numerous book illustrations, including those for Robinson Crusoe. In 1847 he became professor at the Munich academy. He published a cycle of the Seven Ravens from Grimm in 1857.

Many of his water colours, etc., of the early Vienna days, and the Schubert sketches, are in Vienna. Schwind died at Munich on Feb. 8. 1871.

SCHWOB, MARCEL (1867–1905), French author. Many of his novels have a historical setting, but his art is extraordinarily versatile and includes tales of imagination, of the future, legends, psychological essays and many short stories.

In the prefaces to *Coeur* double, Roi *au* masque d'or (1893) Schmob makes an attempt to analyze his art. In spite of his unusual historical, linguistic and scientific knowledge, and his crowded canvas, his style is simple and straightforward. His work includes translations of Shakespeare and Defoe. He had a wide and close knowledge of English literature. He was a friend of Oscar Wilde, who dedicated *Salome* to him. The Vies *imaginaires* (1896; reprint, 1922) is a series of sketches in a-hich the *légendes* of various famous people are the basis, rather than their actual lives.

His works include *Spicilège* (1896) ; *La Croisade des enfants* (1896) ; *La Lampe de Psycht* (1903) ; *La Guerre commerciale,* 2 vol. (1896 and 1904).

SCHWYZ, one of the ancient forest cantons of central Switzerland. Its total area is 351 sq.mi., of which roughly three-quarters is reckoned as "productive" (forests covering about 75 sq.mi. and vineyards about 30 ac.), while of the rest, 18.1 sq.mi. is occupied by the larger lakes (chiefly several square miles of Zurich and of Lucerne, together with a small area of Zug and the whole of Lowerz—1.2 sq.mi. draining into Lucerne); about 0.5 sq.mi. is covered by glaciers. Its loftiest point is the Boser Faulen (9,199 ft.), while the two highest summits of the Rigi (the Kulm, 5,909 ft., and the Scheidegg, 5,463 ft.) are within its borders, but, on the whole, the land is hilly rather than mountainous.

Its title as the "core of Helvetia" is more appropriate in respect of its position, for though much below average size for a Swiss canton. no fewer than seven other cantons touch its borders. It has two main valleys, the Muota, receiving the waters of Lake Lowerz and draining into Lucerne, and the Sihl. which receives the river Alp on which Einsiedeln stands; the reinforced stream, though formed near the head of the Lake of Zurich, flows for a long distance roughly parallel to it and enters the river Limmat below the lake.

The canton has few main-line railways, the principal being a portion of the main St. Gothard line between Sisikon and Kiissnacht. Arth-Goldau (memorable for the great landslide of 1806) is a railway junction of some importance, with a line to Zug and another past Biberbrücke (junction for Einsiedeln and the waterfalls) toward Wadenswil. A mountain railway also terminates at Arth-Goldau for the ascent of the Rigi-Kulm, with a branch to Rigi-Scheidegg. Of other mountain lines in the canton the most important is the electric cogwheel railway from Brunnen to Axenstein.

Population in 1950 was 71,082. In 1930 the population was 62.337, of whom 60,571 were German-speaking, 1.261 Italian-speaking and 371 French-speaking, showing during the 20th century a substantial increase of the German tongue and a reduction in the other elements. There were 59,793 Catholics, 3,450 Protestants and 11 Jews. Schwyz is in the diocese of Choire. The largest towns in 1950 were Einsiedeln (pop. 8,423), a great pilgrimage centre noted for its black Virgin and its Benedictine monastery, and Schwyz (pop. 10.259), which is the political capital and is connected with Brunnen, its port on Lucerne. The canton is essentially a pastoral one, its local breed of brown cattle being much esteemed, particularly in north Italy, but some industrial activity (textiles) also takes place near the Lake of Zurich and the home weaving of silk is still general. The 30 cantonal communes are grouped into six administrative districts. The constitution, dating mainly from 1876, was revised in 1898. The legislature (Kantonsrat) is composed of 103 members elected in the proportion of 1 for every 600 residents, and the elections, since 1907, take place according to the principles of proportional representation. The executive (Regierungsrat) of seven members is elected by a popular vote and, as is the case with the larger body, holds office for four years. The two members of the federal *Ständerat* and the three of the federal *Nationalrat* are also chosen by a popular vote. Since 1876 the "obligatory referendum" has prevailed in the case of all laws and financial resolutions approved by the legislature, while 2,000 electors may claim a popular vote as to any remaining decrees or resolutions. Any 2,000 electors have also the right of "initiative" as to the revision of the cantonal Constitution or as to legislative matters.

History. — The valley of Schwyz is first mentioned in 972 as "Suittes." Later, a community of freemen settled at the foot of the Mythen, subject only to the count of the Zurichgau, as representing the German king. In 1240 the community obtained from the emperor, Frederick II., the privilege of being subject immediately to the empire. Its territory then included only the district round the village of Schwyz and the valley of the Muota. But in 1269 it bought from Count Eberhard, of Habsburg-Laufenburg, Steinen and Rothenthurm. Schwyz took the lead in making the famous everlasting league of Aug. 1, 1291, with the neighbouring districts of Uri and of Unterwalden, its position and political independence specially fitting it for this prominence. An attack by Schwyz on Einsiedeln was the excuse for the Austrian invasion that was gloriously beaten back in the battle of Morgarten (Nov. 15, 1315). In the history of the league Schwyz was always to the front, so that its name in a dialectal form (Schweiz) was from the early 14th century onwards applied by foreigners to the league as a whole, though it formed part of its formal style only from 1803 onwards. After the victory of Sempach (1386) Schwyz greatly extended its borders. An "alliance" with Einsiedeln in 1397 ended in 1434 with the assumption of the position of "protector" of that great monastery; between 1386 and 1436 the whole of the "March" (the region near the upper lake of Zürich) was acquired; in 1402 Küssnacht was bought, and in 1440 the "Höfe," the parishes of Wollerau, Feusisberg, and Freienbach, situated on the main lake of Zurich. All these districts were governed by Schwyz as "subject lands," the supreme power resting with the *Landsgemeinde* (or assembly of all male citizens of full age). Schwyz joined the other forest cantons in opposing the Reformation, and took part in the battle of Kappel (1531), in which Zwingli fell. In 1798 Schwyz, including Gersau (free from 1390), formed part of the République Telliane (or Tellgau), set up by the French, which a week later gave way to the Helvetic republic. In 1803 the separate canton of Schwyz was again set up. Schwyz joined, in 1832, the league of Sarnen, and in 1845 the Sonderbund, which was put down by a short war in 1847. In 1832 the outer districts (Einsiedeln, the March, Kussnacht, and Pfaffikon) formed themselves into a separate canton, an act which brought about a federal occupation of the old canton in 1833, this ending in the dissolution of the new canton, the constituent parts of which were put on an equal political footing with the rest. In 1838 strife broke out in the older portion of the canton between the richer peasant proprietors (nicknamed the "Horns," as they owned so many cows) and the poorer men (dubbed the "Hoofs," as they possessed only goats and sheep) as to the use of the common pastures, which the "Horn" party utilized far more than the others. The "Horn" party finally carried the day at the Landsgemeinde held at Rothenthurm. The cantonal constitution of 1848 put an end to the ancient Landsgemeinde; it was revised in 1876 (when membership of one of the 29 communes became the political qualification), and in 1898.

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SCHWYZ, the capital of the Swiss canton of that name, a picturesque little town, admirably situated, amid fruit trees, on a mountain terrace (at a height of 1,706 ft.), at the north-west foot of the conical peak of the Gross Mythen (6,240 ft.). Including the neighbouring hamlets of Ibach, Rickenbach, etc., the parish had 10,259 inhabitants in 1950, practically all German-speaking and Roman Catholics. The town is about 3 m. from Brunnen, its port on the lake of Lucerne.

Besides a stately 18th century parish church and several convents, it contains a 16th century town hall (housing various precious mss.), as well as several curious old patrician houses.

SCIACCA (Arabic, *Sciaqqak),* a town and episcopal see of Sicily. Italy, on the south coast, in Agrigento province, 52 mi. N.W. of Girgenti by rail, and 30 mi. direct. Pop. (1951) 22,333. It is surrounded by walls erected about 1330, and has two ruined castles, belonging to the Luna and Perollo families, whose hereditary feuds lasted from 1410 to 1529, some fine mediaeval and 18th-century palaces, and several interesting churches. The convent of Sta. Maria delle Giummare, with its battlemented walls, occupies the former palace of the Saracen governors, and contains a painting of the foundation of the convent by Count Roger. The town has only an open roadstead. Three miles E. of the town is the Monte San Calogero (the ancient Mons Cronius) with sulphurous and saline springs and vapour baths, known in Roman times as Aquae Larodes or Thermae Selinuntiae (after nearby Selinus). The town is the birthplace of Tommaso Fazello (1498–1570), father of Sicilian history. Sciacca was bombed by the Allies in World War II.

See I. Scaturro, *Storia della cittd di Sciacca* (1925–26).

SCIALOJA, VITTORIO (1856–1933), Italian jurist and statesman, son of the eminent Neapolitan scientist, patriot and statesman, Antonio Scialoja, was born at Turin on April 24, 1856, and after graduating in jurisprudence was appointed professor of civil law at the University of Camerino when only 23 years of age. In 1880 he was transferred to the University of Siena, and in 1884 to that of Rome. Many of the most distinguished jurists and political men in Italy were his pupils, and through his teachings and writings he exercised a wide influence on juridical thought and practical legislation. In 1904 he was nominated senator. In 1909 he was appointed minister of justice, and during World War I he was minister (without portfolio) in the Boselli and Orlando cabinets. In the autumn of 1919, on the resignation of Senator Tittoni. Senator Scialoja became minister of foreign affairs in the Nitti cabinet, and in this capacity he attended various meetings of the peace conference, either as assistant Italian delegate under Sig. Nitti or as first delegate. He left office on the fall of the cabinet in June 1920, and in the autumn of that year became a member of the Italian delegation at the League of Nations assembly. In 1925 he became president of the Italian delegation at the assembly and Italian representative on the council of the League. He, in fact, collaborated in the drafting of the covenant.

He is the author of a large number of books, pamphlets and articles on legal subjects, of which the most important are the following: *Sopra il precarium nel diritto rontano* (1878); *Degli atti di emulazione nell' esercizio dei diritti* (1878); *Del diritto positivo e dell' equità* (1880); *Responsabilità e volontà nei negozi giuridici* (1885); Italian translation, with an introduction, of Savigny's *System of Roman Law* (8 vols., 1886–98); *Sul diritto al nome e allo stemma* (1889); *Sulla teoria dell' interpretazione della iegge* (1898); *Dizionario pratico del diritto privato* (1899, etc.); *Sulle condizioni impossibili nei testamenti* (1901); *Sulle funzioni della IV. Sezione del Consiglio di Stato* (1901).

SCIATICA, a form of neuralgia or inflammation of the sciatic nerve, or its roots and characterized by pain, along the course of the nerve, running down the back of the thigh and the leg. *(See* NEURALGIA.)

SCIDMORE, ELIZA RUHAMAH (1856–1928), U.S. traveller and author who wrote some of the first guidebooks to Alaska and the Orient, mas born in Madison, Wis., on Oct. 14, 1856. She was educated in boarding schools, and for one year (1873–74), at Oberlin (O.) college. She served her newspaper apprenticeship as a Washington, D.C., society correspondent for the *New York Times* and the *St. Louis Globe-Democrat,* after which she went to Alaska to gather material for newspaper articles and travel books.

Her Alaskan trip was the beginning of her world travel during which she spent many years in Japan. China, India, Java and the

Philippines in the far east and in Europe. Active in the National Geographic society as a member from its earliest days, she served successively as corresponding secretary, associate editor, foreign secretary, and was the first woman to serve on the board of managers. She served as a secretary at two Oriental congresses at Rome in 1897 and at Hamburg in 1902. She contributed to many magazines and while studying the actions of the League of Nations in Geneva, Switz., in 1925 decided to make her home in that city, where she died on Nov. 3. 1928. Her last book. *As The Hague Ordains* (1907), so impressed the Japanese emperor with its sympathetic account of Japanese treatment of prisoners of war in the Russo-Japanese war that at her death the Japanese government asked and received permission to transport her ashes to Japan for interment.

Her books include: *Alaska: its Southern Coast and the Sitkan Archipelago* (1885, republished as *Journeyings in Alaska,* 1889); *Westward to the. Far East* (1890); *From East to West* (1890); *Appleton's Guide-book to Alaska and the Northwest Coast* (1893) ; *Java, the Garden of the East* (189;) ; and *Winter India* (1903).

SCIENCE. Is it possible to define what we mean by science? Perhaps not, for science is one of the major activities of our minds. in this sense resembling art, religion or philosophy. None of these can be understood unless we consider them in relation to their past history. Science may perhaps be regarded as a mood in which we consider our world. No man is always in the same mood, and no man of science remains permanently in the scientific mood. In estimating the value of the judgments of men of science outside their own scientific department it is nell to remember this, for these judgments are sometimes to be rated very low.

As soon as we attempt to discuss science as a whole. a host of difficulties appear. The Latin word *scientia* meant nothing more definite than "knowledge," but the modern usage covers only certain kinds of knowledge. The area of these is now so vast that no man can have a grasp of more than a minute fraction of them. Moreover, even the kinds of knowledge regarded as "scientific" are extremely diverse. They extend from subatomic reactions to mental processes; from mathematical laws of thermodynamics to the economics of race relations; from the births and deaths of stars to the migration of birds; from the study of ultramicroscopic viruses to that of extragalactic nebulae: from the rise and dissolution of cultures and of crystals to the rise and dissolution of atoms and of universes. They include both knowledge of the workings of living bodies and knowledge of the laws of thought, together with that of the nature of their disturbances. Can these innumerable and endlessly diverse topics be brought under any one formula?

These very different activities and disciplines all involve systematic and unbiased observations; the due examination of the records of these by trained minds leads to classification; from such classifications general rules or "laws" are deduced; these laws may be applied to further observations; failures in correspondence between new observations and accepted laws may result in alterations of the laws; and these alterations lead to yet further observations; and so on. This chain of activities is usually held to constitute the "method" of science.

Admittedly this chain is not followed invariably. It may be short-circuited by some sort of mental process of which we know little; but even in such cases the final appeal is to observation, often in that specialized form known as experiment. Further, science is, of its nature, always developing and not a mere body of knowledge. To summarize, science is a search for judgments to which universal assent may be obtained—universal, that is, on the part of those who understand the judgments and their bases. It is a search that never ends and is never satisfied.

It is always dangerous to infer the semantic value or range of meaning of a word on its etymological basis. Nevertheless, it cannot be disregarded that in English, as in other languages with vocabularies even more largely Latin-derived, the complex adjectival form of the word *science,* namely *scientific* (*i.e.,* "knowledge-making"), has been steadily displacing simpler, shorter and more natural formations, such as *sciential, scientic* and their variants, since the beginning of the 17th century. The acceptance of our usage of *scientific* follows closely the growing prestige of what has come to be called "science" (earlier it was known as "natural philosophy"). This correlation of concept and adjective becomes intelligible if me consider the spread of the awareness that science is the making of knowledge and is not knowledge as such. Science has thus become constantly more nearly equated with "research" and has come to connote a process and not a static body of doctrine. This situation is evident enough and can be illustrated by many examples showing that when the process of making knowledge ceases, science subsides into static or recessive tradition. But it is highly important that this should not be taken to mean that science excludes tradition. The reverse is the case, for science necessarily involves a developing tradition. Not a few persons active in advancing science have persuaded themselves that they had no need of tradition, that is. of the history of their subject. Some have at times refrained from studying the work even of their contemporaries and have prided themselves thereon. These men have all deceived themselves, for the man of science cannot forsake his tradition however he strive. Doubtless atomic physics, for example. may be advanced without exact knowledge of the careers, achievements and mental processes of Max Planck and Albert Einstein. Moreover there are episodes of research wherein the researcher is wise to confine himself temporarily to his own thoughts. But those thoughts have been shaped by the scientific tradition. To forget that tradition for a moment does not change the fact that the man of science inherits an age-old way of thinking and that his research is but part of an ever-growing body of knowledge based on tradition. Only by extending knowledge previously won can he build new knowledge. He can no more free himself from the millennial tradition of science than from the language that he speaks or from the civilization in which he has been reared. *"L'histoire de la science,"* said Auguste Comte, *"c'est la science même"* ("The history of science is science itself.").

Despite their philosophical importance controversy on the nature of knowledge, on the question of whether our knowledge is real or whether there is another and deeper reality to which we cannot reach and the even more pressing debate as to how or whether science can give certitude are of no aid in defining, delimiting or understanding the nature of science (*see* KNOWLEDGE, THEORY OF). Science can treat the outer world solely on its own level, that is, the level of *phenomena* (.'things that appear," "appearances"). These can appear only to the senses that we possess. It may be that our senses yield results that are ultimately contradictory or, at least, that our minds find no rest in them. or—which is much the same thing—that our minds can repose only in a sensation of harmony. But the quieting of our minds on such things is ultimately a task of philosophy or religion or both. Science, as such. can have only an indirect share in this.

Evidently, in the study of phenomena our senses often deceive us. But science seeks ever to correct. aid. extend and supplement our senses by technological devices. With these the sphericity of the earth. the discontinuity of matter and of forces. the movements of atoms, the bending of light by the sun's mass and even the mutual convertibility of mass and energy may be demonstrated to our senses. It is also true that science frequently leaves phenomena altogether, to mount into an atmosphere of abstract symbols, usually of a mathematical kind. But science takes such flights only to descend again to the prediction or demonstration of phenomena. Phenomena must ultimately be sensed, and mathematical considerations, however recondite, and scientific instruments, however intricate, are but delicate, remote and specialized ways of extending sense-experience, though sense-experience may for some sciences (and perhaps eventually for all) be ultimately reducible to scale readings.

The Method of Science.—The first modern philosopher of science, Francis Bacon (*q.v.;* 1561–1626), set forth in his *Advancement of Learning* the belief that in any field of knowledge the facts might be collected, according to an accepted and prearranged plan, and then passed through an automatic logical process from which correct judgments would inevitably emerge. This method cannot be applied in practice, since phenomena are beyond number. Therefore, when we seek to explore any field of knowledge, we must somehow choose from among the phenomena—often called facts. The question then arises as to how the man of science can best choose the phenomena to be observed and recorded.

The history of science shows that only those with a knowledge of how their predecessors have succeeded or failed have chosen profitably. In other words, the process of choosing phenomena is an act of judgment on the part of a learned or experienced chooser, a scientist; and the most learned is often modestly unconscious of the depth of his own learning.

But is not this also the case with the choosing of words by that word-chooser whom we call a poet or the choosing of colours by that colour-chooser whom we call an artist? The choice of scientist, of poet, of artist, is necessarily controlled by his knowledge of his special field. his "subject." as we are wont to call it. Perhaps it would be more true to say that the choice is controlled by his experience of the scientific, of the poetic or of the artistic mood. The scientist, like the poet and the artist, exercises his judgment to select those things which bear to each other certain relations which he has himself conceived or which he seeks. He may find something which he has not conceived or does not seek. This discovery may lead him to further search and so to further discovery. And yet no experience of the scientific mood, however profound. no acquaintance with the history of his science: however complete, no reasoning, however deft, will make a man a scientific discoverer. Nor, for that matter, will any knowledge of metre. or of colour, or of the nature and history of verse or perspective make a poet or an artist. Successful scientific men, like poets and artists: may be directed by training and are always moulded by tradition. But they must also possess that incommunicable power of judgment, as necessary in science as in the arts. Thus in the end science, like the other great human activities, comes up against the impenetrable mystery of mind.

We therefore return to phenomena. The scientific man, in practising his art of discovery, has to exercise a series of quite different mental activities. These may be classified as, first, collecting observations; second. forming an hypothesis that links the observations; third, testing the truth or falsehood of the hypothesis; and, fourth, using the hypothesis in examination of further observations or re-examination of those already considered. When the hypothesis answers suitably to repeated or sufficiently delicate tests, our scientist has made a "discovery." It is true that the four processes of choosing, of drawing an hypothesis: of testing it and demonstrating its validity and. lastly, of using it to guide further observational activity are often inadequately distinguished by the scientist in his own thinking. Often, too, the exposition of his discovery helps him! more or less unconsciously, to new acts of judgment, these to a new selection of facts, and so on in endless complexity. But essentially the processes are separable, and the power to wield one of them may be developed while the others are in relative abeyance. It would be easy to select men of science more skilled in some of these processes and less in others. But for due display of nature's ways all these powers must be at work.

On this matter, scientific articles (and especially textbooks) commonly give a false impression. They are composed to convince the reader of the truth of certain views or to put him in possession of certain knowledge. In doing this, such works normally obscure the process by which the views were reached. That process, as vie have seen, usually consists of a series of improvised judgments or working hypotheses, interspersed with a provisional series of observations. Many such judgments are normally found untenable and many observations irrelevant, ill-chosen: badly made or needing further test. An article or book is necessarily and rightly silent on these side issues and false starts: otherwise it would be diffuse beyond all toleration. Nevertheless, these omissions conceal the tracks of the investigator. For this reason, among others, science can never be learned from books, but only by contact with phenomena.

The relationship between the process of discovery and that of demonstration is often missed or glossed over, even by men of science. During the middle ages it was almost consistently avoided. On this point Francis Bacon remained in darkness. He rightly emphasized the importance of systematic fact collection but failed to perceive how deeply the act of judgment must be involved in it. No important discovery has ever been made along Baconian lines, though some discoverers have thought that they were following them. Some of the founders of the Royal society, in the middle decades of the 17th century, regarded themselves as followers of Bacon. Investigation, however, has repeatedly revealed that each great discoverer has worked out his own line of research in a way suited to that line and to his own way of thinking, with little reference to any theory of the nature of science itself.

Study of the philosophy and history of science illumines our view of the world and makes it more worth investigation. It absorbs the reader and raises the status of the man of science. But such study will never be a direct instrument of discovery. The characteristic of the modern scientific scene that separates it from the mediaeval outlook is less possession of a method than constant devotion to and even obsession with observation as the demonstrative test. This point is often missed by those who seek scientific elements among mediaeval activities. Such elements existed; but, with little devotion to observation, they bore little fruit.

From all this it is apparent that the scientific process can be yet further reduced to two main activities: discovery and demonstration. As regards discovery, there is hardly any faculty or power that has not, from time to time, been used by scientific men in their inquiry into nature's ways. But how his ideas reach the man of science is of relative insignificance. They may come in a dream or in an illuminating flash, or follow painful calculation, or be suggested by an analogy (often a false one). In all this the unconscious mind cannot be disregarded. In the end these things are matters of temperament. But it is in the processes of demonstration that we discern the man's efforts as scientific. Discovery is an art, demonstration makes the science. In the series of processes involving investigation, these two kinds of activity are inevitably mingled, but they can often be disentangled by study of accounts that men of science have given of their own experience.

Scientific knowledge is a developing thing. As with other developing things, its structure and functions can be understood only through its history, nhich is, of its nature, "progressive." The "idea of progress" has many implications, mathematical, philosophical, biological, social. spiritual, with which we are not here concerned, but there can be no true science that does not extend its range. Science. of course, may perish, but, in so far as it is alive, it can build only on the science that has gone before. There were indeed periods of history and episodes of civilizations in which scientific progress was retarded. or in uhich its records were corrupted or forgotten or destroyed. These periods and episodes have their special interest because of the fragments of the great tradition that survived them. but examination of them cannot reveal the processes of development of science.

ANCIENT SCIENCE

The traceable history of progressive science divides naturally into tno main periods. One is the active Greek period from about 600 B.C. to about A.D. zoo. The other is the active modern period from about 1450 onward, in the full flood of which we live. Since of Greek science only is the full course known—even in outline—it is related here as the sole possible exemplar of our own. This is not to foretell disaster; but appreciation of the history of Greek science may help to avert dangers from our own. The Greek achievement can be examined in its entirety with steady and unbiased vision.

The Age of Anonymous Science.—When then did science begin? Something remotely resembling it is discernible very early, long before the Greeks. With very slowly increasing skill men of the Old Stone Age fashioned neapons or tools—the two were at first undifferentiated. Perhaps 400.000 years ago these began to assume a symmetrical form involving some mental image of the object before it was wrought. This form implied an adaptation of means to ends, based primarily on trial and error, a crude form of experiment used even by lower animals. Again and again in the succeeding millennia men have made such adaptations. When they became conscious that trial and error is a may to solve problems. men took a great step on the road to science. Some 30.000

years ago they succeeded in portraying animals in positions of movement and in the chase. A further passage to exact observation and record of nature occurred when men ceased to be food gatherers and began to become food growers some 13,000 years ago. There then arose the need to choose the right time to sow and to reap. Apart from day and night, the obvious way to reckon lapse of time is by changes in the moon. Months or moon cycles cannot be made to correspond to any exact fraction of the solar year or sun cycle. But in the earlier agricultural stages the one set was given some temporary approximation to the other.

As men gathered in aggregates, forming cities, and began to be civilized, more exact divisions of time were needed. It became necessary to number the days in the year and in its seasons. This soon became a task for specialists, men who could enjoy the new social surplus. Moreover, the settled agricultural life needed more tools, at first of stone. Thus a professional technology developed.

The age of stone passed into that of metals. The treatment of ores and the extraction and working of metals called for new groups with special knowledge and special leisure. The development of rights in land demanded some sort of survey. Tradition has it that the annual Nile flood rendered necessary an annual remeasurement of the fields of Egypt. Thus geometry (literally "earth measurement") was born. The cutting-up of animals for food and the examination of their entrails for divination yielded, especially in Mesopotamia, some knowledge of bodily structure. These activities are among the sources of what we now call metallurgy, mathematics and anatomy.

As society became yet more complex, commerce increased. The stewards and priests of palaces and temples needed records. Thus systems of numerical notation were invented. Ultimately writing developed from pictographs. The ancient world presents numerous examples of such inventions, fathered by necessity and mothered by experience. All have some claim to be considered in a history of science. Early civilizations united men into larger and ultimately into imperial units. But those who share our Judaeo-Graeco-Roman culture, when they examine the records of the earliest civilizations, are impressed by the failure to stress human individuality.

Investigation of the ancient empires, notably of the Babylonian, has revealed a far more extensive and systematic accumulation of astronomical and mathematical information than was formerly suspected. Science can therefore no longer be called a Greek product. Cumulative records began in the 4th millennium B.C. in the river valleys of both Egypt and Rfesopotamia and perhaps elsewhere. Nevertheless our records of these are still so discontinuous that, while it would be possible to write an account of what we know of them, to reconstruct the history of science in the ancient empires is still impossible. It is, however, important to recall that to the Babylonians we owe exact measurement of the lunar and solar cycles, the tracing of the paths of the planets, the division of the circle into 360 degrees and the designation of constellations, notably those of the zodiac.

Science First Conscious of Itself (c. 600–c. 300 B.C.).—The figure traditionally associated with the beginning of science among the Greeks is Thales of Miletus (*q.v.*) in Asia Minor, who flourished in the first half of the 6th century B.C. The Greek alphabet is thought to have first emerged (from the Phoenician) in Miletus, about 200 years before Thales. He was a merchant, son of a Greek father and of a Phoenician mother! and had visited Mesopotamia and Egypt. He made certain geometrical discoveries, though the Greeks no more invented geometry than they did astronomy. The elements of the latter came to them from Mesopotamia; those of the former, according to their own traditions, from Egypt. The Egyptians, however, had not generally reached beyond an empirical use of certain special relations of such figures as triangles and rectangles, pyramids and spheres.[1] Thales or his Greek contemporaries succeeded in generalizing such special cases and, moreover, made other discoveries familiar in what is now regarded as very elementary mathematics.

[1]The question as to how far the Egyptians generalized mathematical conceptions is still under discussion. On the other hand, there is evidence from their art that they knew and constantly practised the "golden section."

By the 6th century B.C., Greek-speaking peoples had founded colonies in the west, namely in southern Italy and in Sicily. The intellectual activity in these settlements was significant for science, especially that of the "Pythagoreans." Born about 582 B.C., their founder, Pythagoras (*q.v.*) established a brotherhood or sect the influence of which has been very persistent. The Pythagoreans developed what seems now a peculiar teaching on numbers. These were held to have a real and separate existence. The use by the Greeks, as by the Phoenicians and Hebrews, of letters to express numbers encouraged this conception, which has often been given mystical and magical application. But the Pythagoreans gave to the word *mathematics*—which first meant simply "learning"—its special relationship to number. Aristotle in his *Metaphysics* tells that they saw in numbers many resemblances to "the things that exist and are coming into being," almost all things being numerically expressible—in particular the attributes and ratios of the musical scale; and that they therefore regarded numbers as being the elements of all things and saw the whole heaven as a musical and numerical scale. This conception seems very fanciful now, but fancies of this type have repeatedly been of value to science. The human mind, it seems, is somehow attuned to the processes of nature or, as some would say, has attuned itself, perhaps under the guidance of Pythagoreans and others. Certainly we live in a world the major phenomena of which are susceptible of mathematical expression. And it has many times happened that the theoretical developments of mathematicians have been found to bear a relation to observations.

Why and how this should be so are mysteries. Yet consciousness that there is a correspondence between the working of our minds and the working of nature is a conclusion most important for the development of science. We owe this idea to the Pythagoreans. Their conception of the "harmony of the spheres"—on which Aristotle touches—proceeded from the observation that the pitch of musical notes depends on a simple numerical ratio in the length of the chords struck. It was not unnatural that, having made this great discovery, they should have suggested that this ratio might correspond to the distances of the heavenly bodies from their common centre.

A Pythagorean of the 5th century B.C. launched another doctrine which has had repercussions to our time and is still embedded in our language. He supposed that Love and Strife held sway over all things, even material things. In matter itself, in which he distinguished the four elements, water was opposed to fire but allied to earth, while air was opposed to earth but allied to fire. By arranging these elements in pairs, four primary qualities were evolved: namely heat (air and fire), dryness (fire and earth), cold (earth and water) and moisture (water and air). The conception was later extended to the living body. This was held to be composed of four "humours," blood, phlegm, yellow bile (or choler) and black bile (or melancholy), characteristic of the four "temperaments," of which we still speak (sanguine, phlegmatic, choleric, melancholic). This was the first attempt to trace the rules of the external world to the working of man's body.

By the middle of the 5th century both eastern and western schools of Greek thought were becoming overshadowed by the Athenian. In Athens the systematic accumulation of knowledge was rendering old-fashioned those who "took all knowledge to be their province." Something like specialization thus began to appear and has characterized science ever since. It resulted immediately in the recognition of mathematics and of medicine as independent disciplines. The two near contemporary exemplars of these disciplines both bore the name Hippocrates and came from islands of the eastern Aegean.

Hippocrates of Chios, the mathematician (*fl. c.* 450 B.C.), was the first to compose a work on the elements of geometry. One of his discoveries was that the lune bounded by an arc of 90° and by a semicircle on its chord has an area equal to that of a triangle having the chord for base and the centre of the arc for apex. Thus the area of the lune, a figure bounded by curves, can be equated with a figure bounded by straight lines. Of course, this is not equivalent to squaring the circle nor even an approach thereto; but it is the first known introduction of the circle into geometric construction and thus had a great future.

The name of Hippocrates of Cos (*q.v.*) the physician (*fl.* c. 400 B.C.), has been attached to many works. Probably none is his. but the earliest of them are significant for the expression, with religious intensity, of a faith in the constant sequence of cause and effect. Thus in the work called The *Divine Disease (sc.,* epilepsy), we find:

As for this disease called divine, surely it has its nature and causes, as have other diseases. It arises—like them—irom things which enter and quit the body, such as cold, the sun and the winds, things ever changing and never at rest. Such things are divine or not—as you will, for the distinction matters not—and there is no need to make such division anywhere in nature, for all are alike divine or all are alike human. All have their antecedent causes which can be found by those who seek them. (Slightly paraphrased.)

The intellectual history of the 4th century B.C. is filled by the gigantic figures of Plato and Aristotle. They are considered here only in their relation to science.

Plato regards mathematics as yielding that type of certitude to which other studies should conform. Mathematics for him relies for its material upon something of the nature of his "ideas." Many of his thoughts assume a mathematical guise, and he tended to respect a science in the degree to which it had progressed to a mathematical stage. Following his Pythagorean teachers, he regarded the motions of the heavenly bodies as being examples of perfect geometric forms. For astronomy—especially on this theoretic side—Plato had a high regard, and by his followers mathematics became identified with astronomy. We think of astronomy as a field for the application of mathematics; to the Platonists it was rather a field for its exemplification.

Plato regarded the mathematical form of the universe as evidence of the rational mind of its Creator. "God," he is said to have said, "ever geometrizes." To deny the existence of mind as a separate entity was, he held, to assume the universe to be the result of accident. To suggest such a universe was a denial of the validity of philosophy. It is not inconsistent with this view that Plato respected Hippocrates the physician, who "was the first who separated science from philosophy." But the trend of Platonism in general and of ancient Platonism in particular was usually away from observational activity. There have been many evident exceptions, and Platonism has often been helpful to science both in stressing its quantitive aspect and in opposing an entrenched and static Aristotelianism. It was from Pythagorean teachers that Plato derived the so-called "Platonic bodies," the five regular polyhedra which have equal sides and equal angles *(see* SOLIDS, GEOMETRIC). Many centuries later mathematicians proved that the possible number of regular bodies is only five. Moreover, it was from a consideration of these bodies that Kepler developed the first unitary scheme of the universe (A.D. 1596).

Aristotle devoted his incomparable genius to systematizing and organizing the whole area of knomledge. His earliest and, from the modern scientific point of view, his best efforts were on biological topics. The whole of his science and indeed the whole cast of his mind was deeply influenced by his first-hand observations on living things. In his *Parts* of *Animals,* he sets forth his view of the relation between biology and "physics," the latter being for him a general description of the universe. He says:

Of the things constituted by nature some are ungenerated, imperishable, eternal; others subject to generation and decay. The former are excellent beyond compare and divine, but less accessible to knowledge. The evidence that might throw light on them and on the problems which we long to solve respecting them is furnished but scantily by our senses. On the other hand, we know much of the perishable plants and animals among mhich we dwell. We may collect information concerning all their various kinds, if we but take the pains. (Somewhat paraphrased.)

Living things are for Aristotle the type of existence. and existence as a whole presents. according to him, evidence of design. He attempted to analyze the nature of generation. of heredity and of sex. He treated many other topics now discussed by naturalists. There is a profundity in his biological thought which gives it a permanent value. He was a first-class observing naturalist in the modern sense.

Aristotle, like Plato, had Pythagorean tendencies, which he exhibits in his physical scheme. He emphasized the "perfection" of the circle and of the sphere, on which therefore the world is modelled. For him the heavens are a series of concentric spheres arranged round our earth as a central body. These spheres he described, however, as crystalline, mechanizing them from the schemes of certain of his older Athenian mathematical contemporaries.

The mechanical scheme of the universe set out by Aristotle and his successors suggests a series of geared wheels and may have come to the minds of the Greeks through some such complex apparatus. This view of Aristotle was the basis of the theory of the universe that held men's minds for 2,000 years. We may thus summarize it:

1. Matter is continuous.
2. All mundane things are made up of four "elements," which in their turn manifest the four "qualities."
3. Stars and planets move with uniform circular velocity, embedded in crystalline spheres, centred round the earth. Each sphere is subject to the influence of those beyond.
4. Circular, changeless, eternal movement is perfect order. It contrasts with the rectilinear movement which prevails on our changing and imperfect earth.
5. The universe is limited in space and within an outmost sphere. It is unlimited in time, being subject as a whole neither to creation nor to destruction.

Alexandrian Science: First Period, 300–30 B.C.—For the 500 years after Aristotle the scientific centre of the world was Alexandria. There mathematics assumed a prominent position. Among its first exponents was Euclid (*fl. c.* 300 B.C.), whose *Elements of Geometry* determined instruction in the subject for the next 22 centuries.

Another Alexandrian teacher, Aristarchus of Samos (*fl. c.* 270 B.C.), made the first scientific attempt to measure the distances of the sun and moon from the earth and their relative sizes. He estimated the sun as 18 times more distant than the moon (instead of more than 346 times). That he thought the sun far larger than the earth may have suggested to him that it was improbable that a large body would revolve round a relatively minute one. At any rate. he held that the earth rotates on its own axis and revolves round the sun.

Hipparchus (*fl.* 146–127 B.C.) was the greatest astronomer of antiquity. He erected at Rhodes the first recorded observatory. He rendered a great service in developing trigonometry by which numerical calculations can be applied to figures drawn on either plane or spherical surfaces. He made numerous observations and collated the records of earlier Greek astronomers and of their Babylonian predecessors to see if astronomical changes had taken place in the course of the ages. These comparisons led him to two brilliant conceptions:

One was that of the precession of the equinoxes. In 134 B.C. Hipparchus observed a new star in the constellation Scorpio. This discovery suggested the preparation of a catalogue of star positions, of which he recorded the celestial latitude and longitude of more than 1.000. The constellations to which Hipparchus referred these are generally accepted today. He showed great foresight in recording cases in which three or more stars were in a line, so that later astronomers might detect changes in their relative positions. He compared his own positional observations with others of about 150 years earlier and found that there had been changes of a kind that could be explained only by a rotation of the axis of the earth in the direction of the apparent daily motion of the stars. This rotation causes the equinoxes to fall a little earlier each year. Knowledge of this precession and of its rate was necessary for the progress of astronomical theory. The complete cycle of precession takes 26,000 years.

The other great achievement of Hipparchus was his theory of the motion of the planets. When he came to examine the apparent movement of the planets, he had before him two theories, the epicyclic and the eccentric. According to the former, each planet moves on a circle. the epicycle. the centre of which moves on another circle. the centre of which is the centre of the earth. Some of his predecessors had set forth the eccentric view, in which the planet is said to move around the earth but in a circle whose centre is not at the centre of the earth. This secondary centre may also be represented as moving on a circle. Hipparchus explained the behaviour of the sun by a fixed and the moon by a moving eccentric. (The geometric results of moving eccentric and epicycle are identical.)

The epicyclic view was to become the primary basis of astronomy through the mediation of Ptolemy of Alexandria *(see* below), whose works were influential for the next 1,400 years. Ptolemy and his successors, however, invoked also eccentrics. The eccentric theory particularly of the moon and to a less extent of the sun was of service in that calculations based on it accorded more closely with actual observations. From Hipparchus onward. eclipses of the moon could be predicted within an hour or two and those of the sun somewhat less accurately.

At Alexandria. anatomy and physiology became recognized disciplines. The first medical teachers of the school. contemporaries of Euclid, began the practice of dissecting the human body publicly. They compared its structure with that of animals and opposed both Plato and Aristotle by regarding the brain as the sole seat of the intelligence. They observed that arteries, unlike veins, pulsate, but did not ascribe this to the heart's action. thinking that it was an activity of the arteries themselves. They thought of the nerves as hollow and believed that through them was conveyed the hypothetical "nervous fluid." They distinguished between the main brain, or *cerebrum,* and the lesser, or *cerebellum,* observed the cerebral convolutions of both man and animals and associated their greater complexity in man with his intelligence. Their experiments on animals led them to distinguish between the posterior nerve roots of the spinal cord. which convey sensations, and the anterior, which convey the motor impulses.

From about 400 B.C. the doctrine of atoms was current in the Greek world. It was rejected by Aristotle. Later. though important philosophically. it had on the whole a retarding influence on the course of Greek science. It had, however, some influence on Alexandrian anatomy and physiology. Some Alexandrian anatomists supposed that nonatomic "air," equivalent to *pneuma* (πνεῦμα) (see below), is taken in by the lungs and passes to the heart. Here. they supposed, it enters the blood and is changed into a peculiar kind of pneuma or spirit—the "vital spirit"—which is sent to the various parts of the body by the arteries. It is thus carried to the brain. where it is further altered into another pneuma, the "animal spirit." This. they believed, reaches different parts of the body through the hollow nerves.

An Alexandrian school considered the pneuma that circulates in the body to be ultimately drawn from the air, or world-pneuma. This assumption gave a physiological basis to the philosophical conception of the spirit of man as part of the world-spirit. Such a conception is frequent in later writings of the Stoic school *(see* STOICS) and also perhaps in Philo Judaeus and in the Fourth Gospel. Physiology and philosophy thus reacted on each other.

We cannot leave the biological work of the early Alexandrian school without reference to the pupil of Aristotle, Theophrastus (*c.* 372–287 B.C.), who lived well into Alexandrian times. His botanical writings are the best-arranged ancient biological treatises. Among his many acute and accurate observations is his clear distinction between monocotyledons and dicotyledons. Interesting too is his attempted distinction of sex in plants, an attempt successful only for palms. His splendid botanical works had a definite influence on modern biology.

The greatest of the Alexandrian school was Archimedes (c. 287–212 B.C.) of Syracuse, constantly recalled in the mathematical construction of the Archimedean spiral *(see* CURVES, SPECIAL: *Section 38)* and in the mechanical construction of the screw of Archimedes *(see* ARCHIMEDES, SCREW OF) for raising water. The screw as a means of applying mechanical force was perhaps suggested by one of these devices. The familiar story of Archimedes and the crown of Hiero *(see* ARCHIMEDES) shows that he had obtained the relative specific weights of gold, of silver and of a mixture of the two by comparing the relative amount of water displaced by the same weight of the three substances. The scientific aspect of the subject is set forth in his treatise *On Floating Bodies.* This work contains the first record of what we now call "specific weights." Consideration of the scientific use, or development, or exact definition of common knowledge has often thrown light on the nature of the scientific process. Thus to Archimedes the ancient world owed a general exposition of the doctrine of levers. To say this does not mean that Archimedes invented the lever any more than that he had discovered some bodies to be heavier than others. But it is one thing to use or even to contrive a device and another to display its principles and to follow them to their theoretical applications and mathematical analyses. Science owes to the Greeks its first formal. conscious and organized development. just as to Archimedes the doctrine of levers owes its first formal and systematic exposition.

Perhaps the earliest existing work of Archimedes is *On Plane Equilibria.* It sets forth certain fundamental principles of mechanics as rigorous geometric propositions. The work opens with his famous "postulate": "Equal weights at equal distances are in equilibrium; equal weights at unequal distances are not in equilibrium but incline toward the weight at the greater distance." This postulate developed into the principle of the steelyard *(see* WEIGHING MACHINES), and led Archimedes in the end to the discovery of the centre of gravity in a variety of geometric figures.

Among the achievements of Archimedes is his method of measuring the areas of curved figures and surfaces. The simplest expression of this is the effort to "square the circle." His predecessors had broached the idea of "limits"; Archimedes, however, employed limits systematically: a doctrine of great historical and practical importance.

The principle can be expressed simply. A square can be inscribed within a circle. It is evident that the sum of its sides is less than the circumference and that its area less than that of the circle. The number of sides can be doubled to make an eight-sided figure within the same circle. The proposition remains true, however many the sides; but as their number is increased the discrepancy decreases. "In the limit," when its sides become no more than points, the polygon may be conceived as becoming the circle. Archimedes realized that this limit can be approached as nearly as we wish *(see* LIMIT).

Archimedes proved that the area of a circle is equal to that of a triangle of base equal to the circumference of the circle and of height equal to its radius. To calculate this area it is necessary to find the ratio between circumference and diameter. In estimating this ratio Archimedes sought the limit approached by the sides of regular polygons both inscribed in and circumscribed on the circle. The limits for their ratio to that of the diameter he found to lie between $3\frac{10}{71}$ and $3\frac{10}{70}$. The latter has, since his day, been generally accepted as a good approximate value of the quantity known as π.

He applied a comparable process to other curves. In his treatise *The Quadrature of the Parabola* he brings both an inscribed and a circumscribed rectilinear figure into relation with the curve under investigation. The two rectilinear figures, as it were, compress the curve, one from within and the other from without, until they coincide with it. This procedure, together with the use of mechanics for solutions subsequently demonstrated by geometry, leads to the consideration of his extremely important treatise *On Method.*

For the most part, Archimedes, like other Greek men of science, gives his proofs but does not tell how he reached them. In the *Method,* however, addressing Eratosthenes *(see* below) he recalls the discoveries which he had sent to his friend on a former occasion and then says that he is now explaining how he made them.

In essence the *Method* is the application of two principles: (1) that a plane figure may be regarded as an aggregate of an infinite number of parallel lines; and (2) that consideration of the respective weights of two plane figures, one curved and one rectilinear, may reveal the approximate area of the curved figure. The same process may be applied to demonstrate relationship between the volumes of solid curved figures considered as aggregates of an infinite number of parallel plane figures. It amounts to a practical solution of problems of the relation between areas or volumes by analysis. mechanical or other. after which the investigator returns to a synthetical mathematical process. He thus gains by experience some estimate of the solution before he seeks its mathematical demonstration.

An Alexandrian successor of Archimedes. Apollonius of Perga (*fl.* 220 B.c.), developed the knowledge of conic sections. Our familiar terms parabola, ellipse and hyperbola derive from him. The subject has a peculiar interest here since the idea of conics was for more than 1,500 years a purely intellectual exercise. Generations of mathematicians discussed the mathematical properties of these curves, which were not known in nature. Then in 1618 Kepler discovered that planets move in elliptical orbits. Surely here the distinction between pure and applied science was artificial. The human mind is somehow attuned to nature, whose ways it had unwittingly explored for all these ages.

Among the Alexandrian luminaries was Eratosthenes (c. 276–*c.* 194 B.C.), the greatest scholar of his age. His most important achievement was the measurement of the globe of the earth, performed by an operation of beautiful simplicity. He started with these propositions: (1) that at Syene (the modern Aswan) on the tropic and on the Nile, at noon on midsummer day an upright rod casts no shadow; (2) that Syene is 5,000 stadia due south of Alexandria.

The problem is to determine the angle at the centre of the earth subtended by 5,000 stadia. But if on midsummer day the shadow cast by an upright rod at Alexandria is measured, then the angle which the sun's ray makes with the rod can be estimated. Since, however, the sun is so far distant from the earth, its ray at Alexandria is effectively parallel to its ray at Syene. Therefore the angle that it makes with the rod is equal to the angle subtended by 5,000 stadia at the earth's centre (alternate angles). Thus an estimate can be made of the one unknown in the equation, that is, the earth's circumference. His result was reasonably accurate.

Having measured the earth, Eratosthenes proceeded to consider the known parts of it. Here, like all his predecessors, he had self-imposed limitations. He regarded the habitable world as wholly within the northern hemisphere and forming only about one-third of that. He considered that the land-surface of the world was longer from east to west than from north to south and estimated the distance from the Atlantic to the Eastern ocean as 78,000 stadia (about 7,800 geographical miles) and the distance from the parallel of the Cinnamon land (Ceylon) to that of Thule as 38,000 stadia. As he estimated the circumference or equator at 250,000 stadia. Eratosthenes could also estimate the circumference at the parallel of the Pillars of Hercules (Strait of Gibraltar), which he knew was also that of Rhodes. This fundamental parallel (latitude 36°) passed through other important points—the westernmost point of Spain. for example, and the southern points of Italy and of Greece—and along the Taurus mountains. At this parallel the total circumference of the world Eratosthenes estimated at 200,000 stadia. All but 78,000 stadia of this was sea.

At right angles to the parallel of Rhodes. Eratosthenes determined a north-south line between Alexandria and Syene. This, produced northward, he regarded as passing through Byzantium and thence to the river Dnieper. Southward, he considered that it passed to Meroë and then along the Nile.

These fundamental lines, together with those on other parallels of latitude and lines of longitude, are sufficiently accurate for constructing an outline world map in which the Mediterranean area is recognizable.

Alexandrian Science under the Roman Empire, 30 **B.C.–A.D.** 200.—Despite the dominance of Rome, science remained Greek in spirit and language. Its final syntheses are provided by two pupils of the Alexandrian school, Ptolemy (*fl.* c. A.D. 140) for cosmology and geography and Galen (*c.* 130–*c.* 200) for anatomy and biology.

Ptolemy's *Almagest* was of the highest significance for later astronomical development. Its basic cosmic conceptions come from his predecessors but are expounded with the utmost skill. Ptolemy (*q.v.*) invoked epicycles to explain the movements and behaviour of the planets, employing them to resolve some errors and inconsistencies of Hipparchus. He retained, however, eccentrics to explain certain elements in the movements of the planets.

Ptolemy possessed a series of astronomical instruments, the existence of which proves the high degree of mechanical skill evolved during generations in exact metalwork. With these he could determine the date of the equinoxes, the midday altitude of the sun, the zenith distance of the moon at its meridian passage, the meridian transit of stars, the apparent diameter of sun or moon and the latitude and longitude of the moon or of a fixed star. Among his greatest achievements is the determination of the distance of the moon by parallax: the method is in principle that still in use. Ptolemy estimated the moon's distance to be 59 earth radii, which is not very far from the truth. Working on an eclipse method of Hipparchus, he estimated the sun, however, to be only 1,210 earth radii distant, which is one-twentieth of the truth. He had no way of estimating the distances of the lesser planets but followed tradition in accepting apparent speed as the main test of nearness. The resulting scheme passed to the middle ages.

Ptolemy's other great work, his *Guide to Geography,* was a product of knowledge brought to him by Roman imperial expansion. He developed his own manner of representing on a plane surface the curved surface of the earth. In his "projection" the parallels of latitude are arcs of concentric circles. Chief among the parallels are the equator and the circles passing respectively through Thule, through Rhodes and through Meroë. The meridians of longitude are converging straight lines.[1]

The great biological synthesis of antiquity was made by Galen (*q.v.*), a native of Pergamum in Asia Minor. Galen studied at Alexandria but spent most of his active life in Rome. He elaborated a complete physiological scheme which was generally accepted until modern times. Three kinds of pneuma or spirit are involved in addition to the world-pneuma or air. The basic principle of life he believed to be drawn from the air by breathing. Entering the body through the windpipe, it passes, he thought, to the lung and thence to the left ventricle of the heart, where it encounters the blood. His view as to the changes that then take place in the blood was most ingenious and was based on experiments, but the errors that it involved remained current till the 17th century and beyond.

Galen's scientific works are among the most influential of all time. Nevertheless he established no school and had neither disciples nor direct followers. On his death anatomical and physiological inquiry ceased abruptly. Mathematical and mechanical research continued a little longer than biological, but they pass into a silver period in the 3rd century. For science in general the middle ages begin effectively about A.D. 200.

MEDIAEVAL SCIENCE

There followed a period well-nigh barren in positive scientific results until versions of the Greek scientific works appeared in Arabic in the 10th and 11th centuries and in Latin, mostly from Arabic: in the 13th and 14th. Though these later "middle ages" added little to the growth of our scientific heritage, they did something for its coherence and presentation. Consideration of this is best treated for the eastern and for the western share separately.

Islamic Science, c. 850–c. 1200.—After the fall of the western Roman empire, science disappeared with it. In the eastern Roman empire, which mas Greek-speaking, a disintegration began that was never effectively arrested. Much valuable Greek scientific literature was, however: translated into Syriac, the language of the heretical Nestorian Christians. Between 750 and 850 these versions were revised and many others added. From 850 to 950 Nestorian translators at Baghdad rendered the Syriac versions into Arabic. This presentation of Greek science in Arabic is the primary source of "Arabian science" which was to leave a deep impress on the Latin world.

The Arabic language and culture spread afar: to Portugal in the west and to the frontiers of China in the east and over many degrees of latitude. The most characteristic Arabic scientific developments were in alchemy, in mathematics, in astronomy and in medicine.

Alchemy is a term used to describe very diverse kinds of literature; most of it highly mystical. From Egypt, from Byzantium

[1] He has another scheme of projection in which the meridians are also curved.

and perhaps from China, however. Arabic-speaking "alchemists" derived many recipes and methods for industrial processes, and their experiments demanded special apparatus. The greatest Arabic-writing alchemist. Rhazes (d. *c.* 930), who completed his work by goo, makes the earliest known suggestions for furnishing a chemical laboratory. Industrial technology and alchemical apparatus of Arabic origin had an important role in the rise of modern chemistry.

In mathematics, of all peoples of antiquity, none except the Greeks attained so high a standard as the Hindus. Nevertheless. it is impossible to fix dates and hardly even possible to establish sequences for the Indian mathematical works. By the 9th century, however, the Islamic peoples were using the Indian system of numerical notation, the so-called "Arabic numerals." The most influential work that conveyed this was by the Persian Mohammed ibn Mûsâ al-Khowârizmî (c. 825), from whose name the mediaeval word for arithmetic. algorism, was formed. The title of the Latin version of his Algebra is the first western use of the word in the mathematical sense: it means "rectification," that is, transposition of negative terms of an equation to the opposite side. The Arabic speakers also inherited and considerably developed the geometrical and optical works of the Greeks.

Astronomy and with it astrology were constant preoccupations of the Islamic world. They were specially developed in Spain. where schools or groups of experts in these subjects were formed both at Córdova and at Toledo. The tables of positions of stars known as Toledan were drann up in 1080. Their authors sought to replace the Ptolemaic by a strictly concentric system.

In medicine, as in alchemy, the first and greatest original Moslem writer was Rhazes, the type of the oriental man of science whose erudition was all-embracing. He made the first distinction between measles and smallpox. It is impossible to mention Arabic medicine without recalling Avicenna (979–1037), whose work was for centuries standard in Latin as it still is in Arabic. He was scientifically much inferior to Rhazes. The physiology and anatomy of the Arabic writers as typified by Avicenna was a grossly deteriorated version of the Greek. The great Arabic contribution to medicine is the introduction of new vegetable drugs, many of which are still in use.

Science in the Latin West, 1100–1450.—Until the 11th century no western scientific movement needs consideration, since Spain in those earlier centuries must be regarded as within the orbit of eastern culture. In the 11th century the west began to come into relation with the nisdom of the east through Latin translations of Arabic works. These, during the following three centuries, came mostly from Spain but also from Sicily, from Provence and from Syria.

Mediaeval Latin had at first no technical scientific vocabulary. The translators therefore often transliterated Arabic words, and thus many Arabic names of stars, of chemical substances. of apparatus, of plants and even of anatomical parts passed into Latin. Some have survived in modern vernaculars. Moreover, Aristotle's views of the structure of the universe as conveyed in these Arabic-Latin translations from his works and from Ptolemy provided the mediaeval world-picture. The recovery of the works of Aristotle was a major factor in the 13th-century revival of intellectual coherence and gave to scholastic science its essential character. This "mediaeval Aristotle" was later modified by a slow infiltration of direct translation from the Greek.

It is remarkable that the accumulation of knowledge derived from the Arabic, involving rapid development in the whole mental life of Europe, did not arouse a more passionate faith in the value of progress in knowledge. The test of such faith must be the direct appeal to nature. But there was remarkably little of this until the 15th century.

Great emphasis has often been placed on mediaeval "forerunners" of science, notably of Roger Bacon (c. 1214–94). Research on Roger Bacon and on his times has shown that his scientific contribution was small. Comparable investigations of several other mediaeval writers who sought to outline a philosophy of science have yielded new and interesting but basically comparable results. There have been many able attempts to display the experimental achievements of the age. It is true that there were experiments with the compass (perhaps under Arabian influence); that the problem of the path of light within a spherical lens was partially solved on a mathematical basis; that a parabolic burning mirror was constructed or at least attempted; and that a solitary genius made a workable astronomical clock of great complexity. These achievements, scattered over two or three centuries, are minute compared with those of the best Greek or Arabic centuries. They hardly justify a revision of the standard view that modern science arose in the 15th and 16th centuries, primarily as a recovery of Greek science. But the new science had two advantages: first it had a better empirical technology, the product of the mediaeval centuries; secondly, it was aided by a method of exposition that was a real contribution of scholastic thought.

Astronomy—which cannot at this stage be distinguished from astrology—was certainly the main scientific interest of the scholastic age. The practical results of scholastic astronomical activity are. however, meagre. Western knowledge of astronomy was largely based on the activity of Alphonso the Wise (d. 1284), king of Castile. He collected at Toledo a body of scholars, mostly Jews, who had access to Arabic sources and calculated a set of astronomical tables (1252). These spread rapidly through Europe. They contain few new ideas, but certain of their numerical estimates, notably the length of the year. were calculated with very remarkable accuracy. Alphonso is also responsible for a vast encyclopaedia of astronomical knowledge compiled from Arabic sources by a similar group.

In pure mathematics the original achievement of the scholastic age was small, though a borrowed element, the so-called "Arabic" notation, was later to prove of the highest significance. The *Liber* abaci of Leonardo of Pisa (c. 1170–*c.* 1245), which advocates this system with great skill, appeared in 1202. The first book by a Latin Christian to employ this system, it is the essential source of our modern method of numeration, which, however, was extremely slow of general adoption. Other works of Leonardo were much more original, but being before their time had less influence. He was undoubtedly a mathematician of extraordinary ability, but his positive contributions are as nothing compared to his importance as the carrier of the new method.

THE RENAISSANCE AND EARLY MODERN SCIENCE

The Humanistic Century, 1450–1550.—It is not necessary to recount the western recovery of the Greek classics from surviving Greek traditions and texts. This "humanistic" movement was in full action by 1450, and the scientific heritage had been fully recovered by 1550. The intervening 100 years saw also the introduction and spread of the arts of printing and illustration, both of great importance for scientific development. From these general considerations we turn to the specific scientific achievements of the humanistic century. The first practical Latin exponent of the value of experiment is the German cardinal Nicolaus Cusanus (1401–64), whose recorded careful experiment on a growing plant, proving that it absorbs something of weight from the air, is the first modern formal biological experiment and the first experimental proof that air has weight. Carried to its logical conclusion it would have ended the old doctrine of the pneuma. Nicolaus wrote a book on the use of the balance and showed in several ways that he could apply the experimental method in detail. His theoretical views led him to believe that the earth moves, though he reached no formal astronomic theory.

Copernicus (1473–1543), despite the vast scientific change introduced in his name (see ASTRONOMY: History of Astronomy) was a conservative scholar rather than an observer. Induced to seek a new theory of the heavenly bodies by finding that mathematicians differed among themselves on this subject, he concluded that some essential factor had been missed. He found his hint in the surviving traditions of the thought of the Pythagoreans and of Aristarchus and perhaps also in the thought of Nicolaus Cusanus. The renovated scheme set up by Copernicus assumed that the universe is spherical and finite. limited by the sphere of the fixed stars, and that the movements of the celestial bodies are always circular and always with uniform velocities. It invoked epicycles and demanded eccentrics. John Milton gives a description of the Ptolemaic world that fits this attempt to "save the phenomena" when he makes the archangel Raphael tell of those who would

"model Heaven
And calculate the stars: how they will wield
The mighty frame; how built, unbuild, contrive
To save appearances; how gird the sphere
With Centric and Eccentric scribbled o'er,
Cycle and Epicycle, Orb in Orb."
(Paradise Lost, viii, 79–84.)

An important aspect of the humanistic century is the impact of the main technical instrument of Renaissance art, namely perspective. This new device, though it rapidly became a convention, is truly scientific because, given certain conditions, its truth can be demonstrated experimentally and at will and its accuracy estimated Leonardo da Vinci (1452–1519) was its greatest scientific exponent, but it was the product of many minds.

Perspective deeply influenced many sciences. It produced sounder and simpler plans of engines of all kinds and was of great aid in many technical arts. All developments involving geometry in three dimensions became more easily intelligible. Above all it made possible the adequate representations of living things and their parts. Thus Leonardo could both illustrate many devices of his age and make clear on paper, for the first time, many details of the structure of human and animal bodies.

The same movement which linked the study of nature with scientific perspective produced in the first half of the 16th century many exact studies of plant form. Its most characteristic product was the masterpiece of Andreas Vesalius (1514–64), the first great scientific monograph in the modern manner. This appeared in 1543, within a few weeks of the work of Copernicus, his senior by 41 years. Copernicus is essentially a mediaeval figure. Vesalius a modern who employed all the resources of the art of his age to illustrate personal observations. Nevertheless it is important to remember that the researches of Vesalius were solidly and consciously based on a sound knowledge of the 1.300-year-old findings of Galen.

The New Status of Greek Science.—Mediaeval thought on the material world was essentially based on that of the Greeks and especially on Aristotle. By 1500 the whole works of Plato and almost the whole of Aristotle were available in reliable Latin translations direct from Greek. The Renaissance saw a revival of Platonic thought. Moreover, from about 1550 an accumulation of biological works based on Aristotle tended to confirm him as "the master of those that know" in that particular field. At about the same time, however, in the fields of mechanics and of cosmology cracks were beginning to appear in Aristotle's system. These were brought out clearly by Simon Stevinus (1548–1620) in the last years of the 16th century. He investigated the Aristotelian theory of the fall of bodies. His name is associated with the method of resolution of forces, with the distinction of stable and unstable equilibrium and, above all, with the law of equilibrium on an inclined plane in a famous demonstration of the impossibility of perpetual motion. He perceived that science could not well advance until its mathematical framework had been improved. This was facilitated by his introduction of decimal fractions. Several other contemporary devices helped in the same direction: for example, the employment of letters to represent quantities (1591), the conception of conic sections as stages in a series from the line pair to the circle (1604) and the invention of logarithms (1614). With such equipment and with the improvement in the technique of instrument-making, notably of lenses, the great exponents of scientific method of the earlier part of the 17th century —Galileo (1564–1642), Kepler (1571–1630), Descartes (1596–1650)—could proceed with their work. By the middle of that century Aristotle's physics and cosmology had fallen, while his biology was on its way to being rebuilt on his own lines; mathematics had become a recognized instrument of research in the physical sciences; the contributions of Archimedes were recognized, even when applied in the biological field; alchemy had effectively been replaced by a chemistry built mainly on the technological traditions of craftsmen but aided by the apparatus of the alchemists; the exploration of the structure and function of the human body had become a profession. Science itself had emerged as a vocation supported by its specialized philosophers, by its specialized exponents in the arts of discovery in various departments and by its skilled instrument-makers. Science had thus become consciously mature and was prepared for its formal organization in the period which followed. All this was exemplified in the brilliant personality of Galileo (*q.v.*).

The outlook of the first half of the 17th century thus involved on the negative side a rapid waning of the scholastic reliance on ratiocination, and on the positive a new reliance on experience and especially on experiment as a way to make knowledge. A man of science of the 20th century could converse freely with one of 1650, with a very few of 1600, with a handful of 1550, but hardly with one of 1500. What had happened in this first and critical half-century of modern science, from 1600 to 1650?

In cosmology, the explanation of planetary movements by Kepler (*q.v.*) and Galileo's discoveries with the telescope had destroyed geocentric thinking. They had done away with the moral connotation of physical events expressed in the idea of the perfection of the sphere. Incidentally they had destroyed astrology.

There was a new view of the nature of matter. The systematization of mineralogical knowledge and the increased literacy of industrial technicians had given birth to chemistry and destroyed alchemy, removing there too a moral significance from material phenomena.

To express his findings in mathematical terms became the ideal of the physical experimenter. Broadly, this was acceptance of a relation between number and form, for which Descartes (*q.v.*) is still commemorated in the term "Cartesian co-ordinates."

The idea of acceleration is a development of that of mathematical expression but one of such significance that it demands special mention. Its introduction by Galileo was a great seminal idea for all aspects of physics and notably for celestial physics.

Physiology set physics as its ideal. The discovery of the circulation of the blood by William Harvey (1578–1657) and the chemical investigation of the bodily processes by J. B. van Helmont (1577–1644) made possible the first comprehensive treatment of the subject by Descartes.

Living forms, by reason of their great variety, did not yield (and still hardly yield) to physical, chemical or mathematical consideration. The period saw an extension of Aristotelian methods to the classification of animals and of plants. "Natural history" perhaps first achieved this status at the hands of Joachim Jung (1587–1657).

From this point on it is harder to consider science as a whole, even if we avoid considering the applications of science. Scientific thought became specialized. At its dawn about 400 B.C., we saw it dichotomize into mathematics and medicine. So from 1650 we must consider the physico-chemical view on the one side and the biological on the other. Soon there will be much more complex division and recombination.

DETERMINISM AND POSTDETERMINISM

From the second half of the 17th century to the end of the 19th men lived in a world of which the material framework had been outlined by Isaac Newton (1642–1727). The attitude of mind called "scientific determinism," sometimes rashly equated with "scientific materialism," is not quite as old as that. Newton's great work, *Philosophiae Naturalis Principia Mathematica,* was published in 1687. It had little immediate effect: it could at first be read only with difficulty even by mathematicians, and its demonstrations were intelligible to a mere handful of Newton's contemporaries, none of whom moreover was interested in introducing them to less scientific readers. Its wider influence began to be felt after Newton's death. The impact of "Newtonism" on general thought can perhaps be dated from the publication of Voltaire's admirably clear essay on Newton's system (1737).

Though Newton wrote what he called "philosophy" and habitually called himself a "philosopher," he meant by those words just what we mean by "science" and "scientist"; cf. the *Philosophical*

Transactions of the Royal society (over which Newton used to preside), from which anything that we would now call "philosophy" is invariably excluded. Let us therefore consistently render his word "philosophy" by our word "science," which is almost exactly what he meant.

Newton left no doubt as to what he regarded as the principles of science and his hopes for it.' All its difficulties, he held. "seem to consist in this—from the phenomena of motions to investigate the forces of nature, and then, from our knouledge of these, to demonstrate other phenomena." And he goes on: "I wish I could derive all phenomena of nature by some kind of reasoning from mechanical principles; for I have many reasons to suspect that they all depend upon certain forces by nhich the particles of bodies are either mutually attracted and cohere in regular figures or are repelled and recede from each other." Thus he hoped to fit all material events into a framework of relatively simple and mathematically expressible rules. That is what he regarded as the task of his "philosophy" and what for two centuries was regarded as the task of "science."

Newton's marvellous genius ran at its ease only along the line of demonstration to the senses. and it was as a means for such demonstration that his superb mathematical apparatus was designed. He was indeed much interested in theology and spent much time on it; but for philosophy he had a definite distaste. The influence of his science on philosophy (and doubtless through it on religion) has mostly been unwitting, though no less important on that account.

Newton was more gifted with the power of scientific demonstration than any man. He is rightly regarded as the very type of the modern man of science. and we may treat him as the modern scientific exemplar. But this scientific giant presents a different figure when he works in a field ill-suited to his trained talents and works with tools the use of which he has not learned in the best tradition. Newton's incursions into chemistry make a depressing story of waste of most precious effort. His chemical. that is, his alchemical record provides the classical warning that the task of the man of science is demonstration and that his opinions, where unrelated to demonstration, are of little more value than those of other men.

In spite of all this Newton formulated, more clearly than any of his predecessors, those primary statements on which others came to build that comprehensive system which later became known as "scientific determinism." The term was introduced about the middle of the 19th century, but the passages just quoted from Newton's *Principia* contain the essential elements in the determinist faith. Some of the exponents of that faith have, however. extended the conception of "phenomena" far beyond anything that Newton intended. They have, for example, ranked as phenomena events within the mind itself, and they have treated them also as determinate.

The conception that mental events are determinate has been much more revolutionary for religion than anything in the Newtonian system proper. That man's body works on ascertainable mechanical principles had indeed seemed obvious to Descartes before Newton and as long ago as 1627. The followers of Descartes directed the thought of the age for about a century. The Cartesians, however, recognized with their master that men are something more than mechanical systems. Man thinks as well as acts. Only if man's entire nature, including his thinking, could be fitted as links into a long chain of causal development could his actions and his mind be treated as truly determinate. It was in this very way that the conceptions of Descartes and Newton were extended in the middle and later years of the 19th century, especially after 1859, in which year appeared both Darwin's *Origin of Species* and Marx's *Zur Kritik der politischen Oekonomie*. The former contains the germ of biological determinism, the latter that of psychological determinism. Both are sources of the doctrine of social determinism.

Years before Darwin and Marx, the seer William Blake (1757–1827) had seized on the apparently unoffending figure of Newton as the type of those who deny free will—which in fact Newton did not. Blake could not read any part of Newton's science, but echoes of the scientific discussions of his age reached his limited circle. Despite his misunderstandings, Blake had a remarkable vision of scientific determinism. But he was not the first. There were certain schools of thought in the 18th century that followed the determinist path. Such were the French encyclopaedists and some of the first English utilitarians. With these may well be classed certain heretical groups during Renaissance and mediaeval times. Behind these again were strains of Stoic and of Epicurean thought in classical antiquity. Further back, too, at the very dawn of philosophy, we see a cleavage on determinism between the thought of Socrates and that of his rival Anaxagoras. Through all the ages these attitudes have opposed each other. Neither had or could then have demonstrational backing. It was Newton who first demonstrated a law of physical movement the writ of which ran equally on earth as in the heavens, a law which seemed wholly unrelated to any spiritual order. It was this that gave to the conception of determinance an immediacy as well as a practical workaday aspect that it had never previously worn.

Newton sought always to cast his scientific conclusions into a mathematical form. From the time of Galileo, or indeed from the time of Plato, many men have held that the scientific value of any collection of observations can be estimated by the degree to which they are susceptible of arrangement under mathematical formulas. Were this the case, mathematics would be the yardstick by which alone the maturity of a science could be judged. That "science is measurement" is widely held and even more widely tacitly accepted. Yet in fact much science is not, or has not yet become, mathematical.

So far as the 19th century is concerned, it was the conclusions of certain nonmathematical sciences that impinged most directly on philosophical and religious thought. It was the geologists and the evolutionary biologists who raised most acutely the issues primarily responsible for "the conflict between religion and science," by demonstrating that man's place in nature is very different from that which had been taught. Evolutionary doctrine quickly affected historical, social, linguistic and even literary studies. No line of scientific thought has ever so rapidly seized so many minds as that associated with the name of Charles Darwin (1809–82). Now, however, the thunders of the evolutionary conflict rumble only from the further frontiers of philosophical discussion, and the air has long cleared in the area of the original disturbance. Scientific men, though still busy discussing the nature of the evolutionary process, do not spend time answering such remote and ineffectual persons as may deny the demonstrated evolutionary sequences.

But in considering this and other great seminal ideas it must ever be borne in mind that science never considers and cannot consider the world as a whole. It is essential to any science that it proceed by abstracting a part of the universe, to be considered by and for itself. This fragmentation carries with it the secret of the scientific triumph and the secret of a common philosophic fallacy. While one science may combine with another to form a new science with its own technique (for example, entomology and psychology have together produced insect psychology) and while one science can use the results of another, yet each science can describe only its own little bit of the universe in its own terms. These terms are derived by a comparison of yet smaller bits of the universe with other smaller bits. Such terms have little or no application outside the particular science for which they were devised. The technical terms of the sciences have no universal application or value. Their use outside the field for which they were invented is a very frequent source of misunderstanding.

Gross errors have been made, even by scientific men, through transference of scientific terms from their original field of reference. Consider, as examples, the mass of fruitless disputation that has arisen around such words as "evolution," "instinct," "element"; or the employment of the words "race," "tradition," "heredity," "nationality," "value" to give a scientific appearance to nonscientific judgments; or, again, the endless confusion between the scientific, the philosophic and the theological usages of such terms as "substance," "theory," "idea,'! "cause," "purpose," "function." The language of the sciences is a peculiarly difficult subject, for language is a product of complex and ever-changing social conditions. Words cannot be fixed or stabilized and they carry with them a history that needs to be traced right up to the moment of usage.

To enter into the difficult and disputable region of definition of terms would take us right back to a discussion of the very nature of knowledge. Here it must suffice to indicate that there cannot be a "science" of the whole universe. Specifically, it is impossible to reach that end—or perhaps any end—by just adding the sciences together. Even apart from the many difficulties and objections intrinsic to such a process. there are vast regions of experience—those occupied, for example, by art, by literature and by philosophy—that are refractory to scientific treatment. In any event, there is no such thing as a universal science, a scientific treatment of the entire universe. It is, moreover, certain that there never can be.

Nevertheless a science must not be mistaken for a mere fragmentation of knowledge. The necessary minuteness of scientific analysis may give those untrained in the sciences an impression of triviality. That the restriction of the field of experience of scientific men should be a favourite theme for humorists is both legitimate and highly praiseworthy. There are many useful men of science who spend their lives absorbed in minute scientific details and who never learn the importance or significance of their own studies. But, despite such dull, obstinate, timid or temperamentally limited beings, science is a great deal more than exploration of ever minuter details. The objective of scientific analysis is to reach a series of points—a natural frontier—from which the mind can return along its tracks to arrange its findings into some pattern. Such patterns are scientific theories or generalizations. They frequently involve a reunion of the findings of workers in different departments. Often these findings become the starting places for new analytic explorations and the bases of yet further generalizations and thus of new sciences.

The impressiveness of the great scientific generalizations must not deceive us as to their essentially abstractive nature. Each science is as much a consideration of an artificially separated fragment of the universe as is the minutest entomological research. Whether we are discussing the galactic circle, or the antennae, of a beetle or the "expanding universe,'! we are dealing with an artificially separated bit of the world. We often speak of the "field" of a science, and the term is peculiarly applicable to such an area of experience. The essential character of a field is that it is separated from the surrounding country by a fence or hedge. It does not make up the whole landscape. though it contributes to its character. A science, to be such, must have its set limitations.

The term "expanding universe" itself here merits a little consideration, since it is often the subject of a naïve confusion between scientific, philosophic and religious conceptions. The expanding universe of the relativists is, of course, not at all the universe of ordinary thought, but simply a technical term of astronomical and mathematico-physical science. It refers to something the existence of which must be assumed in order to fit together the mathematical deductions from certain physical measurements. For these deductions to fit each other, it is necessary to assume a field that is ever growing larger. This is the expanding universe of the astronomers. The universe: without an adjective, includes many things that are insusceptible not only of measurement but of any sort of mathematical treatment or expression. To such things the term expanding is wholly inapplicable. Csing a verbal, though not a real, paradox, we may say that the expanding universe is part of the universe.

There is an aspect of the necessary conditions of scientific observation that has forced itself upon the attention of men of science during the 20th century. It became more apparent to them that their studies demand for their prosecution certain basic data, that is to say, things "given," or taken for granted. To express the same thought in other words, we say that physical science has its metaphysical foundations. A famous saying of Archimedes brings out this point: "*Give* me a place on uhich to stand," said he. "and I can move the world." His difficulty was, of course. that there is no such place, unless it be, as he says. "given"—that is, taken for granted and imagined for the purpose of his discussion.

Men of science have now come to perceive, more clearly than before, that for scientific observation to have any meaning, certain things must be assumed, accepted, taken for granted, given. The point came into high relief early in the 20th century in connection with the interpretation of certain observations of the behaviour of light from the stars. These observations formed the basis of the physical theory of relativity associated with the name of Albert Einstein (1879–195j), the essence of which may be expressed by saying that the very act of observation affects that which is observed. Within a few years a similar point arose in connection with the intra-atomic physics. It was found that the more accurately the position of a particle could be specified, the less accurately could its velocity be predicted: and vice versa. This is the principle called "indeterminancy" or "uncertainty" (see UNCERTAIKTY PRINCIPLE, THE), which, like relativity, runs athwart the whole view of scientific determinism.

Relativity and indeterminancy are of the utmost importance not only in the specific fields in which they first came into view, but also for any consideration of the ultimate validity of scientific demonstration. In this connection, however, a serious misunderstanding has arisen. It has been assumed that. because the most minutely exact prediction may be impossible to us human beings, physical action is ultimately indeterminate. But the one thing does not follow from the other. Whether nature is indeterminate or not is an entirely different question from whether we can or cannot ascertain all her determinate elements. The indeterminate element may be in ourselves.

Fortunately, it is unnecessary to discuss here in detail physical relativity or physical indeterminancy. Since neither principle is involved in those separate observational sciences which admittedly treat only of artificially separated fragments of the sensually appreciable universe, a scientific "theory" can generally be safely launched regardless of these principles. however important they are for any general consideration of science.

The universe as a whole, meanwhile. is not explained by gravitation plus particulate doctrine of matter plus relativity plus evolution plus subconscious mind plus the doctrine of marginal values plus e'nergetics and so on, even though we should eventually muster all the great scientific generalizations. Such things cannot all be added together. To attempt to do so is to pass into absurdity. Some of them are incommensurate with others of them. And, moreover, such of them as can be added together provide thereby not a goal, but rather a starting place for further exploration (as exemplified in "insect psychology"). The vastness of the territory which has been considered by men in their scientific mood must not blind us to this essentially partial or temporary character of their conclusions. There is a limit beyond which the mood cannot be applied, maintained or endured. The sciences can, at best, describe only a part of the universe.

Thus to the oft-asked question "What does science say about religion?" the strictly true answer is "Nothing whatever" if by religion is meant a general view of the universe and of man's place in it. Notably that must be the answer if religion is to include that inner factor in man's consciousness by which he integrates himself into the universe. Science can say something of scarabs and stars and mountains and, maybe, of the relations of all these things to each other. It may treat of the operation of minds, both individually and collectively, at any rate as judged by an assumed—though unintelligible—parallelism between mind and body. And as regards a religion, science may analyze it into abstracted parts and tell us something about, let us say, the psychology of Buddhism or the debt of Islam to Byzantine Christianity. It may display the influence of a religion on the conduct not only of a society but even of an individual. But science can neither, on the one hand, bring all the diverse parts of the universe into relation with each other nor, on the'other, touch the essential nature of existence of which we are aware through something that we call "consciousness."

Consciousness is the ultimate datum, the thing taken for granted. Consciousness is, as it were. the judge before whom science must recite its piece, which is its narrative of experience of phenomena. These experiences are arranged in a series of acts or scenes each of which bears the name of a particular science. The scenes may be altered, amalgamated, enlarged, increased in number; but external things, seen, heard and felt, they remain. Their recital, and that alone. is the role of science. (C. SI.)

SCIENCE, TEACHING OF. In most countries. science instruction begins in the elementary school. The teacher at this level cannot be a specialist in science teaching, for he must also teach the other subjects of the curriculum, but there is a growing tendency to employ specially trained science consultants who do demonstration teaching in science and who assist the regular teachers in their work.

The teaching of science as a separate subject generally begins with the middle or junior high school (typically, grades six to eight or seven to nine; *i.e.,* second to fourth or third to fifth form). Instruction at this level in Great Britain, the United States and many other countries offers.under the heading of general science, all major aspects of the subject. Many countries, however, follow the French system of offering separate courses in physics, chemistry and biology, starting with simple and descriptive accounts in the sixth or seventh grade (second or third form). The instruction in these fields is typically cyclical, and the instruction continues throughout the secondary school. The Anglo-U.S. pattern of general science is followed by courses in physics, chemistry and biology in the later secondary-school years. Less rigorous courses such as physical science are sometimes offered for less capable students.

Postsecondary-school science courses are many and diverse. Universities offer sequences in each major field of science. from introductory and general courses to highly specialized courses which provide intensive instruction in restricted fields leading to research or to technical vocations. Technical schools provide specialized training for industrial work; science instruction in such schools is focused more on the practical than on the theoretical aspects of science.

Goals of Science Teaching.— The modern world requires a very large number of skilled technicians and practitioners as well as of persons who can add to the store of fundamental knowledge through their own research. A primary responsibility of the science teacher, therefore, is to foster the development of the scientist. But there is a second goal, no less important, which is that of educating each person, to the degree of his capabilities, in scientific understanding to enable him to cope intelligently with his environment and to contribute both to his own well-being and to that of society. Another way of looking at goals is to examine the nature of science itself. Science is. first, a body of tested facts and concepts that satisfactorily interpret natural phenomena and disclose causal relationships, and. second. a means for discovering such facts and principles and for applying them in the solution of problems. There is no single "scientific method," but there are general procedures which distinguish the scientific methodology as a discipline from the methodologies of other fields such as art or philosophy. This aspect of science, heavily emphasized in graduate programs of universities, formerly had little attention at lower levels, particularly in European schools, but emphasis on scientific attitudes and methods as an instructional goal is increasing.

Methods of Science Teaching.— Methods are a reflection of goals. For example, the development of knowledge sufficient to pass the rigorous governmental examinations has been a chief instructional goal in the French *lycées.* As these examinations emphasize detailed memory of facts and principles (and, at least formerly, largely ignored reflective analysis of data, applications of principles, and so forth), instruction has placed a premium on memorization. The formal lecture method is widely employed, and students are expected to take notes and to remember what the teacher has taught. Laboratory work is seldom used, and even demonstrations are generally neglected in favour of a systematic and highly verbal treatment of a logically organized body of scientific facts. Practice in the U.S., as another example, has tended in the opposite direction. The secondary schools have placed a much stronger emphasis on individual laboratory work, demonstrations, problem solving and informal lecturing and discussion. About the middle of the 20th century, however, an American trend toward greater rigour and systematic instruction was paralleled by a European trend toward greater flexibility with less emphasis on strictly memory work. (R. W. Bu.)

SCIENCE FICTION deals with the human drama, the conflicts and adventures, arising out of scientific discovery in the future. There are two basic types. Science fiction proper, an almost step-by-step development of possibilities from known scientific or social data, is exemplified by Arthur C. Clarke's *The Sands of Mars* (1952), which works out the conditions encountered by the first explorers on that planet; by Hal Clement's *Mission of Gravity* (1954), which deals similarly with an entirely alien world and its beings in another solar system; and by George Orwell's *1984* (1949), which presents an uncannily perceptive extrapolation from contemporary totalitarian social patterns. Science fantasy, on the other hand, can leap directly to whatever farfetched assumptions may be necessary to the story. Obeying the sole requirement of dramatic plausibility, it permits the imagination not only to go beyond the known and proved but to contradict it when that is necessary, as exemplified by Alfred Bester's *The Demolished Man* (1953), Ray Bradbury's *The Martian Chronicles* (1950) and Edward E. Smith's *Lensman* series (various dates). Needless to say, the two basic types are frequently combined.

The major themes of science fiction are: (1) space travel to and from other planets, solar systems and galaxies, including the exploration, settlement and exploitation of other worlds as well as encounters with, or between, extraterrestrial life forms; (2) time travel to the future or the past and, similarly, travel to "alternate universes" which are usually different versions of our own; (3) psychological and biological changes in man, brought about by nature or science, and similar changes in other species; (4) "supernormal" powers and talents, achieved either through technology or the advancement of such "fringe sciences" as parapsychology; (5) science applied, directly or indirectly. to human relations for either constructive or destructive purposes. These themes are clearly illustrated in such short-story anthologies as Groff Conklin, *The Best of Science Fiction* (1946) and *A Treasury of Science Fiction* (1948); August Derleth, *Beyond Time & Space* (1950); and Raymond J. Healy and J. Francis MacComas, *Famous Science Fiction Stories, Adventures in Time and Space* (1957).

History.— Even in ancient times certain science-fiction themes were used as vehicles for social satire and criticism and for tales of wonder. These treatments dealt with what was then admittedly impossible. True science fiction, however, assumes a "this *can* happen" attitude which could not exist until the scientific method was defined and until the mechanization of everyday life made great numbers of people aware of science. It was not until the latter part of the 19th century, especially in the works of such writers as Jules Verne and H. G. Wells (*qq.v.*), that science fiction began to acquire its 20th-century forms and its functions not only of entertainment but of speculation and prophecy. In this last it has been more accurate technologically than socially

As a separate and self-aware literary form, science fiction may be said to date in the United States from Hugo Gernsback's founding in 1928 of the magazine *Amazing Stories.* In 1937 it entered a new epoch when John W. Campbell, Jr., took over the editorship of *Astounding Science Fictzon* and established a story pattern emphasizing not only the element of scientific speculation but those of character and human drama as well. Advances in nuclear power and rocketry during and after World War II increased its popularity tremendously. In the United States the number of specialized magazines rose from 8 in 1945 to more than 30 a few years later, and the number of novels and anthologies increased even more rapidly. Serious journals of comment and opinion took note of science fiction. The general magazines, motion pictures, radio and television began to use it much more often. A specialized critical literature came into being.

This phenomenon was especially marked in the United States and the rest of the English-speaking world; however, in varying degrees it took place in most civilized nations—for science fiction had accomplished something unique in the history of literature. The central technological achievements of the period—radar, television, automation, electronic brains, atomic power for peace and war, rockets and eaith satellites—had been science-fiction commonplaces for a generation before their practical realization. With a remarkable degree of general accuracy science fiction had heralded and defined the electronic age, the atomic age and the age of space.

Influence.—Through its readers science fiction had considerable sociological influence. Surveys showed that many of the readers of the better science-fiction magazines were young scientists and technologists or students destined for these fields. Similarly, many science-fiction writers, such as Arthur C. Clarke, Isaac Asimov, Robert Heinlein, John Taine and Edward E. Smith, were themselves scientists or engineers. Science fiction influenced many young people to choose the sciences as a career; it stimulated the imaginations of many scientists in the forefront of discovery; it helped to orient many intelligent laymen to the scientific world of the present and the future.

Nevertheless, science fiction did not break with literary tradition. The same artistic rules apply to it. Its characters must be as fully developed as any others; its plot structures must be as coherent; its emotional impacts must be just as strong. That is why, with the infinite variation of its themes, it holds at its best so much for readers and writers alike.

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SCIENTIFIC MANAGEMENT, a movement once popular (prior to the 1930s) with businessmen and a rather distinct theory of business management.

The movement began with Frederick W. Taylor's experiments in management methods at the Midvale Steel company, Philadelphia, Pa., around 1880. The theory was forged largely by Taylor from his observations and experiences and was not set forth in formal fashion until 1903. Taylor did so then in a paper entitled "Shop Management" and, in clearer fashion in 1911, in a book, *The Principles* of *Scientific Management.*

The Theory.—The basic theory of scientific management is that business managers have an inescapable responsibility for eliminating "waste" and improving the efficiency of the industrial system. Efficiency, in the physical output-input sense, is the end and aim of scientific management.

Taylor stated specifically that managers are responsible for: (1) defining the task which the worker is to perform; (2) selecting the proper worker for the job; and (3) motivating the worker to a high level of performance. When managers properly perform these tasks efficiency increases.

In the late 19th century these ideas were revolutionary. For centuries, the knowledge of methods in various trades had been passed from one generation of workmen to another. Furthermore, workmen over the years had established informal quotas of work which they regarded as fair. Management efforts were largely in the direction of trying to exhort workers to produce more without having any clear idea of how much the worker should or could produce. Taylor believed this state of affairs to be nothing less than a defection on the part of managers. Over a period of years he worked out specific techniques for managers to follow to bring the situation into proper order.

Management Duties and Techniques.—In order to accomplish the primary job of properly defining the worker's task managers must: (1) prescribe the exact order and method of work; (2) prescribe the tools and equipment to be used; and (3) establish the time in which the task is to be accomplished. The first two duties are accomplished through use of motion study. The last duty Taylor accomplished through the technique of time study. This technique became clearly identified with scientific management and became the centre of much controversy. Time study involves the observation of a "good worker" who is using prescribed methods and equipment for the purpose of determining the time in which his task should be performed. Taylor contributed the technique of timing component parts of the total task with a decimal minute watch.

The "good worker" concept is an important one. Managers, in accordance with this philosophy, must seek out and use those men peculiarly well-fitted for the particular job under consideration. This necessitates application of knowledge contributed by engineers, psychologists and physiologists. An important characteristic of the good worker (or "first-class worker," as Taylor put it) is his willingness to accomplish the amount of work which management establishes as proper. (The worker, of course, is picked as physically capable of performing this work.) From these selection duties the modern personnel department of the business firm evolved.

The willingness on the part of the worker to accomplish the prescribed task results from an incentive being offered for such accomplishment. Taylor proposed a piece payment plan which rewarded rather poorly for performance below the task standard set, and handsomely (in terms of accepted rates of pay) for performance above standard. As Taylor strongly emphasized, this system of management is eifective only if standardized job conditions are established and rigorously maintained. The techniques described are aimed at standardization.

Others, following Taylor, contributed refinements of his ideas and techniques. Frank and Lillian Gilbreth devised an extremely thorough method of studying the motions of workers. They sought to reduce working time and effort through discovery of the most effective sequence of motions, and through proper design of the workplace. H. L. Gantt devised a useful visual aid to planning of production (the Gantt chart) in addition to refining concepts of accounting for costs. Still others devised various incentive pay systems.

Status of Scientific Management.—Examination of Taylor's ideas reveals that his philosophy turns on several crucial assumptions. The prime assumption is that the dominant, if not exclusive, motivation of the individual worker is economic. The "normal" man, in the work situation, is interested above all else in increasing his money earnings. Another assumption is that men working individually are interested in doing a good job, but that working in groups they are concerned only with not working harder than others. Group incentives are thus generally ineffective. A further assumption is that in removing the responsibility for planning methods from the worker, and turning that task over to a specialist, a net gain in efficiency results.

These assumptions were attacked sharply during the years following the publication of Taylor's ideas. In particular, critics adduced evidence that men are motivated in working by a number of factors, of which money earnings may be only one. In enumerating these other motivating factors critics inevitably found themselves questioning the additional assumptions implicit in the theory of scientific management. For example, in the years following the depression of the 1930s a popular body of thought developed in which a prime factor in the motivation of the individual worker was conceived to be the degree to which he continues to experience satisfying relationships with other members of a work group. This idea. a product of the "human relations" school, became so widely accepted that the scientific management concept of motivation appeared, superficially, to have been abandoned.

Furthermore, a group of critics argued that removing the planning function from the worker destroyed any opportunity for creativeness on his part. If the individual finds no outlet for creative activity in his work, the argument goes, he becomes no more than an automaton. The worker is restless, dissatisfied, unhappy; labour turnover will be high, strikes frequent. Thus, it is argued, efficiency will decline; the gain from using planning specialists will disappear. This argument was advanced by many thoughtful observers, and there was evidence in the 1950s that it was beginning to receive consideration by some managers.

One might wonder if, since the arguments noted attack critical assumptions in the scientific management theory, this means that the theory was being superseded by some superior system of management.

In evaluating the status of scientific management in the 1950s it is important to remember that a basic change in the labour force had occurred after the late 19th century. In the United States, where scientific management and later criticisms of it had been most discussed, the formal education of the average worker had been phenomenally increased since 1880

The worker tended to be better informed, more critical and more vocal with respect to management methods than was true in Taylor's time. This, together with the great increase in per capita wealth (and hence. perhaps, a lesser preoccupation with the grim task of earning the necessities of life), might well mean that the worker's pattern of motivation had become more complex than it was in the early days of the scientific management movement. Hence, there was reason to believe that scientific management stops short of providing a complete answer to management problems.

But the separation of planning from performance, the chief heritage of scientific management, remained in full effect everywhere. Moderate and thoughtful critics of the theories of Taylor and his followers usually argued only that management had gone too far along the scale from complete control of the job by the worker to complete lack of worker control of anything save the quantity of his output.

The latter-day management problem was to put back into the job something of interest other than earnings. Few questioned the arrangement whereby management determines performance standards, basic work methods. worker qualifications and incentives. The critics merely pointed out the necessity for more intelligent planning of these factors (especially work methods and incentives) in the light of advances in knowledge (particularly psychological) in the mid-20th century.

Taylor's revolution had been accomplished. Scientific management had changed from a movement to an accepted way of managing.

Whether or not a counterrevolution would become necessary depended upon the ability of 20th-century practitioners of scientific management to distinguish theory from techniques; *i.e.,* to continue to accept the responsibility for intelligent planning while adapting specific management procedures to accord with changes in the working population, and in society in general.

See Management Sciences.

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SCIENTIFIC METHOD is a description now reserved for the procedure by which we gain knowledge in empirical studies such as physics, chemistry and physiology. At one time the word "science" was applied to all systematic studies or organized bodies of knowledge, including mathematics and theology. There was a tradition derived from Plato and Aristotle that the system to be expected in a science should be such as we have in mathematics; that is, that all the asserted propositions which are not themselves self-evident should be derived from others that are self-evident. In accordance with this usage the word "scientific." first introduced in its Latin form as a rendering of ἐπιστημονικός in Aristotle's *Posterior Analytics*, i, 2. was applied only to reasoning which produced knowledge like that which we have in mathematics. For many centuries it remained a synonym for "demonstrative." Thus John Locke says in his *Essay Concerning Human Understanding,* iv. 3, § 26, "How far soever human industry may advance useful and experimental philosophy in physical things, *scientifical* will still be out of our reach"; and he explains his meaning later in the paragraph by the remark "*Certainty* and *demonstration* are things we must not in these matters pretend to."

The modern use of "scientific" noticed above appears to have been established in England about the middle of the 19th century. At the beginning of that century physicists and chemists were still called philosophers, and the tools of their trade philosophical instruments. The word "scientist" was invented by William Whewell in 1840, and the earliest evidence in the *Oxford English Dictionary* for an acknowledged particularization of the word science in its special modern sense comes from 1867.

Clearly there may be many different methods by which scientists gain knowledge in different fields of research. Thus Archimedes found a way of determining specific gravities, and A. H. L. Fizeau found a way of measuring the speed of light. In modern times the special methods of research used in the various sciences have become more numerous and more complicated. so that a large part of the training of a future scientist is the imparting of techniques. Knowledge of these is important not only because it is necessary for one who is to make new contributions as an experimenter but also because it is an indispensable link between observation and theory.

A physiologist may use a cathode ray oscillograph without being an expert in electronics, but it will not help him to get evidence for or against a hypothesis about the working of nerves unless he understands its own working at least in outline. Since such a special method involves application of scientific results already attained, it cannot be expounded without an exposition of science. But when me speak of scientific method in the singular, we ordinarily mean some pattern of reasoning common to all empirical sciences, and that is the subject of this article.

Traditional Views: From Aristotle to J. S. Mill.—If there is any common method of the sciences it must obviously be related to what is common in the aims of the various kinds of scientists. Aristotle gives two accounts of the matter which had great influence on subsequent thought. In the first place he introduces the notion of ἐπαγωγή, or induction, as a way of learning distinct from demonstration and logically prior because it provides the premisses needed for demonstration. But in his *Prior Analytics,* ii 23, he talks of induction as a kind of syllogism in which we reach a universal conclusion from an exhaustive survey of the cases it covers; and in his *Posterior Analytics*, i, 1 and 18, he talks of induction as the establishment of a universal truth by consideration of an instance or instances which reveal to thought the necessity of the connection asserted. In modern times these two distinct procedures have been called summative and intuitive induction respectively. Neither can be identified with the procedure of ampliative induction, by which universal propositions are in fact established in the empirical sciences. For scientists do not claim to have proved that copper is a good conductor of electricity by examining every specimen of copper, nor do they claim to have discovered the necessity of the connection by careful reflection on some single experiment. Secondly, Aristotle says in various places (*e.g.,* in *Posterior Analytics,* i, 2) that science is knowledge of αἰτίαι, or causes. Perhaps he meant by αἰτίαι in this context much the same as we mean by "explanations," but his detailed account of the various kinds of causes that he recognized would not be accepted by modern scientists as a statement of their objectives, and the doctrine is not in any case connected with either of the accounts of induction noticed above.

For more than 2.000 years, however, these two pronouncements of Aristotle determined the course of discussion about scientific method even among those philosophers who professed hostility to his doctrines. Thus Francis Bacon. David Hume and J. S. Mill all assumed that the business of the empirical scientist was to establish universal propositions about causal connection, though they differed from Aristotle in the accounts that they gave of causes.

Some part of scientific activity may indeed be described as a search for causes of kinds of phenomena, but it now seems clear that this is not a satisfactory description of all that scientists try to do. (*See* Causality; Induction.)

We need consider here only the general outline of the doctrine which was introduced by Francis Bacon in his *Novum Organum* of 1620 and accepted for a long time after as a correct account of the method of the new science.

According to Bacon it is the business of the scientist to discover the "forms" of phenomena, but in his usage this word "form" (derived presumably from Aristotle's theory of formal causes) means what would now be called a necessary and sufficient condition.

Thus F is the form of P if and only if P never occurs without F but always occurs with F. If either is capable of varying in degree, it is required also that the other should vary in similar fashion. For the discovery of forms in this sense the proper procedure is to digest our information about the phenomenon in three tables showing presence, absence and degrees: the first includes positive instances of the phenomenon, the second negative instances (*i.e.*, cases which are in most respects like known positive instances but do not in fact exemplify the phenomenon under investigation) and the third instances which vary in degree. Together they should enable us to refute all false suggestions put forward in reply to the question "What is the form?" and so to reach the true answer by elimination.

We can say, for example, that anything which does not vary in degree when the phenomenon under investigation varies cannot be its form. It is assumed, of course, that every phenomenon must have a form, or necessary and sufficient condition.

J. S. Mill, whose System of **Logic** (1843) had great influence in the 19th century, wrote of causes rather than forms but defined a cause as an invariable antecedent and modelled his account of induction on Bacon's. He spoke of it, however, as employing a number of different methods: for example, a method of agreement, in which the cause of a phenomenon is revealed by the consideration that it is the only circumstance (other than the phenomenon itself) in which positive instances agree; and a method of difference, in which the cause is revealed by the consideration that it is the only circumstance (other than the phenomenon itself) in which a positive and a negative instance differ.

This doctrine of scientific method could not have obtained the popularity that it once enjoyed if it corresponded to nothing at all in scientific inquiry. Mill's method of agreement is indeed used in the purely observational sciences and his method of difference in the experimental sciences. But the doctrine does not cover the whole field of scientific activity and moreover is misleading in its suggestion that the business of discovery can be reduced to rules. Even when the work of a scientist can be described without distortion as a search for necessary and sufficient conditions, it is not correct to assume that he can find these by application of a standard procedure.

Thus it is that Bacon and Mill both take for granted without warrant that there is no serious difficulty in drawing up an exhaustive list of circumstances which deserve consideration in a search for the necessary and sufficient condition of a phenomenon; yet there is in fact nothing to indicate what should be considered in this connection as a single circumstance. When we single out for attention half-a-dozen distinct features of events, say A, B, C, D, E and F, why should we not also take account of their conjunctions and disjunctions, that is to say, of complex features such as might be represented by "A and B", "C or D" or even more complicated formulas like "[A or (B and C)] and [(D and E) or F]"? And if we allow for all this complication what assurance can there be that the half-dozen features with which we started are the only elementary features that deserve consideration? Mill admits in a somewhat half-hearted way that there may be what he calls plurality of causes. but he does not recognize that his methods are defective in general for lack of any systematic enumeration of possibilities.

Varieties of Scientific Activity.— It is very difficult indeed and perhaps not very profitable to find a formula which will adequately characterize all scientific activity. For while some scientists are concerned for all or most of their time with the making of generalizations from experience, others are concerned more with the elaboration of deductive systems in which such generalizations may be derived from hypotheses that cannot themselves be tested directly because they deal with unobservable entities such as electromagnetic waves. And apart from these two groups, whose methods may be called primary and secondary induction respectively, there are others whose interest in nature is more like that of a historian. Thus the palaeontologist who tries to trace the biological evolution of man wants to discover what happened in certain places at certain times, and the geologist and the cosmologist are equally interested in the course of past events. All use generalizations, but none of them is primarily interested in these for their own sake. If such inquiries are to be called scientific (and that is how they are ordinarily described), it is not even correct to say that all empirical science is inductive, unless indeed the meaning of the word "inductive" is stretched to cover not only the secondary induction noticed above but also any reasoning concerned in any way with generalizations from experience. Perhaps the best we can say is that the pursuit of science is the search for knowledge and understanding through formulation of the laws of nature. This excludes the collection of disconnected scraps of information and draws attention to the special importance of natural laws in our conception of science.

Whatever can be said usefully about scientific method in general must be related to these.

The beginning of science is classification (*q.v.*). Whatever we recognize must be of some kind, and language even at its lowest level is full of general words. But the same things may be classified in many different ways; *e.g.*, according to size, to shape, or to colour. Each classification is based on real characters of the things classified, and each may be useful for some human purpose. There are, however, some that seem more important than others: those, namely, for which the classifying terms of our most primitive language are nouns as distinct from adjectives. Thus "grass," "tree," "stone," "cow," "horse" and "dog" are said sometimes to mark natural kinds, whereas "red," "square" and "hard" serve only for artificial grouping. The point of the distinction is not that we can make anything red or square or hard by calling it so but rather that recognition of a thing as a piece of grass or as a tree or as a stone is the gaining of an important clue to what may be expected of it. If the thing before us is a blade of grass, then it will probably grow bigger, but not to a height of more than a few feet; when touched, it will bend; after a few months it will turn brown and gradually decay; and so on. It is not necessary, however, that I should satisfy myself of the thing's behaviour in all these respects before venturing to call it grass: fortunately I can recognize grass by its appearance and then make a number of prophecies about it with fair confidence. There is very little, on the other hand. that I can safely assume about the future behaviour of a thing merely because it is red.

Here, then, in the classifications called natural, we have the beginning of our intellectual mapping of nature. Long before there was any conscious pursuit of science men took it for granted that there were bounds of natural possibility; *i.e.*, that not all the conceivable combinations of characters were realized in nature. We cannot discard all their assumptions without abandoning also the language we have inherited from them; but we can and do improve on their classifications. Many of the terms for metals. which our children learn with ease because of the great practical importance of metals in modern life, have been added to the vocabulary of men within historic times.

Primary induction is the deliberate attempt to find more laws about the behaviour of the things that we can observe and so to draw the bounds of natural possibility more narrowly. In so far as it is successful. it enables us to make more inferences from the observed to the unobserved and, in particular, more predictions by which we may guide our conduct. But this is not its only value. Already at this stage there is intellectual satisfaction to be had in the discovery of laws: we have a beginning of explanation when we can say that a piece of wire has melted in a candle flame because it is lead and lead always melts at the heat of a candle flame.

Sometimes scientists or writers on science who are interested chiefly in the more advanced stages of science speak of primary induction as though it scarcely deserved to be called scientific. And it would indeed be a great mistake to suppose that science is never anything more than the making of generalizations in the fashion of 17th-century naturalists. But generalization from experience is an indispensable feature of science. In the more advanced sciences such as physics and chemistry, observations are directed by an interest in theory; but what the scientist deduces from his theory and then tries to test by observation or, if possible, by experiment (*i.e.*, observation in circumstances over which he has control) is always some universal proposition. Here primary induction comes late in the temporal order of a scientist's activities, but it is still primary in the sense that it is basic in his final argument and logically independent of the superstructure of the theory. For a generalization which has been confirmed by experience only after it has been deduced from a theory is not invalidated by the discovery of a flaw in the theory, though it may perhaps lose something in reliability when it is no longer linked with other generalizations through the theory.

With primary induction we may conveniently include arguments of the kind sometimes called proportional generalizations. If we have observed many A things and found that the frequency of B things among them has remained fairly constant in the neighbourhood of a fraction *f*, we are inclined to say in general terms that the proportion of **A** things which are B is about f. Unless the class of *A* things is known to be finite. we cannot take this remark as an ordinary statement of proportion; but in practice we may use it as a guide to expectation, when we wish to know whether something which is *A* is .likely to be also B. Often it is said to be a statement of the probability (*q.v.*) of an *A* thing's being B.

Secondary induction is the attempt to incorporate the results of primary induction in an explanatory theory (*q.v.*) covering a large field of inquiry. At this level in science it may be impossible to make progress without the introduction of concepts far removed from those used by primitive men in their classification of perceptible objects. In retrospect we can see that physical theory has contained such concepts for a long time (*e.g.*, the concept of energyj ; but until the 20th century the fact could be ignored because it was still possible to provide in imagination some sort of model for the interpretation of the statements of physical theory. When it was supposed that electromagnetic waves were transmitted through an ethereal jelly, the model was already inappropriate in some features but not in so obvious a way that it could not still be taken seriously by great scientists. Since then the difficulty of bridging the gap between theory and common sense has become more obvious. Modern views on this subject are discussed in the article EXPLANATION.

The Role of Hypothesis. — From the nature of the scientific enterprise it is clear that the reasoning by which it proceeds cannot be reduced to validating schemata like those of deduction; that is, to patterns of inference which guarantee the truth of the conclusion provided only that the premisses are true. There may of course be deductive arguments in natural science, but the laws and theories which are said to be established by scientific research are not deduced from observations. On the contrary, each is put forward first as an hypothesis (*q.v.*) which together with certain initial data entails the facts of observation. Our effort is to construct a deductive system "from the wrong end up" but not, of course, a trivial system in which the hypothesis itself could be deduced from the facts of observation. To be worth consideration a hypothesis of law must restrict the field of possibility more than that field is already known or assumed to be restricted; and similarly a suggested theory must be more restrictive than the set of laws which it is supposed to co-ordinate and explain; in other words, it must have some consequences other than those we already accept.

For these reasons it has been said that the conclusions of ampliative induction are never more than probable; but this pronouncement is unfortunate in some ways. The word "probable" is ordinarily used to recommend propositions when we are not completely satisfied about them; but we do in fact claim to know some results of induction (for example, that arsenic is poisonous), and adoption of the suggestion that we should apply the word "probable" to all results of induction would therefore lead to a blurring of a useful distinction. On the other hand, it is important to appreciate that the cases in which we say that we know some result of induction differ only in degree from cases in which we are not prepared to commit ourselves by use of the word "know"; and this is at least part of what philosophers have tried to convey by saying somewhat paradoxically that the results of induction are never more than probable. In mathematics, a general proposition such as C. Goldbach's conjecture of 1742 that every positive even integer is the sum of two primes (see NUMBERS, THEORY OF) may perhaps be regarded as highly probable because it has so far survived all attempts to find a counter-example. But no accumulation of evidence of this kind would ever justify a claim to knowledge of the truth of the generalization: for that, it would be necessary to produce an argument of a totally different kind, and the possibility of such an argument is at least conceivable. In natural science: however. there can be nothing corresponding to mathematical proof, and the customary requirement for the use of the word "knowledge" is therefore different.

The theory of statistics (*q.v.*) supplies principles for the marshalling of complex evidence in many different inductive studies, but if we take "scientific method" to mean a rule or set of rules by obedience to which any fairly intelligent person can make discoveries in natural science whenever he wishes, we must admit that there is no scientific method. For the all-important act in scientific discovery is the finding of a hypothesis that will survive testing, and this cannot be reduced to a routine. When we are looking for a necessary and sufficient condition of a phenomenon, or, less exactingly, for a sufficient condition only, we naturally consider only circumstances which are to be found accompanying some instance; and attempts were made by Bacon and by Mill to formulate rules of primary induction on this basis.

But the notion of accompanying is not very precise, and it is in fact impossible to set out any exhaustive list of circumstances that deserve consideration, because an intellectual search of this kind admits of no device like the systematic quartering of the ground by which we can make sure of success in a search for some material object that has been lost. An argument from analogy (*q.v.*) may perhaps suggest an interesting hypothesis here or in secondary induction, but again there is no infallible procedure for discovering fruitful analogies. In short, the finding of the right hypothesis is always a problem, rather than a task. But in this it resembles the finding of proofs in most parts of mathematics, and it must not be thought that success in either case is just a matter of luck.

If we take "scientific method" in the looser sense of a program or policy, then undoubtedly there is a scientific method, namely the policy of making hypotheses for the purposes of primary and secondary induction as described above. Once formulated, this seems to be obviously rational, and some philosophers of modern times are inclined to talk of such scientific activity as though it were nothing but the commonest of common sense. But the deliberate pursuit of knowledge by this method is a comparatively recent enterprise of mankind: at the beginning of the 17th century. when Bacon wrote his *Novum Organum,* it was a novelty not very well understood; and a thinker as great as Descartes could maintain that there was no essential difference between physics and geometry. A hundred years later, after the founding of the Royal Society and the great triumphs of Newton, the method was still something that could arouse debate among intelligent men, as may be seen from the curious remarks of Newton in the General *Scholium* that he added at the end of his *Principia.* In 1739 Hume, who thought Newton "the greatest and rarest genius that ever rose for the ornament and instruction of the species," found himself driven nevertheless to the conclusion that induction could be nothing but customary association of ideas (which Locke had called "a sort of madness") because it was clearly not to be justified as a form of deduction. If the method or policy now seems obviously wise, that is because we understand our situation better than our predecessors did and are therefore no longer inclined to think we can get what we want in any other way.

The Scope of Scientific Method. — The prestige acquired by physics, chemistry and physiology from the middle of the 19th century became so great that there have been many attempts to apply the methods of these sciences in other fields. These efforts have in turn provoked attempts to erect barriers beyond which scientists should not presume to go. In particular there has been much talk of demarcating a boundary between the proper spheres of science and of religion. It is desirable therefore to consider the scope of scientific method; *i.e.,* whether there are any limits to its application.

Because the various special sciences have all been separated successively from the matrix of philosophy (*q.v.*) much as colonies are separated from their mother country, those who advocate the application of scientific method to new fields sometimes think of themselves as liberators and champions of enlightenment against obscurantism. At times the attitude of professional philosophers toward science may perhaps have given some justification for this view; but in general it is a mistake to think of philosophy as opposed to science. For in the past the word "philosophy" was used, as we have seen, to cover all' that is now called science. and in its more restricted modern usage it signifies the search for clarity by the study of the relation of concepts. So long as scientific advance does not involve the asking of any questions about the relations of concepts of high generality science has little. if any, contact with philosophy in the modern sense, and those who are actively engaged in the advance may come to think of philosophical inquiries as fruitless and even perverse. This was the situation in chemistry, for example, at the beginning of the 20th century. But when the development of scientific theory leads to suggestions which are at variance with common sense or at least so far removed from the realm of common sense that they cannot he illuminated by familiar analogies. scientists themselves say that their work has a philosophical aspect; *i.e.*, that it involves clarification of concepts. This happened in physics with the appearance of the relativity and quantum theories.

Conversely. philosophers of the 20th century who are especially interested in the progress of science have sometimes described their work as scientific. Bertrand Russell. for example. published in 1914 a book entitled Our *Knowledge* of *the External World as a Field for Scientific Method in Philosophy,* and thereafter the phrase "scientific philosophy" occurred often in philosophical literature. This way of speaking seems. however. to involve an unjustified extension of the use of the word "scientific." Those who adopt it wish no doubt to convey the impression that the philosophy which they favour is a permanent intellectual acquisition and not merely the product of a fashion or the expression of personal attitude. But there is usually no difficulty in distinguishing the conceptual inquiries of the philosopher from the empirical researches of the natural scientist, and there is nothing to be gained from a blurring of the distinction.

When we say that psychology and sociology are empirical sciences, rather than departments of philosophy in the modern sense of that word, what we have chiefly in mind is the possibility of using primary induction in these studies. But those who issued the first declarations of independence on behalf of these studies sometimes revealed in their claims an extravagance like that which is too often found in political nationalism. Thus Émile Durkheim maintained in his *Règles de la méthode sociologique* (1894) that sociological laws were not reducible to those of any other science; and in psychology also it has sometimes been held that explanation can be achieved only by the introduction of hypotheses which are themselves purely psychological. It is clear that for research to be practicable there must be a division of academic labour and that there can be no specialization without the distinction of one science from another. But this does not entail the denial of all possibility of co-operation or require that the distinction between primary and secondary induction, which is of the greatest importance in physics, should reappear separately in all other branches of science. There may of course be principles of explanation other than those of physics, but the question whether the laws of one department of science can be explained by reference to those of another is to be settled in each case by scientific inquiry, not by a priori pronouncements from separatists or universalists.

Since psychology and sociology have been recognized as sciences it is sometimes asked whether scientific method can be applied in history. This is a confusing question. Those who ask it may perhaps mean by "scientific method" no more than the use of modern techniques such as the radio-carbon method of dating a wooden object. Or again they may mean simply a dispassionate and unprejudiced approach to controversial issues. In either case the answer is "Yes." If, however, the questioners wish to know whether history can become a branch of science, the answer seems to be that history cannot be a science like physics, chemistry or even sociology. since it deals with individual persons and events, but that it may be scientific in the same sense as astronomy and geography, which also apply generalizations to individual objects.

In all ages history has in fact exhibited the patterns of explanation favoured by its authors. When men believed in magic: their history was full of magical causation. When it was the ideal of explanation to relate everything to the divine purpose, history was conceived as theodicy or the tracing of God's plan. When in the second half of the 19th century the principle of the survival of the fittest was thought to be the supreme principle of explanation in all biology, there were soon historians ready to apply it in their accounts of the vicissitudes of men and societies.

In all this there is nothing to indicate any need for drawing a boundary to the application of scientific method. On the contrary, it seems absurd even to suggest that there might be such a boundary within the realm of fact as opposed to value. For whenever we make an assertion that cannot be checked either by hard thinking alone or by observation alone, we commit ourselves to judgment by scientific method. This is not to say that we cannot reasonably support any of our statements by appeal to authority, but rather that in this field all rationality. including the rationality of relying on any authority, depends in the last resort on the rationality of scientific method as described above. For even those who cite miracles as evidence of the reliability of their authority assume premisses derived from induction, as for example that events of certain sorts do not happen without divine intervention.

Valuations as opposed to statements of fact are not established by scientific method. This is indeed a truism, and if we wish to speak of a limit to the applicability of scientific method me may perhaps say that we have found it here. But we must be cautious in the way in which we draw the boundary. For discoveries made by scientific method are undoubtedly relevant to some of our valuations. Although chemical analysis of an artist's materials does not contribute to an aesthetic judgment of his work, scientific knowledge about the consequences of a man's act may be of the greatest importance for a moral judgment of its rightness. What we must guard against here is the suggestion that moral distinctions are meaningless unless they can he identified completely with distinctions of the sort that scientists can study.

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SCILLA, a large genus of mostly small bulbous herbs of the lily family, native to temperate regions of the old world and commonly known as squill, wild or wood hyacinth and bluebell. Several are grown for ornament, mainly for early spring bloom. Their flowers are few to many in terminal racemes, and blue, purple, rose or white. The cultivated forms are hardy and should be left undisturbed for a number of years, but should be given an occasional top dressing of well-rotted manure. *See* SQUILL; BLUEBELL. (J. M. BL.)

ROCHE

SIBERIAN SQUILL (SCILLA SIBERICA)

SCILLITAN MARTYRS, a company of early north African Christians who suffered under Marcus Aurelius in A.D. 180 and whose *Acta* are at once the earliest documents of the church of Africa and the earliest specimen of Christian Latin. The martyrs take their name from Scilla (or Scillium), a town in Numidia. Their trial and execution took place in Carthage on July 13, A.D. 180. In this martyrdom is an excellent example of "Acts of Martyrs" properly so called. The document is in brief legal form, beginning with the date and the names of the accused, and giving the actual dialogue between them and the judge, and may well be a transcript of the official report of the trial proceedings.

The Scillitan sufferers were 12 in all—7 men and 5 women. Six had already been tried; of the remainder, to whom these "Acts" primarily relate, Speratus is the principal spokesman. He claims for himself and his companions that they have lived a quiet and moral life, paying their dues and doing no wrong to their neighbours. But when called upon to swear by the genius of the emperor, he replies: "I recognize not the empire of this world; but rather do I serve that God whom no man hath seen, nor nith these eyes can see."

SCILLY ISLES, a group of about 140 small islands and islets, off Cornwall, Eng., 25 mi. W. by S. of Land's End. The origin of their name has never been authoritatively settled. The islands, none of which is more than 160 ft. high, are wild and picturesque, with sheer cliffs and many large caves hollowed out by the Atlantic. Because of the reefs and shoals by which these shores are surrounded, navigation becomes perilous in rough weather. A local proverb tells that for every man who dies a natural death on the islands the sea takes nine.

On an outlying rock to the southwest is Bishop Light. first built, with infinite difficulty, in 1858, and other lighthouses are on Round Island and Penninis head (St. Mary's). The islands are part of an almost submerged granite mass that has been broken up by the sea. This mass was probably joined to the mainland between the Armorican folding and the Upper Cretaceous periods. During Pliocene times it was submerged, since when there has been an elevation from time to time as can be seen in the raised beaches and the terracing of the rocks.

Some of the islands, *e.g.*, St. Agnes and Gugh, are joined together by bars of shingle and blown sand, and the tops of the larger ones have been flattened by erosion. According to legend. the Scilly Isles are the only visible remains of the land of Lyonesse. Olaf I Tryggvesson in his saga tells of his visit to the Scillies in the 10th century and his conversion there to Christianity which he then introduced to Scandinavia.

The climate of the islands is unusually mild, snow being rarely seen and the range of temperature being from 46° to 58° F. Fuchsias, geraniums and myrtles attain an immense size, and aloes, cactus and prickly pear flourish in the open. The gardens of the governor on Tresco Island are subtropical in character.

Great flocks of sea birds haunt the remoter parts, and rare land birds, such as the golden oriole, are occasional visitors. On some of the islands there are deer, and Tean has a warren of white rabbits.

The raising of early asparagus, spring vegetables and flowers is the principal industry. From its start in 1881 and its figure of 65 tons of cut flowers in 1885, this trade had expanded to over 1,200 tons, representing 60,000 blooms by the mid 1950s. Grown in the open air in winter, protected from the Atlantic gales by hedges, the Scilly flowers are more popular than those forced under glass.

The true islands number about 40, with a total area of 6.3 sq.mi., but only 5 are inhabited—St. Mary's, Tresco, St. Martin's, St. Agnes and Bryher. The total population in 1951 mas 2,154, of which 1,625 lived on St. Mary's. Hugh Town in St. Mary's is the capital. occupying a sandy peninsula. The town possesses a harbour and a roadstead where large vessels can lie at anchor. Governed by a county council, the islands are part of the St. Ives parliamentary division of Cornwall.

The islands are served by steamers from Penzance and by air from St. Just, and there is radio, telephone and telegraph communication with the mainland.

On Tresco there are ruins of an abbey and of two fortifications called Oliver Cromwell's tower and King Charles's tower. Rude pillars and circles of stones and barrows are common, the most remarkable being a barrow on the Isle of Samson, 58 ft. in girth, and containing a very perfect "kistvaen," or sepulchral chamber of stone.

It is not until the reign of Henry I that we have written evidence concerning the Scillies. The king gave the isles to the abbot and church of Tavistock and secular priests were temporarily substituted for regulars by the abbot in 1345. Sharing the dignity of lords of Scilly with the abbot was the family of Blanchminster (de Albo Monasterio) in the reign of Edward I.

Ralph de Blanchminster held of the earldom of Cornwall lands in Scilly at a yearly service of 300 puffins in 1345. In 1484 value of the lands was estimated at 40s. in time of peace and nothing in time of war. The Blanchminsters resisted and imprisoned the coroner of Cornwall and in 1319 were granted a coroner of their own. In 1547 Silvester Danvers, a coheir of the Blanchminsters, sold his moiety of Scilly to Sir Thomas Seymour, by whose attainder in 1549 it fell to the crown, which already possessed the church land and revenues.

In 1571 Elizabeth I leased the islands for £10 a year to Francis Godolphin, uho built Star castle above Hugh Town in 1593. During the Great Rebellion Hugh Town gave shelter to Prince Charles until his escape to Jersey in 1646. The islands were occupied by Roundheads for two years but in 1648 declared for the king nith Sir John Grenville as governor. After his surrender to Admiral Blake in 1651, Cromwell's tower mas built on Tresco.

Early a haunt of pirates, the islands were afterward notorious for smuggling. In 1834 Augustus Smith succeeded the Godolphins as lessee and introduced compulsory education and other measures to improve the condition of the inhabitants. His nephew T. A. Smith-Dorrien-Smith succeeded him in 1872 and in 1933 A. A. Dorrien-Smith. his son, surrendered to the duchy of Cornwall the four islands of St. Mary's, St. Martin's, St. Agnes and Bryher, retaining the others on a 59-year lease.

SCIPIO (originally meaning "staff"), the name of a patrician branch of the Cornelian gens in ancient Rome, whose most important historical representatives are separately noticed.

SCIPIO, PUBLIUS CORNELIUS, consul in 218 B.C., sailed with an army to southern Gaul to prevent Hannibal's advance on Italy (see HANNIBAL). Having arrived too late, he himself returned to Italy, but boldly sent his army on to Spain under his elder brother Gnaeus to check the Carthaginian forces still there. In northern Italy he hoped to fight delaying actions against Hannibal along the tributaries of the Po. Being repulsed and wounded at the Ticinus, he retired to the Trebia where he was joined by his colleague Ti. Sempronius Longus, who insisted on fighting and was defeated (Dec. 218).

In 217 Scipio was sent as proconsul to Spain; he and his brother smashed near the Ebro Hasdrubal's attempt to break through to Italy (215), and by 212 they had captured Saguntum.

From this base they could move farther south; advancing separately, however, they both met disaster and death, Publius on the upper Baetis, Gnaeus in the hinterland of Carthago Nova (211). But for seven years they had denied Hannibal the resources of Spain.

See Polybius, iii; Livy, **xxi–xxxv;** for the Spanish campaigns *A.* Schulten, *Fontes Hispaniae antiquae,* iii *(1935).* (H. H. SD.)

SCIPIO AEMILIANUS AFRICANUS, PUBLIUS CORNELIUS, the younger (185/4–129 B.C.), was the younger son of L. Aemilius Paullus, under whom he served at the battle of Pydna (*q.v.*) in 168 B.C. He was adopted by the elder son of Scipio Africanus, P. Cornelius Scipio, whose name he assumed. His early years are described by Polybius (xxxi, 23–29), who gained his friendship. In 151, when the Romans had met with defeats in Spain, he volunteered for service there as military tribune; his integrity, personal bravery and honest diplomacy, reminiscent of the qualities of his adoptive grandfather, were appreciated by Spanish tribes long sickened by Roman treachery.

In 150, when on a military mission to Massinissa (Masinissa), he nas asked by the Carthaginians to mediate in their war against Massinissa, but he achieved no result. In the following year, after Rome had declared war on Carthage, he served in Africa as military tribune with conspicuous ability, and in 148 Massinissa, at the point of death, asked him to arrange the future of Numidia: Scipio divided it between the king's three sons. Returning to Rome to stand for the aedileship, he was by a special vote of the people elected to the consulship of 147 and was granted the command against Carthage.

Scipio returned to Africa with his friend Gaius Laelius and possibly also Panaetius he blockaded Carthage and, in 146, destroyed the city, enslaving the survivors and establishing the province of Africa. He celebrated a triumph and received the name of Africanus (Minor).

His censorship in 142 was marked by traditional sternness. Ti. Claudius Asellio. whom he demoted from the equites, prosecuted him in 140. For two years (140–139; less probably 136–135) he served on an embassy to Egypt, Syria, Pergamum and Greece. On his return he prosecuted L. Aurelius Cotta for extortion (138) and supported a measure to introduce secret ballot in judicial assemblies of the people (137). Military disasters and inefficiency in Spain required the dispatch of a capable soldier: to this end, since re-election to the consulship had been forbidden in 151, by special dispensation he was elected consul for 134. After reestablishing discipline in the Roman army he brought the war in Spain to an end by the blockade and destruction of Numantia in 133 (traces of his camps and earthworks there still survive): he received the additional cognomen Numantinus.

He returned to Rome after the death of his brother-in-law Tiberius Gracchus, but expressed disapproval of his unconstitutional behaviour, quoting the Odyssey (i, 47): "So perish all who do the like again." He opposed a proposal of the tribune C. Papirius Carbo to allow the re-election of tribunes (131 or 130), thus increasing his unpopularity with the masses who naturally had resented his attitude to Gracchus. In 129 he carried a measure which affected the working of the Gracchan land commissioners, probably however only warning them off public land held by the allies in order to avoid "international" issues. The night before he was to have spoken on the agrarian laws he died in mysterious circumstances: various persons were later suspected of murder, or even Scipio himself of suicide, but very probably he died a natural death.

An admirer of Greek literature and learning, he gathered around him the so-called "Scipionic circle," a coterie which included Polybius, Panaetius, C. Lucilius, Terence and Laelius and aimed at blending the better elements of Greek and Roman life. Upright himself, he tried to revive and uphold earlier Roman standards of conduct. His thought, Stoic in philosophy. moved on traditional lines, and he tried to maintain Rome's accustomed relations toward the Italian allies and the provinces. An able soldier and orator, he acted as a moderating influence on the constitutional difficulties of his day which increased after his death. Cicero, who made him the chief speaker in his De *Republica,* regarded his era as the golden age of aristocratic government. (H. H. Sd.)

SCIPIO AFRICANUS, PUBLIUS CORNELIUS, the elder (236–184/3 B.C.), son of P. Cornelius Scipio (*q.v.*), is said to have saved his father's life at the engagement on the Ticinus and, as military tribune, to have strengthened Roman resistance to Hannibal after Cannae (216). After his curule aedileship (213), though only a *privatus,* he was, without constitutional precedent, appointed by the Roman people to a proconsular command in Spain (210). There all south of the Ebro was in Carthaginian hands, but he boldly continued his father's offensive strategy.

By a brilliant swoop Scipio captured the enemy's headquarters, Carthago Nova, from which all three Carthaginian armies in Spain happened to be ten days' distant (209); there he gained stores and supplies, Spanish hostages, the local silver mines, a splendid harbour and a base for advance farther south. After training his army in new tactics he defeated Hasdrubal Barca at Baecula (Bailén) in Baetica (208); whereas normally the two rear ranks of a Roman army closely supported the front line, Scipio here, under a screen of light troops, divided his main forces, which fell on the enemy's flanks. When Hasdrubal broke away, ultimately to join his brother Hannibal in Italy, Scipio wisely declined the impossible task of trying to stop him and decided rather to accomplish his mission in Spain, the defeat of the other two Carthaginian armies still there. This he brilliantly achieved in 206 at the battle of Ilipa (*q.v.;* Alcalá del Rio, near Seville), where he held the enemy's main forces while the wings outflanked them. After quelling a disturbance among some troops on his lines of communication and bringing some restless Spanish allies to heel, he secured Gades, thus making Roman control of Spain complete.

Elected consul for 205, Scipio boldly determined to disregard Hannibal in Italy and to strike at Africa. Having beaten down the political opposition of Q. Fabius and other senators, he crossed to Sicily with an army consisting partly of volunteers. In 204 he landed with perhaps 35,000 men in Africa. where he besieged Utica. Early in 203 he burned the camps of Hasdrubal Gisco and his Numidian ally Syphax. Then. swooping down on the forces which the enemy were trying to muster at Campi Magni (Souk el-Kremis) on the upper Bagradas, he smashed their army by a double outflanking movement. After his capture of Tunis the Carthaginians sought peace terms, but Hannibal's subsequent return to Africa led to their renewing the war in 202. Scipio advanced southwestward to join the Numidian prince Massinissa (Masinissa) who was bringing his invaluable cavalry to his support. Then he turned eastward to face Hannibal at the battle of Zama (*q.v.*); his outflanking tactics failed against the master from whom he had learned them, but the issue was decided when the Roman and Numidian cavalry, having broken off their pursuit of the Punic horsemen, fell on the rear of Hannibal's army. Victory was complete and the long war ended; Scipio granted comparatively lenient terms to Carthage. He was named in honour Africanus. (See also PUNIC WARS.)

In 199 Scipio was censor and became *princeps senatus.* Though he vigorously supported a philhellenic policy, he argued during his second consulship (194) against a complete Roman evacuation of Greece after the ejection of Philip V of Macedon. fearing that Antiochus III of Syria would invade it; his fear was premature, but not unfounded. In 193 he served on an embassy to Africa and perhaps also to the east. After Antiochus had advanced into Greece and been ejected by a Roman army, Scipio's brother Lucius was given the command against him, Publius serving as his legate (190); together the brothers crossed to Asia, but Publius was too ill to take a personal part in Lucius' victory over Antiochus at Magnesia. Meantime in Rome Scipio's political opponents, led by the elder Cato, launched a series of attacks on the Scipios and their friends. Lucius' command was not prolonged; the generous peace terms which Africanus proposed for Antiochus were harshly modified; and the "trials of the Scipios" followed. On the trials the ancient evidence is confusing: in 187 an attack on Lucius for refusing to account for joo talents received from Antiochus (as war indemnity or personal booty?) was parried; and Africanus himself may have been accused: but not condemned, in 184. Anyhow. his influence was shaken and he withdrew from Rome to Liternum, where, embittered .and ill, he died soon afterward (184/3).

Scipio married Aemilia, daughter of the L. Aemilius Paullus who fell at Cannae. He had two sons (Publius, debarred by ill-health from a public career, and Lucius, praetor in 174) and two daughters, one of whom became the mother of the Gracchi. A man of wide sympathies, cultured and magnanimous, Scipio easily won the friendship of such men as Philip of Macedon and native princes in Spain and Africa, while he secured the devotion of his own troops. Though essentially a man of action, he was also something of a mystic in whom contemporary legend saw the favoured of Juppiter Capitolinus as well as a spiritual descendant of Alexander the Great. One of the greatest soldiers of the ancient world, by his tactical reforms and strategic insight he created an army which defeated even Hannibal and asserted Rome's supremacy in Spain, Africa and the Hellenistic east. His philhellenic sympathies led him to champion Rome's imperial and protective mission in the world. For ten years (210–201) he had commanded a devoted army at the people's wish; but, though convinced of his own powers, he offered no challenge to the dominance of the Roman nobility ensconced in the senate, except by normal political methods (in which he showed no outstanding ability). Reaction against his generous foreign policy and against his encouragement of Greek culture in Roman life led to his downfall amid personal and political rivalries, but his career had shown that Rome's destiny was to be a Mediterranean, not merely an Italian, power.

For the sources, of which the chief are Polybius and Livy, *see* Ed. Meyer, *Kleine Schriften,* ii, pp. 331 ff. (Halle, 1924), and H. H. Scullard, *op.cit. infra. See* further *B. H.* Liddell Hart, *A Greater than Napoleon: Scipio Africanus* (London, **1926;** Boston, 1927); W. Schur, *Scipio*

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SCISSORS: see CUTLERY.

SCLATER, JOHN ROBERT PATERSON (1876–1949), Canadian clergyman, who was an early leader in the United Church of Canada, was born in Manchester, Eng., on April 9, 1876. Ordained in the Presbyterian Church of England in 1902, he was minister of the Greenhill Presbyterian church, Derby (1902–07), and of the New North church, Church of Scotland, Edinburgh (1907–23). He was chaplain to the 9th Royal Scots (Highlanders) and the Royal Scots (territorial forces) (1909–23) and in World War I served on the Forth defenses and in the chaplain's department of the Y.M.C.A. in France (1916–17). In 1923 he went to Canada and after serving as minister of the Parkdale church in Toronto (1923–24) became minister of Old St. Andrews church, a position he held until his death. He had been Warrack lecturer at the Scottish Theological colleges in 1921 and became well known throughout Canada and the United States as a lecturer, serving as Lyman Beecher lecturer at Yale in 1927 and as Dudleian lecturer at Harvard in 1936. At the last university he was also select preacher and a member of the board of preachers at various periods in the 1930s and 1940s. He was moderator of the United Church of Canada (1942–44). Among his published works are *Modernist Fundamentalism* (1926) and *The Public Worship of God* (1927). He died in Scotland on Aug. 24, 1949.

SCOLECITE, a zeolite mineral of the natrolite group. It is a hydrated silicate of lime and alumina. It commonly occurs as bundles of radiating fibres and when heated sometimes curls up like a worm; the name is derived from the Greek word meaning a worm, It is usually colourless or white and more or less transparent. It crystallizes in the monoclinic system, with angles very near those of the cube. Scolecite occurs frequently with other zeolites in the western isles of Scotland, Iceland, in the Deccan trap area in India and at Table mountain, Colo., among many other localities.

For composition, structure, etc., *see* ZEOLITE.

SCOLOPACIDAE: *see* SNIPE; WOODCOCK; SANDPIPER.

SCONE, a civil parish of Perthshire, Scot., containing Old Scone, the site of a historic abbey and palace, and New Scone, a modern village, about 2 mi. N.N.E. of Perth, near the left bank of the Tay. Pop. (1951) 3,014.

According to tradition Scone became the capital of "Pictavia" in succession to Forteviot in the 8th century and remained that of Alban after the union of Picts and Scots. In 906 Constantine III and Bishop Cellach held a council concerning the church on the Mote hill of Scone, hence also called Hill of Worship. Kenneth MacAlpin is said to have brought from Dunstaffnage the Stone of Destiny, on which Scottish kings were crowned until its removal to Westminster abbey by Edward I of England. A Culdee foundation which existed there from early times was superseded by an Augustinian house founded by Alexander I *c.* 1115. Scone remained the normal place of the coronation of Scottish kings, the last being that of Charles II in 1651. It was also the scene of many medieval parliaments.

At the Reformation the abbey was burned by a mob from Perth and the lands were given to the earl of Gowrie. On the Gowrie forfeiture in 1600 these were granted to Sir David Murray of Gospertie, afterward Viscount Stormont, to whose descendant, the earl of Mansfield, the estate still belongs. Sir David completed the mansion begun by Gowrie, but it was pulled down in 1803 to make room for the present house.

A church built on the Mote hill in 1604 was demolished in tde late 18th century, except for one aisle. Scone was visited by James Edward Stewart in 1716 and by Prince Charlie in 1745. The old cross of Scone stands in the park, which also contains a racecourse. (E. W. M. B.-M.)

SCOPAS of Paros, sculptor and architect, was considered by ancient writers one of the greatest artists of the 4th century B.C. He is said by Pliny to have worked on the sculptures of the mausoleum of Halicarnassus (c. 350 B.C.) together with Bryaxis, Timotheus and Leochares, and to have carved the reliefs on one of the columns of the temple of Artemis at Ephesus; and by Pausanias to have been the architect of the temple of Athena Alea at Tegea. Unfortunately, though sculptural remains of all three buildings have survived. none can with certainty be associated with Scopas. In the case of the mausoleum. there is the difficulty of apportioning the extant reliefs to four different artists of whose style little is known. In the case of the Ephesian temple only three of the 36 columns that Pliny says were decorated have survived. And the few battered pieces that remain of the pedimental sculptures of the temple at Tegea are not necessarily the work of Scopas, for Pausanias attributes to him only the cult statues of Asclepius and Hygieia. Nevertheless, since Scopas was the architect of the temple, it is possible that he also at least sketched the designs for the pediments; and since the extant heads show a highly individual and forceful style, they may give an idea of Scopas' work. The squarish form, the deep-sunk eyes and a strongly emotional quality have, therefore, been thought to be characteristic of Scopas.

Pausanias, Pliny, Strabo and other ancient writers mention and sometimes briefly describe a number of statues made by Scopas for Asia Minor, the Peloponnesus and Attica, and some of these works have been tentatively identified in Roman marble copies and in the reliefs on Roman coins. Among them are a bronze Aphrodite seated on a goat, an Apollo Smintheus, an Apollo Citharoedus, a Maenad, a group of Eros, Himeros and Pothos, and a large group of Achilles, Nereids and Tritons.

Scanty though our knowledge of Scopas is, it can be surmised from the little which remains that he, together with Praxiteles and Lysippus. were the outstanding sculptors of the middle and second half of the 4th century B.C., who imparted to their work a new grace and emotional quality and whose influence was felt for many generations.

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(G. M. A. R.)

SCOPES TRIAL, beginning July 10, 1925, at Dayton, Tenn., and lasting 11 days. was one of the most widely publicized legal cases in 20th-century U.S. history. The charge was that John Thomas Scopes, a teacher of science in Rhea high school in Dayton, had violated the Tennessee state law prohibiting the teaching in public schools of any theories that deny the divine creation of man as taught in the Bible. Scopes, a biologist, had been teaching evolution. The basis for the sensational nature of the trial was laid by the increasing alarm of a Christian movement, known as Fundamentalism (*q.v.*), over the challenge of science and evolutionary theory to a literal interpretation of the Scriptures.

The legislature of the state of Tennessee was the first to pass an antievolution law, by an overwhelming majority (95–11), and the measure was signed by the governor on March 13, 1925. The essential section stated that it was "unlawful for any teacher in any of the universities, normals and all other public schools of the state, to teach any theory that denies the story of the divine creation of man as taught in the Bible, and to teach instead that man has descended from a lower order of animals."

When the American Civil Liberties union in New York city heard of the passage of the Tennessee law, the executive director Roger N. Baldwin sent a news release to leading Tennessee newspapers offering the services of the union to defend any teacher who would personally test the constitutionality of the statute by his classroom teaching. Baldwin soon received a telephone call from George Rapplyea, proprietor of a drug store in Dayton, stating that he had been discussing the offer with John Scopes. Assured of support. Scopes formally violated the law, and the public prosecutor in Dayton secured an indictment.

The leading lawyers on both sides of the case were probably the most famous and the most appropriate who could have been produced for the occasion. William Jennings Bryan (*q.v.*) came to Dayton to assist the local prosecutor. The defense counsel was headed by Clarence S Darrow (*q.v.*), the most famous criminal lawyer of his generation. He was assisted by Dudley Field Malone, a liberal Catholic and one of the great courtroom orators of the time, and by Arthur Garfield Hays, the outstanding civil liberties attorney of the day.

The dramatic nature of the case and the fame of the lawyers assured extended newspaper coverage. Each day an average of about 175,000 words were telegraphed out of Dayton during the 11 days that the case was in court. The case was followed daily by tens of millions of readers in both the United States and Europe.

The rulings of the judge prevented any testing of the civil liberties issue of the constitutionality of the law or any testimony as to the validity of the doctrine of evolution The sole relevant question, said the judge, was whether Scopes had actually taught the doctrine of evolution. The defense freely admitted that he had.

The case might, thus, have closed more rapidly had not Bryan made the serious mistake of permitting Darrow to get him on the stand and subject him to a long and grueling cross-examination as to his beliefs relative to the Fundamentalist attitude on science and biblical authority The process, perhaps Darrow's most animated and sarcastic courtroom performance. was a devastating experience for Bryan; many believed it hastened his death which occurred five days after the close of the trial. Darrow had adroitly used the judge's rulings on the irrelevance of the validity of the doctrine of evolution in the case to prevent Bryan from delivering a long oration he had prepared.

Scopes was convicted and fined $100. The defense appealed the case to the state supreme court which, in 1927. upheld the constitutionality of the 1925 law, but cleared Scopes on a technicality. It thus turned out that the Scopes trial was more a contribution to public education on science and religion than a test of civil liberties.

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SCOPIDAE: see HAMMERKOP.

SCOPOLAMINE (HYOSCINE) is one of the belladonna alkaloids. It is obtained from a number of solanaceous plants including the deadly nightshade, henbane and Jimson weed. On racemization (see STEREOCHEMISTRY: Racemization), atropine is obtained.

Scopolamine is the most active of the belladonna alkaloids, partly because of its greater solubility, which permits more rapid passage to the site of action Like atropine. it has a depressant action on parasympathetic nerves and in larger doses on autonomic ganglia. It also has a marked depressant action on the central nervous system, and this is the basis of its main therapeutic uses.

Combined with morphine it produces "twilight sleep," a state of analgesia and amnesia. This drug combination became popular for use during childbirth since the patient remains more or less conscious but does not usually recall later the unpleasant circumstances of the event. This and similar combinations are used for preoperative medication.

Scopolamine taken orally is an effective remedy for seasickness, probably because of its central depressant and its antispasmodic action It also finds use in controlling the rigidity and tremor of Parkinson's disease. It is a toxic drug and is administered only in minute quantities.

See also ALKALOIDS; ATROPIYE. (V. E.)

SCORE (French. partition; Italian, *partitura;* German. *Partitur*) is the name given to the copy of a work of music containing the notation for one or many performers, and is so called from the way in which the music is divided by bars scored through the series of staves on which the music is written. In a solo work the score is the only copy of the notation. In concerted works the notation of each performer constitutes a part—*e.g.,* violin part, flute part—and a score shows the vertical alignment of each of the parts. Indications of both individual and simultaneous performance are thus provided for the principal performer, the conductor and the listener.

The word score is used in several specialized senses. The arrangement or reduction of an orchestral score for piano is commonly known as the piano score. A vocal score (of operas and choral morks), consists of the vocal parts set out as in the full score, but with the orchestral score reduced for the piano. A short score is the sketch made by a composer for a full score, showing the main features set out on a few staves. An open score shows the parts, usually of a contrapuntal exercise, written on separate staves for greater clarity. A miniature score (or pocket score) is the published version of a full score reduced in size so as to be more convenient for study or following an orchestral work in performance.

The practice of writing music in score dates from the schools of polyphonic music in the early middle ages It was replaced at the beginning of the 13th century by the choirbook—a large-size manuscript in which the soprano and alto parts usually faced each other on the upper halves of two opposite pages with the tenor and bass parts occupying the lower halves. This arrangement was considered economical since the upper parts, which sang the texts required more space than the slow-moving lower parts. The music was read by the entire choir grouped around the choirbook set on a stand.

In the 15th and 16th centuries vocal and instrumental music was published in partbooks. These partbooks contained the notation of only single parts. The parts of madrigals were sometimes published crosswise on single sheets, which allowed each of the singers seated around a rectangular table to sing from his particular part.

The modern form of score, in which the bar lines are scored vertically throughout the parts, appeared in the 16th century in the madrigals of Cipriano de Rore and the orchestral music of Giovanni Gabrieli. In scores of all kinds the arrangement of the parts follons accepted schemes. In vocal works the arrangement from top to bottom is. soprano, alto, tenor bass. Scores for unaccompanied choir in four parts are sometimes known as SATB scores In scores of chamber works for string instruments the arrangement follons the compass of the instruments first and second violins. viola. cello, double bass, nith the part of a figured bass or a supporting keyboard instrument below. Parts for wind instruments in chamber norks are placed above the strings in the same arrangement as that in the orchestral score, known as the full score.

The full score is divided from top to bottom into five main sections: woodwind instruments, brass. percussion, harps and keyboard instruments, and strings. The order followed for the woodwind is: flutes, oboes, clarinets and bassoons, with the higher and lower members of their families placed appropriately. In a work using a nide variety of instruments the woodwind section would thus be set out in this order: piccolo. flutes, bass flute: oboes, oboe d'amore. cor anglais. heckelphone; clarinet in E flat, clarinets in B flat or A, bass clarinet; bassoons. double bassoon. The order for the brass instruments is: horns, trumpets, trombones. tuba. The percussion section is headed by the part for timpani followed by the keyboard percussion instruments (glockenspiel, xylophone and vibraphone) and the instruments of indefinite pitch (triangle cymbals. etc.). the latter requiring only a single line. The next section shons parts in double staves for harps, piano or organ. At the bottom of the score the string section is aligned as in chamber works.

In concertos the part of the solo instrument is placed immediately above the strings. In choral norks the choral parts may appear either above the strings or, as in the illustration from the finale of Beethoven's Choral Symphony, betneen the viola and cello parts. In full scores of operas and oratorios solo parts appear above the choral parts. In military band scores the woodwind and brass are followed, in descending order, by string basses and percussion instruments. Brass band scores are usually arranged in the order of cornets, horns, baritones, trombones, euphonium and basses, and drums.

Score reading, which is part of the equipment of conductor, consists of reproducing the essential features of a full score at

SCORE OF THE FINALE OF THE CHORAL SYMPHONY (NO. 9 IN D MINOR) BY BEETHOVEN the piano. It demands the ability to read simultaneously in the alto and tenor clefs as well as the treble and bass clefs, and to transpose parts of many of the woodwind and brass instruments Score reading of complex modern works is sometimes undertaken in the form of a piano duet.

Students of the orchestra and listeners generally find that the ear can be greatly helped by the eye in following the performance of orchestral and choral works with the score. This enables the general design of the work to be more easily grasped and ingredients of orchestral effects to be readily identified.

See also MUSICAL NOTATION.

See G Jacob, *How to Read a Score* (1944). (E LR.)

SCORESBY, WILLIAM (1789–1857), English arctic explorer, scientist and clergyman, who contributed particularly to the knowledge of terrestrial magnetism, was born near Whitby, Yorkshire, Oct. 5, 1789. His father William Scoresby (1760–1829), made a fortune in the arctic whale fishery. The son made his first voyage with his father when he was 10 years old, but on his return he was sent back to school until he was 14. After this he was his father's constant companion, and was with him on May 25, 1806, in the whaler "Resolution," when he reached 81° 30′ N. lat. (19° E. long.), then the highest latitude attained by a freely navigating ship.

Scoresby then attended the natural philosophy and chemistry classes at Edinburgh university and in his voyage of 1807 he began to study the meteorology and natural history of the polar regions. In 1811 his father resigned to him the command of the "Resolution," and in the same year he married. In a voyage two years later he established the fact that the temperature of the polar ocean is warmer at great depths than at the surface. He was elected a fellow of the Royal Society of Edinburgh in 1819 and about the same time he communicated a paper to the Royal Society of London "On the Anomaly in the Variation of the Magnetic Needle." In the following year he published *An Account of the Arctic Regions and Northern Whale Fishery,* in which he gathered the results of his own observations, as well as those of previous navigators. His voyage of 1822 to Greenland, during which he surveyed and charted 400 mi. of the east coast, between 69° 30′ and 72° 30′ was the last of his arctic voyages, for his wife had died while he was away and on his return he entered the church.

In 1824 the Royal society elected him a fellow and after two years at Cambridge he took his degree (1825) and was appointed to the curacy of Bassingby, Yorkshire. The discharge of his clerical duties at Bassingby, and later at Liverpool, at Exeter and at Bradford did not prevent him from continuing his interest in science to which he added social questions, especially the improvement of conditions in factories. When crossing the Atlantic in 1848 he made some valuable observations on the height of waves and he voyaged to Australia in 1856 in order to obtain magnetic data.

Scoresby died at Torquay on March 21, 1857.

See R. E. Scoresby-Jackson, *The Life of William Scoresby* (1861) (L. M. Fs.)

SCORIA, in geology, lava that is moderately frothy or vesicular and has a structure like that of a clinker. The name is from the Latin word meaning "slag." Ejected masses of scoria are often called cinders, a term conveniently used for all lumps of vesicular lava.

See VOLCANO.

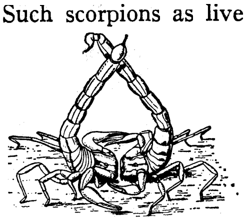
SCORPIO or SCORPIUS (the Scorpion), in astronomy, a constellation and sign of the zodiac. The constellation appears rather low in the south in the early evenings of summer for observers in middle northern latitudes. The stars outline a sprawling figure that might seem to suggest a scorpion or perhaps a kite with a long tail. The brightest star, Antares, is a supergiant at the distance of something like 170 light-years. This red star has several hundred times the sun's diameter and is intrinsically 1,000 times as luminous as the sun.

The region of the heavens from Scorpius eastward to Sagittarius and northward into Ophiuchus surrounds the direction of the centre of our galaxy. This region exhibits a spectacular display of star clouds of the Milky Way, star clusters including great globular clusters, and bright and dark nebulae. In photographs the dark cosmic dust is frequently illuminated by involved stars in patches of reflection nebulae, remindful of the glows around street lamps on a foggy night. (R. H. BR.)

SCORPION, a common name applied to any representative of the order Scorpiones of the class Arachnida (*q.v.*). Although different in size, all scorpions are more or less alike in appearance and are easily distinguished from other Arachnida by a combination of characters which are never wanting. Their pedipalpi, always held forward, are powerfully developed and provided with pincers resembling the claws of a crayfish or lobster. The first portion of their abdomen is as wide as the cephalothorax, while the last five annular segments forming the "tail," or postabdomen, are much more slender and sharply set off from the preceding seven segments of the preabdomen. At the end of the tail is a sting, somewhat curved and pointed. Its base is enlarged and contains a pair of poison glands which open near the tip of the sting. The curvature of the sting is such that the sting may be used only when the tail is raised above the preabdomen and thrust forward. Finally, on the ventral side of the abdomen, immediately behind the genital opercula, a pair of combs is situated, an organ not found in any other animals but scorpions.

The carapace or shield covering the dorsal surface of the cephalothorax bears a pair of median and from three to five pairs of lateral simple eyes. The mouth is ventral in position and is situated between an anterior and a posterior lip. In front of the mouth and above the base of the pedipalpi a pair of short appendages, the chelicerae, are used for mashing and shredding of food, for which purpose they are provided with small, but strong pincers. The first two of the four pairs of walking legs have maxillary plates and harbour glands secreting digestive enzymes. When a scorpion wants to eat, it grasps an insect with the pincers of the pedipalpi, stings it, mashes it with the chelicerae, injects digestive enzymes into the wound and when all tissues of the insect have become fluid under the influence of the enzymes, pumps the insect dry with the aid of its own pharynx, which acts both as a pump and as a strainer. Nothing but the chitinous empty shell remains of the insect. The liquid food is passed into the midgut and its immense digestive glands, where it is further subjected to the action of enzymes and absorbed by special cells, while the unused remnants are excreted through the anus situated at the end of the tail, just in front of the sting. Insects form the chief food of scorpions, but spiders and millipedes are also eaten. However, food requirements are not very great and scorpions can endure hunger for more than a year without dying.

Such scorpions as live usually in moist localities require water for their existence, but species living in deserts may go without water for many months.



FROM "CAMBRIDGE NATURAL HISTORY," BY PERMISSION OF THE MACMILLAN COMPANY, PUBLISHERS

FIG. 1.—MATING OF BUTHUS OCCITANUS (AFTER FABRE)

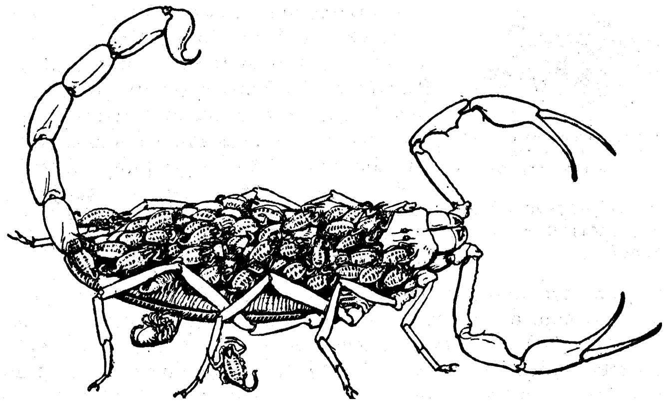
Scorpions live in hot and tropical countries. On the American continent they are found from the southern United States to Patagonia. In Europe several species are found in Greece, Italy and Spain, and at least one species goes as far north as southern Germany. The geographical distribution of scorpions was made the subject of several special studies and recalls in a general way the distribution of mammals. On many islands, including New Zealand, scorpions are wanting. On the other hand, cosmopolitan species may be found occasionally even in countries not suited for their life. The author of this article has in his collection (1945) a specimen which he caught in Connecticut, running on a lawn and evidently imported with lumber. In their natural habitat scorpions live under stones and under bark, in crevices of rocks, under dead leaves and rubbish, in open fields and in forests, in stone walls, in barns and stables, in outhouses and deserted buildings, in thatched roofs and in dark basements.

In countries where the dwellings are poorly screened, scorpions are common visitors in the rooms. Having a natural tendency to get into crevices, scorpions manage to get even into well screened homes by passing under a screen door. The author has repeatedly captured scorpions in such buildings and is also able to substantiate a number of reports of individuals who were stung by scorpions in bed. Although common in some countries with very dry climate, scorpions are sensitive to moisture. During the dry season they hide regularly in the ground and may not be easily seen. But as soon as the rainy season begins and the ground becomes soaked with water, the scorpions find their way to the surface and stay under loose stones where they are quite commonly found.

The life of scorpions is comparatively simple. Even the most primitive forms of animal association are not known among scorpions. All species lead strictly individual lives and avoid each other or else fight to death, the victor usually devouring the victim. In very large cages several individuals may be kept together because they have enough room not to encroach on one another. But in smaller containers not more than one scorpion may be kept alive. Growth is accompanied by moulting, as in all arthropods. The old skin cracks around the carapace and is shed completely, including the lining of the foregut and hindgut and of the four pairs of book-lungs situated on the ventral side of the third to sixth preabdominal segments. The total number of moults is not exactly known and may vary somewhat even in the same species. When the state of maturity is reached the sexes show visible differences in the relative proportions of the body. The male is more slender and has a longer "tail." It also has a pair of organs used in copulation, but visible only when the specimen is turned over on its back. On finding a female the male engages in a primitive sort of courtship, consisting mainly in grasping the hands of the female with his own hands and rubbing his tail against her tail. After copulation the male is often attacked by the female and devoured unless he manages to escape.

The fertilized eggs develop inside the mother and the young are born alive. At this stage they already possess all the characters of scorpions, but the proportions of their bodies are very different from those of their parents. Moreover, they are quite helpless and incapable of eating because their midgut is completely filled with embryonic yolk.

Unable to take care of themselves they climb on the back of their mother often completely hiding from view the body of the latter so that nothing but the appendages and the tail remain visible. The mother carries her young around, but does not feed them. They exist for a while on the nourishment which they derive from digesting the embryonic yolk. After the first moult, while the young still cling to the back of the mother, the body becomes in appearance more like that of the adult, only many times smaller. The yolk is now digested. The creatures become more active, often drop off their mother's back, and begin soon to leave her for good to start their own individual existence.



BY LISBETH KRAUSE

FIG. 2.— MATERNAL CARE IN SCORPIONS. FEMALE CENTRUROIDES INSULANUS WITH YOUNG SCORPIONS ON HER BACK

The most interesting feature of a scorpion is of course its poison. Prabably because of their poisonous qualities, scorpions were known and feared already in ancient times. Observations on the effect of their poison have been made many times in the past, but scientifically correct data are only few and comparatively recent. One of the sources of error is the same as in all similar observations, namely the lack of knowledge of the physiological state of the animal on which the observation was made and of the quantity of poison injected by the scorpion into the wound and its relation to the total weight of the victim. Another, often even more serious, error is due to the fact that many observations refer simply to "a scorpion," whereas there are some 500 species of scorpions in the world and in many localities several species may occur close to each other. It is known that different species vary a great deal in the degree of virulence and type of their poison. Exact knowledge can therefore be had only under carefully controlled laboratory experiments, while general observations may only supplement such knowledge when the offending species is determined by an expert. Such observations have led to the conclusion that at least two types of scorpion poison exist. One of these is local in effect and comparatively harmless to man. It is exemplified by the European *Euscorpius italicus* and the American *Centruroides vittatus*. The other type is neuro-toxic, resembles the venom of some snakes and produces serious effects on the organism often resulting in death. This type is represented in the United States by *Centruroides sculpturatus* and its close relative, *Centruroides gertschi.* Poison for experiments may be obtained in pure form without injury to the scorpion by electric stimulation. It is soluble in water, in glycerin and in physiological salt solution. The poison of *Buthus australis* of North Africa contains some 20% to 25% of a substance which becomes solid on drying. This substance seems to be neither of protein nor lipid nature, retains its virulence for a long time in the dry state, but is destroyed when boiled for half an hour. The amount of poison produced by the glands of a scorpion depends largely upon the size of the specimen.

Buthus occitanus of southern France produces at one time about 8 milligrams of fluid poison. The weight of dried poison of *Buthus quinquestriatus* of North Africa, Syria and Palestine was estimated at a minimum of 2 milligrams.

The symptoms caused by scorpion poison of the less virulent type consist mostly in sudden sharp pain followed by numbness of the limb and local swelling. The symptoms pass within an hour or two. There is no more danger to man from this type of scorpion poison than there is from the sting of a wasp or a hornet. The author observed in his laboratory the effect of the poison of *Vejovis spinigerus* of Arizona on the large centipede *Scolopendra polymorpha.* The sting produces almost instantaneously paralysis of the legs of the segment which was stung and of two adjoining ones.

A few moments later one more segment on each side becomes paralyzed, so that altogether five segments are affected. The paralysis lasts for some time, but disappears in a few hours. Besides *Centruroides vittatus* and *Vejovis spinigerus,* to this type belong also the formidable-looking *Hadrurus hirsutus* and *Hadrurus spadix* of Arizona and Utah.

It seems that the Central American *Centruroides margaritatus,* which reaches the length of 95 mm. ($3\frac{3}{4}$ in,), is equally harmless.

Sot so with species whose poison is neuro-toxic. Here the symptoms resemble poisoning with strychnine. The sting produces a sharp pain, followed by numbness of the limb; speech becomes difficult; discharge of saliva is copious; the patient becomes restless; breathing is hard and death is not uncommon. The numerous deaths from scorpion sting in Durango, Mexico, seem to be all caused by *Centruroides suffusus,* the most common scorpion in that state. The injection into a vein of a middle-sized dog of a solution containing between 1 and 1.5 milligrams of dried poison of the European *Buthus occitanus* is sufficient to cause death.

The effect of the poison on different animals varies a great deal. The European hedgehog is practically immune to scorpion poison, as it is also to the venom of European snakes. African rodents of the genus *Gerbillus* are nearly 300 times less sensitive than guinea pigs. Dogs are very sensitive to the poison of *Buthus australis,* but *Canis cerdo* (=*Vulpes zerda),* the fennec, of North Africa is immune. Birds are quite sensitive. Sparrows and pigeons are easily killed with the poison of *Scorpio maurus*. Frogs are easily killed, and fish of the species *Motella tricirrata* succumb in less than two hours after a subcutaneous injection. It has been shown that the poison has a haemolytic action, destroying red blood corpuscles, and in this respect is also comparable to the venom of snakes.

The story that scorpions commit suicide by stinging themselves, when surrounded by a ring of fire, is based on misinterpretation of their behaviour and has long since been disproved. However, the generally accepted idea that all animals are immune to their own poison is not quite correct. Scorpions possess a certain degree of immunity. This is true of *Palamnaeus scaber (=Scorpio afer)*, according to older statements. But *Buthus australis* may be killed by injections of its own poison provided the dose contains at least 0.25 to 0.5 mgm. of dry weight, *i.e.*, provided that the dose is nearly 200 times greater than the one necessary to kill a guinea pig. Scorpions are very sensitive to heat and die easily when exposed to the rays of the sun in a closed container. What happens when a scorpion is subjected to heat is simply this: first it tries to escape and failing in this, begin3 to strike frantically with its tail as if in an attempt to sting. Finally it becomes insensitive, overcome by heat, and dies unless removed and allowed to recuperate. The treatment against scorpion poison consists in an application of cold, administration of barbiturates, and injections of a special scorpion serum. The latter is made in Brazil, Mexico, London and Algeria.

Notwithstanding their poison, scorpions have some enemies which destroy them. In the tropical rain forests of Mexico and Central America one can often see army ants disturbing scorpions in the progress of their own raids. Many times the size of their tormentors, scorpions succumb rapidly to their attacks, are overpowered and dismembered. African baboons have been observed catching scorpions of large size, tearing off their tail and greedily devouring the rest of the body. Remnants of scorpions were found in the stomach of a large lizard, *Varanus griseus,* in Transcaucasia. It has been also reported that certain natives of Algeria enjoy eating live scorpions. The author has seen chickens in Arizona dismembering scorpions with their bills. Artificial combats staged by otherwise ignorant people have little scientific value, but they have shown that scorpions entangled in the web of the black widow spider succumb to the poison of the latter. Of course, under normal conditions, scorpions never get into webs of any spiders, while those spiders which scorpions occasionally use for their own food never make webs. It is not yet quite clear whether scorpions of one species are immune to the poison of another species. But it is certain that the blood of scorpions acts as an antitoxin in the case of the same species. In combats between two individuals of the same species, the weaker one is killed, not by poison, but by brute force.

Some of the symptoms produced in man and animals by neuro-toxic scorpion poison stand in direct relation to its effect on various tissues. Both transversely striated and smooth muscles contract under direct influence of weak solutions. Intravenous injections raise the blood pressure considerably. Serous exudation is produced in kidneys. Liver cells undergo fatty degeneration within a few minutes, the liver acquiring a yellowish colour. Necrosis of the liver may take place within 30 minutes after the injection of a large dose of scorpion poison.

The size of scorpions varies considerably. Some species are only 13 mm. ($\frac{1}{2}$ in.) long, while the largest attain 175 mm. ($6\frac{7}{8}$ in.). Although even the smallest scorpions are large enough to be easily studied under lo power, the identification of species is not a simple matter. There is a great deal of variation in most characters so that even a specialist often has difficulty in assigning a specimen to its proper species. The six recent families into which scorpions are divided. as nell as the genera, are easily determined. Their distinction is based on structural characters such as sternum, combs, spines, rows of granules on fingers and on the surface of the body. etc. Being physiologically of the least importance these characters were less subject to functional modifications and remained more or less stationary throughout long geological periods, this being one of the reasons why palaeozoic scorpions are so much like recent ones in appearance. Specific characters are finer and less stable. The species found in Europe and those in the United States are well known and have been described many times. Of the four families represented in the United States, the Buthidae alone have been so far shown to contain dangerously poisonous species, namely the two species of the genus *Centruroides,* mentioned above. Four other species belonging to this genus are found in the U.S. In view of the fact that, of the 30 species known to occur in the U.S., less than a quarter have been studied with a view of ascertaining the type and virulence of their poison, caution in handling scorpions is advisable.

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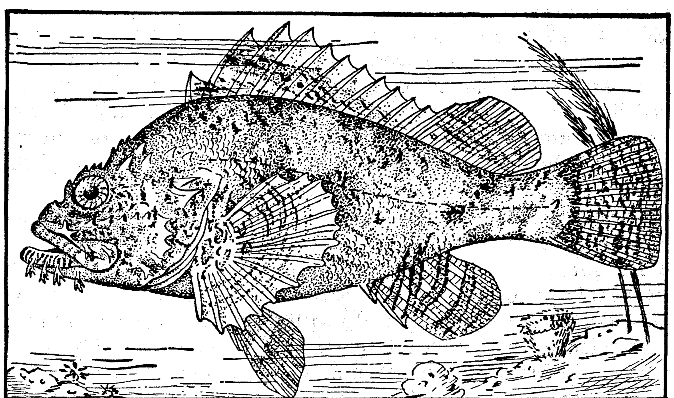
(A. Ph.)

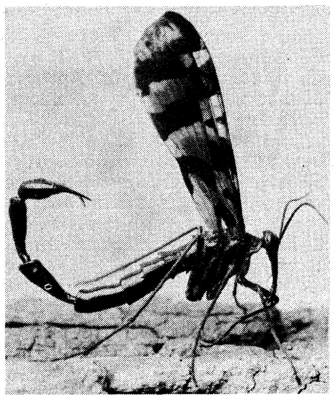
SCORPION FISHES (Scorpaenidae), a family of spiny, marine fishes, characterized as are other families of the order Cataphracti (the Cottidae, etc.), by a bony stay across the cheek. The name is particularly used for the many mostly small (a foot or less long), bottom species in the shore waters of all warm seas (*Scorpaena,* etc.). These usually have mottled colours and are found on rough bottoms or among seaweed. In cooler, coastal waters of the North Pacific, there are larger (the largest two or



SCORPION FISH (SCORPAENOPSIS CACOPSIS), FROM HAWAII AND TAHITI; MANY SIMILAR SPECIES OCCUR ON THE SHORES OF ALL WARM SEAS

three feet long), freer-swimming, less spiny species (*Sebastodes,* etc.), commonly known as rockfish, and of greater market value In the cold waters of the North Atlantic there is a bright red one, the rosefish (*Sebastes marinus*), which is excellent for the table. So far as known all members of the family are good to eat, but persons handling the warm-water ones, especially, should use care, as wounds from their sharp spines may be very painful and cause swelling. In the cool-water species, the small eggs hatch within the body of the mother as a rule, broods of hundreds if not thousands of tiny fishes being spawned. (J. T. N.)

SCORPION FLY, the common name for insects of the family Panorpidae, order Mecoptera (*q.v.*), and by extension often applied to the order as a whole (*see* below). The name refers to the fact that in male panorpids the abdomen terminates in a bulb-like segment which is held over the back, after the manner of a scorpion. In both sexes the chewing mouth parts are borne at the tip of a stout beak, the antennae are long and many-segmented, and there are two pairs of membranous, net-veined wings, which in many species are darkly spotted or banded. The largest genus, *Panorpa,* comprising about 170 species, is widely distributed in forested areas of the northern hemisphere. Adult scorpion flies, usually found on the wing in summer, feed on dead animals, especially insects, but the larvae are thought to be predaceous on minute soil animals. The immature stages of only a few species are known; the larvae resemble caterpillars, and pupation occurs in a cell in the soil.


ROSS E. HUTCHINS
A MALE SCORPION FLY (PANORPA) COMMON IN THE SOUTHERN UNITED STATES

Besides Panorpidae, the order includes the hanging flies, family Bittacidae, which hang by their forelegs and catch insect prey with their raptorial hind feet; and the tiny, blackish snow scorpion flies, family Boreidae, with greatly reduced wings.

Snow scorpion flies are occasionally seen walking over the surface of snow; both the adults and larvae are said to feed on mosses. The order is small, numbering about 350 known living species, but it is very widespread in distribution and is of great antiquity.

Scorpion flies are altogether harmless to man and serve a useful function in nature as scavengers.

See INSECT: *Classification: Mecoptera.* (G. W. Bs.)

SCORZONERA (*Scorzonera hispanica*), a hardy perennial, native to central and southern Europe, and cultivated in gardens as a vegetable for its fleshy cylindrical roots, which resemble those of salsify (*q.v.*) except in being black outside. They should be treated in every respect like salsify. The genus is a member of the family Compositae, and closely allied to *Tragopogon,* to which salsify belongs.

SCOT, MICHAEL (? 1175–*c.* 1232), Scottish translator, mathematician and astrologer. He studied at Oxford and Paris. and after being ordained, held various benefices in Italy, but refused the appointment of archbishop of Cashel in Ireland. Having acquired a knowledge of Arabic at Toledo, he became one of the scholars of the court of Frederick II, and at the instigation of the emperor superintended (along with Hermannus Alemannus) a fresh translation of Aristotle and the Arabian commentaries from Arabic into Latin. The chief of these were the *De Animalibus,* the *De anima,* the *De coelo,* and probably the *Physics* and the *Metaphysics,* and also the *De Sphaera* of Al Bitrogi. Scot's own books, dealing almost exclusively with astrology, alchemy and the occult sciences generally, are mainly responsible for the development of the Michael Scot legend. Chief among these are *Super auctorem spherae,* printed at Bologna in 1495 and at Venice in 1631; *De sole et luna,* printed at Strassburg in 1622 in the *Theatrum chimicum,* and containing more alchemy than astronomy, the sun and moon being taken as the images of gold and silver; *De chiromantia,* an opuscule often published in the 15th century; *De physiognomia et de hominis procreatione,* of which there were 18 editions between 1477 and 1660.

The *Physiognomia,* which also exists in an Italian translation. and the *Super auctorem spherae* expressly state that they were undertaken at the request of the emperor Frederick. Michael is said to have foretold, after the manner of the ancient oracles, the place of Frederick's death, which took place in 1250.

Around his own death many legends gathered. He was supposed to have foretold that he would end by a blow from a stone of not more than two ounces in weight, and that to protect himself he wore an iron helmet, and that, raising this in church at the elevation of the host. the fatal stone fell on him from the roof. Italian tradition says he died in Italy; other accounts place his death in his native country, and his burial at Holme Cultram in Cumberland or in Melrose abbey. In the notes to Scott's Lay of *the Last Minstrel,* Scott recounts the exploits attributed by popular belief to the magician. "In the south of Scotland any work of great labour and antiquity is ascribed either to the agency of Auld Michael, of Sir William Wallace or the devil." Other powers and exploits are narrated in Folengo's Macaronic poem of *Merlin Coccaius* (1595). Michael's reputation as a magician was early established. He appears in the *Inferno* of Dante (canto xx, 115–117) among the magicians and soothsayers. He is represented in the same character by Boccaccio.

SCOT AND LOT, a phrase common in the records of English medieval boroughs, applied to those householders who were assessed to any payment made by the borough for local or national purposes. They were usually members of a guild merchant.

SCOTER (*Oidemia nigra*), a diving duck. also known as the black duck from the male being. save for a stripe of orange down the bill, wholly of that colour. Of all ducks the scoter has the most marine habits, keeping to the sea in all weathers, and coming to land only to breed. A second species, the velvet scoter, *O. fusca,* of larger size. with a white spot under each eye and a white bar on each wing, is less abundant. It has its American counterpart, *O. americana,* and a third, the surf-duck, *O. perspicillata,* with a white patch on the crown and another on the nape, and a curiously parti-coloured bill, is not uncommon in North American waters. All the species have their true home in arctic or subarctic countries. but the scoter itself breeds occasionally in Scotland. The nest is on the ground and contains five to eight creamy eggs. The females are soot coloured above and brownish white beneath. The flesh of all these birds has an exceedingly strong taste. and ranked as fish in ecclesiastical dietary.

SCOTLAND, the most northern of the three countries that constitute Great Britain. Scotland includes the Outer and Inner Hebrides and other islands off the west coast, and the Orkney and Shetland islands off the north coast. With England lying to the south, it is bounded on the north and west by the Atlantic ocean and on the east by the North sea. It is separated from England by the Solway firth, the Sark, Scotsdyke (an old embankment connecting the Sark with the Esk), the Esk (for 1 mi.), the Liddel, the Kershope, the Cheviot hills, the Tweed and a small area known as the "liberties" of Berwick. The greatest length, from Cape Wrath in Sutherland to the Mull of Galloway, is 274 mi., and the greatest breadth, from Buchan Ness to Applecross in the shire of Ross and Cromarty, 154 mi.; but from Bonar Bridge at the head of Dornoch firth to the head of Loch Broom it is only 26 mi. wide, and 30 mi. from Grangemouth on the Forth to Bowling on the Clyde.

The coast line of Scotland is estimated at 2,300 mi., the arms of the sea being so numerous and in several cases penetrating so far inland that few places are beyond 40 mi. from salt water. The area is 29,795 sq.mi.

The name Scotland (the ancient Caledonia—a name still poetically used) originated in the 11th century, when (from the tribe of Scots) part of it was called Scotia (a name previously applied to nhat is now Ireland) ; and the name of Scotland became established in the 12th and 13th centuries.

PHYSICAL GEOGRAPHY

Physically, Scotland is divided into three structural regions—the Highlands (subdivided by Glen More into the northwestern and southeastern Highlands); the central lowlands (a tract of southwesterly to northeasterly trend, between a line drawn roughly from Girvan to Dunbar and a line drawn from Dumbarton to Stonehaven); and the southern uplands. To these. geographers add a fourth division, to be regarded as at least a subregion of the Highlands, viz., the lower eastern slopes of that region bordering the North sea, from Stonehaven and Aberdeen in the south to the high plain of Caithness in the north. It may be termed the northeastern region.

The Highlands. — Nearly all this region is high ground, deeply trenched with valleys and sea lochs. The Highland hills stand in a succession of more or less parallel confluent ridges, having in the main a trend from northeast to southwest. These ridges are separated by longitudinal and furrowed by transverse valleys. The longitudinal valleys, which run in the same general direction as the ridges, have had their trend defined by geological structure, such as a line of dislocation (the Great Glen), or the plications of the rocks (Lochs Ericht, Tay and Awe, and most of the sea lochs of Argyllshire). The transverse valleys run northwest or southeast and are for the most part independent of geological structure. The valley of the Garry and Tay crosses the strike of all the Highland rocks, traverses the great fault on the Highland border, and finally breaks through the chain of the Sidlaw hills at Perth. River-gorges are characteristic features in many of the valleys. In the Old Red Sandstone they are particularly prominent where that formation has lain in the way of the streams sweeping down from the Highlands. In the basin of the Moray firth some fine examples may be seen on the Nairn and Findhorn, while on the west side of the Cromarty firth some of the small streams descending from the high grounds of the east of the shire of Ross and Cromarty have cut out defiles in the conglomerates, remarkable for their depth and narrowness. Toward the south margin of the Highlands instances of true canyons in the Old Red Sandstone are to be seen where the Isla and North Esk enter that formation.

While many of the Highland mountains, viewed from near at hand, tower above the surrounding country, and are often of noble form, from a distance they are seen not to vary much from a general uniformity of height. A few exceptions occur along the western seaboard of Sutherland, in Skye, and elsewhere. but their structure explains the reason of their prominence. Regarded broadly, the Highland mountains are monuments of erosion. the relics of an old plateau, the surface and former slopes of which are shown approximately by the summits of the existing masses and the directions of the chief waterflows. The surface is rugged. The rocks project in bosses and crags, which roughen the sides and crests of the ridges. The shape and colour of these roughnesses depend on the nature of the underlying rock. Where it is hard and jointed. weathering into large quadrangular blocks, the hills are distinguished by the gnarled bossy character of their declivities, as may be seen in Ben Ledi and the heights to the northeast of it. Where. on the other hand, the rock decays into smaller debris, the hills assume smoother contours, as in the slate hills running from the Kyles of Bute to Loch Lomond.

The process by which the ancient plateau has been trenched into valleys and confluent ridges is best displayed among the higher mountains. where erosion proceeds at an accelerated pace. The long screes or talus slopes at the foot of every crag and cliff bear witness to the continual waste. The headwaters of a river cut into the slopes of the parent hill. Each valley is consequently lengthened at the expense of the mountain from which it descends. Where a number of small torrents converge in a steep mountain recess, they cut out a crescent-shaped hollow or half-cauldron. which in the Scottish Highlands is known as a corrie. Usually the upper part of a corrie is formed by a crescent of naked rock, from which long trails of debris descend to the bottom of the hollow. Every distinct variety of rock has its own type of corrie, the peculiarities being marked both in the details of the upper cliffs and crags, and in the amount, form and colour of the screes. The Scottish corries have been occupied by glaciers. Hence their bottoms are generally ice-worn or strewn over with moraine stuff. Often a small tarn fills up the bottom ponded back by a moraine. It is in such localities that we can best observe the evidences of the glaciers that once overspread the country. Among these high grounds also the gradual narrowing of ridges into sharp, narrow, knife-edged crests and the lowering of these into cols or passes can be well seen. The stages in this demolition are clearest where the underlying rock is of granite or similarly tough material, which at the same time is apt to be split and splintered by means of its numerous transverse joints. The granite mountains of Arran furnish excellent illustrations.

Where a rock yields to weather with considerable uniformity in all directions it is likely to assume conical forms in the progress of denudation. Somelimes this uniformity is attained by a general disintegration of the rock into fine debris, which rolls down the slopes in long screes. In other cases it is secured by the intersection of joints. whereby a rock, in itself hard and durable, is divided into small angular blocks, which are separated by weathering and slide down the declivities. In many instances the beginning of the formation of a cone may be detected on ridges which have been deeply trenched by valleys. The mountain Schiehallion (3.547 ft.) is an instance of a cone not yet freed from its parent ridge. A further stage in denudation results in isolated groups of cones completely separated from the rest of the rocks among which they once lay buried. Such groups may be carved out of a continuous band of rock extending into the regions beyond. The Paps of Jura, for instance, rise out of a long belt of quartzite which stretches through the islands of Islay, Jura and Scarba. In many cases, however, the groups point to the existence of some boss of rock of greater durability than those in the immediate neighbourhood, as in the Coolins (Cuchullins or Cuillins) and Red hills of Skye and the group of granite cones of Ben Loyal, Sutherland. The most impressive form of solitary cone is that wherein, after vast denudation, a thick overlying formation has been reduced to a single outlier, such as Morven in Caithness, the two Bens Griam in Sutherland. and the pyramids of red sandstone on the western margin of the shires of Sutherland and Ross and Cromarty. While in Scotland the dislocation of rocks has generally prevented the formation of continuous escarpments, there are instances of these in the wide basalt plateaus of the Inner Hebrides. where lava has been poured out in nearly horizontal sheets, with occasional layers of tuff or other softer rock between them.

Platforms' of erosion, successively established by the wearing down of the land to sea level, occur both in the Highlands and among the southern uplands The flat-topped moorlands in the eastern Grampians reach heights of 3,000 to 4.000 ft. above the sea. The summits of Lochnagar and Ben Macdhui may be taken as examples. These mountains lie within granite areas; but not less striking examples may be found among the schists. That these high plateaus are planes of erosion is shown by their independence of geological structure. the upturned edges of the vertical and contorted schists having been shorn off and the granite wasted and levelled along its exposed surface. An example of the similar destruction of a much younger platform is to be found in the terraced plateaus of Skye, Eigg, Canna. Muck, Mull and Morven, which are portions of what was probably originally a continuous plain of basalt. Though dating back only to older Tertiary time, this plain has been so deeply trenched by denudation that it has been reduced to scattered fragments.

The Highlands are separated into two disconnected and in some respects contrasted divisions by the depression of the Great glen, extending from Loch Linnhe to Inverness. In the northwestern section the highest ground is found along the Atlantic coast. mounting steeply from the sea to an average height of 2.000 to 3.000 ft. The watershed consequently keeps close to the western seaboard. in some places not above $1\frac{1}{2}$ mi. from it. From these hills, which catch the first downpour of the rains from the ocean, the ground falls eastnard. Numerous eminences, however, prolong the mountainous features to the North sea and southeastward to Glen More. The difference of the general level on the two sides of the waterparting is reflected in the length of their streams. On the west the drainage empties itself into the Atlantic after floaing only a very fen miles; on the east it has to run 30 or 40 mi. At the head of Loch Nevis the western stream is but 3 mi. long, while the eastern has a courie of some 18 mi. to the Great glen. Throughout the northnestern region uniformity of features characterizes the scenery, betokening, even at a distance, the general monotony of structure. But the sameness is relieved along the western coast of the shires of Sutherland and Ross and Cromarty by groups of cones and stacks, and farther south by the terraced plateaus and abrupt conical hills of Skye. Rum and Mull.

The southeastern region of the Highlands, having a more diversified geological structure, offers greater variety of scenery. Most of the valleys, lakes and sea lochs run in a southwesterly and northeasterly direction, a feature strikingly exhibited in west Argyllshire. But there are also several important transverse valleys, that of the Garry and Tay, already noticed, being the most conspicuous example. The watershed, too, is somewhat different. It first strikes eastward round the head of Loch Laggan and then swings southward: pursuing a sinuous course till it leaves the Highlands on the east side of Loch Lomond. The streams flowing westward, however, are still short, while those running to the northeast, east and southeast have long courses and drain wide areas. There is a marked contrast between the configuration of the northeastern district, and the other parts of this region. In that area the Grampians rise to level or gently rounded summits, often more than 3,000 ft., and in a few places exceeding 4.000 ft. in height, and bounded by steep declivities and sometimes by precipices. Farther southwest, in the shires of Perth, Inverness and Argyll, they give place to the more typical hummocky crested ridges of Highland scenery which, in Ben Nevis and Aonach Beg, reach heights of over 4,000 ft. Geological structure alone does not account for this contrast, and one reason may lie in the heavier rainfall, and consequently stronger erosion. to which the western mountains! facing the Atlantic ocean. have been exposed. Long narrow strips of flat land occur in the more important valleys. Most of the straths and glens have a floor of detritus which, spread out between the bases of the boundary hills, has been levelled into meadow land by the rivers and provides almost the sole arable ground in each district. It is appropriate here to notice certain terms common throughout Scottish topography in application to types of valleys and low-lying land. for examples of most of them are found in the Highlands or on their borders.

Straths are broad expanses of low ground between hills, usually traversed by one main stream and its tributaries; *e.g.,* Strath Tay, Strath Spey, Strath Conon. This name, however. has also been applied to wide tracts of 10x1-land which embrace portions of several valleys, but are defined by lines of heights on each side; the best example is afforded by Strathmore — the "Great Strath" —between the southern margin of the Highlands and the line of the Sidlaw hills. This long wide depression, though it looks like one great valley, includes portions of the valleys of the Tay, Isla, North Esk and South Esk. all of which cross it. Elsen-here in central Scotland such a wide depression is known as a *howe,* as in the Howe of Fife between the Ochil and Lomond hills. A *glen* is a narrower and steeper-sided valley than a strath. though the names have not always been applied with discrimination. Most of the Highland valleys are true glens, Glencoe being the best known example. The hills rise steeply on each side, sometimes in grassy slopes. sometimes in rocky bosses and precipitous cliffs, while the bottom is occupied by a lake. In the south of Scotland the larger streams flow in wide open valleys called *dales,* as in Clydesdale, Tweeddale, Teviotdale, Liddesdale, Eskdale and Nithsdale.

The strips of alluvial land bordering a river are known as *haughs,* and where, along estuaries, they expand into wide plains they are termed *carses.* The carses oi the Forth extend seaward as far as Bo'ness and consist chiefly of raised beaches. The Carse of Gowrie is the strip of low ground intervening between the Firth of Tay and the Sidlaw hills. Brae signifies the steep bank of a river, and so any slope or hillside.

Scottish lochs (or lakes) are sometimes classified into four groups — glen lochs, rock tarns, moraine tarns, and lochs of the lowlands, of which the first and most important are practically confined to the Highlands and the second and third are far more numerous there than elsewhere. The small rock tarns, lying in rock basins on the flanks of mountains, or the summit of ridges or rocky plateaus, are by far the commonest, and especially so in the northwest. They almost invariably lie in strongly ice-worn platforms, and are held to occupy hollows produced by the gouging action of the ice-sheets in glacial times. Moraine tarns — small sheets of water dammed back by moraines left by retreating glaciers — are also numerous in the Highlands, nestling in the bottoms of corries. In the southwest, where the glaciers continued longest to reach sea level, lakes retained by moraine barriers are seldom found above the sea. More important, if less numerous than either of these categories, are the larger glen lochs, which are associated with the finest inland scenery in the Highlands. These occupy depressions in the glens, not due to local heaping up of detritus, but true rock basins, often of great depth. It is commonly but not invariably held that these depressions were formed by the erosive action of ice! since glaciers occupied the glens where they occur and wore down the rocks along the sides and bottom; but it is a point of difficulty in this theory whether ice could have eroded the deepest of the hollows.

The western Highland coast is intersected throughout by long narron- sea lochs or fjords. The mainland slopes steeply into the sea and is fronted by chains and groups of islands. These fjords are submerged land valleys, for the whole western coast has subsided to a considerable depth beneath its former level. The Scottish sea lochs must be considered in connection with those of western Ireland and Norway. The whole of this northwestern coast line of Europe bears witness to recent submergence. On this view the Outer and Inner Hebrides were formerly one with themselves and the mainland, and the western isles therefore are truly grouped with the Highland province of Scotland. Nearly the whole coast line is rocky. On the west the coast is mostly either steep rocky declivity or a sea wall, though strips of lower ground are found in the bays. The cliffs vary in character according to the nature of the rock. At Cape Wrath, precipices 300 ft. high have been cut out of the Archean gneiss. The varying texture of this rock, its irregular foliation and jointing. and its ramifying veins of pegmatite give it very unequal powers of resistance. In some places it projects in irregular bastions and buttresses, in others it retires into deep recesses and tunnels, but shows everywhere a characteristic ruggedness. In striking contrast to these precipices are those of the Cambrian red sandstone a few miles to the east. Vast vertical walls of rock rise to a height of 600 ft., cut by their perpendicular joints into quadrangular piers and projections, some of which stand out alone as islets in front of the main cliff.

The population of the Highlands is naturally scattered, since great tracts of mountain and moorland are uninhabitable. The few small towns and larger villages are for the most part such as have grown in modern times as touring centres and places of summer residence along the west coast and the railways, in particular the line between Perth and Inverness. Settlements remote from these influences are commonly small, and some on the western seaboard share with Norwegian fjord-side settlements the characteristic of having their chief lines of access by water. The Highlands are not rich in minerals; only a few workings, such as that of the iron ore of Raasay, near Skye. are encountered; north of Fife coal is virtually nonexistent, except for the pit at Brora in Sutherland. The development of hydroelectric power, especially since the creation in 1943 of the north of Scotland hydroelectric hoard, gives promise of considerable industrial activity. Otherwise, homestead industry, such as the manufacture of Harris tweed in the Outer Hebrides, can maintain itself (apart from local consumption) only by the special excellence of its products. It thus follows that the Highland population is principally agricultural and concentrated upon the limited cultivable areas, the resources of which it tends easily to outgrow, so that the Highlands have sent and still send abroad many emigrants. Only a few alluvial basins — up to an elevation of 1,200 ft. in Banffshire, but usually much lower—the levels of raised beaches, and narrow isolated coastal strips offer fair agricultural land and a more or less complete subsistence to the crofters; those on the coastlands may add to their means of livelihood by fishing. while others may take service as gamekeepers on the large sporting estates which occupy a high proportion of the total area, or in the forestry reserves.

The Northeastern Region. — This division embraces the considerable low-lying areas in eastern Aberdeenshire and the northern parts of Banff, Moray and Nairn, together with the level strip of land bordering both sides of Moray firth. Farther north. the Highlands of Sutherland sink close to the coast, but the narrow coastal belt there broadens northward again in Caithness. which does not strictly belong to the Highlands. In the southeastern part of the region (east and southeast of Moray firth) the principal rivers—Spey and Dee. and, within the angle formed by these, the Don, Wthan. Deveron and others — drain long valleys separated by extended spurs of the Highland mountains. The hills sink to a fairly wide foreland, sloping gently to the sea, or broken off in low cliffs. On this part of the coast there are neither islands nor deep inlets, though plenty of small bays offer shelter for shipping, especiaily fishing vessels. Northward, the coast is deeply indented by the firths of Moray, Cromarty and Dornoch, and a further series of fine rivers, hardly less famous among salmon and trout fishermen than those just mentioned, enter the sea from the mountains to the west. The chief of these rivers are the Findhorn, Beauly, Conon, Shin and Helmsdale. The peninsulas between the firths reach no great elevation — an extreme height of 800 ft. is found in the Black Isle south of Cromarty firth. The coastal lowland of Sutherland, as already indicated, is very narrow, but Caithness is a wide moor, terminating almost everywhere seaward in a range of precipices of Old Red sandstone.

The population of this region is, on the whole, closer on the coastal lands than in the interior; the largest towns, such as Aberdeen, Peterhead, Fraserburgh, Banff. Inverness and Wick are seaports. In Sutherland population is almost confined to the raised beaches of the narrow coastal belt. On the other hand a fairly dense rural population covers most of the area between the lower Dee and the Deveron and extends far up the valley of the Spey. The region is not devoid of fertile lands! although their preparation for tilling has, in the past, necessitated in some parts immense labour in clearing the glacial boulders with which they were bestrewn. A high standard of farming is reached in the lower parts of the Dee and Don basins, the Laigh of Moray, and other localities. Oats and turnips, with some barley, are main crops, and the lower lands of the eastern division are famous for cattle. On the higher grounds sheep are more prominent. Granite is quarried at several points in the same division and granite polishing is a characteristic industry at Aberdeen. Pure water, favourable for malting, has helped in the establishment of the distilling industry. The fisheries centre mainly on Xberdeen, which is-also the principal port for the export of herrings; the pelagic fisheries are carried on mostly from more northerly ports — Peterhead, Fraserburgh and Wick (as well as the Orkney and Shetland Islands).

The Central Lowlands. — These constitute a broad depression with southwesterly to northeasterly trend lying between the Highland line that runs from the head of the Firth of Clyde to Stonehaven and the pastoral uplands that stretch from Girvan to Dunbar. They may be regarded as a long trough of younger rocks let down by parallel dislocations between the older masses to the south and north. The depression as such, however, is of great geological antiquity. Long dislocations have sharply defined its northern and southern margins. By other fractures and unequal movements of upheaval or depression portions of the older rocks have been brought up within the bounds of the younger, and areas of the younger have been enclosed by the older. On the whole, these disturbances have followed the prevalent northeasterly trend, and hence a tendency may be observed among the main ridges and valleys to run in that direction. The chains of the Ochil, Sidlaw, Pentland, Renfrew, Campsie and Fintry hills, and the valleys of the Strathmore, Firth of Tay, and the basin of Midlothian are examples. But the dominant cause in the determination of the topographical prominences and depressions of the district has been the relative hardness and softness of the rocks. Almost all the eminences in the lowlands consist of hard igneous rocks, forming not only chains of hills such as those just mentioned and others in Ayrshire and Lanarkshire, but isolated crags and hills like those on which stand the castles of Edinburgh and Stirling, and others conspicuous in Fife and the Lothians.

Of the three chief valleys in the central lowlands, two, those of the Tay and the Forth. descend from the Highlands. and one, that of the Clyde, from the southern uplands. Though on the whole transverse. these depressions furnish another notable example of that independence of geological structure already referred to. The gorge in which the famous Falls of Clyde are situated is the best example of a river gorge in the lowlands. Lochs are not many. Occasional rock tarns are found in the hills. The larger Iochs of the lowlands lie in hollows of the glacial detritus, which is strewn thickly over the lower grounds. As these hollows were caused by original irregular deposition rather than by erosion, they have no intimate relation to the present drainage-lines. The lakes vary in size from pools to sheets of water several square miles in area. As a rule they are shallow in proportion to their extent and surface. They were once more numerous than they are now, for some have disappeared through natural causes and others have been drained. The largest sheets of fresh water in the lowlands are lakes of the plains.

The fact that two-thirds of the population of Scotland live in the central lowlands on one-tenth of the total area of the country is evidence of the pre-eminent industrial position of this region. Among the geographical reasons for that pre-eminence we find, first, ease of communication, both internal and external. The Firth of Clyde on the west, the Firths of Forth and Tay on the east, deeply indent the coasts and offer access for shipping directly or near to the chief industrial centres. Secondly, the Carboniferous rocks of the lowlands carry important coal fields, of which, with the working out of the once rich Lanarkshire field, the most productive are those in Ayrshire, about the head of the Firth of Forth. in the Lothians and in Fife. Iron is allied with coal, notably in the Ayrshire and Lanarkshire fields. Oil shale is worked in Midlothian and West Lothian. but its importance has declined; lead is worked in Lanarkshire. Upon the Lanarkshire coal field, the city of Glasgow and its neighbouring industrial towns, there centre a variety of great manufacturing industries—shipbuilding and engineering, cotton, woollen and linen manufactures, brewing and distilling, chemical, pottery and glass manufactures, and many others. Elsewhere certain great industries are definitely localized. such as the jute manufacture and jam and marmalade making at Dundee; the woollen industry in Stirlingshire and Clackmannanshire. linen manufacture at and about Dunfermline, Arbroath and Montrose, that of linoleum and oilcloth at Kirkcaldy. that of paper in places neighbouring to Edinburgh, and the dyeing industry at Perth. All the textile industries, the paper mills, and the distilleries owe their establishment in part to ample supplies of pure mater. Rich agricultural lands, albeit restricted in area: lie close to the manufacturing districts, especially in the east, in Perthshire, Angus.' Fife and the Lothians; barley, a high yield of wheat on a small acreage, and potatoes are crops especially noted.

The Southern Uplands. — These extend from the north channel in the southwest to St. Abb's Head in the northeast, and form a well-defined belt of hilly ground, and though much less elevated (their highest point is 2,764 ft. above the sea) than the Highlands, rise with scarcely less abruptness above the lower tracts that bound them. Their northwestern margin for the most part springs boldly above the fields and moorlands of the central plain, and its boundary for long distances continues remarkably straight. On the south and southeast their limits in general are less prominently defined but are better seen west and southwest of the Nith, from which they extend to the sea and Loch Ryan, terminating in the extreme southwest in a plateau of which the loftiest point is little over 1,000 ft. above the sea. The Cheviots do not properly belong to the uplands, from which they are separated by Liddesdale and other hollows, and on which they abut abruptly. But though geologically the one set of mountains must be separated from the other, geographically it is convenient to include within the southern uplands the whole area between the central plain and

[1]By a resolution of the county council in May 1928, the county reverted to its older historic name of Angus in place of Forfarshire. Other instances of shire names derived from the county town giving place to the older name are the three Lothians—East, West and Midlothian—for Haddingtonshire, Linlithgowshire and Edinburghshire, and Moray for Elginshire.

the border. A survey of the uplands, therefore, presents in succession from southwest to northeast the Kirkcudbrightshire and Ayrshire mountain moors, the Lowthers, the Moffat hills, the Moorfoots and the Lammermuirs. Distinguished by the smoothness of their surface, they may be regarded as a rolling moorland, traversed by many valleys conducting the drainage to the sea. This character is well observed from the heights of Tweedsmuir. Wide, mossy moors, 2,000 ft. or more above the sea, and sometimes level as a racecourse, spread out on all sides. Their continuity, however, is interrupted by numerous valleys separating them into detached flat-topped hills, seldom marked by precipices of naked rock. Where the rock projects it more usually appears in low crags and knolls, from which long trails of gray or purple debris descend till they are lost among the grass. These smooth green hills form excellent pasture land, while the alluvial flats in the valleys, and even some of the lower slopes, are fitted for grain and green crops. Only in the higher tracts are there rugged features recalling the character of Highland scenery. In the heights of Hart Fell (2,651 ft.) and White Coomb (2,695 ft.), whence the Clyde, Tweed, Annan and Moffat Water descend, the high moorlands have been scarped into gloomy corries, with crags and talus slopes, which form a series of landscapes all the more striking from the cuntrast with everything around them. In Galloway, also, the highest portions of the uplands have acquired a ruggedness and wildness more like those of the Highlands than any other district in the south of Scotland. In that region the Silurian rocks have been invaded by large bosses of granite, and have undergone a variable amount of metamorphism which has, in some places, altered them into hard crystalline schists. These various rocky masses have yielded unequally to disintegration; the harder portions project in rocky knolls, crags and cliffs, while the softer parts have been worn down into more flowing outlines. The highest summit in the south of Scotland—Merrick (2,764 ft.)—consists of Silurian strata much altered by proximity to the granite, while the rest of the more prominent heights [all in Kirkcudbrightshire) —Rhinns of Kells (2,668 ft.), Cairnsmore of Carsphairn (2,612 ft.), and Cairnsmore of Fleet (2,331 ft.)—are forined of granite.

The watershed of the southern uplands runs from the mouth of Loch Ryan in a sinuous northeasterly direction, keeping near the northern limit of the region till it reaches the basin of the Nith, where it quits the uplands, descends into the lowlands of Ayrshire, and, after circling round the headwaters of the Nith, strikes southeastward across half the breadth of the uplands, then sweeps north and eastward between the basins of the Clyde, Tweed and Annan, and then through the moors that surround the sources of the Ettrick, Teviot and Jed, into the Cheviot hills. Here, again, the longest slope is on the east side, where the Tweed hears the whole drainage of that side into the sea. Although the rocks throughout the southern uplands have a persistent northeasterly and southwesterly strike, and though this trend is apparent in the bands of more rugged hills that mark the outcrop of hard grits and graywackes, nevertheless geological structure has been much less effective in determining the lines of ridge and valley than in the Highlands. On the southern side of the watershed, in Dumfriesshire and Galloway, the vaileys run generally transversely from northwest to southeast. But in the eastern half of the uplands the valleys do not appear to have any relation to the geological structure of the ground underneath.

In the southern uplands, owing to the greater softness and uniformity of texture of the rocks, as compared with those of the Highlands, rocli tarns are comparatively infrequent, except in Galloway, where the protrusion of granite and its associated metamorphism have reproduced Highland conditions of rock structure. The best known and one of the most picturesque of moraine-dammed lochs is the wild and lonely Loch Skene, lying in a recess of White Coomb at the head of Moffat Water. Others are sprinkled over the higher parts of the valleys in Galloway.

On the east the southern uplands plunge abruptly into the sea near St. Abb's Head in a noble range of precipices 300 to joo ft. in height, and on the west terminate in a long broken line of sea wall, which begins at the mouth of Loch Ryan, extends to the Mull of Galloway and reappears again in the southern headlands of Wigtown and Kirkcudbright. Southward they sink to the narrow lowland bordering Solway firth.

On the grassy hills of the uplands, from end to end, sheep farming is naturally an outstanding occupation, and with it is associated the woollen industry centred in the chief inland towns of the Tweed basin. In the west (Galloway, Ayrshire) dairy farming is highly developed for the supply of the neighbouring populous centres in the lowlands. Into the western dales, too, some of the industries of the lowlands extend, with some coal mining in Nithsdale, quarrying of freestone, etc., while the granite of Creetown and the neighbourhood is famous. But, as a whole, the human, like the physical, geography of the southern uplands, is clearly differentiated from that of the Highlands and the lowlands; it approaches more nearly in character to that of the northeastern region of England. (O. J. R. H.; X.)

GEOLOGY

Scotland lies on the course of a pre-Devonian: southwestwardly trending mountain chain, stretching from Scandinavia to Ireland and called Caledonian by Eduard Suess. The front of this chain is situated in the northwest Highlands. Its latest manifestation is the corrugation of Ordovician and Silurian in the southern uplands, where Charles Lapworth demonstrated the true worth of graptolites.

Pre-Devonian of the Northwest Highlands and Islands.—The oldest Scottish rocks, grouped as Lewisian complex, outcrop in Lewis and on the adjacent mainland coast. Some claim as earliest members certain metamorphic sediments, including magnesian marbles and graphitic schists. With these occur much more abundant igneous gneisses (acid, intermediate and basic). Locally, late dikes of the complex have suffered but little from metamorphism, though elsewhere transformed into hornblende schist. A great development of "flinty" crush-rock, a product of frictional fusion, follows an east-southeastwardly inclined shear zone along the east coast of the Outer Hebrides.

Torridonian succeeds Lewisian with complete unconformity. From Islay to Skye, the formation starts with Lower Torridonian basal conglomerates, epidotic grits, gray sandstones, flags and gray and black shales (7,000 ft.). Farther north, Middle Torridonian arkose (6,000–8,000 ft.), with local breccias, rests among and covers over "fossil hills" of Lewisian gneiss, which are sometimes more than 2,000 ft. in individual height. Upper Torridonian sandstones, flags and shales attain 4,500 ft.

Durness Quartzite and **Limestone.**—Durness sediments, Lower Cambrian extending into Lower Ordovician, are of American facies in lithology and fauna: basal quartzite, 320 ft.; quartzite with vertical worm "pipes," 270 it.; dolomitic shales, mudstones and dolomites, with *Olenellus*, etc., 50 ft.; grit, with *Salterella* and also *Olenellus*, 30 ft.; limestones and dolomites, some fossilerous, 1,500 it. Plutonic (possibly early Devonian) intrusions of alkalisyenite, borolanite, etc., accompanied by sills, cut these sediments. Contact effects include dedolomitization.

The sediments and intrusions pass east-southeastward in disturbed fashion under the Moine thrust of the Caledonian chain! which is overlain by crystalline schists and traceable from Durness to Skye. Near Durness, a thrust-outlier (Klippe) of the Moine Thrust-mass (nappe) is down-faulted 10 mi. in advance of the main outcrop. In Assynt and Glencoul, subsidiary thrusts carry 1,joo ft. slices of Lewisian for miles over Cambrian. Spectacular inversion occurs at Loch Alsh. Isoclinal packing, *Schuppenstruktur*, mylonitization, etc., are diagrammatically exposed at many localities.

Pre-Devonian of the Highlands Southeast of Moine Thrust.— Sedimentary quartzo-feldspathic and micaceous schists are prevalent northwest of the Caledonian canal, and are grouped together as Moine schists. Several minor outcrops of Lewisian igneous and sedimentary types are by some authors interpreted as Lewisian inliers interiolded with unconformable Moines. The Inchhae porphyritic granite, now gneissose, was intruded into the Moines before these had suffered regional metamorphism; and adjacent indurated hornfeis retains minutiae of sedimentary structure, such as grains, ripple marks and sun cracks. Garnets are widely developed in the Moine schists, and some distance east of the Moine thrust granitic injection is common with associated sillimanite. At Tarskavaig in Skye there is a thrust mass under the Moine thrust. the rocks of which are variously interpreted as Moines or Torridonian. Some think all Moines are metamorphosed Torridonian; others regard Moine metamorphism as pre-Torridonian.

Moines cross the Caledonian canal: or Great Glen fault: but half of the Highlands to the southeast consists of undated Dalradian schists. The fault, according to good but inconclusive evidence, is a tear fault with horizontal displacement of 65 mi. In the Dalradian, quartzites. limestones and graphitic schists are characteristic members; the Schichallion boulder-bed may be glacial; pillow lavas occur at Loch Awe; basic intrusions are widespread. Current or graded bedding, both in Dalradian and Moine sediments, often settles age relations. The Dalradians overlie Moines, pitching off them toward Loch Awe and Banffshire. Large-scale recumbent folds with fold faults (slides), the whole refolded, are typically shown at Ballachulish and elsewhere.

Zonal mapping of regional metamorphism was first carried out in the Dalradian belt. The grade, varying from roofing slate to sillimanite-gneiss, is low at Loch Awe. in Banffshire and along the southeastern Highland border. In the sillimanite zone granitic permeation is characteristic.

Middle Cambrian limestone (near Callander) and Upper Cambrian to Ordovician pillow lavas, radiolarian cherts and serpentine with fossiliferous shales outcrop discontinuously along the Highland Border fault. At Stonehaven they are unconformably overlain by Downtonian sandstones with mudstones, tuffs and conglomerates (2,760 ft.), that yield fish and *Dictyocaris*.

Silurian of **Lesmahagow** and **Pentland** Anticlines in the Midland **Valley.**—Lesmahagow exposures of Silurian show: (?) Wenlock graywacke and shale. 1,300 ft.; Ludlow mudstone, graywacke and shale. 1.480 ft.; Downtonian yellow. red and chocolate sandstone with a quartzite conglomerate and some mudstone. 2,700 ft. The Wenlock-Ludlow rocks have yielded many brachiopods and molluscs, especially in the Pentlands; also scorpion, phyllocarids, eurypterids and fish. The three last appear again in the Downtonian.

Ordovician and Silurian of the Southern Uplands.—Closely packed isoclinal folding and rapid cross-strike change of facies and thickness are characteristic. The Ordovician commences with Arenig pillow lavas, continuing into the Llandeilo and capped by Llandeilo radiolarian cherts (70 ft.)—the term Llandeilo is used in Lapworth's sense. Near Girvan 1.500 ft. of Arenig volcanic rocks are associated with serpentine, gabbro and granite. the whole exposed to erosion before deposition of conglomeratic Cpper Llandeilo (830 ft., including 60 ft. interbedded fossiliferous Stinchar limestone). Southeast of Stinchar valley. Cpper Llandeilo becomes conformable to the volcanic series. and consists of mudstones and grits (joo ft.) and conglomerate (500 ft.). Farther southeast it passes to grit and graywacke (1,000 ft.) and then near Moffat to 20 ft. of graptolite shale (Glenkiln). The Caradoc (including Ashgillian) at Girvan is mostly mudstones, grits. flags and shales (2,800 ft.) with interbedded shelly and graptolitic faunas. Near Moffat this reduces to 100 ft. of graptolite shale and barren mudstone (Hart Fell). Acid lavas occur at Wrae in Tweeddale.

A general palaeontological break introduces the Silurian. although without upheaval at Moffat. The Llandovery at Girvan consists of conglomerates, grits. flags, shales and thin limestones (1,050 ft.) with interbedded shelly and graptolitic faunas. Near Moffat there are only 100 ft. of graptolite shale (Birkhill). The Tarannon, hoxvever, both at Girvan (2,100 ft.) and Moffat (3,000–4,000 ft.). consists of grits, flags and shales with occasional graptolitic intercalations. Wenlock is doubtfully represented near Girvan by conglomerates, grits. flags and shales (joo ft.), with minor graptolitic and shelly layers. Near the English Borders Wenlock conglomerates, grits, graywackes, shales and mudstones (1,000 to 1.500 it.) contain several graptolitic bands with occasional eurypterids, Shelly layers also occur. In the same district Ludlow mudstones with limestone-nodules and grits (500–7jo ft.) yield shells.

Ordovician and Silurian conglomerates usually contain material derived from the Arenig lavas. Quartzite appears as pebbles in the Caradoc, and micaschist in the Llandovery. Undated post-Silurian mineral veins occur at Leadhills.

Devonian.— The Scottish Devonian is wholly continental Old Red sandstone, and except at Stonehaven and Lesmahagow follows older formations with striking unconformity. Three divisions are recognized with distinct faunas and floras. Fish have furnished the majority of determinable fossils. The Lower Old Red Sandstone is most fully preserved in the midland valley (19.000 ft., including lavas. Kincardineshire). Dull purplish brown sandstone is widespread, covered in Strathmore by red sandstones and marls. Conglomerates attain great prominence towards the Highlands and southern uplands. Volcanic rocks (basalts. andesites, rhyolites) occupy a roughly central position in the 10x1-land sequence (6,500 ft. in Ochils. well exposed also Pentlands to Ayrshire). In the Highlands (Oban, Glencoe. Ben Nevis) and also at Cheviot, lavas greatly exceed sediment. Glencoe and Ben Nevis are famous for cauldron subsidences. At both localities granites (or granodiorites) with northeastern dike swarms are later than the lavas. Granites cutting Lower Old Red Sandstone also occur at Distinkhorn (Ayrshire) and Cheviot. Others penetrate folded Silurian (southern uplands). Many undated Highland granites are probably of Lower Old Red age; but granite pebbles are well known in Lower Old Red Sandstone conglomerates (Glencoe, Stonehaven).

Middle Old Red Sandstone is widely developed in northeast Scotland (18,000 ft. in Caithness), extending to Orkney and the Moray firth. It largely consists of flags, often bituminous, calcareous, ripple marked and sun cracked. The Rhynie chert with wonderfully preserved plants is generally referred to this formation.

Upper Old Red Sandstone (some thousands of feet thick) is found in the midland valley and northeast Scotland, everywhere, except perhaps in Shetland. unconformable to its predecessors. Red sandstones with some wind-rounded grains are common in its earlier parts; while paler sandstones with cornstones occur toward the conformable base of the Carboniferous.

Carboniferous.— The Scottish Carhoniferous. a marine, estuarine and terrestrial accumulation; is typically developed in the midland valley and along the English border. The two areas of deposition were always connected across the east end of the southern uplands. Farther west (Sanquhar) Upper Carboniferous rests on Silurian. In the Highlands. Carboniferous is scarcely known (Campbeltown. Bridge of Awe. Morven). In the midland valley and on the borders it follows Upper Old Red Sandstone conformably. but with a palaeontological break. Subdivisions in Edinburgh district are: Calciferous Sandstone series, including Cementstone group (1,000 ft.) and Oil Shale group (3,000 ft.); Scottish Carboniferous Limestone series. including Lon-er Limestone group (700 ft.), Limestone (or Edge! Coal group (1,050 ft.). and Upper Limestone group (1,0jo ft.); Millstone Grit (800 ft.); Productive Coal Measures (1,500 ft.); Barren Red Coal Measures (in Ayrshire. 1.joo ft.). Palaeontologically, the sequence is important for abundant Lower Carhoniferous land plants and estuarine fishes. These are completely replaced by Upper Carboniferous forms one-third way up the Millstone Grit. Spreading deltas may have accelerated migration.

Economically. the oil shale and the two coal-bearing groups (with ironstones) are valuable. Marine limestones are scarcely represented except in the Lower and Upper Limestone groups (near Edinburgh, eight beds reach the quite exceptional total of 230 ft.). A well-known 40-ft. fresh-water limestone (Burdiehouse) occurs in the Oil Shale group.

Rapid variations of group thicknesses are characteristic, as on the two sides of the Kerse Loch fault near Patna in Xyrs'nire. Change of facies is exemplified by restriction of workable oil shale to West Lothian and its borders. Vulcanicity is common till the close of the Rlillstone Grit. Special activity reigned abour the end of the Cementstone group (Clyde plateau, Arthur's Seat, Garleton hills). Products include essexitic basalts, mugearites, trachytes and phonolites. Contemporaneous weathering of Millstone Grit basalts has given valuable bauxitic clay (Ayrshire).

New Red Sandstone.— The Scottish New Red deposits are of continental facies. From Trias on the Solway a train of Permian outcrops reaches intermittently across the southern uplands and midland valley to Arran. In Ayrshire the Permian succession consists of lavas and tuffs (basalt and nepheline-basalt. 500 ft.) overlain by brick-red desert sandstone (1.500 ft.). The volcanic period was one of faulting, and was further marked by ash-necks (also prominent in East Fife) and doleritic intrusions—some (essexitic) carry nepheline. others quartz. It also corresponds roughly with the "Permo-Carboniferous" intrusion period responsible for many quartz-dolerite sills and east to west dikes between Stirling and Northumberland. In Xrran. 2.000 ft. of Permian. mostly brick-red desert sandstone and breccia. underlies 1.000 ft. of Trias, interbedded sandstone and marl with occasional nodular limestone. A mass fallen into a Tertiary volcanic neck includes *Pteria contorta* shales (Rhaetic).

The base of the Mesozoics from Mull northward consists of Trias conglomerates and sandstones with concretionary cornstones. Red colouration is often subordinate. In western Mull 200 ft. of these rocks underlie 40 ft. Rhaetic with *Pteria contorta*. Elsewhere Rhaetic is only doubtfully distinguishable.

In Elgin two outliers of New Red Sandstone have yielded remarkable reptilian faunas. One of these outliers is of marked desert character and is perhaps Permian; the other is certainly Trias.

Jurassic.—Low-lying outcrops of Jurassic, conformable to Trias. are preserved on the west and east coasts of the Highlands. On the west, where a cover of Tertiary lavas has furnished additional protection, the type area. richly fossiliferous. is Skye and Raasay: Lower Lias (Broadford Beds, with prominent *Gryphaea* limestones. 340 ft.; Pabba Shales. 700 it.); Middle Lias (Scalpa Sandstone, 240 ft.); Upper Lias (shales. 80 it.: thinner with 8 ft. ironstone in Raasay): Inferior Oolite (mainly sandstone. 780 ft.): Bathonian Great Estuarine series (hituminous shales with thin shelly limestones. 600 ft.); Cornbrash (limestone with comminuted shells, only in Raasay. 20 ft.); Callovian. restricted (sandstone remnant in Skye); Oxfordian (shales. 120 ft. in Skye); Corallian (calcareous grits and shales, 140 ft. in Skye); Kimmeridgian (shales, 40 ft. in Skye).

At Brora on the east coast are found: Lower Lias (shales with thin coals. 80 ft.); faulted against Great Estuarine series (over 80 ft. shale, sandstone etc.. with 3 it. Brora coal at top'): Callovian. restricted (marine limestone, j ft.); Lower Oxfordian (shales. 275 ft.): Upper Oxfordian (gritty sandstone. 170 ft.); Corallian (limestones. 20 ft.; sandstone and shales 200 ft.): Kimmeridgian (shales and boulder-beds. 1,500 ft.). The boulders of the boulder-beds consist of Old Red Sandstone. Many are big: one measures 150 × 90 × 30 ft. They have fallen from a moving submarine fault scarp and are mixed with corals and shells. The throw of the fault exceeds 2.000 ft. In Skye another 2.000 ft. post-Corallian fault can be shown to have been planed down by erosion before Upper Cretaceous times. Also. in Mull and on the Moray firth the Great Glen fault seems to have stirred in Kimmeridgian times.

Cretaceous.— Transgressive Upper Cretaceous is known *in situ* (Skye. Scalpa. Raasay. Eigg. ?\lull. Morven). as a block in a Tertiary vent (Arran), and as remanié flints (Xberdeenshire). The Morven succession is: Cenomanian Greensand (45 ft.); White Sandstone (35 ft.); Silicified Chalk with *Belemnitella mucronata* (5 it.). The White Sandstone consists of desert sand blown on to the Scottish shore of the Franco-Britto-Russian Chalk sea. Desert conditions presumably reduced river polution to a minimum. In Morven. Cretaceous is still preserved 1.600 ft. above sea level.

Tertiary.— The Cretaceous Chalk was upraised. weathered and silicified and its crannies filled with desert sand (Mull). Subsequent conglomerate, lateritically weathered ash and leaf beds among lavas bespeak a change to moist climate and volcanic eruptions. Botanical research suggests dates ranging from Oligocene to Miocene. Subaerial basalt lavas characterize Skye. Eigg, Mull and Morven. Exceptionally these lavas are columnar (Staffa). The basalt succession in Mull is: olivine-rich flows, 3.000 ft.; olivine-poor, 3.000 ft. The Sgur of Eigg pitchstone seems to he an acid lava that filled a valley, the sides of which, consisting of basalt, have since been eroded away. Great plutonic centres occur at St. Kilda, Skye. Rum, Mull, Ardnamurchan and Arran. Some think that most of the lavas. still preserved, were fed from these centres. A Kilauean sink. repeatedly renewed in central Mull. mas often occupied by a crater lake: and lavas flowing into it developed pillow structure. T'ent-agglomerates are abundant in Skye. Mull. Ardnamurchan and Xrran.

The Skye plutonic centre is well known for its gabbro to granophyre succession: Rum for its peridotites; Mull and Ardnamurchan for their ring-dikes—in Mull the plutonic succession is very complex and begins with granophyre. in Ardnamurchnn it is essentially gabbroidal; Arran is specially noteworthy for the doming of its granite's roof. Peripheral upheaval is also conspicuous in Rum. and peripheral folding in Mull and Skye. Cone-sheet complexes are extensively developed in Skye, Mull and Ardnamurchan. The Skye, Rum. Mull and Arran centres have crowded dike-swarms. The general dike direction is northn-est. Some believe that most of the Hebridean lavas were fed from dikes (fissure eruptions). It is certain, however. that the great centres were established before the dike-swarms. since they locate the latter. It is also certain that most of the dikes are later than any lavas spared by erosion.

West Highland scenery has been shaped entirely since the Tertiary eruptions. The magnificent mountain and valley forms of Skye are cut in Tertiary plutonics.

Possible Pliocene gravel occurs near Turriff, Fyvie and in central Ruchan. all in Aberdeenshire.

Pleistocene and Recent.— During the Glacial period. Scotland functioned as a complex centre of dispersal within the great North European ice sheet. Scandinavian currents were almost excluded except in Shetland, while Scottish currents freely invaded England. Some districts were crossed by ice that traversed the sea bed bringing in shells and. in Caithness, Mesozoic erratics. Glacial erosion is often pronounced. Crag and tail is developed to perfection in Edinburgh and elsewhere. Rock basins are numerous in the Highlands, with Loch Coruisk as a diagrammatic example. Characteristic deposits are: West Highlands, hummocky moraines: East Highlands. fluvio-glacial gravel: Lowlands, boulder clay, either flat or in drumlins, and gravel kames. In Glen Koy glacially dammed lakes are recorded by conspicuous strand-lines; and throughout most of eastern Scotland glacially diverted rivers can he traced by channels now left dry.

Raised beaches up to about 100 ft. occur round Scotland. but not in the Outer Hebrides. Orkneys and Shetlands. The higher beaches are late Glacial and are locally interfered with by glacial readvance (Loch Lomond and Mull). The best-marked beach, often about 30 ft.. has a temperate fauna. It rests in places on a peat or forest bed that continues below sea level. Traces of early man are found in this raised beach. (E. B. B.)

FLORA AND FAUNA

Flora.— The flora of Scotland is much affected by the varied climate to be found in so small a country, by the varied geology and physiography and by the activities of man. The Atlantic climate of the west coast and islands is warm and wet and the rocks are mainly poor and acidic. X general covering of peat with comparatively little glacial drift beneath it grows a sour herbage of sedges (*Carex* and *Eriophorum*) with some heather (*Erica* and *Calluna*) and such northern shrubs as bearberry (*Arctostaphylos*), crowberry (*Empetrum*) and blueberry (*Vaccinium*). An exception is a narrow strip along the west coast of the Hebrides and some of the mainland. where shell sand of high basic content has been washed up by the ocean and blown inland; behind the marram-covered dunes is a flatter expanse of sandy soil with a stable grassland of *Agrostis-Festuca-Trifolium* type, with many calcicolous flowers. Tree growth is sparse or nonexistent on the western coasts where winds are excessive in frequency and strength, but where there is shelter birch woods grow readily, with rowan and willow interspersed. Vestigeal oak and pine may also be found along the fjordlike sea lochs of the mainland. The tree line is low in Scotland, rising from 500 ft. near the west coast to around 2 000 ft. in central Scotland. The west Highlands and islands show vestiges of a Lusitanian flora, for example, pale buttermort (*Pinguicula lusitanica*), dwarf cicendia (C. *pusilla*), and the moss *Myurium hebridorum*.

Glacial drift is commoner across the Grampian hills, toward the east, and in the southern uplands, so heather is much commoner on the still acidic moors, and may attain to an almost unbroken stand. These heather moors are an example of arrested succession, for if left to themselves they nould gradually become woodland of birch and Scots pine, with oak in the better situations. Mankind has left very little pristine oak and pine forest in Scotland, and such stretches as remain are the subjects of earnest efforts towards conservation. The moors are grazed by sheep and are burnt periodically. This form of husbandry keeps the heather young and prevents regeneration of forest, but a consequence in the west is the serious spread of the bracken fern *(Pteris)*. Sheep and burning on heather moors favour the density of red grouse (*Lagopus scoticus*), a valued object of sport. The upper 1,000 ft. of the hills of the Highlands, rising to over 4 000 ft., may be said to carry a more or less pristine flora of boreal mountain grassland with many saxifrages and such miniature shrubs as *Loiseluria* and dwarf willow. Areas of serpulite grit, including Ben Lawers (3,984 ft.) have a rich alpine flora. Some of the eastern hills of the southern uplands carry a grassy flora which under sheep and burning is moving towards a predominance of moor mat (*Nardus*).

In both the Highlands and the southern uplands a good deal of land is now being afforested, mostly nith exotic conifers. Scotland, early isolated from Europe, has but three species. Scots pine. juniper and uncommonly the yew. Larch was introduced about 1725 and since then Norway spruce and many west coast species from North America.

The eastern side of Scotland is highly farmed, much land being on the Old Red Sandstone; natural grassland and untouched places are few. the sea cliffs and some estuarine situations being the only sites which may be said to carry a natural flora. The central plain is in the same case, but there are a few bogs here which hold distinctive plants such as the ericaceous shrubs, *Andromeda polyfolia* and *Ledum groenlandicum*. It is still not unusual to find plants new to Scotland which are common in the subarctic.

Fauna. — The fauna of Scotland is an enviable one for so small a country. The largest wild mammal is the Atlantic gray seal *(Halichoerus)*, which is more numerous off Scottish coasts than anywhere else. The island of North Rona, less than half a square mile in extent, lying nearly 50 mi. N.W. of Cape Wrath, has a stock of some thousands at the autumn breeding season. The common seal (*Phocus*) is fairly generally distributed and locally numerous. The red deer is truly wild in Scotland, one-eighth of the whole country being scheduled as deer forest, and the species ranges over another 1,000,000 ac. of sheep ground. The total number may be between 75,000–100,000. Roe deer are found wherever there are woods or scrub. Feral goats (goats that have gone wild) occur in many deer forests and on a few small islands. Foxes and badgers are common in Scotland. Both species prey extensively on the rabbit, an introduced animal. and. as far as the northern Highlands are concerned, introduced as late as 1845. The wildcat has increased and widened its range in the first half of the 20th century. Otters are common on the river systems. and on small islands they may live wholly on sea fish. The polecat is extremely rare and for some time was considered extinct. Pine martens are probably more numerous than at the turn of the century and may be expected to increase with reafforestation. Nevertheless. there are more pine martens in treeless northnest Sutherland than elsewhere in Scotland. The mountain hare is distinctly cyclic in population and is a pest on hill sheep ground in peak years. The brown hare occurs where there is true soil and agricultural husbandry. not on the hills and peat moors.

The early isolation of various island groups has led to the evolution of distinct types of some animals, notably the voles Differentiation has gone far enough for sub-specific rank to be accorded. Thus, there are the Orkney, Raasay and Mull subspecies of field or bank voles. The same phenomenon is evident in some birds. There are St. Kilda, Hebridean and Shetland wrens and Hebridean starlings and thrushes. The Island of Soay in the St. Kilda group holds a pure stock of a primitive, brown, short-tailed sheep of Moufflon type. The original animals are thought to have been placed there by Norsemen 1,000 or more years ago.

Scotland lost the brown bear in the 9th century, the elk and the reindeer in the 12th. and the beaver in the 16th. These animals could not subsist adequately in Scotland now for the vegetation has so greatly changed. The last wolf was killed in Inverness-shire in 1743.

The bird life of Scotland is rich. though many species found farther south do not occur. Its chief glories are the numerous seabird cliffs thickly populated by auks, fulmars and gannets; the existence of more than 100 pairs of golden eagles; the breeding colonies of the night-flying Leach's fork-tailed petrel on four small. remote islets; and the sight and sounds of green-shanks and black-throated divers in the deer-forest country. Graylag geese still breed in the Hebrides. and certain places are focal points in the wintering of other northern geese.

Most Scottish rivers are run by salmon and sea trout, and many lochs hold distinct races of char. Pike are in many river systems by accident or design, but the muddy-water fish common to English rivers are for the most part absent from Scotland.

Biological exploration of the invertebrate life of Scotland is far from complete and the life histories of many insects already known have not been determined. Summer visitors to the west Highlands appear intensely aware of a tiny dipterous fly known as the midge (*Culicoides*). (F. F. DG.)

HISTORY

The kingdom of Scotland is best dated from the early years of the 11th century when four tribal kingdoms — Scots, Picts, British and Angles, two of which, Scots and Picts, had been united in 843, were amalgamated. The Scots were an Irish tribe who settled, about the beginning of the 6th century. in the district of Dalriada known later as Argyll. The Angles, in the second half of the same century, colonized what became the Lothians'and the counties of Berwick, Selkirk, Peebles and Roxburgh. The British, who occupied the country between the Solway firth and the Firth of Clyde, were akin to the Welsh. The identification of the Picts and Caledonians whom the Romans found in the country in the first centuries of the Christian era has been for generations a subject of controversy. For Scotland in Roman days *see* CALEDONIA, also BRITAIN.

Christian Scotland. — Scottish history has been said to begin with the mission of St. Columba in 563. Columba was an Irishman of noble birth who became a monk and a priest and settled in Iona to undertake the conversion of the portions of North Britain which were still heathen. Iona belonged to the small kingdom of Dalriada, which had. comparatively recently, been founded by the race to which Columba belonged, and its ruler was his kinsman. The Scots had come from Ireland, a Christian land, and had brought their religion with them. and Christianity had persisted from Roman times. or had been revived, in Strathclyde. In the beginning of the 5th century. St. Ninian had preached in Strathclyde and Galloway and had sent his disciples to convert Pictland, and it is very possible that many of the religious foundations in the northeast of Scotland. generally ascribed to St. Columba, really date from an older missionary effort.[1] Some years before St. Columba landed in Iona, a great Christian teacher, known as St. Rentigern or St. Mungo, mas labouring in Strathclyde, and to his mission is traced the foundation of the future city of Glasgow. St. Columba. therefore, cannot be said to have converted Scotland, but he laboured as a missionary in Pictland and he made Iona the centre of Scottish Christianity. In the century succeeding his death in 597 one of the most important contributions made by Scotland to the history of Great Britain was the direct result of his work — the reconversion of the north of England to Christianity. A pagan reaction in the second quarter of the 7th century

[1] W. D. Simpson, *The Historical St. Columba* (1927).

had dethroned the Christian king, Edwin of Northumbria, who ruled from the Humber to the Forth. When his nephew Oswald, who in exile had been educated at Iona, obtained the kingdom of Northumbria by his victory at Hexham in 633 he brought Scottish missionaries to rebuild the shattered fabric of Christianity. The influence of Scotland upon English Christianity was, however, short-lived. There were some differences of method, organization and ritual between the Irish church and the Roman church. Oswald's successor. Oswy, declared in favour of Roman custom, and the Scottish missionaries abandoned Northumbria after the Synod of Whitby (663 or 664).

Picts, Scots and Norse.—The kingdom of Northumbria had by this date reached the height of its greatness and its rulers were ambitious of conquering the north of the island. In 68j a great Northumbrian army invaded Pictland but was defeated at the battle of Nechtansmere. fought near Dunnichen in Forfarshire. This defeat brought the end of Northumbrian supremacy in England; the centre of English power shifted southward and the menace of an English conquest was removed. North Britain was to be left, for some centuries. to work out its own destiny. The Picts became supreme in the north and gained control over both the Scots of Dalriada and the British of Strathclyde. Then the Picts mere weakened by the attacks of the Norsemen, who first attacked the coasts in the end of the 8th century and about 83j began to make permanent settlements. Dalriada threw off Pictish control and in 843. when the Norsemen were attacking Pictland, Kenneth MacAlpin, king of the Scots, established a claim by the Celtic law of tanistry to the Pictish throne.

The union of Picts and Scots was folloned by an attempt to snatch the Lothians from Northumbria, then devastated by the Danish invasions; but the effort was unsuccessful, and Kenneth's successors were themselves engaged in struggles with the Norsemen, who occupied the Hebrides and the Orkney and Shetland Islands and made settlements along the western and northern coasts and on the east coast as far south as the Moray firth. They also attacked the kingdom of Strathclyde and founded colonies between the Esk and Dee rivers. The islands became definitely Scandinavian. as also did a large part of Caithness. During the long conflict with the Norsemen, the Scots sometimes allied themselves with the English against the common enemy from the time that Constantine III took Edward the elder to "father and lord" *c.* 920. and these alliances constituted, long afterward. a ground of the English claim to the overlordship of Scotland; but there were other occasions upon which the Scots joined the Norsemen against the English.

The most important alliance between the Scots and the Norse was made in 937 when the Scottish king. Constantine III was among those defeated by Athelstan of England at Brunanburh (perhaps Burnswark on the Solway). Constantine's object was the realization of a persistent ambition which is, perhaps, the most remarkable feature of Scottish history in the two centuries following the union of the Picts and Scots—the severance of the Lothians from the kingdom of Northumbria. These attempts continued throughout the 10th century, the decisive event being perhaps the grant of Lothian by Edgar to Kenneth II, but not till Malcolm II completely defeated the Northumbrians at the battle of Carham, near Coldstream (c. 1016 or 1018?), was the area between Forth and Tweed secured for the Scottish kingdom. Malcolm was followed in 1034 by his grandson, Duncan, who had already succeeded by inheritance to the throne of Strathclyde, and thus Scots, Picts, Angles and British were all included within the kingdom which came to be known as Scotland. The Norsemen still held the islands; the Hebrides were not recovered till after the middle of the 13th century, and the Orkneys and Shetlands not till the middle of the 15th century, when they passed from Denmark to Scotland through the marriage of the Danish princess Margaret to James III.

ANGLICIZATION AND FEUDALIZATION

Macbeth and Malcolm 111.—Duncan, the Duncan of Shakespeare's Macbeth, the first ruler of the historical kingdom of Scotland. did not experience the "plenteous joys" which brought tears into his eyes in the play. He met with defeats both from the Northumbrians and from the Norsemen, and in 1040 he was slain in a civil war by his own general, Macbeth, who had a claim to the succession, both in his own right, and as the representative of his wife and stepson. Macbeth, whose accession also represented a reaction of the north against a dynasty now associated with the south, was almost certainly in alliance with the Norwegian earl of Caithness and Sutherland, a cousin of Duncan, named Thorfinn. While Thorfinn lived, attempts to dethrone Macbeth, who proved himself an efficient ruler, were unsuccessful, at all events in Pictland, though Strathclyde and the Lothians may have acknowledged Malcolm Canmore the son of Duncan. After Thorfinn's death Malcolm defeated and slew Macbeth at Lumphanan in Aberdeenshire (1057). The kingdom of which Malcolm III took possession was a Celtic kingdom. though one of its provinces was peopled by Angles. Local and tribal custom prevailed alike in Scotland proper (the district north of the Forth and Clyde) and in Galloway; the speech was Celtic; the court and the administrative system, so far as the latter can be said to have existed, were Celtic. The church still retained, to a large extent, the structure and customs of Irish Christianity, although in the beginning of the 8th century a powerful Pictish monarch had ordered his people to keep the Roman date for Easter (one of the points disputed at the Synod of Whitby) and this rule had afterward been followed in Dalriada and probably in Strathclyde. The Celtic church did not repudiate papal authority, but there was no opportunity for the exercise of papal jurisdiction. Diocesan organization did not exist. There was only one bishop of the Scots; his see was St. Andrews and he could enjoy little influence outside-his own neighbourhood. Such organization as the Columban church had originally possessed was based upon powers claimed by the abbots of the monasteries, but the abuse of appointing lay abbots had destroyed the early monasticism, and a later order of monks, the Culdees, which had developed in the 9th century, had no administrative authority.

Queen Margaret.—The disorganized state of the Scottish church, and some peculiar customs which marked its ritual, shocked the conscience of Malcolm's wife, an English princess, Margaret, who, after the Norman Conquest, sought refuge in Scotland along with her brother, Edgar the Atheling. After their marriage in 1070 English influence increased in Scotland, and southern places such as Edinburgh and Dunfermline became the chief residences of the court. For the rest of his reign Malcolm was involved in frequent fighting against William the Conqueror and his sons. Margaret was a woman of saintly life—she was canonized a century and a half after her death—and her own desire was to be a nun. She would have been the glory of a cloister, but she accepted her mission to redeem an ignorant and almost schismatic nation. She was not destined to fulfil that mission herself, but its accomplishment was, nonetheless, her work. There were many difficulties in her way. She could not introduce a diocesan system until there was a vacancy in the one Scottish bishopric and none occurred in her lifetime. She could not reform the monastic system and bring it into line with European monasticism because Malcolm, though amenable in many ways to his wife's influence, refused to surrender the gains which he and other laymen, the great men of the land, enjoyed from the secularization of monastic revenues. She did succeed in changing some Scottish customs. She brought English clergy to convince the Scots of the error of their ways (Malcolm, who had been in exile in England, acting as interpreter); she restored the monastery of Iona which had been destroyed by the Northmen; and she encouraged the Culdees as the nearest approach to the religious life which she admired. Her most important personal achievements were the introduction of an English-speaking court and of English-speaking clergy, and the education of her children in English ways and traditions. She bore six sons to Malcolm, but he was not allowed to give any one of them his own name, or the name of any of his predecessors; four of them were named after Saxon kings of England.

Anglicization of Church and Administration.—Margaret's three sons, who successively came to the throne, had all had some personal experience of English life. Malcolm III and his son Edward were killed in 1093 in one of the raids on the north of England from which his pious wife vainly tried to restrain him. After his death there was a Celtic reaction against the anglicizing influences introduced by Margaret (who was herself dying when her son Edgar brought her the news of the deaths of his father and brother). The English who had followed the queen to Scotland were driven out. and Edgar and his brothers. Alexander and David. took refuge in England. It was with English help that Edgar regained his throne in 1097; he died ten years later and was succeeded by Alexander. and he in turn by David (1124–53). The three brothers were all their mother's sons, and they continued her work. All three were pious and all three were English in tastes and sympathies. and were bent upon converting Celtic Scotland into a feudal kingdom of the Anglo-Norman type. Piety and policy both pointed in one direction: the church was to be one of the most powerful instruments of anglicization. Edgar abandoned Malcolm's palace at Dunfermline and held an English court at Edinburgh. Alexander suppressed a Celtic rebellion in Moray and Mearns so efficiently that he earned the description "the Fierce." and he followed up his victory by founding a house of Augustine canons at Scone (the coronation place of the Pictish kings and their Scottish successors) and filling it with English monks. The anglicization of the country, outside the western and northern Highlands, was to a considerable extent the result of ecclesiastical influences. Alexander I and David I planted English monasteries in many districts of Scotland, south of the Moray firth. and endowed them so liberally that David acquired a popular reputation for sanctity.

The plantation of monasteries was accompanied by a diocesan organization of the church. This was essential for efficient ecclesiastical administration and for the exercise of papal supremacy, but it was also useful as a means of furthering royal policy. The new bishops were English. their sees were richly endowed with lands, and their religious authority was enhanced by their position as territorial magnates. Diocesan organization was delayed by claims asserted by the sees of Canterbury and York to possess superiority over the church in Scotland. Two Englishmen in succession. Turgot. the chaplain and biographer of Queen Margaret, and Eadmer, the ecclesiastical historian. were elected to the see of St. Andrews. but Turgot acknowledged the superiority of York and Eadmer that of Canterbury, and neither was allowed to reside in Scotland. Alexander I would not tolerate pretensions which, apart from introducing complications into the relations between church and state. were likely to compromise the independence of the Scottish crown. Ultimately, on Eadmer's death in 1124, Robert. the English prior of the new monastery at Scone, was consecrated to the see of St. Andrews by the archbishop of York, without prejudice either to the claims of York or to the freedom of the church in Scotland. Under David I the process of organization went on rapidly. and all the mediaeval Scottish dioceses except Argyll had been founded by the end of his reign.

David I was more familiar with English ways than any of his brothers. His sister was married to Henry I and he spent some years of his youth at the English court, made friends with Anglo-Norman barons and married the widow of one of them. He changed his system of land tenure in Scotland by making to his English friends grants of land. on the model of the charters granted by the Anglo-Norman kings of England. The first of the Scottish Bruces, for example, received by charter a grant of over 200.000 ac. in Xnnandale. and the progenitor of the house of Stewart crime to Scotland as the king's steward and the recipient of charters conveying great tracts of land in Ayrshire and Renfrewshire. There was no dispossession of the existing landowners: they were to hold their rights, in future, from the new lord instead of directly from the crown. Such charters were granted not only to newcomers. but also to great landlords who had hitherto held their lands by tribal custom and were glad to receive written guarantees of their possessions and privileges. Gradually the whole of the land. outside the Highlands. came to be held under feudal law, and the landowners, whether Anglo-Normans or representatives of the old Scottish families (who intermarried with David's new nobility), were. like the monks and the bishops, inevitably instruments of the royal policy of anglicization. The civil! as well as the ecclesiastical, organization was gradually remodelled in accordance with English (and European) institutions, and under David and his successors great officers of the household (whose functions were analogous to the duties of later administrative departments) came into existence. The English office of sheriff was borrowed for purposes of local government, and the old tribal laws of the component parts of the kingdom were replaced by adaptations of English legislative measures. To the influences of an English court, an English church. and an English system of law and land-tenure were added the effects of English trade. Commerce was mostly with England and from England was adopted the institution of the burgh. The early Scottish burgh charters were all founded on English models and colonies of English (and Flemish) merchants settled in Scottish towns. These processes. initiated under the sons of Queen Margaret, had a continuous development until the outbreak of the War of Independence. A series of Celtic revolts against the anglicizing policy of the crown occurred in the course of the 12th century and in the beginning of the 13th. but they were all suppressed (sometimes with English help) and before the death of Alexander III in 1286 the organization of Lowland Scotland. from the Moray firth to Tweed and Solway, was definitely English, and the English tongue was spoken in a large portion of the area.

Relations with **England.**—While this process of anglicization was in progress, political relations with England were not, for many years. entirely friendly. The border line between the two countries had not been definitely ascertained. As the rulers of Strathclyde, the Scottish kings had some claim to Cumberland and Westmorland, and they cherished an ambition of annexing portions of the old Northumbrian kingdom beyond the Tweed. The raids of Malcolm III (Canmore) had led William I to found Newcastle-upon-Tyne in 1080 and William II to fortify Carlisle in 1092, and the boundary line might be regarded as stretching from the Tyne to the Solway, although the English did not admit Scottish claims between Tweed and Tyne. Matilda, the wife of David I, as daughter of Waltheof. brought him the earldom of Huntingdon and 'some claim to that of Northumbria. Henry I recognized his brother-in-law's claim to the former, but refused to acknowledge that Northumbria had passed to Matilda from her grandfather. Earl Siward. When the English throne was disputed between Stephen and the empress Matilda, David invaded England in support of the empress. who was his niece. His real purpose was to take possession of Northumberland and he succeeded in effecting it in spite of his defeat at the battle of the Standard, fought near Northallerton in Xug. 1138. Stephen, whose wife was also a niece of David. granted Northumberland as an English fief to Prince Henry, the heir to the Scottish throne. The gift did not secure David's loyalty, for when the future Henry II made his first, and unsuccessful. attempt to gain the English throne in 1149. David aided him and was promised the whole area north of the Tyne. This promise was repudiated by Henry II on his accession in 1154. David had died in 1153, his son had predeceased him, and his young grandson, Malcolm IV (1153–65), had to surrender David's territorial gains. so that in 1157 the boundary of the kingdoms became fixed at Tyne and Solway.

The ambition of annexing Northumbria continued to guide Scottish policy, and William the Lion (1165–1214), the brother and successor of Malcolm IV, hoped to attain it by joining the English rebels against Henry II in 1173–74. His capture near Alnwick in July 1174 not only put an end to such expectations but resulted in the temporary loss of Scottish independence. The 10th-century alliances against the Danes were by this time interpreted in England as having involved a feudal subjection of Scotland to England and, since the time of William the Conqueror, the Scottish kings had held English fiefs and had done homage for them. The precise nature of this homage had not been defined and the meaning of the ceremony had been left deliberately ambiguous. What the Scottish kings gave as homage for English lands. English kings could receive as homage for the crown of Scotland. Henry released William only after forcing him to consent to the treaty of Falaise (1174) by which he did homage avowedly for the Scottish crown. The treaty was cancelled 15 years later by an agreement between William and Richard I, who sold the rights extorted by his father, receiving in return a sum of 10,000 marks required for the third crusade. The bargain merely annulled the treaty of Falaise and left the question of homage precisely where it had been in 1174. One ancient controversy was, however, settled immediately after the agreement was made. The treaty of Falaise had also admitted the subordination of the Scottish to the English church, but its provisions did not come into operation because of the rival claims of Canterbury and York. In 1192, after the close of a controversy between William the Lion and the papacy. Pope Celestine III issued a Bull declaring the Scottish church to be the special daughter of the Holy See, "with mediation of none." The church in Scotland was still denied the privilege of a metropolitan see, although in 1225 Honorius III granted the clergy permission to hold regular provincial councils under the presidency of an elected "conservator of the privileges of the Scottish church." It was not till 1472 that St. Xndrews was given metropolitan jurisdiction in Scotland; 20 years later a province was detached and placed under the newly founded archbishopric of Glasgow.

The Golden **Age.**—William the Lion (the ascription of that title to him is an unsolved problem) continued to hope for the restoration of Northumberland. He offered to purchase it in 1194, but refused to accept it when Richard I proposed to exclude from the bargain the right of holding fortified castles; and he made further unavailing efforts, including an admission of the right of King John to choose a wife for his son Alexander, the heir to the Scottish throne? as well as to the possessions of the Scottish royal house in England and to their Northumbrian claims—a dangerous expedient in view of English pretensions to overlordship. Alexander II (1214–49) tried to seize Northumberland during the struggle which followed the grant of Magna Carta; but in 1236, by the treaty of York, he resigned his claims to the earldom of Northumbria and also his possessions in Huntingdon in return for a grant of lands in the north of England. His reign witnessed the last of the Celtic revolts against the policy of anglicization, and in his later years Scotland entered upon a period of consolidation and prosperity which continued throughout the reign of his son. Alexander III (1249–86). The recovery of the Western Isles, which had been under Norse rule, was achieved by Alexander III after the battle of Largs (1263), in which the Norwegians were defeated. In 1266 Eric of Norway surrendered the Hebrides in return for a money payment. There was continuous peace with England. Alexander was the nephew and also the son-in-law of Henry III, and his relations both with him and with his brother-in-law, Edward I, were on the whole friendly. The borders, about to be the scene of almost incessant fighting for two and a half centuries, were quiet and peaceful. Later tradition did not err in regarding the reign of the last of the old line of Scottish kings as a golden age. His death closed the period of anglicization and in the later middle ages Scotland drew its inspiration rather from France than from England.

THE WAR OF INDEPENDENCE

The Succession Problem.— Alexander III was killed by a fall from his horse in March 1286. His two sons and his daughter had predeceased him and his only living descendant was his daughter's infant child Margaret. daughter of Eric of Norway. Her age, her sex and her nationality would have combined to prevent the succession of the little Maid of Norway, if there had been any adult male claimant nearly related to the late king. But Alexander left neither brother, nephew nor cousin, and there was no living legitimate descendant of any Scottish monarch later than David I. Of the three grandsons of David, two, Malcolm and William, had succeeded to the throne. The third, David, who had been given the English earldom of Huntingdon, had left a son and three daughters. The son had died without issue; the eldest daughter had married an Anglo-Scottish baron. and her grandson John Balliol (through her daughter. Devorguilla, the foundress of Balliol college at Oxford) was, by the theory of primogeniture, the direct heir to the crown. But the rule of succession by primogeniture was not yet firmly established, and the claim of Balliol was disputed by Robert Bruce, the son of the second daughter of David of Huntingdon. Bruce argued that a grandson. being closer in descent to the grandfather from whom the claim was derived, was his true representative, rather than a great-grandson who was separated from him by an additional generation. Years before, when Alexander II was childless, Bruce had been recognized as heir presumptive, and the birth of Alexander III had deprived him of a chance which in 1286 he held to have recurred. The Scots were thus faced by a choice between the minority of a baby girl who was the daughter of a foreign sovereign, and a civil war between two Scottish claimants. The nobles decided that the former was the lesser of the two evils, and the Great Council of Scottish tenants-in-chief, clerical and lay, appointed guardians to conduct the government in the name of Margaret of Norway.

English Intervention.— At first, it seemed as if the choice were to involve the country in both evils: for the Bruce party began to raise a rebellion, but Edward I of England, a great-uncle of the baby queen. intervened to secure her throne. This intervention was welcome in Scotland; in the late king's minority, his father-in-law. Henry III, had taken part in Scottish politics, describing himself as principal counsellor to the king of Scots rather than claiming overlordship. Edward I now made no pretension to the right and duty of an overlord to act as guardian during a minority. The long continuance of peace with England, and the two centuries' tradition of the adoption of English speech. manners and institutions, made it natural for him to offer. and for the Scots to accept, a guarantee of the succession of the little Maid. Edward, in fact, devised the statesmanlike scheme of a union of the two crowns by the marriage of the heiress of Scotland to his son Edward (afterward Edward II). English, Scottish and Norwegian commissioners met to discuss the question, and in the summer of 1290 the treaty of Birgham-on-Tweed defined the conditions of the marriage. In proposing his scheme, and in the terms of the treaty. Edward showed every consideration for Scottish feelings, and it was provided that after the marriage, and even after the succession of a son of the marriage to both crowns, the two kingdoms should remain separate organizations. Doubtless Edward hoped that a union of the kingdoms would follow a union of the crowns, but he was content to lay the foundations of that union. Further, it was agreed in the treaty that, should there be no heir of the marriage, the crown of Scotland was to revert to the proper heirs and the kingdom of Scotland was to be "free in itself, without subjection, as it hath hitherto been." Any rights, pertaining to the crown of England were reserved, but these rights were neither asserted nor defined.

The agreement promised a peaceful future for both countries, as far as their relations with each other mere concerned, hut within two months the Maid of Norway died on her way to Scotland (Sept. 1290). Civil war between the Bruces and the Balliols was inevitable. and each party wished to secure Edward's support. During the minority of Alexander III the Bruce family had supported the policy of Henry III in Scotland. and Robert Bruce, the claimant, was. like Balliol. an English landowner, had held high official positions in England. and had fought with Edward during the Barons' Wars. There are indications that he would have acknowledged English overlordship in return for Edward's support, but such a bargain would not have fulfilled the purpose which Edward had begun to cherish—the reduction of Scotland to the position of a vassal kingdom of England. A compact with the Bruces would only have resulted in placing behind Balliol all who upheld Scottish claims to independence, and Edward was determined to obtain an acknowledgment of his paramount authority from all the 12 competitors—there were rivals to Balliol and Bruce, but with clearly inferior pretensions. After collecting evidence from monastic chronicles about the history of the overlordship controversy, Edward asked the Scottish nobles to meet him at Norham-on-Tweed in May 1291. There he at once announced his intention of establishing his claim to be the feudal overlord of the kingdom of Scotland, and he gave the Scottish magnates some days to consider their attitude. Meanwhile, a great English army was assembling on the opposite bank of the Tweed. Edward's claim was not entirely repugnant to an assembly consisting largely of Anglo-Norman barons, some of whom held lands in England as well as in Scotland, and, after a protest had been entered in the name of the "community" of Scotland the English overlordship was admitted and the admission was duly recorded. The lord paramount then ordered an enquiry into the claims of the various competitors. who were reminded that any symptoms of recalcitrance would be followed by a declaration that the kingdom, owing to failure of heirs. had reverted to the overlord. Edward then made a progress as far north as Perth, through the kingdom of his (as yet unidentified) vassal.

Balliol's Revolt.—In Nov. 1292 Edward, after a judicial investigation, gave his decision in favour of John Balliol, thus defining the right of succession in accordance with the later rules of primogeniture. Within three years the vassal king mas in revolt against his overlord. who had subjected him to ignominious treatment. Whether Edward deliberately intended to produce this result is uncertain. Balliol's character and disposition suggested that he would submit to almost any humiliation rather than face Edward's wrath and, if the English king did contemplate a conquest of Scotland, he cannot have wished to undertake it in 1295, when he had on his hands a Welsh rebellion, a French war and serious domestic quarrels. Edward, in insisting on the letter of a feudal suzerain's right, showed no appreciation of incipient Scottish nationality. The remark attributed to him when news was brought of Balliol's alliance with France, "Has the fool done this folly?" indicates that he was surprised by the audacity of his vassal. Balliol, indeed, seems to have been compelled by Scottish opinion to take action. Edward at once assembled a powerful army to give effect to a new claim—that Scotland, as the fief of a disobedient vassal, had passed by forfeiture into the direct possession of the feudal superior. The strength of Scottish feeling is illustrated by the stubborn resistance offered by the Anglian population of the prosperous mercantile town of Berwick-upon-Tweed, where English rule might have been expected to be more welcome than in any other part of Scotland. Edward took vengeance by a merciless massacre (the first act of warfare for nearly a century) and gave a precedent for a cruel and relentless struggle. At first it seemed as if the conquest mere to be a very simple process. Scotland mas divided—the Bruces denied support to Balliol—and Edward, easily defeating a Scottish army at Dunbar (April 1296), made a triumphal march through Scotland. The annexation of the country and its loss of the status even of a vassal kingdom was emphasized by the destruction of the Great Seal and by the removal to London of the national records and of the "Stone of Destiny" upon which the Scottish kings were crowned. In October Edward returned home, leaving Scotland under a military occupation.

William **Wallace.**—English soldiers and officials were far from tactful; but the explanation of the revolt that followed is not to be found in garrison outrages. The lay magnates who had accepted the English overlordship were largely of Anglo-Norman blood; the smaller landowners and the lower classes of the population nourished a stronger dislike to English rule than did their natural leaders who had deserted the cause of independence. They found at once a nen. leader in Sir William Wallace, a younger son of a Renfrewshire landowner, and it was soon proved that only leadership was wanted to enlist an army of soldiers drawn from all parts of Scotland. including the Highlands. On Sept. 11, 1297, Wallace, as commander of "the army of the commons of Scotland." routed the English army of occupation at Stirling bridge, and for a year he ruled Scotland in the capacity of guardian for John Balliol. Meanwhile. Edmard I, relieved both of foreign and of domestic anxieties, prepared to lead an army to Scotland in person. At Falkirk, on July 22, 1298, he defeated Wallace, who escaped but resigned his office of guardian. The victory did not, hon-ever, restore the English to the position they had held in 1296. The spirit of resistance. thoroughly awakened. was not dismayed by defeat. New guardians were appointed, including Robert Bruce, the future Robert I and grandson of the competitor, and Edward, summoned to London by fresh domestic complications, had to leave Scotland unconquered. It was not till the autumn of 1303 that he was able to undertake operations on a scale adequate for his purpose. He brought a great army to Scotland in September, traversed the country. met with little resistance, and spent the winter in Scotland. In the summer of 1304, having captured Stirling castle, he again left behind him what he believed to be a conquered country. In 1305 Wallace was captured, and in August the noblest of Scottish patriots was put to the cruel death prescribed by English law for a traitor.

Robert Bruce.—Six months later, Robert Bruce and John ("the Red") Comyn. both of them ex-guardians of Scotland, met secretly in the Greyfriars church at Dumfries. Comyn was a nephew by marriage of Balliol and was regarded as the representative of the Balliol claims. A meeting of the only two possible candidates for the Scottish throne must have been held for the purpose of adjusting their claims with a view to further resistance. The result of the conference was to make resistance inevitable and immediate. There was a quarrel, and Bruce stabbed Comyn; his followers dispatched the wounded man. It was impossible for Bruce to conceal his real aims from Edward, and! though he had made no preparations for resistance, he was crowned in March 1306 at Scone. His chances of success seemed slight. for the kindred and friends of the great families of Balliol and Comyn were violently hostile to him; and the clergy, who had hitherto supported the cause of independence, were likely to be alienated by a crime which combined murder with sacrilege. A defeat at Methven. near Perth. in June, might well have put an end to the rising, and Bruce's failure in the battlefield was followed by other misfortunes. He spent the winter of 1306–07 as a fugitive—his adventures are described in Barbour's *Bruce* and in Sir Walter Scott's Lord *of the Isles* and *Tales of a Grandfather*. But Bruce was to prove himself a great national leader, the determination of the Scots to regain their independence had been strengthened by the death of Wallace, and even the clergy did not desert the new monarch in spite of a papal excommunication. In the spring Bruce appeared on his own lands in Ayrshire, and in May he won a victory at Loudoun hill in the same county. Then an event happened which changed the whole situation. Edward I had spent the winter at Lanercost abbey in the north of England, and had moved to Carlisle, where in March he sentenced to death two of Bruce's brothers who had fallen into his hands. On hearing the news of Loudoun hill he resolved to lead his army to Scotland in person, but he died at Burgh-on-Sands on July 7 and his successor abandoned the campaign.

Edward II probably had adequate reasons for returning to London, but he missed a great opportunity in Scotland. One of his father's difficulties had been that Scottish barons and bishops were ready to take. and just as ready to break, oaths of allegiance to the sovereign of England. He could not rely upon the unfailing support of any Scottish family or faction. The murder of Comyn had accomplished what all the first Edward's oaths had failed to achieve—the creation of an English party in Scotland which could be trusted unswervingly to maintain English interests. There was an irreconcilable blood-feud between Ring Robert and the friends and adherents of the murdered Comyn. Edward II left this party without support and without any definite plan of campaign, and between 1307 and 1310 King Robert crushed its members individually. A futile and half-hearted invasion led by Edward in 1310 did nothing to retrieve the balance and for the next four years Bruce, with the help of his brother Edward and of the "Black" Douglas. not only expelled English garrisons from Scottish castles but was able to inflict great damage by raids upon the northern counties of England. At last, in 1314, Edward II made a serious effort to recover his father's conquest and suffered at Bannockburn (June 24) the greatest disaster which an English army had ever sustained. The fight was not of Bruce's seeking; he had avoided a general action in 1310 in accordance with the usual Scottish policy of guerrilla warfare. A pitched battle was too great a risk in view of the comparative resources of the two countries, and it mas an imprudent challenge accepted by Edward Bruce from the English governor of Stirling castle in the summer of 1313 that led to what proved to be the only successful battle on a great scale ever won by the Scots over the English. But Bannockburn was won, and it was sufficient for the vindication of Scottish independence. The English stubbornly declined to admit the accomplished fact. For many years Bruce carried terror into the northern counties and he also dealt a serious blow to English dominion in Ireland. It was not till after the deposition and murder of Edward II that the regents for his son, Edward III. agreed to the treaty negotiated at Edinburgh and ratified at Northampton (1328) by which England acknowledged the independence of the kingdom of Scotland.

Revival of the Conflict.—In the following year King Robert died, leaving as his heir a son, David I1 (1329–71), who, though only a child of five. had already been married, in accordance with a provision of the treaty of Northampton. to Joanna, a daughter of Edward II. In 1330 Edward III threw off the yoke of his mother and her paramour, Mortimer, who had deposed his father, and a new phase of the War of Independence began. It was then that the most disastrous effects of the murder of Comyn began to operate. Bruce had vanquished the Scottish opponents whose bitter enmity that deed had provoked. but they had resolutely refused to acknowledge his sovereignty or, in the mediaeval phrase, to "come into his peace." Their estates had been forfeited and they had taken refuge in England. Thus. when England had again a strong king and Scotland a weak one, there was at the English court a body of "disinherited." as they were called, who urged the young Edward to wipe out the shame of Bannockburn and Mortimer's treaty of peace. Though not included in the terms of the treaty some promise to restore the disinherited seems to have been made, but the Scottish regent. Randolph, earl of Moray, a nephew of King Robert. felt that it was not safe to take this step while the king was a child and to antagonize the new possessors. It was an ominous circumstance that the new English king had invited from France Edward Balliol, the heir of John Balliol. who was known to be contemplating an attempt to regain his father's vassal throne. In the summer of 1332, while England and Scotland were officially at peace, Edward III connived at Balliol's leading an army of the disinherited for the recovery of Scotland. The earl of Mar, uho had just succeeded to the regency on Randolph's death, was defeated by Balliol at Dupplin moor (Aug. 1a. 1332), and in September Balliol was crowned at Scone as Edward I of Scotland. The English king then openly espoused Balliol's cause and, abandoning his grandfather's final policy of complete annexation, reverted to the earlier project of a vassal kingdom

Before Edward III could come to Balliol's assistance his vassal had been ignominiously driven out of Scotland, but he led a large army to the siege of Berwick-upon-Tweed, which had been recovered by Bruce in 1318. The Scots suffered a crushing defeat at Halidon hill, near Berwick (July 19. 1333), and the town fell into English hands. Edward then modified his consent to the revival of the vassal kingdom by extorting from Balliol a cession of most of the southeast of Scotland (including the counties of Linlithgow, Edinburgh. Haddington, Berwick, Selkirk, Peebles and Roxburgh). This district passed under the administration of English officials, but Balliol. in spite of successive invasions of Scotland by his overlord in the years 1334–37, never established himself as king. Then there occurred another change in the political situation, involving effects similar to those which had followed the death of Edward I, 30 years earlier. In the autumn of 1337 Edward III, partly because of Philip VI's support of the Scots, entered on the long war with France, and he at once lost interest in Edward Balliol's feeble pretensions and even in the defence of the ceded territory. The Scottish regents were left, as Robert Bruce had been left, to suppress Scottish traitors and expel English garrisons, until, by 1341, Perth, Stirling and Edinburgh were in Scottish hands. the English had been driven out of a large area in southern Scotland. and the young David II was brought back from France, whither he and his English queen had been sent for safety in 1334.

The Franco-Scottish Alliance.—The diversion of English ambition from Scotland to France really marked the close of the War of Independence, but it also inaugurated a new series of hostile relations between England and Scotland. Although John Balliol had made his original defiance of Edward I in the assurance of support from Philip IV of France, the help given by the French in the earlier stage of the struggle for independence had been negligible. In 1298 Philip had agreed to a truce, and again in 1303, the darkest hour in Scottish history, he had concluded a permanent peace with England. When the struggle began again, however, the French under Philip VI had given refuge to the young David II and French support of Scotland was one of the reasons for the English attack upon France. When that attack began in earnest in 1346 Edward III offered to restore the portions of Scotland which were still in English hands on condition of Scottish neutrality in the Anglo-French war. The Scots made a decision which on several later occasions they declined to revoke. The explanation of their persistent adherence to a Franco-Scottish alliance lies in their conviction that no peace with England could possibly be permanent. If the English became the masters of France, they were not likely long to acquiesce in the existence of a small independent kingdom on their northern borders. If they failed to establish English dominion in France they we e equally sure to seek such compensation as a conquest of Scotland would afford, and the Scots, if they deserted France in its hour of need, could expect no help in their own. The Franco-Scottish alliance as a factor in European history. began in 1346, when the Scots, invading the north of England in the interests of France. were defeated with colossal losses and David I1 himself captured at the battle of Neville's Cross, fought near Durham on Oct. 17, about two months after Crécy. The English at once reoccupied a large area of southern Scotland and thus provided an unanswerable reason for the maintenance of Franco-Scottish friendship. While England held portions of France and of Scotland, an alliance of the two victims was inevitable. There was, indeed, no other bond of union between French and Scots, and the political alliance was by no means always a happy or cordial arrangement, although France took, in the development of Scottish civilization, the place which had been held by England before the War of Independence, and profoundly influenced Scottish law and institutions as well as manners and customs.

The Ransom of David 11.—Scottish intervention in the Anglo-French war proved to be rather irritating than actually dangerous to England, and Edward III made a remarkable attempt to get rid of the complications which it involved. His prisoner. David II, was childless and extravagant; he hated his heir, Robert the Steward, the son of his half-sister and his own senior by some years. David was released in 1357 and the Scots undertook to pay a heavy ransom in instalments spread over many years. The Scottish crown was thus impoverished and David, who had been kindly treated in London and had made many friends in England. listened to a suggestion of the English king that the ransom should be commuted for an acknowledgment of an English prince as the heir to the throne of Scotland. The son of Robert Bruce actually made this proposal to the Scottish parliament, which contemptuously repudiated it. The long-continued negotiations for the ransom of David II accelerated an important development in the parliamentary constitution of Scotland. Whatever it may have derived from the Celtic heritage of the kingdom, the great council of the land had been organized by the descendants of Malcolm Canmore upon an English model. It was both the supreme court of law and an advisory council of the sovereign, and it was composed of the tenants-in-chief, clerical and lay. To these two estates of the realm. the clergy and the barons, was added in the 14th century a third estate, consisting of representatives of the royal burghs. Burghs had first been summoned to attend the king in parliament when Robert I's financial needs were urgent, in 1326, and they were called again to assist the return from France of David II in 1341. Their help was now required in greater measure for the payment of the ransom, and it was therefore necessary to secure their concurrence in the decisions taken by parliament. The presence of burgess representatives in parliament or in the less formal meetings of the estates known as general councils was thus continuous from 1357. It cannot be shown to have exercised any notable influence upon either the authority or the policy of the crown, but its influence may be traced in a long series of legislative measures dealing with trade, commerce and police.

THE CONFLICT BETWEEN THE CROWN AND THE BARONS

The Early Stewart Kings.—The War of Independence and the subsequent warfaré with England deeply affected the relations between the crown and the great baronial families. The distribution of the estate of the disinherited among Bruce's supporters was one of the causes of the dangerous greatness of the house of Douglas and of other Scottish families. and in the course of the English wars the crown was frequently weakened by the premature deaths of monarchs and by the recurrence of minorities. The initial weakness of the crown after the death of Robert I was, however, due not to such accidents but to the personality of his first three successors. David II was a futiie ruler and a worthless man, and the determination of the Scots to maintain their independence receives additional proof from the circumstance that his reign did not witness its loss. When he died in 1371 the nephew who succeeded him, Robert II (1371–90), the first monarch of the house of Stewart. was jj years of age and already worn out by a strenuous public life. His reign was largely spent in conflict with England, but he took no part in the warfare. Scotland had been included in truces between England and France. and when the Anglo-French struggle entered on a new phase in 1377 the Scots renewed their efiorts to expel the English from the occupied country in the south. Their success provoked invasions by John of Gaunt 'and by Richard II, which resulted solely in devastations of Scottish soil. The best remembered incident was the battle of Otterburn (1388), a chivalrous and romantic episode, but negligible as a military event. The next king. Robert III (1390–1406), was a lame old man who with some reason described himself as "the worst of kings and the most wretched of men." His legitimacy was doubtful, his parents having only been married with papal dispensation 10 years after his birth, and he made no effort to repress the disorders which were rampant in the country. During the early years of his reign the government was in the hands of his younger brother, the earl of Fife. whom he created duke of Albany. but in 1399 his eldest son, the duke of Rothesay. ousted his uncle from the regency. There was a bitter feud between Rothesay and Xlbany and in 1401 Xlbany recovered power. In the following year Rothesay died mysteriously at Falkland (the story is told in Sir Walter Scott's Fair *Maid of Perth*), and rumour. which has crystallized into tradition. ascribed his death to Albany. The old king was alarmed by the fate of his heir and early in 1406 he sent his remaining son, Prince James, to be educated in France. The boy was captured by the English at sea and Robert III died when the news reached him. The reign of James I nominally covers the years 1406–37, but he was a prisoner in England until 1424, and during this period Scotland was governed by Xlbany until his death in 1420 and thereafter by his son. Murdoch, 2nd duke. The regency of the elder Albany witnessed the foundation of the first Scottish university (St. Andrews, 1411a)—partly an endeavour to repress the Lollard heresy which had reached Scotland—and the battle of Harlaw, mhich has frequently been misinterpreted as a decisive struggle between Celt and Saxon in Scotland. It was. in fact, a fiercely fought skirmish between Donald of the Isles. a grandson of Robert II, who claimed the earldom of Ross in right of his wife. a member of a lowland family, and the burghers of Aberdeen, reinforced by the earl of Mar and other Aberdeenshire lairds. Donald. having defeated the Mackays and the Frasers (Highlanders who opposed his claim), n-as inarching to plunder the town of Aberdeen. Like other disaffected Scottish barons. he had made an alliance with England, and Harlaw was an episode in Anglo-Scottish warfare. Xlbany made considerable progress in the recovery of southern Scotland from the English. and he also encouraged the recruitment of Scottish soldiers for the struggle in France. In the year after his death the Scots rendered their most distinguished service to the French in helping to win the victory of Baugé (1421), the first French success since the invasion of France by Henry V of England.

The first two Stewart kings had been feeble rulers and though the elder Albany was a strong man his position, and possibly his personal ambitions. prevented him from suppressing the feudal anarchy which threatened the monarchy and paralysed the central administration. while his son was weak and easygoing. James I, who was released on payment of a ransom in 1424, was fearless and determined and he resolved to establish order and good government—in his own words, to "make the key keep the castle and the bracken bush the cow." He was merciless in his treatment of the great barons and he roused many enemies. He tried to find support for his reforms by making bicameral the general council or parliament, as he had seen the English parliament to be, and by introducing representatives of the shires; but the statute passed in 1428 for this purpose was inoperative. Nonetheless, the parliaments of the reign passed a long series of beneficent legislative measures; the king's difficulty lay in enforcing them. In 1437 he fell a victim to a conspiracy organized by his uncle. the earl of Athol, who, as the indisputably legitimate son of Robert II's second marriage, claimed to be the rightful king. His son and successor James I1 (1437–60) was a child of six and the advance made by the central government during the personal rule of James I was lost in the intrigues and factions of a minority. When James II began his personal rule the great house of Douglas, in spite of sustaining a severe blow by the murder of its young chief in the course of the royal minority, was a grave danger to the supremacy of the crown. James found a pretext for invading the Douglas dominions while the 8th earl of Douglas was on a pilgrimage to Rome. and Douglas, on his return, made a league with his three brothers. Archibald. earl of Moray. Hugh. earl of Ormond, and John: lord of Balveny, and with a great northern magnate, the earl of Cramford. The king heard of the league and sent for Douglas to Stirling castle, giving him a safe-conduct. The earl refused to break the bond into which he had entered and James. losing his temper, stabbed him fatally (Feb. 1452). An obedient parliament found that the earl was "guilty of his own death by resisting the king's gentle persuasions to aid him against rebellious subjects." but the murder was necessarily the signal for a final conflict between the crown and the house of Douglas. James defeated the Douglases on the battlefield at Arkinholm, near Dumfries, and captured their strongholds; and the 9th earl fled to England to reappear in Scotland in the next reign.

Recovery of Southern Scotland.—The Douglases had been involved in many intrigues with England, but they had played a notable part in the recovery of southern Scotland and by the year 1460 this task had been completed except for the town of Berwick-on-Tweed and the castle of Roxburgh; the town of Roxburgh, once one of the leading Scottish burghs, had been entirely destroyed in the course of more than 160 years of almost continuous warfare. The outbreak of the Wars of the Roses in England afforded a suitable opportunity for the recovery of the castle and James besieged it in the summer of 1460. He himself. interested in the growing use of artillery. was watching the operations of his gunners when he was hit and killed by "a piece of mis-framed gun that brak in the shooting." and Scotland was again plunged into the woes of a minority. Roxburgh castle mas taken a few days after the king's death, and with the expulsion of the English from Scotland the real reason for the Franco-Scottish alliance had come to an end. While the English held large portions of France and of Scotland alike, an alliance of their two enemies was inevitable. and James I had repeated the Scottish refusal of English offers of friendship on condition of Scottish neutrality in the French war. The Scots had rendered greater military assistance to the French than they had received from them. but it mas the French who bore the brunt of the conflict against the common enemy. and in negotiations with the English they never failed to protect Scottish interests. By 1460 the alliance had served the purpose for which it was formed; the English held only Calais in France and Berwick in Scotland. During the minority of James III (1460–88) the Scots took advantage of the civil war in England to obtain the cession of Bern-ick-on-Tweed from

Margaret of Anjou, the wife of Henry VI, giving in return some help to the Lsncastrian cause. Edward IV retaliated by an intrigue with John. Lord of the Isles, and the exiled Douglas but the Scots recognized the accomplished fact of Yorkist supremacy in England and a truce for 15 years was made in 1464.

James **III** and **IV.**—During the first years of the minority of James III, Scotland was ruled by a statesman. Bishop Kennedy of St. Andrews, and though there were troubles after his death, the young king, when he assumed the government in 1469, began his reign in fortunate conditions. There was peace with England; his father had destroyed the perilous greatness of the Douglases; his marriage with Margaret of Denmark led to the acquisition of the Orkney and Shetland Islands, which had been Scandinavian for centuries; and the prestige of the kingdom was enhanced by the creation of the metropolitan see of St. Andrews in 1472. Four years later the lord of the isles was reduced to submission by an army led by some of the great barons whose ambitions had hitherto been dangerous to the crown. Yet James 111 was one of the most unfortunate of the Stewart kings. His nobles complained that he "delighted mair in music and policy of building than in the government of his realm," and they preferred his brother, the duke of Albany. The brothers quarrelled, Albany fled to France, and James was sufficiently unwise to break the truce with England. The 9th earl of Douglas was still in receipt of an English pension and with Douglas as an intermediary Edward IV made a treaty with Albany for his establishment on the Scottish throne as an English vassal, and for the restoration of the house of Douglas. Albany, calling himself Alexander, king of Scots, led an army to the borders. accompanied by Kichard, duke of Gloucester (afterward Richard III). Gloucester retook the town and castle of Berwick-on-Tweed, which thus passed finally out of Scottish hands (1482), and Albany invaded Scotland. The army which James led to meet him brought about a revolution; the nobles, under the leadership of the earl of Angus, the head of the Red Douglases who had risen on the ruins of the older or Black Douglases, seized and hanged the musicians and architects who were the king's friends. and made an agreement with Albany. The amusing story of how Angus gained his nickname. Archibald-Bell-the Cat, is told in Scott's *Tales* of *a Grandfather*. In the following year Albany was again an exile in England, and in 1484 he and Douglas again invaded Scotland with small English force, but mere defeated. Albany escaped to France, where he was killed in a tournament in 1485, and the 9th and last earl of Douglas died a prisoner in the monastery of Lindores.

Four years later James III was killed in a civil conflict. The faction of the nobility which conspired against him and defeated him at Sauchieburn near Stirling (June 1488) had seized the person of his son and heir, the prince of Scotland, and brought him to the field against his father. This circumstance indicates the permanent character of the change in Scottish politics brought about by the victory of James II over the Douglases. Neither of the two rebellions against James 111 was directed against the dynasty, and each of them was the result of widespread political opposition to the king's conduct of public affairs, and not of secret conspiracies inspired by jealousy of the house of Stewart. It is also significant that. in 1488, the rebels defended their action on political grounds; rebellion for the first time admittedly required an excuse capable of being stated openly. The revolution was followed by indications of a tendency toward constitutional government and an assertion of parliamentary authority, but this tendency did not survive the assumption of power by James IV (1488–1513) in person. He was an able and strenuous ruler, and he soon acquired complete control over the traditionally amenable Scottish parliament. He humbled rebellious barons who, either as partisans of the late king, or for other reasons, resisted him, and he annexed to the crown the title of lord of the isles and by personal visits established royal authority in the Hebrides.

(R. S. R.; E. W. M. B.–M.)

SCOTLAND, ENGLAND AND FRANCE

James **IV's** Foreign Policy. — For some time James IV seemed to be content to follow the traditional policy of the French alliance. He built a great navy, encouraged his captains to challenge the English seamen. and for a short period (1495–97) gave half-hearted support to Perkin Warbeck's pretensions to the English throne. But, anxious to make Scotland count in European politics, he heeded, at least intermittently, those older counsellors who advised him against automatically committing the realm to the support of France and the enmity of England. Failing to find a Spanish bride, he eventually accepted Henry VII's offer of the hand of his elder daughter Margaret. This marriage, celebrated by the poet William Dunbar as the union of the thistle and the rose (1503), was a triumph for the statesmen who argued that Scotland need not be on perpetually hostile terms with its great neighbour, and it brought the northern country a brief spell of commercial prosperity. Among those who appreciated its benefits was the famous scholar. John Major, who a little later was to urge, in his *Historia Majoris Britanniae* (1521), the expediency of royal intermarriages with a view to the ultimate union, on a peaceful basis, of Scotland and England.

Another century was to pass before this happy consummation became a reality. Meanwhile, Anglo-Scottish relations deteriorated soon after the aggressive Henry VIII succeeded his more cautious father (1509). and the formation of the Holy League (including England) against France determined the headstrong Scottish monarch to adhere to the old custom of helping France in its hour of need. Disregarding the temperate views of Bishop Elphinstone and others like him, James crossed the border with a strong army and was defeated and killed at the battle of Flodden (Sept. 1513), leaving his crown to an 18-month old infant and his kingdom to the hazards of another minority.

James V and the French Alliance. — The marriage of the queen-mother, Margaret Tudor, to the earl of Angus (1514) debarred her from the regency and this was entrusted instead to Alexander, duke of Albany, son of James III's treacherous brother, and by birth and education a Frenchman. Albany's tenure of office (1515–24) was marked by indecisive warfare with England and by quarrels between Margaret and her second husband. The regency was terminated in 1524, when the young king was declared to be old enough to govern the realm, but for four years the real power lay with Angus, who, though estranged from his wife (the marriage being annulled in 1527), did his best to further the interests of England, until in 1528 James escaped from the control of his hated stepfather.

James V (1513–42) was in some ways a capable as well as a popular ruler, but the circumstances of his age proved too much for him in the end. Henry VIII, after his breach with Rome, urged his nephew to follow his example, and his overtures brought James face to face with the same dilemma as had beset his father. Largely dependent on clerical aid and advice, unsympathetic to the doctrines of the reformers and unwilling to suppress the monasteries, the king chose to adhere to the traditional policy of the Franco-Scottish alliance. He made two French marriages, first to Madeleine, daughter of Francis I, and then, after her death (1537), to Mary of Guise. His refusal to meet the English king at length induced Henry to revive the claim of homage and to invade Scotland. James by his very success in restoring order had lost the favour of many of his nobles and barons, especially in the borders and the Western Isles (Hebrides), and they refused to support what they called a French war. It was therefore Cardinal Beaton and the clergy who furnished the army that was routed at the battle of Solway Moss (Nov. 1542); the king, broken in health and spirit, died at Falkland on Dec. 14, a week after the birth, at Linlithgow, of his daughter and only surviving legitimate child, Mary, queen of Scots.

The early years of the reign of Queen Mary (1542–67) gave Henry VIII an opportunity to wean Scotland from the old church and the old alliance. for the new regent, the earl of Arran (who was heir-presumptive to the throne), was hostile to Beaton and inclined to favour the doctrines of the Reformation. In July 1543 a marriage was arranged between Henry's heir (afterward Edward VI) and the infant Scottish queen, but the English king then overplayed his hand by making unacceptable conditions. Beaton and Arran were reconciled and the marriage treaty was repudiated (Dec. 1543). Henry's ill-advised retort was to send the earl of Hertford (afterward the protector Somerset) to conduct savage campaigns of reprisal in southern Scotland (1544 and 1545); and, in turn, this "rough wooing" threw the Scots into the arms of the French. The assassination of Beaton (May 1546) in revenge for the martyrdom of George Wishart did not alter the course of Scottish diplomacy, nor did the death of Henry VIII and Somerset's victory at Pinkie (Sept. 1547) in the last battle fought between the national armies of Scotland and England. Arran opened negotiations for the marriage of the girl queen to the heir to the French throne, and in Aug. 1548 (with this ultimate aim in view) Mary was sent to France.

The French helped the Scots to recover their territory and included them in the peace made with England in 1550. Thereafter the French soldiers remained in Scotland and incurred general odium. Arran (who was given the title of duke of Chatelherault as a solatium) resigned the regency in 1554 in favour of Mary of Guise, whose policy was to make Scotland a province of France—a Frenchman even shared the chancellorship with the earl of Huntly. The marriage of Queen Mary to the dauphin (April 1558) injured rather than assisted the French alliance, for it was suspected (and it is now known) that Henry II of France had induced the young queen to recognize his own and his heirs' quite fictitious claim to succeed her, in the event of her decease without issue, in Scotland. The event had shown the French cause, viewed at close range, to be as unpopular as the English.

Social and Economic Conditions.—Despite royal minorities, baronial turbulence and foreign entanglements, Scotland, toward the close of the middle ages. made some progress in the arts of peace. Episcopal initiative, royal patronage and papal good will made possible the foundation of the universities of St. Andrews (1412), Glasgow (1451) and Aberdeen (1495), and an education act of 1496 enjoined barons and freeholders to put their eldest sons and heirs to grammar school and to "the schools of art and law." The printing press was introduced and the Royal College of Surgeons was established during the reign of James IV: at this time Scottish letters reached their pre-Reformation height with the poetry of William Dunbar (*c.* 1460–1520), and a little later the new learning came to Scotland in the work of John Major (1469–1550) and Hector Boece (*c.* 1465–1536).

Trade and industry were the subjects of a large number of parliamentary enactments. Commerce was in the hands of the merchants of the guild in the greater royal burghs (of which there were about 45 by the middle of the 16th century), and the trade routes ran to the Baltic ports, the Netherlands. France. England and Ireland. From Leith, Kirkcaldy. Perth, Dundee. Montrose, Aberdeen, Inverness and Ayr. cargoes of wool, woolfells. skins and hides. salmon and herring. moved outward. and to them, in return. were shipped iron, timber, salt, tar, flax and hemp, wines and spices. fine cloths and articles oi fashion and luxury. Goods and services were supplied locally by the craftsmen of the royal burghs and of the lesser "burghs of barony," of which about 100 were erected by charter between 1450 and 1560. The towns were not large. Edinburgh may have had 20 000 inhabitants, and the others far fewer—Glasgow perhaps 4 500, Stirling not more than 2,000. Arbroath only 1,000, although these three were among the 20 largest burghs. All but a small fraction of the total population (estimated at about 750,000) were engaged in the basic and changeless tasks of subsistence farming—groning, in open fields. oats (the food crop). "bere" or rough barley (the drink crop), a little wheat. rye and flax, raising a few cattle for beef or as plowing oxen, and. in the border country, keeping large flocks of sheep for the sake of their fleeces.

THE REFORMATION IN SCOTLAND

Diplomatic and Religious Revolution.—The popular revolt against a church which had largely fallen from spiritual grace, which gave rich livings to a few men mostly driven by secular ambitions and which starved the parishes for the upkeep of the cathedrals. larger abbeys and collegiate churches, may be dated from the burning in 1528 of Patrick Hamilton, abbot of Ferne. As elsewhere, there was some mixture of motives; nobles and lairds envied the church its relatively great wealth, and English gold forwarded the Protestant cause. But the dissemination of the Bible "in the vulgar tongue," especially from 1543, the example of George Wishart (1546), and the admonitions of John Knox, gave Scottish Protestantism a popular appeal, and the movement received form and shape when its leaders leagued together as "the Lords of the Congregation" and signed the first National Covenant (1557).

When the Roman Catholic Mary Tudor died and was succeeded by her half-sister Elizabeth (Nov. 1558), English help for the Scottish Reformers became a possibility; it became a certainty in the following year, when the husband of Queen Mary (now claiming to be rightful queen of England as well as Scotland) succeeded in France as Francis II. The Franco-Catholic menace was too real and pressing to be overlooked by Elizabeth, who promised, and sent, military and naval assistance by the treaty of Berwick (Feb. 1560). The diplomatic revolution was sealed by the treaty of Edinburgh (July 1560), which provided for the departure of the French troops (Mary of Guise having died in June) and which marked the end of the "auld alliance." The religious revolution was effected in August, when a parliament, irregularly summoned but broadly representative of the nation, abolished papal authority and forbade the celebration of mass. When, therefore, Mary, widowed at the age of 18. returned to Scotland, she came to govern a state nhich had, in a few fateful months, broken away from the land which she loved and the faith which she professed (Aug. 1561).

Mary, and **the** Early Policy of James **VI.**—The saga of Mary's life in Scotland (1561–68) provides the romantic high light of Scottish history—her conflicts with Knox and her inability to secure toleration for her co-religionists; her marriage schemes and her hopes of succeeding Elizabeth on the English throne; her choice of her cousin Henry, Lord Darnley (who stood next to herself in the English succession) as her second husband (July 1565), in defiance of her half-brother. the earl of Moray, whom she forced to flee; the murder of her secretary, David Rizzio (March 1566), and the birth of her son. James, in the following June; her constant quarrels with her worthless husband and the strong suspicion that she was privy to his assassination (Feb. 1567) (*see* CASKET LETTERS); her fatal selection, as her third husband, of the earl of Bothwell. known to be a principal actor in the crime (May 156;) ; her defeat and surrender at Carberry hill (June) ; her abdication in favour of her son as king and of Moray as regent. and her imprisonment in Lochleven castle; her escape within a year. her final defeat at Langside, and her flight to England (May 1568), to suffer confinement that was to end only with her execution (Feb. 1587).

The historical rather than the biographical interest of the reign concerns the rise of the Protestant church of Scotland. Knox's *Confession of Faith* was adopted in 1560 and his *Book of Common Order* in 1564, but the nobles, greedy to seize and secularize the church lands, refused to sanction the *First Book of Discipline* (1560), in which he proposed an adequate endowment of the kirk and laid down its responsibility for the education of the laity and the relief of the disabled poor, as well as the cure of souls; of special importance was his insistence on the establishment of a school in every parish. Ecclesiastical organization depended in the localities on the kirk sessions, which began to be set up as early as 1559, and at the centre on the general assembly, which first met in Dec. 1560; provision was made in 1563 for payment, from "thirds of benefices," of ministerial stipends. The Protestant revolution, furthered by Mary's failure in diplomacy and politics. was sanctioned by parliament in Dec. 156;.

hlary's departure left a "queen's party" to trouble the four suocessive regents for the young James VI (1567–1625) (who was also to become King James I of England in 1603)—Moray (1567–70), Lennox (1570–71), Mar (1571–72) and Morton (1572–78)—and not until Edinburgh castle was captured in 1573 did the resistance of Mary's adherents cease. The presbyterian system of graded church courts—general assembly. provincial synod presbytery and kirk session—became the characteristic feature of

Scottish Protestantism by 1581; the main advocate of this fully developed organization was Andrew Melville, who denounced even a modified episcopacy, insisted upon the essential parity of ministers, and maintained that ecclesiastical authority, the power of the keys, was different from, and independent of, the civil authority, the power of the sword. These claims were bound to lead to a struggle between church and state; they caused friction with Morton, and they aroused the undying hostility of King James when (in 1581) he assumed the government.

James's leading ambition was to succeed Elizabeth on the English throne; to this end his policy was steadily directed and from it nothing could deflect him — neither pity and anger over his mother's death, nor diplomatic flirtation with Spain, nor concessions to the Scottish Catholics. His secondary aim, not unconnected with the other, was to make the Church of Scotland episcopal in government, as was that of England. After being kidnapped in the raid of Ruthven (Aug. 1582) and held a prisoner by the extreme Protestants for ten months, he escaped and induced parliament to pass the Black acts, asserting the royal supremacy and the king's right to appoint bishops (1584). Presbyterian recovery came in 1592 with the "Golden act," which partially repealed the earlier statute and confirmed the status of the church courts. The ministers in turn pushed their claims too hard, and from the end of 1596 James was in command of the situation; he obtained the approval of the general assembly for his proposal to create titular bishops with seats in parliament. Meanwhile, as early as 1585 he had made a league with England, and his constant care not to offend Elizabeth or her chief ministers brought its reward in March 1603, with his accession to the English throne.

Constitutional Progress. — The 16th century saw the introduction of several improvements in the machinery of government. The full parliament or the less formal assembly, which had previously been called a general council and was now styled a convention of estates, met fairly frequently; king, queen, regent or even a faction in temporary possession of the power of the state consulted it upon all matters of high policy — legislation and taxation, justice and the legalization of a *coup* d'dtat. The three estates — prelates, nobles and burgesses of the royal burghs — attended, though sometimes in small numbers and always prepared to entrust their authority to the committee of the lords of the articles (the articles being the agenda for the meeting). The extant records, which are scanty, suggest that by 1525 this committee was chosen by the device of cross election, whereby the nobles chose the prelates and the prelates chose the nobles; whether (as was later the case) those two estates together elected the burgess members does not appear. The lesser barons, whom James I had tried to bring in, mostly refrained from attendance, but they did turn up in large numbers at the Reformation parliament (Xug. 1560); and James VI in 1587 carried out his ancestor's wishes in this matter by authorizing their representatives (two for each shire, save Clackmannan and Kinross, which were allowed one each) to sit and vote in parliament.

The financial theory was that the king, who was a large landowner, "should live of his own," without troubling the poor lieges, but parliament from time to time voted a tax or "stent" for a stated purpose; in that case the practice was that the clergy paid one-half, the nobles one-third and the burghs one-sixth. The judicial system was much strengthened in 1532 when, from moneys granted by the papacy to the crown, the college of justice or court of session was established. This court was composed of a president and 14 other lords, and it was supreme in civil justice. The other important constitutional development of the century concerns the growth, out of informal or ad *hoc* meetings, of an assembly representative of all the royal burghs and dealing with municipal and commercial affairs — theconvention of royal burghs (1552).

THE UNION OF THE CROWNS

Enhancement **of** Royal Power. — The resources and prestige of the English crown gave King James greater authority in Scotland than any of his predecessors had enjoyed. No longer was it possible for disaffected nobles to conspire with, and accept bribes from, a foreign monarch beyond the Tweed; instead the magnates of the realm now found it profitable to stand well with James VI and I. His chosen instrument of executive government was the privy council, and he contrived to ensure, by manipulating the customary cross elections, that the councillors should also control the lords of the articles, and, through them, parliament itself. In the field of local administration he endeavoured, though with little success, to transplant Tudor efficiency to his northern kingdom through the institution of justices of the peace (1609). His pacification of the borders (now "the middle shires") by means of patrols of mounted police under an Anglo-Scottish commission was more effective (1605). By the Statutes of Icolmkill (1609), many of the chiefs in the Western Isles were induced to profess the Protestant faith, to become responsible for the good order of their estates, and to undertake to give their sons a lowland education. The earl of Orkney was beheaded in 1615 and his earldom annexed to the crown. The plantation of Ulster was begun in 1610 and an ambitious scheme for settling Acadia, or Nova Scotia, was launched in 1621; but the French saw to it that the plan miscarried, so that it led only to the granting of Nova Scotia baronetcies.

Convinced that episcopacy agreed best with monarchy, James achieved his greatest triumph in the church. His adroit and tortuous manoeuvrings finally gave him complete control of the general assembly. Parliament reaffirmed the royal supremacy in ample terms in 1606, the general assembly approved an episcopal constitution in 1610, bishops with Anglican consecratian were appointed in the same year, and all was ratified by a statute of 1612. An episcopal superstructure had been imposed on a presbyterian foundation, and James was wise enough not to press the innovations in ritual known as the Five Articles of Perth (1618).

James, king of Great Britain (by royal prerogative), was the first to use the "Union Jack" and to secure the recognition of mutual rights of citizenship: but English mercantile jealousy frustrated his plans for a closer union (1607).

Charles I and the Covenants. — Charles I (1625–49), having alienated his natural supporters, the nobles, by providing for the maintenance of the ministry out of ecclesiastical lands and teinds or tithes (1625–33), imperilled the Jacobean compromise by seeking to make the government and worship of the church uniform with those of the Church of England. His book of canons (1635) and a new prayer book (1637) impressed the Scots as being popish, and resistance came into the open at the St. Giles riot in Edinburgh (July 1637). The National Covenant, protesting against the recent innovations, was drawn up and signed with enthusiasm in 1638 and in December of that year the Glasgow general assembly abolished episcopacy. The Covenanters (*q.v.*), with the good will of Charles's English opponents, invaded northern England in the Bishops' wars (1639–41). The king attempted to win over his Scottish critics by concessions (1641) and after this policy had failed he was obliged to summon the Long Parliament to get rid of the Scottish army, by payment or by fighting. England's Civil War was no affair of the Scots (whose grievances had been settled), but parliament's need of help induced the Covenanters to offer their aid against the royalists on the basis not of a civil league but of a pact for religious uniformity on the presbyterian model. In accordance with the Solemn League and Covenant (1643), the Scots did help in the parliamentary victory of Marston Moor (July 1644). Organized royalist opposition was ended in England by the battle of Naseby (June 1645) and in Scotland by the defeat at Philiphaugh of the marquis of Montrose, who had turned in disgust from the covenanting extremists (Sept. 164;). In May 1646 Charles surrendered to the Scots, who were still hoping that the king, a devout Anglican, would accept reconciliation on the basis of the Solemn League and Covenant.

Cromwell.—Amid the tangled manoeuvres and negotiations that followed Charles I's admission of defeat, the salient fact was that Cromwell's army was stronger than Scots and parliament, royalists and Covenanters, or any combination of them. In accordance with the Engagement, a design to restore the king, the duke of Hamilton led a force of Scottish invaders to their doom at Preston (Aug. 1648). After the execution of Charles I in Jan.

1649, another royalist reaction, this time on behalf of the ludicrous figure of the covenanted Charles II, was crushed, first at Dunbar (Sept. 3, 1650) and finally, on the first anniversary of that battle, at Worcester. All Scotland lay at Cromwell's feet.

In some ways the protector was surprisingly gentle toward the conquered country. Impartial law was enforced sound order was maintained, and trade with England and its plantations was opened to the Scots merchants. The general assembly mas forbidden to meet but the lower courts were undisturbed. Scotland was admitted into the commonwealth by what had the appearance of a voluntary union and was given representation in the united parliament under the terms of the various paper constitutions of the time. But material benefits and legal rights did not reconcile the Scots to alien administration. Toleration of the Independents, on which Cromwell insisted, was in their eyes hateful and wicked. Commerce was injured by the protector's Dutch wars, and maritime danger and loss intensified economic dislocation; this in turn, in conjunction with the growing trend toward larger seagoing ships, led to the concentration of trade in such ports as Leith, Bo'ness, Dundee, Aberdeen and Glasgow, and the degradation of the lesser coastal burghs into fishing villages. Thus even financial prosperity eluded the Scots and the taxation that was levied to help to defray the huge expenses of the military establishment rendered the Cromwellian union—tied as it was both to the sanction of the sword and to religious laxity—trebly unpopular. Though the country took no initiative in bringing about the Restoration (1660), that event was almost universally welcome.

RESTORATION AND REVOLUTION

The Second Episcopacy.—The Presbyterians looked to their covenanted king to respect and favour their legally established church, but Charles's ideas were quite different. His way with men whom he regarded as disloyal sectaries was short and brutal. An obedient parliament in March 1661 passed the Act Rescissory, which at a blow repealed all legislation enacted since 1633 and automatically reinstated episcopacy as the lawful government of the church. Persecution of dissenters began soon after and became the keynote of the reign. Bishops were appointed and given the duty of supervising the lower courts of the church. Lay patronage of livings was restored, all office-bearers had to renounce the covenants, fines were imposed for nonattendance at parish churches, the clergy were ordered to send in lists of absentees, and soldiers were quartered in disaffected areas, especially in the southwest. The people rallied round their ejected ministers, secret conventicles were held, and further repression was attempted: this in turn led to the bearing of arms at field meetings and eventually to open rebellion.

The first rising came late in 1666, when the western insurgents marched upon Edinburgh but were easily defeated at Rullion Green, in the Pentland hills. The earl (later the duke) of Lauderdale came into power as royal commissioner and he was the virtual ruler of Scotland, in Charles's name, until 1679 His policy alternated between phases of mildness and conciliation and bouts of savage persecution; its outcome was another armed rebellion. On June 1, 1679, the Covenanters had a victory over James Graham of Claverhouse (later Viscount Dundee) at Drumclog in Lanarkshire, but three ueeks afterward their small force was crushed by James, duke of Monmouth, at Bothwell Bridge. The king's brother and successor, the duke of York, governed Scotland from 1680, a period which was marked by the widespread use of the boot and the thumbscrew and was long remembered as the "killing time." The closing years of Charles's reign saw the southwest seething with sullen resentment or open defiance of the government.

When the Roman Catholic duke of Tork succeeded as James VII (1685–88), the earl of Argyll, in conjunction with Monmouth in England, headed yet another western rebellion, but the government easily suppressed it, and captured and executed its leader. A fanatically loyal and submissive parliament imposed the death sentence for mere attendance at a conventicle, but even it baulked at toleration for Roman Catholics, on which the king had set his heart (1686). Falling back on the royal prerogative James issued a Declaration of Indulgence (1687), which ended persecution but, because of the popular antipathy to popery, earned him little gratitude from his now thoroughly alarmed subjects. His appointment of Roman Catholics to high office in the central government and his arbitrary nomination of others to burgh magistracies and town councils (1687–88) made the vast majority of the people ready to welcome the Revolution, but no overt action was taken until news came from England of the king's flight and the landing of William of Orange. Then Holyrood, given over to the papists, was sacked, and the episcopal clergy in the south and southwest were "rabbled."

The Revolution.—A convention of estates, summoned by the prince of Orange in April 1689, declared that James had forfeited the crown, and settled it on William and Mary, their issue: and then Princess Anne. The Claim of Right also stated that episcopacy was an insupportable grievance and ought to be abolished, and this avowal of the policy and intention of the convention (which was converted into a parliament in June) inevitably made the Scottish Episcopalians, now and for two generations, a Jacobite party. Edinburgh castle held out for King James until June 13, and Viscount Dundee, his chief Scottish champion, was killed in the hour of victory at Killiecrankie (July 27). His death ended any danger of a Jacobite restoration. Presbytery was re-established in 1690, and later that year the general assembly met, for the first time since 1653. The revolution was complete in church and state.

The *Massacre* of *Glencoe*.—The new regime was disliked in the Highlands and some of the chiefs were slow to take the oaths of allegiance to the king and queen; one of them, Alexander Macdonald of Glencoe, was late in doing so and the government resolved to punish him and his men as technical traitors. Sir John Dalrymple, master of Stair, probably had in mind such a precedent as the issue of "letters of fire and sword." in James VI's reign, against the Macgregors; that clan had, as a result, been expelled from their lands and dispersed. In the case of the Macdonalds, however, the punishment (entrusted to Captain Campbell of Glenlyon) involved the slaughter, in circumstances of peculiarly revolting treachery, of nearly 40 persons, though the majority of the clansmen and their families escaped to the hills (Feb. 12, 1692). Apart from Jacobite propaganda, much sympathy was felt for the Macdonalds and antipathy toward the government, and William was criticized for visiting Dalrymple, the responsible official, with the belated and light punishment of dismissal from office in 1695.

Economic Enterprise.—The greatest change brought by the 17th century to the Scottish economy was the nine years' experiment in free trade under the Cromwellian regime, but Scotland, as we have seen, was unable to take full advantage of the opportunities of the time. Both before and after the protectorate, prosperity eluded the nation, mainly because both industry and commerce were still subject to restrictive practices of the kind associated with feudal privilege. Efforts were made to break out into new lines. The crown granted many monopolies to encourage individuals or partnerships to set up new industries, *e.g.*, linen weaving, glass blowing, soapmaking and leather tanning. Other attempts were made to maintain and expand the traditional rural and semirural occupations, such as the trade in black cattle, the knitting of stockings, the weaving of coarse plaiding, coal mining, and the export of cured salmon and herring; a fishery society on a grand scale was promoted by Charles I (1632) and also by Charles II (1661), but in each case the result was total failure. Some success, however, attended the numerous joint stock companies which were set up by parliament or privy council, especially after 1661; the New Mills manufactory of fine cloth, established in East Lothian, was typical of these (1681–1713).

For the most part the burghs looked askance at these ventures; as early as 1633 they got parliamentary confirmation, in the amplest form, of their exclusive trading rights and, while these were seriously modified by a statute of 1672, they recovered much of the lost ground in 1681 and 1690. Between 1660 and 1707 a large number both of burghs of barony (with local markets and crafts) and of nonburghal weekly markets and annual fairs were set up in favour of nobles and lairds. The alarmed merchants of the royal burghs tried, by the "communication of trade" (1693), to induce the greater of the "unfree" burghs to share the right of foreign trade in return for an undertaking to pay 10% of the burghal tax; but the scheme never worked well.

The Darien Disaster.—The revolution further stimulated the nation in its hankering for economic adventure and material advance. This spirit found expression in a statute passed in 1695 (the year in which the Bank of Scotland was set up). which provided for the formation of an overseas trading company. The English parliament, from mere jealousy, forced the withdra al of the promised English capital; the Scots thereupon raised the money themselves and proceeded with the foolhardy project of colonizing the isthmus of Darien (Panama), on territory claimed by Spain. It was a delicate moment in European diplomacy. and the 1,200 emigrants and traders sent out in 1698 encountered, in addition to an intolerable climate, Spanish hostility and English aloofness; two further expeditions joined in the hopeless struggle against disease, famine and Spanish attacks, and the remnants of Scotland's greatest colonial adventure withdrew in March 1700, after suffering a loss of life and treasure of crippling dimensions.

UNION OF THE PARLIAMENTS

Constitutional Developments.—In Scotland it was Dutch William and the jealous English parliament who incurred the odium of the Darien disaster, but in truth the disaster was a bitter and tragic lesson in the realities of the constitutional dilemma and in the unworkability of the regal union. Before 1689 it was only on rare occasions—at the Reformation crisis (1560) and during "the Troubles" (1638–51)—that parliament had directed national policy; at other times its powers were entrusted to the lords of the articles, a small and manageable business committee drawn from each estate and having a membership resembling too closely that of the privy council. The 17th-century sovereigns of the house of Stewart had to allow their English parliament a great and growing share in the shaping of national policy, but they were able to keep-the Scottish parliament, as it had generally been, little more than a dignified court of registration; as long as the real power lay between the crown and the English ministers, the union of 1603 was practicable. It was disappointing that, in succession, negotiations for a commercial treaty (166;) and for a closer union (1670) broke down, but no acute constitutional problem was posed by these failures.

The reforms of 1689–90 transformed the situation. The lords of the articles were abolished and parliament obtained the right of initiating legislation. Proceedings were minuted, rules of debate were adopted, votes were free and effective, and casual vacancies were supplied by new elections. An act of 1690 modified shire representation to accord better with the distribution of wealth and population: the 11 largest shires got 4 members each, 4 others got 3 each. 16 were left with 2 apiece. Clackmannan and Kinross with 1 each. The 90 "barons" or lairds now formed the largest estate. There were 67 burgesses from 66 royal burghs (including 2 from Edinburgh), and by 1700 some 60–70 of the 140-odd peers were accustomed to attend the sittings in Parliament house. For the last 17 years of its life (1690–1707) the Scottish parliament acted vigorously and effectively in domestic affairs and tried also to control foreign policy; and the existence of two sovereign legislatures under one crown made the continuance of a mere regal union impossible.

In 1689 and again in 1702–03 projects for a closer union miscarried, and in 1703-04 international tension provoked a dangerous legislative warfare between the two parliaments. On both sides of the border, however, statesmen were beginning to realize, with much reluctance, that an incorporating union offered the only mutually acceptable solution to a problem suddenly become urgent. Scotland's need was for economic security and material assistance. England's for political safeguards against French attacks and a possible Jacobite restoration, for which Scotland might serve as a conveniently open backdoor. England's bargaining card was freedom of trade; Scotland's. acquiescence in the Hanoverian succession. Both points were quickly accepted by the commissioners appointed by Queen Anne to discuss union and within three months they had agreed on a detailed treaty (April–July 1706).

The two kingdoms were to be united, the Protestant succession was adopted, and trade was to be free and equal throughout Great Britain and its dominions. Subject to certain temporary concessions, taxation. direct and indirect, would also be uniform. and England, with calculated generosity, compensated Scotland for undertaking to share responsibility for England's national debt by payment of an equivalent of £398,085 10*s*. Scots law and the law courts, and the whole fabric of feudal privilege, were to be preserved. In the united parliament the northern country, because of its relative poverty, was given the inadequate representation of 45 commoners and 16 lords. By separate statutes annexed to the treaty the Presbyterian Church of Scotland and the Episcopal Church of England were secured against change or disturbance, and the Scottish parliament allocated its quota of the 45 commons seats—30 to the shires and 15 to the burghs.

With only minor amendments the Scottish parliament passed the treaty by 110 votes to 69 in Jan. 1707, and the English ministers had no difficulty in either house. Jacobite assertions that the treaty was carried by bribery in Scotland have been shown to be without substance. The royal assent was given on March 6 and the union went into effect on May 1, 1707.

The Jacobite Risings.—The Revolution settlement, the Hanoverian dynasty and the union of 1707 were alike detested in the Highlands. where Jacobite, Roman Catholic and Episcopal sentiments were cherished. Within 40 years of the passing of the treaty four attempts were made in favour of the exiled Stewarts. Two of these which need not be considered were a French invasion which misfired completely (1708) and a west Highland rising, aided by Spain, which was nipped in the bud at Glenshiel (1719). But the 1715 and the 1745 rebellions were formidable affairs.

In the summer of 1715 the earl of Mar, an embittered and unstable ex-unionist, raised the Jacobite clans and the Episcopal northeast for "James III and VIII" (the Old Pretender). **A** hesitant leader, Mar advanced only to Perth and wasted much time before challenging Argyll's numerically inferior force; the result was the drawn battle of Sheriffmuir (*q.v.*), and at the same time the hopes of a southern rising melted away at Preston (Nov. 1715). James arrived too late to do anything but lead the flight of his chief supporters to France.

The outlook in 1745 seemed hopeless, for another French invasion, planned for the previous year, had miscarried and little help could be expected from that quarter. The number of Highlanders prepared to turn out was smaller than in 1715, and the lowlands were apathetic or hostile; but the charm and daring of the young prince. Charles Edward, and the absence of the government troops (who were fighting on the continent) produced a more dangerous rising. Within a few weeks Charles was master of Scotland and victor of Prestonpans (Sept. 21); though utterly disappointed as regards an English rising, he marched south as far as Derby (Dec. 4), and won another battle (Falkirk, Jan. 17, 1746) before retreating to the Highlands. The end came on April 16, when the duke of Cumberland crushed the Jacobite army at Culloden, near Inverness. About 80 of the rebels were executed, many more were driven into exile, and the Highland dress was proscribed until 1782, while the Episcopalian clergy were heavily penalized; but the government, through the commissioners for the annexed estates, did their best to foster education, farming, linen spinning and other crafts from the Highland rents that fell into their hands (1752–84).

Government and Administration.—Scotland's share in the united parliament of 16 representative peers, 30 "barons" or shire members, and 15 burgesses fell short of its deserts. and the position worsened for each of the three groups who had some say in the legislative process. Between 1711 and 1782 Scottish peers who were created peers of Great Britain were. by a ruling of the house of lords. denied a seat as such in the upper chamber; this was resented by many Scots and widely regarded as a major breach of the union. The numbers of shire voters were inflated, in the interests of certain large landowners, by the collusive transfer of the superiority, without the actual possession, of an estate of the qualifying value (£400 per annum); the fictitious votes of these "parchment barons" went far to make many county elections farcical. Burgh representation was limited. in accordance with the feudal structure of society and the Scottish parliament's rigid insistence on traditional privilege, to the 66 royal burghs. Of these, Edinburgh got its own member, but the others were split into districts of four or five neighbouring burghs, without regard to their relative importance, so that Glasgow shared a member with the three small towns of Dumbarton, Renfrew and Rutherglen, and five small fishing villages in Fife got the right that was denied to flourishing places like Paisley, Leith and Greenock.

Parliament in these circumstances could not serve as a focus of the national life, which sought other channels in farming, trade and industry, in education. literature and the arts, and in the disputes and schisms which rent the church. Politics engaged the interest of a tiny minority of the people—a handful of ambitious nobles and lairds, and the legal families of Edinburgh and the Lothians, who formed almost a hereditary caste. The purchase of municipal votes, the claims of kinship in shire elections, the unofficial appointment of an outstanding politician as "manager" for Scotland, and the open use of state patronage to reward loyal support were routine practices. and they explain the general apathy of the nation toward the proceedings at Westminster.

Apart altogether from parliament. there were defects and anomalies in the methods of administering Scotland between 1707 and 1832. The Scottish privy council, the old agency of central executive government, was abolished in 1708 and this measure was denounced by some as a breach of the treaty. From 1709 until 1746 a third secretary of state, with Scotland as his province, was sometimes appointed, but throughout most of the century the English ministers in London relied on a Scottish manager to keep Scotland quiet and amenable. The severe English treason law was extended to Scotland in 1709 as a means of combating the Jacobite threat. That there was no exaggerated sense of respect for the law of the land is clear from the continued prevalence of smuggling and from the Shawfield riot in Glasgow (1725) and the Porteous riot in Edinburgh (1736), each of which was in some sense a popular demonstration against state regulation of trade. The greatest and most far-reaching legal reform of the century was the abolition, from 1748. of heritable jurisdictions—the private rights of justice which were a basic element of the feudal order of society. Thereafter the royal, or public, courts of law improved their standing, while a money economy took the place of the old personal relationships.

In the localities an attempt was made to strengthen the justices of the peace (1708); but neither they nor the commissioners of supply—the great landowners who controlled county finance—were efficient instruments of government. The baronies gradually wilted and lost their powers under the act of 1747 which dealt with heritable jurisdictions. The town councils of the burghs were narrow, self-elective oligarchies; their besetting sin (as portrayed vividly in John Galt's The *Provost*, 1822) was their negligent or corrupt alienation of valuable common lands. The most successful agent of local administration was the kirk session, and it was also the body that was most responsive to the pressure of public opinion. It maintained the parish school, it relieved (with pittances it is true) the aged and impotent needy, it succoured the victims of fire, flood and famine, and it endeavoured to make the parishioners a moral and law-abiding community.

The Rise of the Whigs.—The most capable, and the most notorious, of the Scottish managers was Henry Dundas, who was the trusted lieutenant of the younger Pitt and later became Viscount Melville. During the greater part of the period 1775–1804 he was the virtual ruler of Scotland; his administration was so autocratic, his control of elections so nearly complete. that he was styled "King Harry the Ninth." From the 1780s advanced politicians were advocating the reform of both parliament and the burghs. but the government set its face against the agitation. The outbreak of the French Revolution (1789) at first evoked much sympathy in Scotland. and the Society of the Friends of the People demanded universal suffrage and annual parliaments. As the violence of the revolutionaries developed, the government came to regard the reform movement as seditious; the outbreak of war with France and the inception of the Reign of Terror in that country (1793) impelled the panic-stricken ministers and judges to repression and persecution. Whig protests against "the Dundas despotism" were unavailing and after grossly unfair trials Thomas Muir was sentenced to transportation for 14 years and Thomas Fyshe Palmer for 7 years. Fears of a French invasion led to the enrolment of volunteers in 1794 and of a militia in 1797, but the sullen masses now suspected a design to lure them into foreign service; there was a riot at Tranent in which 11 persons were killed, and four further sentences of 14 years' transportation were imposed. Deposed in 1796 from the deanship of the faculty of advocates because of his political sympathies. Henry Erskine assumed the leadership of the Whig party. The foundation of the *Edinburgh Review* (1802) gave the reformers a journal of standing in which to attack the Tory government. Viscount Melville was impeached in 1805 for peculation; though he was acquitted in the following year, his power was shaken. Nevertheless, his party remained in office, with the exception of a brief interlude in the years 1806–07, until 1830, and stubbornly resisted the ever growing demands for reform.

Social and Economic Life.—The population of Scotland in 1707 has been estimated at about 1,100,000, of which total the towns held less than a quarter. Edinburgh, with some 40.000 inhabitants living in great congestion in its lofty and picturesque tenements, the whole dominated by the massive pile of its ancient castle, was much the largest, as well as the gayest and most colourful, of the towns. Glasgow, the second city, housing 12,500 people, won the admiration of visitors for its broad streets, handsome churches and fresh country air; while favourable comment was sometimes made also on Dundee. Aberdeen and Perth, each with 5,000–8,000 inhabitants. The remaining towns, numbering about 200, depended on local markets, a little coastwise trade and a few petty craftsmen; many burgesses were in fact small crofters living in a village community, and their mean hovels and the ubiquitous heaps of street garbage proclaimed their primitive mode of life.

In the countryside what attracted the eye and evoked the adverse criticism of the traveller was the absence of enclosures, the lack of trees, the open fields, the bad roads and the poor inns. Men moved about only when journeys were unavoidable, and then stayed overnight with friends or relatives in private houses. Nobles and lairds fared tolerably well, the land yielded beef and mutton, ground game, pigeons and game birds, the rivers and seas held salmon, herring, white fish and shellfish; oatmeal was the staple foodstuff, home-brewed ale or claret the customary drink, and the country had a good culinary tradition in rich soups and savoury sweets. The diet of the farmers and tenants showed far less variety and indeed tended toward monotony. Housing was bare and simple, even for the wealthy, and homespun woollens were worn almost universally. If, however, life was harsh and severe, the hardships were suffered in common by a society that was well-knit and had no barriers between the classes: social snobbery was nearly unknown and the laird and his man conversed as equals.

During the 18th century the Scottish economy underwent radical changes. From 1723, when the Society of Improvers in the Knowledge of Agriculture in Scotland was set up, farming techniques were revolutionized in all the better districts; enclosures, crop rotation, fallowing, manuring, drilling, the planting of trees and the growing of winter feed for cattle marked the improved estates. The board of trustees for manufactures (1727) fostered the spinning and weaving of linen. New developments were facilitated by the establishment of stable but enterprising banks, particularly the Royal Bank of Scotland (1727) and the British Linen company (1746). Glasgow's tobacco trade with Virginia and Carolina brought fabulous wealth to its merchant princes. until the outbreak of the American Revolution (1775) put an end to the artificial monopoly. The foundation of the Carron ironworks (1759) and the opening, especially in the last two decades of the century, of new coal pits in the west foretold the transformation of the country that was to come after 1800. A brand new industry appeared in 1779, when the first cotton mill was built at Rothesay, and took firm root with the opening of the New Lanark mill in 1786; by 1800. heavily concentrated in Lanarkshire and Renfrewshire, cotton was Scotland's premier industry. By this time, too, there were 2,000 seagoing ships, instead of the 100 of 1707.

Social changes accompanied the various "improvements." The population grew to 1,608,000 in 1801. when Edinburgh and Glasgow each had about 80,000 inhabitants, and many other towns were likewise attracting new settlers from the country. From about 1750 Edinburgh entered on its gayest. most cultured and most fashionable period; with its newspapers and assemblies, its societies, clubs and coffeehouses. its distinguished university and medical school, it was a brilliant and cosmopolitan city, which, from 1772, carried out in the gracious squares, streets and terraces of the New Town Scotland's most successful town planning of all time. In a modest way other towns strove for elegance and sophistication, while the lairds, benefiting from enhanced rent-rolls. built larger and more comfortable homes, often in the new Palladian style. It is, however, clear—and it was deplored by the ministers—that by 1800 the addiction to heavy drinking was spreading to all classes.

THE REFORM ERA

Parliamentary and Administrative Reform.—Scotland had its share of the postwar discontents of the years 1815–20, and political rioting. which was dubbed the "Radical war;" broke out in 1819–20; the outburst was closely related to agrarian distress and industrial unemployment. In the reign of George IV (whose visit to Edinburgh in 1822 brought a ruling monarch to Scotland for the first time since the reign of Charles 11), the demand for reform gained momentum and the Whigs were returned to power in 1830. The necessity for reform is apparent from the fact that in all Scotland the shire voters fell short of 3.000. while the burgh franchise, confined to magistrates and councillors, extended at most to 1,200 persons. In 1832 came the first instalment of the needed change; the act of that year gave Scotland eight more members, all the additional seats going to the cities and the larger industrial towns. The vote was entrusted to the £10 householder in the burghs and to the £10 proprietors and £50 occupiers in the shires.

Further changes, both in the franchise and in the distribution of seats, were made in Scotland. as in England, by the Reform acts of 1867–68 and 1884–85. In two stages adult male suffrage was conveyed to town and country, while Scotland's quota of seats was again raised, to 60 and eventually to 72. By 1885 Glasgow had seven members. Edinburgh four: Aberdeen and Dundee two each, and Lanarkshire formed six divisions; the arrangements followed the population figures closely and for the first time in the history of the united parliament Scotland had no grievance over its representation at Westminster. In 1872, also, the Secret Ballot act safeguarded the voter against any form of intimidation.

The long and unsavoury tradition of an unofficial manager was abandoned by the Tory government in 1827 and from then until 1885 Scottish administration was controlled by the home secretary, advised by the lord advocate; statutory boards were set up in Edinburgh to supervise poor relief (1845), lunacy (1857), prisons (1877) and fisheries (1882), while an education department, nominally a committee of the privy council, came into being in 1872. These arrangements were both untidy and inefficient, but it was only after considerable agitation that, in 1885, a Scottish secretaryship, of cabinet rank, was conceded. The statutory boards retained a substantial measure of independence, but the secretary's staff, known as the Scottish office, came to be recognized as the chief central agency. The board of supervision (responsible for poor law administration) was transformed in 1894 into the local government board.

Burgh reform was enacted for Scotland in 1833, two years before a similar change was made in England; the councils of the 66 royal burghs and 13 parliamentary burghs (as defined in 1832) were to be elected by the £10 householders. Legislation of 1833 and 1847 allowed the older burghs to adopt a "police" system, including new and growing duties in the sphere of the social services; and acts of 18jo and 1862 permitted "populous places" to become "police burghs." The kirk sessions (greatly weakened by the Disruption of 1843) lost their powers in poor relief to parochial boards (1845) and in education to school boards (1872). County police forces. under the commissioners of supply, were made permissive in 1839 and compulsory in 1857. Other acts dealt with the registration of births. deaths and marriages (1854), public health and water supply (1867) and county roads (1878), but the biggest change came in 1889 with the establishment of elected county councils, administering police. roads, health services and many other branches. The local government reforms of the century were completed with a measure consolidating municipal legislation (1892) and another which committed all parochial duties, save in education, to popularly elected parish councils (1894).

Liberal Ascendancy.—In the general election of 1832 Scotland returned to the reformed parliament 41 Whigs (or Liberals) and 12 Tories (or Conservatives). This was an omen, for until 1900 the Liberals won every general election in Scotland, usually by a substantial margin; there were in 1885 more Scottish burgh seats with unbroken records of Liberal representation since 1832 than without. This experience contrasts sharply with that of England, which was accustomed in Victorian times to a fairly regular saing of the pendulum. The Tory candidates appealed mainly to the landowners and the farmers, whose numbers and influence were steadily declining, while, on their left, the Liberals had little to fear from Chartist or socialist rivalry. The powerful support of Presbyterian dissent. the manufacturing interest, the urban middle class and large sections of workers was aligned behind the Liberals, who also enjoyed the backing of the two leading newspapers—the *Glasgow Herald* and the *Scotsman*. They were thus able to give the British parliament something like a constant bias toward progressive ideas and to advance effectively their cherished causes of free trade (1846), temperance legislation (1853), public education (Scottish act 1872), adult male suffrage (1884), the reform of Scottish administration (1885) and responsible local government (1889 and 1894).

The near-monopoly of Scottish representation held by the Liberals was ended by Gladstone's decision to grant Irish Home Rule (April 1886), which led to the defection of the Liberal Unionists and to the loss of influential press support. In alliance, and ultimately in amalgamation, the Conservatives and Unionists, as champions of the new patriotism and empire loyalty, commanded a volume of support in Scotland that was comparable to that of their opponents. Thus in 1885, before the split, the Liberals had won 62 of the 72 seats, but in 1900 38 Conservatives were returned and only 34 Liberals; Glasgow. which had been represented in 1885 by seven Liberals, elected seven Unionists in 1900. Two generations of Liberal dominance were ended.

The Industrial Age.—In the course of the 19th century the Scottish economy underwent profound changes. Agriculture, protected by the corn laws from 1815 to 1846, and thereafter exposed to the full blast of world-wide competition, tended to become localized and specialized; the arable area shrank, the farming population decreased. Highland crofts and even sheep farms became uneconomic, but Scotland was famed for the wheat of the Lothians and the east country seed potatoes, for Ayrshire dairy products, Clydesdale horses and fruit, and Aberdeen-Angus cattle. Mechanization was applied in turn to the basic processes of the spinning and weaving of cottons, woollens and linens. The hand-loom weaver was squeezed out of the labour market, though for a long period (1820–70) the Paisley shawl makers fought gallantly to maintain their skilled craft. Banks became larger and fewer; there were ten by 1900 (and only six by 1954), most of them with numerous branches throughout the country.

The most spectacular advances were, however, made by the metallurgical industries, which became closely integrated and interdependent and, as heavy industry. dominated the economic life of the country. At its base, coal mining was the primary concern of large numbers (over 100,000 by 1900) in the central lowland belt, stretching from Ayrshire to Midlothian and west Fife. Ironworks, profiting irom David Mushet's discovery of the properties of blackband ironstone (1801) and from James Beaumont Neilson's invention of the hot-blast furnace (1828), were concentrated in north Lanarkshire. Henry Bell's successful steamship, the "Comet" (1812), inspired the establishment of many shipyards. especially on the Clyde. but 'also on the Forth. Tay and Dee. So, too. from the modest beginning of the short Monkland-Kirkintilloch line (1826), a network of railways was spread over the entire country, control ultimately going to five main-line companies. Throughout the century marine and general engineering expanded steadily, and from the 1880s steel-making was carried on intensively in the Motherwell area. By 1900 heavy industry was the life-blood of the nation, though other activities. particularly seaborne commerce and a wide variety of small local businesses, shared in the general prosperity.

The second phase of the Industrial Revolution wrought enormous. and often adverse, changes in the structure of society and in living conditions. The total population increased during the 19th century from 1.608.000 to 4,472,000; even more remarkable was the geographical redistribution of the inhabitants. While one after another the Highland counties passed their peak and began to experience depopulation. and while the numbers in the prosperous farming areas remained fairly stable. the figures for the central lowlands increased sharply every decade. The counties of Ayr, Renfrew. Dumbarton, Lanark. Stirling. West Lothian and Midlothian, with 522.000 inhabitants in 1801, had no fewer than 2,673,000 in 1901: that is, nearly 60% of the total population lived in an area equal to 11% of the whole. Glasgow and Edinburgh, including their suburbs. had 762,000 and 317,000 persons respectively; and great advances were shown, not only by such old towns as Dundee. Aberdeen, Paisley. Leith and Greenock. but also by new, or almost new, concentrations: like Airdrie. Coatbridge, Wishaw, Motherwell. Clydebank and Cowdenbeath. From the 1840s, many thousands of Irish immigrants and their descendants went to swell these totals; it is estimated that in some towns they numbered as many as a quarter of the inhabitants.

While life was pleasant and exciting for the well-to-do, the years 1800–50 meant for the toiling masses crowded in filth and degradation in city slum and mining village inescapable squalor, insecurity and poverty, congestion, disease and death. Typhus fever took a steady toll of the poor. and cholera, in its three major visitations (1832. 1848 and 1854). killed many thousands. The marvels of the age. railway and steamship travel, piped water. gas lighting, did not reach the wage earner. Poor relief was chaotic and inadequate. juvenile delinquency all too prevalent, intemperance the almost universal response to the discontents of the working class. The hasty and unplanned industrialization of the country involved happiness for the few and social deterioration for the many.

Rise of the Social Services.—In the first half of the century private charity did something to alleviate distress by may of soup kitchens, the distribution of clothing and food at times of grave unemployment and the provision of medicines through dispensaries for the poor. Savings banks. mechanics' institutes: friendly societies, trade unions, temperance societies (from 1829) and "ragged" or industrial schools (from 1841) were among the various kinds of collective action taken to combat the ills of society. From 1800, and more especially from 1833. the civic authorities were being entrusted with wider "police" powers which included street cleaning, lighting and water supply. The amendments of the poor law in 1845 encouraged the relief from the parochial rates of the aged and orphans, the impotent and the indigent.

In the main: however, it was only after 1850 that strenuous, and ultimately successful, endeavours were made by the central and local government to ameliorate the conditions of the poorer inhabitants. The cause of temperance was advanced by the Forbes-Mackenzie act (1853). which set up strict control of the liquor trade. Where the need was most acute, a clean and adequate supply of water was provided for Glasgow through the Loch Katrine scheme (1859). Medical officers of health were appointed at Edinburgh (1862) and Glasgow (1863), and soon after special fever hospitals were established. Slum clearance on a large scale was begun at Glasgow in 1866 and at Edinburgh in 1867. Gas lighting was municipalized at Glasgow in 1869 and at other towns not long afterward: electricity and the tramways (horse-drawn from the 1870s, electrified from about 1900) followed in the 1890s. The provision of public parks. municipal washhouses and baths, model lodginghouses and public libraries brought new amenities to the ordinary town dweller, and co-operative societies offered him cheap groceries. Some measure of the general improvement wrought by the social services is afforded by the fact that the death-rate fell from 22 to 17 per 1,000 in 40 years (1860–1900).

THE TWENTIETH CENTURY

Party Politics 1900–1955.—The Scottish electors, by a narrow margin, had supported the Unionist government in 1900, but by 1905 they reverted to their traditional allegiance; in that year they returned 58 Liberals, 12 Conservatives and Unionists, and 2 members of the Labour party. The nation generally favoured the radical policies of the Liberal administrations during the years 1905–14, as instanced by the introduction of old age pensions (1908), house of lords reform (1911). national insurance (1912) and the very controversial Irish Home Rule bills of 1912 and later years; and the two general elections of 1910 made little change in the relative strength of the parties.

World War I.—From Aug. 1914 until Nov. 1918 all energies were bent to the single object of winning the war. In that struggle some 74,000 Scotsmen were killed and a much larger number suffered from wounds, sickness and exposure. The long agony of trench warfare added many heroic pages to the regimental histories, while at home it was a time of feverish industrial activity, of civilian privations, but also, fortunately, of little direct war damage. Party politics were mostly laid aside under a coalition government, though the Clyde Workers' committee advocated extreme socialism and prepared the way for what came later to be known as Red Clydeside.

Between the Wars.—In the "coupon election" of Dec. 1918 (in which, for the first time, all women over 30 could vote), Scotland returned 60 supporters of the Lloyd George administration that had been in office for the latter part of the war, and only 14 opponents. Government by coalition continued until 1922, when party politics were resumed. The most striking feature of the years 1922–31, in Scotland to a far greater degree than in England. was the advance of the Labour party, who won 30 of the 74 Scottish seats in 1922, 35 in 1923, and 38 in 1929; concurrently, the Conservatives made marked gains from the once great Liberal party, who held only 9 Scottish constituencies in 1924 and 14 in 1929. From about 1927 industrial depression and the example of Ireland led to a revival of the demand for Scottish Home Rule, which had been mildly advocated by the Liberals for a generation before World War I; and the Scottish Nationalist party was founded in 1927 to press for complete self-government.

The acute financial crisis of 1931 precipitated the formation of a broad-based national government and the subsequent rout of the Labour opposition. which was reduced in Scotland to seven members. From 1931 the political scene was dominated by the great depression and the measures taken to promote economic recovery, until, from 1936, this major issue was overshadowed by the even greater menace of the approach of war. In Nov. 1935 the national government, now predominantly Conservative in composition and policy, was returned to power with a reduced but still substantial majority (over 240 in the whole country) and won 46 Scottish seats; the 28 others comprised 20 official Labour seats. 4 Independent Labour, 1 Communist and only 3 Liberals.

World War *II* and After.—For nearly six years (1939–45) military, naval and air operations occupied men's thoughts to the exclusion of politics in the narrow sense; though casualties were fortunately fewer (34,000 in the services and 6,000 civilians) than in World War I, and air-borne destruction was lighter than might have been expected. it was again a period of anxiety and danger, of privation and all-pervading "austerity." In May 1940 a national coalition government was formed under the leadership of Winston Churchill. A party truce was agreed and observed for the duration of the war. but toward its end political restiveness declared itself through the election of Sir John Boyd Orr as an

Independent member for the Scottish universities and of Robert McIntyre as a Scottish Nationalist at Motherwell (both in April 1945). In domestic affairs the greatest event of the time was the Beveridge report, outlining a comprehensive plan of social security and a national health service (Dec 1942).

The most remarkable trend of the postwar years was the emergence, to something very like parity. of the Conservative and Labour parties, with the Liberals being squeezed out of existence as a middle group. Labour may be said to have non Scotland by very narrow margins in 1945 and again in 1950, but the returns in 1951 showed the two major parties exactly balanced. nith 35 seats each. while Orkney and Shetland returned Scotland's solitary Liberal member. With one net gain (Central Ayrshire) in 19jj, the Conservatives (including associated parties) could in turn claim to have achieved a slender victory at the polls

Although Scotland had attained (through the Scottish Grand committee) a limited share of legislative devolution and (through the Scottish departments located in Edinburgh) a substantial measure of administrative devolution, agitation continued for a separate Scottish parliament to deal with Scottish affairs. Before 1949 the nationalist movement, while it had attracted much attention and inspired widespread discussion. had achieved by direct political action only one short-lived parliamentary victory and a few gains in local and other elections. In 1949, however, the Scottish covenant nas launched, in an efiort to ain all-party support for a Scottish parliament. Within two years the sponsors of the covenant claimed over 2,000,000 signatures

Economic and Social Development. — The basis of the Scottish economy — excessive and even unhealthy reliance on heavy industry — remained unaltered down to 1914; a large flow of orders for the building of both naval tonnage and merchant vessels kept the shipyards busy and gave an illusion of continuing prosperity. The stimulus of wartime needs in the years 1914–18, for repairs and new ships. for armaments and service clothing, and for home-grown food, meant temporary boom conditions for many of the metallurgical and textile concerns and for farming in general, but such developments as the enforced abandonment of foreign markets (*e.g.*, for coal shipments and textile goods) mere the worst possible augury for Scotland's future. These lessons were brought home painfully during the 1920s, when short spells of profitable enterprise, as in the replacement of lost merchant ships. alternated with long bouts of trade stagnation or depression. The background was supplied by industrial disputes (most notably the prolonged coal stoppage of 1921 and the nine-day general strike of 1926), mounting figures of unemployment and the fierce competition offered in a shrinking world market by such foreign rivals as Indian jute, Polish coal, Czechoslovakian linens and German ships.

The great depression. which began with the financial crisis of 1931, affected Scotland. with its insufficiently varied economy. with peculiar severity. Wheat sold for 24*s*. 8d. a quarter, instead of (as during the war) 70*s*.; at one time in 1931 only one of Scotland's 77 furnaces was in blast; Clyde shipbuilding output. which had stood at 750,000 tons in 1913, sank to 56,000 in 1933; and the unemployed total rose to 407.000 in 1933, or over 30% of the insured workers. Scotland's plight had indeed never been worse.

The country climbed slowly from the depths of the great depression: its recovery was assisted by the adoption of full protection (1932); the designation of central Scotland, as of other areas, as a distressed (later a special. and finally a development) area (1934): the establishment of the Herring Industry board in 1935 (followed in 1951 by that of the White Fish authority); the institution of industrial estates. with factories for renting. starting at Hillington in 1937; and the rearmament orders that flowed in during the years before the outbreak of World War II. That great conflict did less damage to the economy than did World War I; from it. indeed, some positive gains accrued, including steady and assured support for agriculture, and the fruitful work of the north of Scotland hydroelectric board (1943). Under the Labour governments of 1945–51, coal mines, railways and certain sectors of road transport were nationalized, and the welfare state meant high wages and full employment; while strenuous efforts were made, by private as by public enterprise, to introduce new, light, consumer industries. The improvement and diversification of the country's economy were also the aims of the forestry commission. the Scottish council (development and industry), the Scottish tourist board and the crofters' commission, nhile the planning of three New Towns, at East Kilbride. Lanarkshire. Glenrothes. Fife, and Cumbernauld, Dunbartonshire, was another move in the same direction.

Gron th of the population continued in the 20th century (see belon). though at a slower pace than formerly, from 4,472,000 in 1901 to 5,096,000 in 1951. This increase is more than accounted for by the gron th of the eight central counties, stretching from Ayr to Midlothian and Fife (from 2,892 000 to 3,573,000); and by 1951 no less than 82.9% of the inhabitants dnelt in towns of over 1,000 people In the arable farming areas of the east. as well as the crofting Highlands and the dairying southwest, rural parishes were everynhere declining in the face of urban growth.

State policy was directed toward the much-needed improvement of Scottish housing. After 1945 the annual output of building rose to reach a peak of aver 39,500 in 1953, most of these being local-authority houses for renting (see *Housing* below). As a result the numbers living in houses of one or two rooms (which were generally of low standard) fell from 49.6% of the population in 1911 to 29.7% in 1951. Much slum clearance remained to be done; e g., over three-fourths of the inhabitants of tao of Glasgon's wards still lived in one or two rooms. Yet the general death rate dropped from 1j per 1,000 in 1900 to 12 in 1952, while infant mortality which had never been below 100 per 1,000 until 1916, stood at 29 in 1956.

Noteworthy, too, are the social changes which cannot be measured statistically The masses. with increased leisure and higher real wages, made greater use of the agencies of instruction, enlightenment and entertainment such as libraries, museums and art galleries, daily nenspapers and evening classes, rural institutes, clubs and societies. the cinema (from the 1900s), the radio and dance hall (from the 1920s) and television (from 1952). The increased mobility of all ranks by motorbus and car, by bicycle and afoot, brought the countryside back to the city dweller and contributed to the general improvement of the health of the nation.

(G. S. P.)

POPULATION

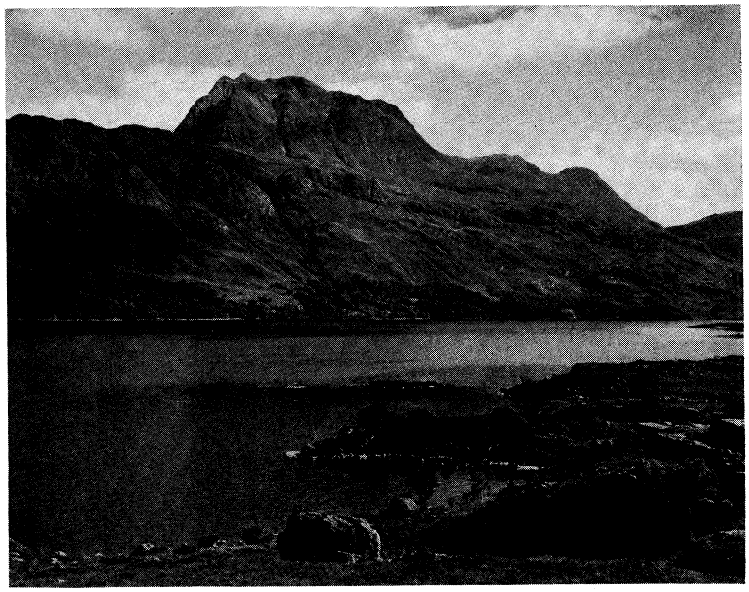
At the census taken in 1961 the population of Scotland was 5,178,490 (females 2,694,320). This was an increase of 1.6% on the number enumerated at the previous census of 1951 and continued the series of intercensal increases recorded at every census except 1931, when a decrease of 0.8% on the 1921 figures was recorded. Since the mid-19th century the population has approximately doubled. At the 1841 census the total population enumerated was 2,620,184, which represented an increase of more than 1,000,000 on the total at the first official census in 1801. At the end of the 15th century it is estimated that the population did not exceed 500,000 — Edinburgh having about 20,000 inhabitants, Perth about 9,000, and Aberdeen, Dundee and St. Andrews about 4,000 each.

Since the middle of the 19th century there has been a net emigration from Scotland to other countries of about 1,870,000, of whom about 1,400,000 have emigrated since 1900. In 1921–30 emigration was over 390,000, or about 8% of the population at the beginning of the decade. Because the age groups affected were in the lower range, the consequential loss was greater than the total suggests. The 1920s were years of considerable unemployment but in the next decade and during World War II the outward flow of migration mas checked, and in the years 1931–51 the net loss was about 240,000, mainly to England. After 1951 it averaged about 24,000 a year.

There has also been an appreciable inflow of population. At the 1931 census 346,050 of the population (7.14%) were born outside Scotland. In 1951 the number was 400,537 (7.86%), of whom 231,794 were born in England and Wales, 43,354 in Northern Ireland and 45,126 in the Republic of Ireland.

If the population were evenly distributed throughout Scotland it would have amounted in 1961 to 174 per square mile. Actually,

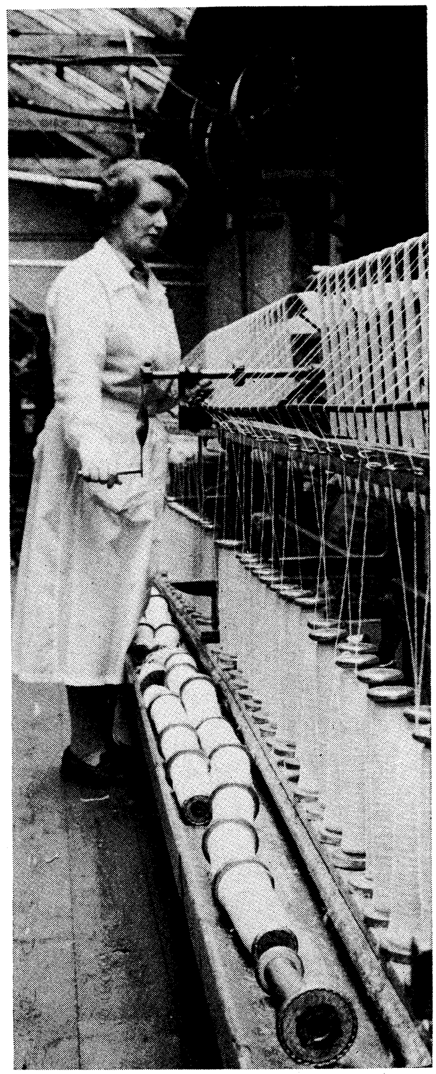
Balmoral castle, on the River Dee, Aberdeenshire; Scottish baronial style



Loch Maree, with Ben Slioch (3,217 ft.) in the background, county of Ross and Cromarty, northern Scotland

City of Edinburgh seen from Calton hill. Edinburgh castle stands in the background on the left. The Greek style temple commemorating Dugald Stewart is on the right

Hammer throwing event at the Royal Braemar gathering for Highland games, Aberdeenshire

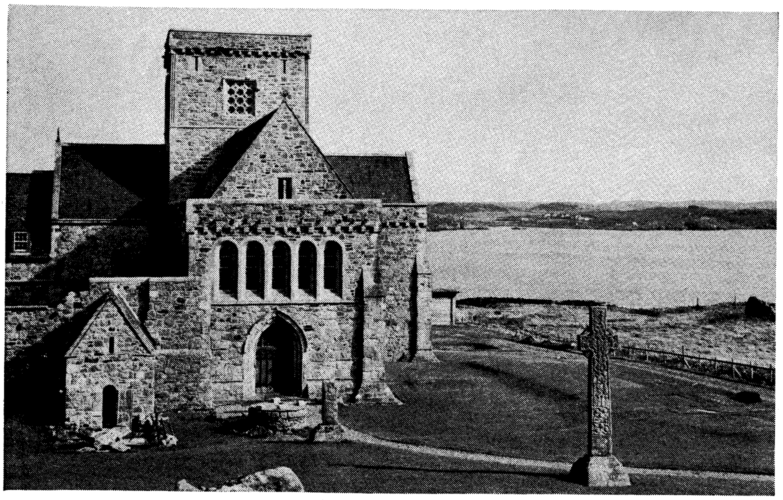


Worker in an Inverness tweed and woolen mill

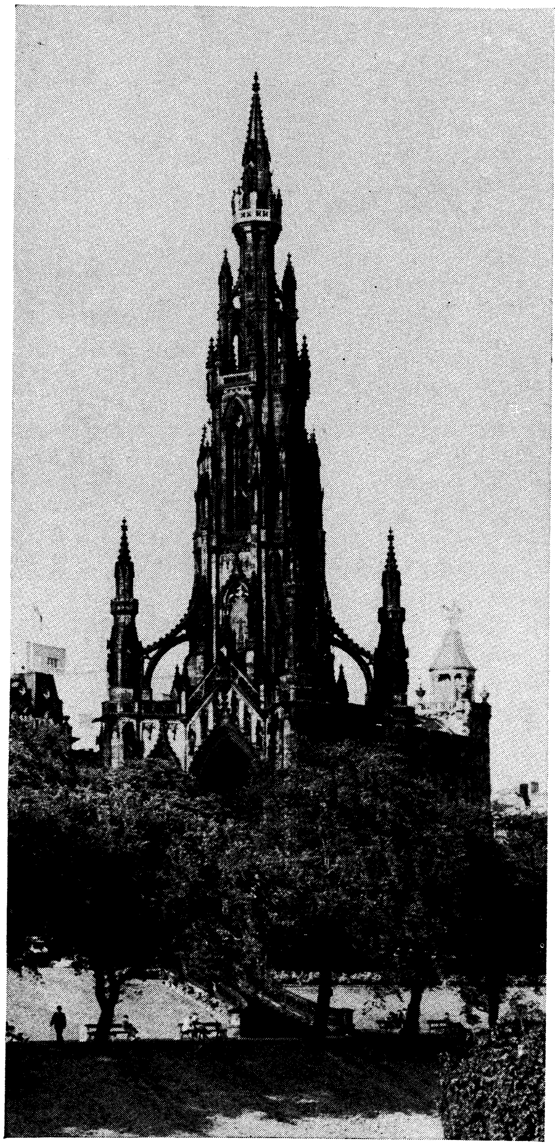
VIEWS OF SCOTLAND AND SCOTTISH LIFE

BY COURTESY OF (BOTTOM LEFT) THE BRITISH TRAVEL AND HOLIDAYS ASSOCIATION; PHOTOGRAPHS. (TOP LEFT) AEROFILMS, LTD., FROM EWING GALLOWAY, (TOP RIGHT, BOTTOM RIGHT) BEN DARBY, (CENTRE LEFT) AUTHENTICATED NEWS

SCOTLAND

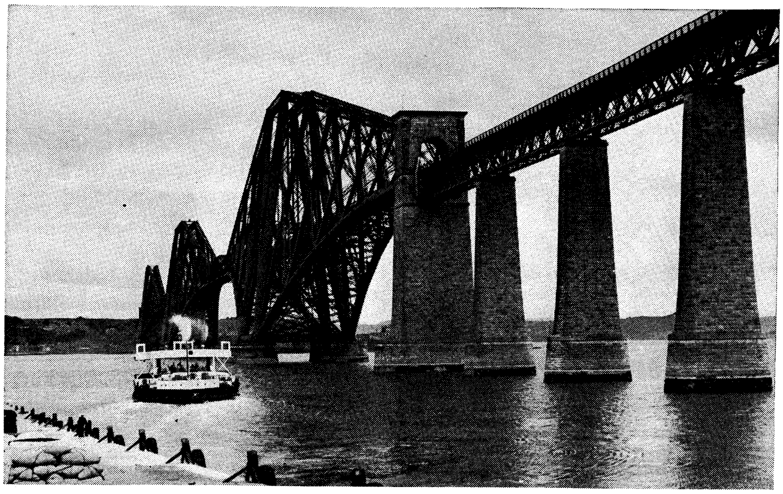


Cathedral, 13th–16th centuries, Isle of Iona. The Iona cross is in the foreground; 9th or 10th century

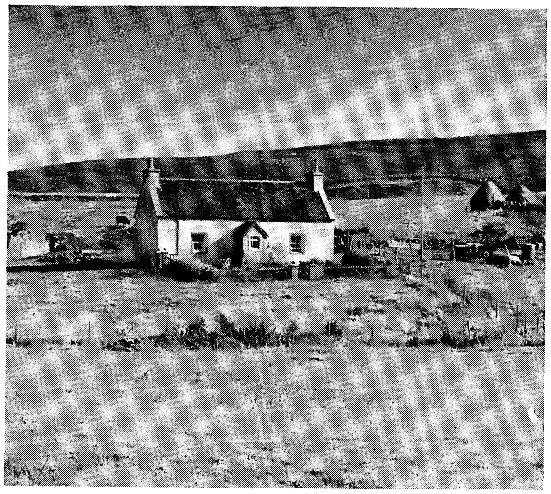


Sir Walter Scott monument, East Princes street gardens, Edinburgh. Erected in 1846, the 200 ft. Gothic spire forms a canopy over a statue of Scott

East end of Union street, Aberdeen, showing the municipal buildings (1868–74) in the right foreground



Firth of Forth bridge, Edinburgh. Its two main spans are each 1,700 ft., its length is 5,330 ft. Designed by John Fowler and Benjamin Baker



Croft (small tenant farm) near Aultbea

SCENES IN SCOTLAND

BY COURTESY OF (TOP LEFT) THE BRITISH TRAVEL AND HOLIDAYS ASSOCIATION; PHOTOGRAPHS, (TOP AND BOTTOM RIGHT) BEN DARBY, (CENTRE LEFT) THE SCOTSMAN PUBLICATIONS LTD., (BOTTOM LEFT) ALTHENTICATEO NEW6

by far the largest part of the country had a population density of less than one person per square mile, the maximum degree of concentration being found in the highly industrial area lying approximately between the upper reaches of the Firth of Clyde and the Firth of Forth. A secondary but much smaller concentration is found along the southwestern and the eastern coasts. During the period 1951-61 there was a slight loss of population in most of the northern and border counties. and a more than compensating gain in the central industrial area. The population in the different counties is shown in Table I.

TABLE I.—Area and Population of Civil Counties in Scotland
(1951 census)

Civil counties		Area (sq. mi.)	Population
1. Northern:	Zetland (Shetland)	551	17,809
	Orkney	376	18,743
	Caithness	686	27,345
	Sutherland	2,028	13,442
2. Northwestern:	Ross and Cromarty	3,089	57,607
	Inverness	4,211	83,425
3. Northeastern:	Nairn	163	8,421
	Moray	476	49,156
	Banff	630	46,400
	Aberdeen	1,971	298,503
	Kincardine	382	48,810
4. East Midland:	Angus	874	278,370
	Perth	2,493	127,018
	Fife	504	320,541
	Kinross	82	6,704
	Clackmannan	55	41,391
5. West Midland:	Stirling	451	194,858
	Dunbarton	241	184,546
	Argyll	3,110	59,315
	Rute	218	15,129
6. Southwestern:	Renfrew	225	338,815
	Ayr	1,132	342,855
	Lanark	898	1,626,317
7. Southeastern:	W. Lothian	120	92,764
	Midlothian	366	580,332
	E. Lothian	267	52,653
	Berwick	457	22,441
	Peehles	347	14,117
	Selkirk	268	21,055
8. Southern:	Roxburgh	665	43,171
	Dumfries	1,075	88,423
	Kirkcudbright	897	28,877
	Wigtown	487	29,107

During the period 1951-61 speakers of Gaelic declined by 19,939 to 75.508, of whom 1.079 spoke no English. The two principal Gaelic-speaking counties were Ross and Cromarty and Inverness. In 26 counties less than 1% of the population spoke Gaelic. There had been comparatively little diminution since 1891 in the number of children aged three and four years speaking Gaelic but not English. which would indicate that the language was still largely in use in the homes of the people. The percentage speaking only Gaelic began to fall after the beginning of school life, and continued low through middle age, rising again with those aged 60 and over.

Births during 1931–50 totaled 1.849,272, an annual average of 92.464. In 1955 there were 92,539 births. equal to a rate of 18 per 1.000 of the population. Births per 1,000 married women aged 16-44 in 1955 were 134.2. The average size of the families of women aged 4j-jo at the time of the 1951 census was 2.52. The corresponding figure for 1911 was 5.08.

The average annual death rate for Scotland in 1931–50 was 13.2 per 1,000. This rate had progressively diminished since 1861–70, when the registered rate reached 22.1. Deaths from all causes in 195j numbered 61.645. representing a death rate of 12 per 1.000.

The average annual marriage rate in 1931–50 was 8 1 per 1.000 of the population. The comparable figure in the period 1921–30 was 6 9 During and immediately after World War II the rate rose considerably. reaching 9.4 in 1945. In 19jj there were 43,212 marriages registered. which represented a rate of 8 4 per 1.000. The rate was higher in the central industrial area than in the north or south. The Marriage (Scotland) act, 1939, operating from July 1, 1940, abolished irregular marriages by declaration. including what was often known as the "Gretna Green marriage" and "marriage before the sheriff." It instituted a new form of civil marriage. to be contracted after publication of notice in the office and presence of registrars authorized for the purpose. In 1955 there nere 8.333 such civil marriages.

The populations of the largest towns (1961 census) were: Glasgow 1,054,913, Edinburgh 468,378, Aberdeen 185.379, Dundee 182,959, Paisley 95,753, Greenock 74,578, Motherwell and Wishaw 72,799, Coatbridge 53,946, Kirkcaldy 52,371.

SOCIAL CONDITIONS

Religion. — The Church of Scotland (Presbyterian) is the most influential and powerful religious body in Scotland (see SCOTLAND, CHURCH OF and FREE CHURCH OF SCOTLAND). Its system of government is based on the right of congregations to choose their own ministers. The administration of each parish is in the hands of a kirk session, comprising the minister and ruling elders, nominated by the congregation; groups of parishes constitute presbyteries; and these latter are grouped in synods. The presbyteries send clerical and lay representatives to the general assembly of the church. held annually in Edinburgh. The number of communicants in the Church of Scotland at the end of 1954 was 1,292,127. The Roman Catholic population in Scotland is estimated to be more than 760,000. It is located mainly in Glasgow and the neighbouring towns, where many Irish immigrants have settled, but there remain a number of Roman Catholic communities in the isolated parts of the Highlands and in the Hebrides which were unaffected by the Reformation. The Episcopal Church in Scotland had 56 528 communicants in 1955 Other religious groups include the Baptists, the Methodists. the Congregationalists and the Unitarians, while there is also a Jenish community of about 15,000 mainly concentrated in Glasgow.

Education. — History. — Schools were founded in Scotland during the middle ages under the patronage of the church and latterly also of the burghs, but it was only after the Reformation that the ideal of a comprehensive system of education was formulated. The First Book of *Discipline* (1560), drawn up by the leaders of the Reformed Church. included a scheme which provided that every town was to have a school and every parish a schoolmaster, and that the children of all, whether rich or poor. were to receive education according to their capacity. The Reformed Church lacked the resources needed to carry out this scheme, but the ideal behind it was never lost sight of. and in 1696 the Scots parliament enacted that it should be the duty of the heritors (landowners) of every parish to provide a "commodious house for a school" and the salary of a teacher.

From 1834 Scotland received parliamentary grants for education, and government inspection of schools followed. The supervision of the schools had long remained with the church, but the Education (Scotland) act of 1872 transferred the organization and administration of education to popularly elected school boards, and made education compulsory betneen the ages of 5 and 13. The school leaving age was raised to 14 in 1901 and to 15 in 1947. The Roman Catholic Church and the Scottish Episcopal Church retained their voluntary schools until the passage of the Education (Scotland) act 1918, which substituted for the school boards 33 county and 5 urban ad *hoc* education authorities and provided for the transfer to them of church schools subject to conditions designed to preserve their denominational character. The Local Government (Scotland) act, 1929. eliminated the separate education authorities and committed the local administration of education to the county councils and the tonn councils of the four cities (Edinburgh. Glasgon. Xberdeen and Dundee). The Education (Scotland) act. 1945, contained fewer important innovations than the English act of 1944, as some of the major changes effected by the English measure had already been carried out in Scotland. The Education (Scotland) act, 1946. which consolidated earlier Scottish educational legislation, conferred on the secretary of state for Scotland various poners and duties. including the distribution of grants, nhich are exercised through the Scottish education department and laid on the 35 education authorities the duty of making adequate provision for educational needs.

Types of *Schools*.—There are three main classes of schools in Scotland, all subject to inspection; public schools. managed by education authorities; grant-aided schools, conducted by bodies of voluntary managers nho receive grants from the secretary of state, and independent or private schools, nhich receive no assistance from public funds but are required to be registered In the year ending July 31, 1957, there were 3,234 public schools, with over 842,000 pupils, 31 grant-aided schools with over 15,000 pupils, and approximately 160 independent schools attended by about 22,000 pupils. Over a quarter of the public schools are one-teacher schools. while those with not more than three teachers amount to almost half the total. Of the public and grant-aided schools, 787 provide secondary education. and of these 203 provide a full secondary course extending to at least five years. Primary and secondary education is available free in public schools. The functions of education authorities include the medical inspection of school children, the provision of milk and midday meals, the convevance of children living at a distance from school and the award ofbursaries covering both school and postschool studies.

The primary school is attended by children from 5 to about 12 years of age. The Schools (Scotland) code prescribes only the broad general lines which the curriculum should follow, the actual framing of detailed courses being left to the school authorities, subject to the approval of her majesty's inspector. Pupils are allocated, generally between the ages of $11\frac{1}{2}$ and $12\frac{1}{2}$, to the various types of secondary course according to their fitness to profit from them, assessed on teachers' estimates of attainment, intelligence tests and attainment tests. Regard is also paid to the wishes of the parents. Secondary schools are of two main types. those providing courses extending to three years (junior secondary schools) and those providing courses of five or six years (senior secondary schools). In each type of school the courses are intended to provide a general education. but they are differentiated to suit the varying needs and abilities of the pupils, and include academic, commercial, technical, domestic and rural courses. There are a number of comprehensive or omnibus schools in which all types of courses. both junior secondary and senior secondary. are provided. Modified courses are also provided for pupils of limited ability. Most schools are attended by both boys and girls. The courses in senior secondary schools normally extend to five or six years and lead to presentation for the Scottish leaving certificate, which is awarded and issued by the Scottish education department. A student securing the requisite number of passes obtains exemption from the entrance examinations of Scottish and some other universities and also admission to or exemption from the examinations of a number of other professional and examining bodies. Special schools are provided by education authorities for children with physical or mental handicaps.

There are 21 approved schools in Scotland to which the courts under the Children and Young Persons (Scotland) act, 1937, may send children under the age of 17 who need care and training. All but one of these schools are under voluntary management.

Further Education.—The great majority of young people enter employment direct from school, most of them at the age of 15. Since 1942, those who wish to enter certain industries have in many parts of the country been given the opportunity of attending full-time prevocational courses. Once they are in employment, young people may supplement practical experience by attending evening classes or part-time day-release classes. Apprenticeship training schemes are in operation in various industries. Advanced instruction in various technical and commercial subjects, in the arts and in domestic science is provided in the colleges, known as central institutions. which are under the management of independent bodies of governors and function to a considerable extent on a regional basis. Three agricultural colleges are under the general administration of the department of agriculture and the remaining 13, which include the Royal College of Science and Technology in Glasgow and the Heriot Watt college in Edinburgh. are under that of the Scottish education department. Many of the central institutions award diplomas or certificates. Others present students for national diplomas, or for certificates awarded after three and five year courses of part-time classes. For certain courses, some of the central institutions are affiliated to local universities and prepare students for degrees.

The number of students attending cultural and recreational classes for adults in 1957 was about 95,000. Through the generosity of the 11th marquess of Lothian, Newbattle Abbey college was opened as a residential college of adult education under a representative governing body in 1937. Facilities for leisure-time occupation for young people over school age are provided largely by voluntary associations and the churches with assistance from education authorities. who also make some direct provision.

All teachers in public and grant-aided schools in Scotland are expected to hold one of the certificates issued by the secretary of state on successful completion of a course of professional training. Courses of training last from one to three years according to the nature of the certificate and the degree or other qualification already held. The total number of certificated teachers employed at Oct. 7, 1957, in educational establishments of all kinds was 36,109.

TABLE 11.—Attendance at Scottish Educational Establishments,

Sessions	1938–39	1956–57
Nursery schools and classes		4,461
Primary schools and departments		603,427
Secondary schools and departments	179,930	240,188
Special schools and classes		
Approved schools	1,596	1,264
Central institutions (day and evening classes)	21,281	29,170
Further education centres (day and evening classes)	172,518	216,714

Universities.—There are four universities in Scotland: St. Andrews (founded 1411), Glasgow (1451), Aberdeen (1494) and Edinburgh (1583). By the Universities (Scotland) act, 1858. as modified by the Universities (Scotland) act, 1889, the government of the universities as regards things academic is entrusted to the senate and as regards finance and general administration to the university court. Within this framework, the University of St. Andrews, under the Cniversity of St. Andrews act, 1953, enjoys a constitution differing in some respects from those of the other universities because its teaching activities are divided between Dundee and St. Andrews. The local ton-n councils, including Dundee in the case of St. Andrews university, are represented on university courts. Although the universities receive parliamentary grants, they are autonomous institutions, with their own endowments.

The titular head of each university is the chancellor, elected for life by the general council. The office of vice-chancellor is usually held by the principal of the university, who is appointed in the case of the universities of St. Andrews, Glasgow and Aberdeen by the crown, and in Edinburgh by a body of curators of patronage. The principal is also president of the university senate, and the rector, elected triennially by the matriculated students, is the president of the university court. The court is the supreme authority in regard to finance and the regulation of the duties of professors and lecturers. The university senate consists of the principal, all the professors, and readers and lecturers specially elected, its main responsibility being the teaching and discipline of the university. The general council, comprising the chancellor, the members of the university court, professors, lecturers and readers, and all graduates. meets twice a year to consider proposals for alteration or improvement in the arrangements of the university. The domestic affairs of each faculty in the university are administered by a dean. The faculties consist of arts, science, divinity, law and medicine.

In 1901 Andrew Carnegie founded the Carnegie Trust for the Universities of Scotland. the annual income of which (about £120,000) is devoted partly to the payment of students' fees and partly to assist the universities in their development projects and in fostering research. This gift, together with bursaries provided by education authorities, has helped to make it possible for anyone to attend the university who is able to obtain the necessary qualifications for admission.

The Royal College of Surgeons, the Royal College of Physicians of Edinburgh and the Royal Faculty of Physicians and Surgeons of Glasgom jointly confer registerabie medical qualifications.

The Arts.—Since the end of the 19th century Scottish contributions to the arts have been mainly in the fields of painting and writing. The scene dominated by William MacTaggart and the painters of the Glasgow school until the outbreak of World War I was later occupied by S. J. Peploe (1871–1935). His chief contemporaries were Leslie Hunter (1879-1931) and F. C. B. Cadell (1883-1937) and the influence of the group can be seen in the work of W. G. Gillies. MacLauchlan Milne and William MacTaggart, grandson of the landscape painter. The work of the painters and sculptors is seen at the annual exhibitions of the Royal Scottish academy in Edinburgh and the Royal Institute of the Fine Arts in Glasgow. Other annual exhibitions are those of the Society of Scottish Artists, which specially encourages experimental work, and the Royal Scottish Society of Painters in Water Colours. In architecture the functionalism of Charles Rennie Mackintosh (1869-1928) has had a wide influence, even more abroad than in Scotland. For the work of such earlier Scottish painters as Allan Ramsay and Sir Henry Raeburn see their biographies.

For Scotland's main contribution to literature see SCOTTISH LITERATURE. It should be noted, however, that the revival of interest in drama has been a marked feature of the 20th century and the work of James Bridie (O. H. Mavor) (1888-1951) has had a stimulating effect. It was largely due to his inspiration that the Glasgow Citizens' theatre was founded. There are now thriving repertory theatres also in Dundee. Perth and Edinburgh. The Scottish Drama association has successfully formed many small amateur groups throughout the country.

In 1947 the Edinburgh International Festival of Music and Drama was founded. With its complementary art exhibitions. film festival and military tattoo. it is held annually for three weeks in late August and early September and has established itself as a notable event in the British calendar.

Cultural Institutions.— Library services are operated both by tonn councils which have adopted the Public Libraries (Scotland) acts, 1887 to 1955, and by county councils under the Education (Scotland) act. 1946. The development of libraries in Scotland has been greatly stimulated both by the liberality of Andre\\ Carnegie during his lifetime and also by the support of the Carnegie United Kingdom trust. which is responsible for the establishment of the Scottish Central Library for Students.

The Library of the Faculty of Advocates in Edinburgh. which had been founded in the 1680s and had enjoyed since 1709 the privilege of deposit under the Copyright act of that year, became the National Library of Scotland in 1925, when its great collections of books and manuscripts, other than those concerned aith lan. were offered to the nation. The library contains the largest collection of Scottish books and manuscripts in the world and. nith a leaning to the humanities rather than natural sciences, it maintains collections representative of the western norld and especially of France. Spain and the United States.

The Royal Scottish museum established in Edinburgh in 1854, is financed by the government and is under the administration of the Scottish education department. There are four departments: art. archaeology and ethnology; natural history; geology; and technology. It provides a world-wide review of the natural and applied sciences and of man's handicrafts, exclusive of pictorial art and modern sculpture. It lays considerable emphasis, however on the Scottish fauna and upon Scottish achievements in the realm of industry and technology. The National Gallery of Scotland, opened in 1859, and the Scottish National Portrait gallery, opened in 1889 (both in Edinburgh) are financed by the treasury and a number of private endowments and are controlled by a board of trustees responsible to the secretary of state. The National Gallery of Scotland contains a collection of European paintings from the 14th to the early 20th century which includes such masterpieces as Velasquez "An Old Woman Cooking Eggs,· \ermeer's "Christ in the House of Martha and Mary," Rembrandt's "Hendricke Stoffels in Bed." Watteau's "Fête Vénitiennes" and Constable's "The Vale of Dedham." Scottish painting is represented more thoroughly. uith particular emphasis on Ramsay, Raeburn and Wilkie, and on moderns such as Peploe, Hunter and Cadell.

The National Museum of Antiquities of Scotland (Edinburgh) has one of the most important prehistoric collections in Britain; a notable Roman section including the Traprain treasure: rare relics of the Celtic church and other dark age and Viking metalwork, with a large series of sculptured monuments. Relatively less of consequence has survived from medieval Scotland. The museum has the best collection of Scottish coins and of 17th- and 18th-century Scottish weapons and accessories, and considerable domestic and "folk-life" sections.

The National Trust for Scotland was founded in 1931 to promote the preservation of lands and buildings of beauty or historic interest. Among the properties the trust has acquired are such scenes of beauty and grandeur as Glencoe and Rintail, such monuments of the past as Bannockburn and Culloden, and the birthplaces of such national figures as Thomas Carlyle (at Ecclefechan), J. M. Barrie (at Kirriemuir) and Hugh Miller (at Cromarty). The trust has restored old buildings to use, as in the old burgh of Culross in Fife, and also holds several castles and family mansions. such as Crathes castle and Falkland palace, on terms which, while securing access to the public. enable the family to remain in residence, thus perpetuating a living historic association.

GOVERNMENT

Central Government.— Since the union of the Scottish and English parliaments in 1707, Scotland has been represented in the house of lords and the house of commons. The provision of the Treaty of Union whereby the holders of Scottish peerages created before 1707 are represented by 16 of their number elected at the beginning of each parliament still stands but there is a much greater number of Scotsmen in the house of lords uho hold peerages of Great Britain or the United Kingdom created since then. In the house of commons, by the Treaty of Union. Scotland was given 45 members. This number has been increased at different times since the Reform bill of 1832. By the Representation of the People act, 1948, Scotland was divided into 71 constituencies, each of which returns one member to the house of commons.

In the house of commons it is the practice for bills which apply exclusively to Scotland. and occasionally the Scottish part of a bill applying to Great Britain, to be referred for consideration to the Standing Committee on Scottish Bills.

On the union of the English and Scottish parliaments the ministers who had previously been responsible for Scottish administration for the most part ceased to exist. The law officers, known as the lord advocate and the solicitor general for Scotland. continued to discharge their legal functions and soon after the union of 1707 an additional secretary of state was appointed for Scottish affairs. But the appointment was by no means continuous and between 1 jog and 1746 the office was vacant during 20 years. The additional secretaryship came to an end altogether in 1746. For a period thereafter Scottish business fell to the department of the northern secretary of state; and in 1782 the home secretary was made responsible for Scottish affairs. the lord advocate, chief law officer of the crown in Scotland, acting as his adviser. This arrangement was increasingly resented in Scotland and in 1885 the new office of secretary for Scotland was created. To the holder of this office were transferred functions relating to Scotland previously assigned to the home secretary, the privy council. the treasury and the local government board. The headquarters of the secretary for Scotland, the Scottish office. were in London. In 1926 the office of secretary for Scotland was abolished and the functions of its holder transferred to a principal secretary of state. The Scottish ministers. in addition to the secretary of state who is a member of the cabinet, include the lord advocate. the solicitor general. a minister of state and three parliamentary undersecretaries.

During the 19th century and the early years of the 20th century a number of boards were established in Edinburgh to deal with various aspects of Scottish administration. All of these boards mere in varying degrees subject to the control of the secretary for Scotland. In 1928 three of the most important of them were replaced by departments of the standard civil service pattern. each directly answerable to the secretary of state. In 1935 a division of the Scottish office (*i.e.*, the secretary of state's office in London) was opened in Edinburgh. Then in 1939, by the Reorganization of Offices (Scotland) act. the functions of the Scottish departments and boards were transferred, with minor exceptions, to the secretary of state, who set up four administrative departments in St. Andrew's house, Edinburgh. These four main departments are the department of agriculture for Scotland, the Scottish education department, the department of health for Scotland and the Scottish home department. In the spheres of foreign and commonwealth affairs, trade, industry, employment, supply, transport (with the exception of roads. which became the responsibility of the secretary of state for Scotland in 1956) and defense, in which the life of Scotland is closely interlinked with that of England and Wales, the responsibility for administration is vested in departments of ministers whose functions extend throughout Great Britain. The secretary of state takes a general interest, however, in all administration affecting Scotland and ensures that, even in matters for which he is not directly responsible, the interests of Scotland are safeguarded.

Local Government. — Scottish local government has its antecedents in the burghs, shires and parishes of medieval Scotland. The burghs were primarily settlements of merchants and craftsmen, often with special privileges and property granted to them by charter from the crown or from territorial magnates for the fostering of trade. The shire was the area over which the sheriff, as the royal representative, had jurisdiction for the preservation of law and order. The parish nas centred on the church and concerned itself from early times with the relief of the poor and with education. In the 19th century, the industrial revolution and the attendant huge increase in population in central Scotland brought new and pressing problems of local government and at the same time a demand for more democratic control of local government units. Throughout that century there was a twofold movement: to set up town councils for the new communities which had come into being; and to reform the constitutions of town councils of the old royal and parliamentary burghs. Elected county councils were set up in 1889 and were given powers chiefly in relation to roads, police and public health; elected parish councils were set up in 1894 but were abolished in 1929.

The local government system in Scotland as it exists today mas established by the Local Government (Scotland) act, 1929, but is now based for the most part on a consolidating act of 1947. The country is divided into 33 counties, two pairs of which—Perth and Kinross, and Moray and Nairn — are combined for certain purposes; there are also large and small burghs and four counties of cities (Edinburgh. Glasgow. Dundee and Aberdeen); the part of the county outside the burghs is known as the "landward area" and is divided into districts. Local government is by town councils, county councils and district councils. The powers of town councils vary according to the degree of importance of the burgh. In the counties of cities the town council performs all local authority functions; in the 20 large burghs the town council performs almost all functions except education. valuation for rating and, in some cases. police; in the 173 small burghs the town council performs some (*e.g.*, housing, water supply and cleansing). but another large group (including education, police, classified roads and health services) is performed by the county council. In the landward area of the county the county council exercises all local authority functions except certain minor ones mostly concerned with amenity which are entrusted to district councils. District councils may also exercise powers delegated to them by the county council.

Town council elections in burghs are held annually to replace the third of the council who have been longest in office. The whole of each county council is elected once in every three years. The district council is elected along with the county council.

The cost of the services provided by the local authorities in Scotland is met principally from rates and government grants, and, to meet expenditure of a capital nature, by the raising of loans. Rates are levied on the owners and occupiers of lands and heritages on their ratable value. as shown in the valuation roll; properties are revalued every five years under the Valuation and Rating (Scotland) act, 1956, but the roll is made up yearly to show gross annual, net annual and ratable values. There are two main kinds of government grants. Grants are paid toward the cost of specific services (such as education, housing, roads, child care, police, fire services and civil defense) and are normally a given percentage of approved expenditure. The other type of grant is the exchequer equalization grant which is given toward the general expenditure of local authorities; the effect of this is to bring the financial resources of local authorities up to a certain national average. Other sources of local authority income include rents of local authority houses; fees, fines and miscellaneous charges; and profits from trading undertakings such as transport services, markets and slaughterhouses.

A feature of burgh finance peculiar to Scotland is the "common good." which originally formed the main revenue of burghs and normally consisted largely of property granted in the foundation charter or subsequent gifts. The purposes for which the income from the "common good" can be used include, generally speaking, anything which furthers the general good of the inhabitants or the dignity of the burgh, and thus it can be used for purposes for which there is no authority to levy a rate. Not all burghs have a "common good" and in 1947 local authorities in general were given power to set up "fee funds" from certain fees and commissions, which may be used for any purpose for which the "common good" may be used.

Law and Administration. — By the Act of Union of 1707 the legal system then existing in Scotland was preserved and the civil and criminal jurisdiction of the Scottish courts has remained separate and distinct from that of England. The supreme civil court is the court of session, which is composed of 15 judges and sits in the old Parliament house in Edinburgh It is divided into an outer house consisting of seven judges, and an inner house consisting of two divisions of four judges. Each division sits as a court of appeal — the first presided over by the lord president and the second by the lord justice-clerk — to hear appeals from the outer house or the sheriff court (see belou). A right of appeal from the decision of the court of session normally lies to the house of lords. The supreme criminal court of Scotland is the high court of justiciary, of which the judges are the same as those of the court of session. It sits not only in Edinburgh but also on circuit in certain cities and burghs. Trials before the high court are always trials by jury, the Scottish jury consisting of 15 persons. The verdict may be returned by a majority and may in cases of reasonable doubt be one of "not proven." Since 1926 the high court, sitting as a court of criminal appeal, has been empowered to hear appeals in certain cases tried by jury in either the high court or the sheriff court. There is no appeal in criminal cases to the house of lords. Scotland is divided for local judicial purposes into 12 sheriffdoms, for each of which the crown appoints a sheriff and a number of sheriffs substitute. The sheriffs of Lanarkshire and of the Lothians and Peebles and the sheriffs substitute throughout Scotland are whole-time resident judges presiding over the sheriff courts, a Scottish institution of great antiquity. The other ten sheriffs are part-time officers, chosen from among leaders of the Scottish bar, whose functions are normally limited to hearing occasional appeals from their sheriffs substitute and to performing certain administrative duties. The sheriff court has a civil jurisdiction virtually concurrent with that of the court of session (except that it cannot deal with divorce) and it also has a wide jurisdiction in criminal cases. Minor criminal offenses may be tried in the burgh police court presided over by magistrates appointed (except in the case of one stipendiary in Glasgow) by the town council from among their own number, or in counties before justices of the peace appointed by the secretary of state for Scotland on the recommendation of local advisory committees.

Responsibility for the institution of criminal proceedings in the high court and the sheriff court rests with the lord advocate, who is assisted in the discharge of this function by the solicitor general, four advocates depute and procurators fiscal stationed throughout Scotland. The crown office in Edinburgh, of which the permanent head is the crown agent, is the central department concerned with this work. Prosecutions in the burgh and justice of the peace courts are instituted by prosecutors specially appointed by the town council or the justices. (*See* also SCOTS LAW.)

Liquor Licensing System. — The sale and supply of excisable (*i.e.*, alcoholic) liquor is regulated by statute. For each county and each burgh with a population exceeding 7,000 (and for a few smaller burghs) there is a licensing court which in a county is composed of an equal number of county councilors and justices of the peace. and in a burgh is composed of the magistrates. Licensing courts of appeal consider appeals against decisions of the licensing courts. In addition to fixing (within a statutory maximum) the hours during which liquor may be sold the licensing court grants certificates, valid for one year at a time, to keep licensed premises. There are three forms of certificate—for hotels, public houses and grocers. Clubs do not require a certificate from a licensing court. but must be registered by a sheriff after inquiry and consideration of any local objections. On Sundays public houses and grocers may not sell liquor; but hotels may supply residents and travelers.

Under the Temperance (Scotland) act. 1913, a local authority must, if required, hold a poll in the parish, burgh or ward concerned to decide (1) whether there should be no change in the power of the licensing court to grant certificates; (2) whether the number of certificates should be reduced by 25%; or (3) whether no certificates should be granted. except for the sale of liquor with meals. Between 1920 and 1929 there were 1,079 polls; between 1929 and 1957 only 25. In 1957 there were 17 areas with a limited number of certificates and 22 with none.

Police, Prisons and Borstal Institutions.— Before 185;. the provision of police forces in Scotland was governed by adoptive acts. In that year, however, the Police (Scotland) act made the establishment of efficient police forces in every county compulsory. In burghs, most of which already maintained police forces, the establishment of police forces was made compulsory in 1892. The Local Government (Scotland) act. 1929, transferred to county councils responsibility for policing all burghs other than large burghs (*i.e.,* burghs with a population of 20.000 or more) then having their own force. and limited to burghs with a population of 50,000 the right to establish their own forces in future. The Police (Scotland) act (1946) empouered any two or more police authorities to amalgamate their police forces and administer them by a joint committee; and also empowered the secretary of state to amalgamate police forces compulsorily if he considered this to be in the interests of police efficiency. The law relating to police administration was consolidated by the Police (Scotland) act. 1956. There were 33 police forces in Scotland in 1956, with strengths ranging from 16 to 2,590; the total establishment was 8.843.

Under the Prisons (Scotland) act. 1877. the administration of prisons in Scotland was transferred from the local authorities to the state. and prison commissioners for Scotland were established. The administration passed in 1929 to the prisons department for Scotland and in 1939 to the Scottish home department. The acts governing the administration of prisons and Borstal institutions were consolidated under the Prisons (Scotland) act, 1952. There are eight prisons, two of which have sections set aside for the detention of Borstal inmates, and four separate Borstal institutions. one of which has a small prison section attached. The average number in custody in 1957 was 2,435, of whom 1,935 were prisoners. 84 criminal lunatics and 416 Borstal inmates.

Social Services.——Formerly the relief of destitution mas dealt with under the poor law which in Scotland goes back to 1424. The act of a Scots parliament in that year and other early acts, however, were largely concerned merely with restricting begging to those nho could not win their living otherwise. But eventually there mas developed a system of relief based on the parish and administered largely by church authorities. The law was consolidated in the Poor Law (Scotland) act of 1845 which remained on the statute book for a century. Relief (or public assistance) was mainly "outdoor" (*i.e.,* the recipients remained at home) and was paid in cash. The authorities administering the law had also a duty to provide medical relief where necessary. "Indoor" relief was provided in poorhouses, nhen a poor person required institutional or hospital care. The emphasis in Scotland was on outdoor rather than indoor relief. In 1930 the administration of the Scottish poor law was transferred from some 87j parish councils to 55 large authorities made up of 31 county councils and 24 town councils of large burghs. Central supervision was exercised, in terms of the act of 1845, by a board of supervision nhose duties eventually fell to the department of health for Scotland.

The breakup of the poor law in Scotland (as in the rest of the United Kingdom) began with the Old Age Pension act of 1908 and ended with the passing of the National Assistance act of 1948. Under the latter act relief of poverty by cash payments is undertaken by the national assistance board. but the former public assistance authorities are required to provide residential accommodation for the aged and infirm who require care and attention. The act also empowers the authorities to provide welfare services for the blind. deaf or dumb, and other handicapped persons.

Under the National Health Service (Scotland) act, 1947, there was set up a comprehensive health service similar to the English one (see SOCIAL SECURITY). The following are the principal parts: a full family doctor service with an associated pharmaceutical service; a general dental service; a supplementary ophthalmic service; all forms of hospital care and treatment, both inpatient and outpatient; specialist opinion and treatment; an ambulance service; and arrangements for prevention. care and aftercare of illness (including care of mothers and young children, school health services and day nurseries. domiciliary midwifery services, health visiting. home nursing and domestic help services, vaccination and immunization. and health education). There are three main agencies for the administration of the health service. The 2j executive councils administer the general practitioner services. Almost half of their members are appointed by the doctors. dentists and chemists in each area, and the remainder by the secretary of state or the local authorities. There are five regional hospital boards responsible generally for hospital, specialist and allied services. with the actual day-to-day management of hospitals entrusted to 83 boards of management. Regional board members are appointed by the secretary of state, and board of management members by the regional boards. County councils and town councils of large burghs, as local health authorities, are responsible for the remaining services which are grant-aided by the state to the extent of 50%. All the services are available to every member of the public without any insurance qualification. Charges to patients were introduced in 1951, 1952 and 1956 covering part of the cost of the general dental service, the pharmaceutical service, the supplementary ophthalmic service, and the supply of certain appliances to hospital outpatients. The remainder of the services are free of charge. Estimated total expenditure to be charged to exchequer funds in 1958–59 was £58,300,000 with £10,500,000 from weekly contributions under the National Health Service Contributions acts, 1957 and 1958, and approximately £2,500,000 met by local authorities from local rates.

Housing.—Although the provision of houses by local authorities began late in the 19th century. up to 1919 practically all the houses in Scotland nere privately owned or built by private owners and let to tenants. The rents of these latter houses were first controlled in 191j and for many of them the rents were still controlled in 1953 at a level fixed in 1920. Building by local authorities began on a serious scale in 1919 when state assistance was introduced. In the next 20 years 337,000 houses were built, about two-thirds by local authorities; conditions nere substantially improved. special government subsidies being provided for slum clearance and the relief of overcrowding, and grants for the reconditioning of rural houses. Over 28.000 houses were built during 1 War 11 In 1943 it was estimated that 500.000 houses were still needed. Between 1945 and 1957 nearly 321,000 permanent houses, mainly of three and four apartments, in addition to 32,000 temporary houses. were built. About 91% of the permanent houses were built by local authorities or the Scottish Special Housing association (a body set up to assist local authorities by building in areas of greatest need). Since World War II government subsidies for housing have been available on a large scale to local authorities, but subsidies for new houses to meet other than special needs were reduced by the Housing and Town Development (Scotland) act. 1957. That act introduced a special subsidy to encourage the provision of overspill houses to meet the needs of congested areas in other districts. a problem of increasing importance. Additional subsidies are payable for houses in remote areas, houses for agricultural workers, multistoried flats. experimental houses and in certain circumstances for houses built in

TABLE III.—Houses Built, 1945–57

Year	Private enterprise	Local authority	Other agencies	Total
1945	141	1,428	—	1,569
1946	499	3,811	—	4,310
1947	1,354	10,773	22	12,149
1948	1,541	19,547	123	21,211
1949	1,102	24,180	565	25,847
1950	782	24,314	715	25,811
1951	1,145	20,997	786	22,928
1952	2,242	27,623	1,082	30,947
1953	2,393	35,992	1,163	39,548
1954	2,608	35,331	914	38,853
1955	3,523	29,278	1,268	34,069
1956	4,576	26,290	1,035	31,901
1957	3,513	28,326	598	32,437
Total	25,419	287,890	8,271	321,580

local materials. Since 1949 subsidies and grants have been available to local authorities and private persons for the improvement and conversion of existing houses. In 1952 and 1953 postwar controls on private building were substantially relaxed and in 1954 were abolished altogether, but the volume of private building has been relatively small since 1919.

The 1951 census showed that 31.5% of Scottish houses had only one or two rooms; 9.3% of the households were living at a density of more than two people per room (14.6% in central Clydeside and 15.6% in Glasgow), and 12.6%, 34.4% and 49% did not have exclusive use of a piped water supply, a water closet and a bath respectively.

After World War II local authorities were encouraged, as a first step in the improvement of housing conditions, to concentrate on the building of additional houses so that each family might have a home of its own, but there has since been increasing emphasis on slum clearance and redevelopment. While the provision of new houses has remained a primary aim of housing policy, the Housing (Repairs and Rents) (Scotland) act. 1954, was introduced with a view to ensuring that the best use was made of the existing stock of houses. The act required local authorities to submit proposals for dealing with unfit houses in their areas; these proposals showed that in the three years 1956–58, local authorities intended to demolish or close about 40.000 unfit houses. With the aim of arresting the deterioration of many privately owned. rent-controlled houses, the act also provided that a two-fifths "repairs increase" in the rent of such houses should be allowed, provided that the house was in or was put into good repair, and that an "expenditure test" on repairs could be satisfied. The Rent act. 1957, in its application to Scotland, raised the amount of this increase to one-half and introduced a new alternative increase of one-quarter for houses in good repair: no "expenditure test" is required for the latter increase. The Rent act also removed from rent control houses with a rateable value in excess of £40; any new tenancy of a house is likewise free from rent control.

ECONOMICS

Agriculture.— Until the latter part of the 18th century progress in Scottish agriculture was restricted by warfare and unrest, insecurity of tenure and feudal practices. The quickening of enterprise then was marked by the introduction of new crops, such as turnips and sown grasses and clover, and new methods of rotation farming and by the enclosure and equipment of land in convenient units. This resurgence did not extend, however, to the Highlands and islands where conditions for the crofters were severe. Wholesale clearances in many districts during the first half of the 19th century compelled many crofters either to emigrate or to move into areas already congested. The Crofters' Holdings (Scotland) act. 1886 and later statutes, conferred a measure of security of tenure and provided for the fixing of fair rents, enlargement of crofts and common grazings, improvement of the breeds of livestock. construction and improvement of roads and piers and the development of home industries.

In Scotland the agricultural depression of the late 19th century was marked by a reversion from tillage to stock farming, by rural depopulation and by the breakup of estates and the growth of owner-occupation. The urge toward progress was evidenced, however. by the introduction early in the 20th century of formalized agricultural education, followed after World War I by the establishment of research organizations. Acts of parliament passed in 1919 and 1934 enabled the department of agriculture to acquire estates and farms for land settlement. Government action to meet the depression also included assistance first given to wheat growers in 1932 and extended in 1937 to growers of barley and oats; a subsidy to beef producers; and facilities under marketing acts to regulate production and the marketing of produce. Minimum and overtime rates of wages were fixed under the Agricultural Wages (Regulation) (Scotland) act. 1937. Rates were not uniform for all districts until 1949 when the Scottish agricultural wages board fixed uniform rates throughout Scotland.

Following the outbreak of World War II a system of guaranteed prices and assured markets for the main agricultural commodities was introduced. A high level of food production was still needed after the mar and expansion programs were launched in 1947 and 1952 to increase further the contribution of home agriculture to the national larder. The Agriculture act. 1947, required the government to review annually, in consultation with representatives of agricultural producers, the industry's economic condition and prospects. Following each annual review, the government fixed guaranteed prices for 12 products—cattle, sheep, pigs, milk, eggs. wheat. barley, oats, rye, potatoes, sugar beet and wool. As a supplement to prices, special grants and subsidies were available for certain classes of livestock and fertilizers and for various agricultural operations; *e.g.*, plowing, cultivation of marginal land. drainage, provision of water supplies, bracken eradication. Capital grants were provided under the Hill Farming act, 1946. and the Livestock Rearing act. 1951, for the improvement of land and facilities in poorer agricultural areas. Originally created to assist in the administration of wartime services, a system of agricultural executive committees was continued after the war under the Agriculture (Scotland) act, 1948. This act embodied in permanent form many wartime provisions, including provisions consolidated in a later act, giving a large measure of security of tenure to tenant farmers.

Special provision for the crofting areas of the Highlands and islands was made in the Crofters (Scotland) act, 1955, which brought about important changes in crofting law designed to open the way for the reorganization of holdings and for greater efficiency in their management. It provided for the setting up of a crofters commission and introduced special schemes of assistance designed to suit crofting conditions.

Over 15,000,000 of Scotland's 19,000,000 ac. are devoted to agriculture. Over 3,000,000 ac. are under arable cultivation. 1,000,000 ac are permanent grass and nearly 11.000,000 are rough grazings. The demand for land for urban purposes is continuous, however, and each year up to 4.000 ac. of cultivated land are needed for new houses, schools, factories, etc. There are about 73,000 individual agricultural holdings of more than one acre. About one-quarter of these are owned by the occupiers. Only about 32,000 of the 73,000 holdings can be regarded as full-time farms; the remainder are smaller units and crofts which normally provide only part-time jobs for their occupiers. Farming falls into three main types: arable cropping with stock rearing and fattening in the east; sheep and cattle raising in the Highlands and in the southern uplands; and dairying in the southwest. Livestock and livestock products are the major part of the agricultural output. The dairy breeds of cattle include the Ayrshire and British Friesian; Aberdeen Angus. Beef Shorthorn, Galloways and the picturesque West Highland or Kyloe breed and their crosses are the

TABLE IV.—Principal Crops in Scotland in 1957 main beef breeds. In Dec. 1957, 92% of all the cattle in Scotland was attested as free from bovine tuberculosis. The predominant sheep breeds are Blackface. South and North Country Cheviots, all hill types. and on lowland farms crosses with these breeds and the Border Leicester. Second crosses with English breeds provide lambs suitable for both grass and winter feeding on lowland farms. Poultry are kept on most farms and are of particular importance in Aberdeenshire and Orkney. Pig production has become more important. In 1957 livestock in Scotland numbered: cattle. 1,779,000 (dairy 790,000, others 989,000); sheep. 7,802,000; pigs. 473,000; poultry, 9,158,000; and horses on agricultural holdings. 26,000. The number of horses dwindles yearly. as farm mechanization increases.

Scotland has achieved renown for progressive work in agricultural research nhich is performed at ten institutes: the Rowett institute (founded 1911) dealing with animal nutrition; the Animal Diseases Research association (1921); the Scottish Society for Research in Plant Breeding (1921); the Hannah Dairy Research institute (1928); the Macaulay Institute for Soil Research (1930); the Animal Breeding Research organization (1945); the National Institute of Agricultural Engineering. Scottish station (1946); the Poultry Research centre (1947); the Scottish Horticultural Research institute (1953); and the Hill Farming Research organization (1954).

Forestry.—In primitive times great forests covered much of Scotland but various factors, including the use of charcoal for iron smelting and the extension of sheep rearing, had greatly reduced these by the end of the 18th century More settled conditions during the 19th century led to a revival of interest among landowners in tree planting and at the beginning of the 20th century it is estimated that Scotland had over 1,000,000 ac. of woodland, although this included a large area of scrub oak and birch. World War I made great inroads on the country's reserves of standing timber and in 1919 the forestry commission mas established to prepare and execute a national forest policy. Before the commission's first young plantations had come to maturity World War II made further great demands on the country's timber reserves and in 1946 the commission embarked on an extensive scheme. the aim of which is to provide in Great Britain 5,000,000 ac. of productive noodlands. It was intended that half of this acreage should be in Scotland. Planting proceeded at a steadily increasing rate. Between 1947 and 1956 the forestry commission planted approximately 262,900 ac., and during the same period private owners were estimated to have planted 69,000 ac. At the end of 195j the area of plantations in Scotland extended to 815,000 ac.. of which 388,000 ac. were privately owned and 427,000 ac. belonged to the forestry commission. The main species planted are the native Scots pine. the Sitka and Norway spruces, the European. Japanese and hybrid larches, the Corsican pine and the Douglas fir. The volume of timber produced in Scotland in 1955 from thinnings and clear fellings in private estates and forestry commission plantations was 18.800.000 cu.ft. The 1,135,000 ac. owned by the forestry commission in 1955 were organized in 204 separate forest units. The number of men directly employed was about 4.600. Afforestation brought new life to dwindling communities; three new villages were formed to house forest workers: Ae in Dumfriesshire, Dalavich in Argyll and one at Glentrool forest on the borders of Wigtownshire and Kirkcudbrightshire.

Under the Forestry act, 1945, responsibility for Britain's forest policy is shared by the secretary of state for Scotland and the minister of agriculture. The forestry commission is in Scotland also guided by a national committee which includes Scottish forest commissioners.

Four national forest parks established in Scotland are: Argyll (58 000 ac.). Glenmore. Inverness-shire (12,500 ac.), Glentrool, Kirkcudbrightshire (129,900 ac.) and the Queen Elizabeth Forest park. Perthshire and Stirlingshire (41.500 ac.).

Fisheries.—Sea fishing is an important item in the Scottish economy, the herring catch being more than half the total for Great Britain and the white fish or demersal catch about one-fifth. The chief kinds of white fish caught are haddock, cod and whiting; lemon soles, halibut, hake and plaice are also valuable catches, though less in quantity. Drift-net fishing is the principal method of catching herring; trawling and seine-net fishing and great lining, in that order. are the principal methods of catching white fish. The chief fishing port is Aberdeen. Other important ports are Leith. Fraserburgh. Peterhead and Lossiemouth on the east coast; Lerwick in Shetland; and Ullapool, Stornoway, Mallaig, Campbeltown, Tarbert and Ayr on the west coasts. In 1957 the total quantity of fish landed in Scotland by British vessels was 5,876,220 cwt. valued at £12,867,593 and shellfish valued at £583,264. The principal kinds are indicated in Table V.

Table V.—Commercial Fishing Catch, 1957

	Amount (cwt.)	Value (£)		Amount (cwt.)	Value (£)
Herring . . .	1,648,700	1,640,300	Whiting . .	725,500	1,410,900
Other pelagic fish .	111,600	94,200	Other demersal fish	822,600	3,093,300
Haddock . .	1,689,000	4,114,100	Lobsters (value only) . . .	—	266,400
Cod . . .	878,700	2,514,800	Other shellfish (value only) .	—	316,800

In addition 109,505 cwt. of fish valued at £259,391 were landed by foreign vessels.

Shipments of fish to overseas markets from Scottish ports included 52,000 barrels of pickle-cured herring. The fishing fleet comprised 138 sail vessels? 2.920 motor vessels! 3 steam liners and 164 steam trawlers. a total of 3.225 vessels. The number of Scottish fishermen was 11,623, of whom 1,489 were crofter fishermen and 1,151 were partially employed in fishing.

Salmon fishing is a valuable industry. In 1957 the total salmon catch was 1.581 tons valued at £855,786, of which 310 tons were taken by rod and line and the remainder by commercial net fisheries. The number of men directly employed in commercial salmon fishing during the season was 1.720.

The secretary of state for Scotland. through the Scottish home department, is responsible for Scottish fisheries. The department employs fishery officers at the principal fishing ports; has a marine laboratory, employing four research vessels, at Aberdeen, and a Fresh-water Fisheries laboratory at Pitlochry; and maintains a fleet of fishery cruisers. The Herring Industry board and the White Fish authority operate throughout the United Kingdom; the former has its chief office in Scotland, and the latter has a committee for Scotland and Northern Ireland with delegated powers.

Mining and Minerals.—Coal is the chief source of the mineral wealth of Scotland. The earliest records appear to be the charters granted, toward the end of the 12th century, to William Oldbridge of Carriden in West Lothian, and in 1291 to the abbot and convent of Dunfermline, but coal was not used for domestic purposes till about the close of the 16th century.

After World War I lack of demand in both the home and overseas markets led to a fall in the output of the Scottish coal fields and there was much unemployment in the mining districts. In 1939, 30,500,000 tons of coal were produced compared with 41,300.000 tons in 1910 and during World War II there was a further decline to 21,400,000 tons (1945). Between 1950 and 1955 the average annual production was about 23.000.000 tons. Since the end of World War II coal has also been won from opencast workings at the rate of betneen 500,000 and 1,000,000 tons a year. At the end of 1955 nearly 84,000 people were employed. Apart from thin seams and the prevaience of water, adverse geological conditions in the form of steep inclinations, fault dislocations and igneous intrusions make coal mining comparatively difficult in Scotland. Nevertheless, much progress has been made in mechanized coal mining, modernization of underground transport and power-operated surface installations. Until 1930 the Lanarkshire field produced nearly one-half the coal mined in Scotland but the workable reserves of coal in this field then began to show signs of becoming exhausted. New reserves, honever, have been opened in Fife, the Lothians, Stirlingshire and Xyrshire, and the first undersea bore for coal ever undertaken by any country was completed in the Firth of Forth in 19j5.

The Coal Industry Nationalization act, 1946, vested the ownership and control of the industry in the National Coal board. In Scotland the board took over all the large collieries, representing about 97.3% of the total production; the remainder, mostly small surface mines. continued under the former owners under licence.

Ores of iron and other metals, apart from lead and zinc, have been virtually exhausted, but appreciable deposits of nonmetalliferous minerals remain. Among the minerals worked are limestone, shell sand, dolomite, high grade silica rock and sand, molding sand, ganister, fire clay, bauxitic clay, serpentine, talc, diatomite and barites. Granite for ornamental, monumental and building stone is worked in Aberdeen and Kirkcudbright, and other building stones are widespread. Slate and flagstone are also worked, as are sands and gravels for building and stone for road construction.

Large areas in Scotland are covered with peat, which is still used in remote districts as a domestic fuel and in central Scotland for horticultural purposes. Considerable progress has been made at Altnabreac Moss, Caithness, with a scheme for using peat as a fuel for gas turbines to generate electricity.

Electricity. — Electricity in Scotland is generated from both steam and water power. The generation and distribution of electricity is in the hands of two public boards responsible to the secretary of state — the North of Scotland Hydroelectric board, established in 1943, which is responsible for the north of Scotland district (covering roughly the area north and west of the Firths of Clyde and Tay), and the South of Scotland Electricity board, which in 1955 took over from the British Electricity authority responsibility for electricity in the south of Scotland.

The electricity generated in the south of Scotland is chiefly from steam, although there are hydroelectric stations on the Falls of Clyde and in Gallomay. At the end of 1957 there were 12 steam stations, with a capacity of 1,252 megawatts (Mw.), and 7 hydroelectric stations, with a capacity of 119 Mw. The total annual output was 5,402,000,000 units (5,098,000,000 from steam and 304,000,000 from hydroelectric stations). Works under construction included a new station at Kincardine-on-Forth, which would eventually have a plant capacity of 760 Mw.

In the north of Scotland district there are steam stations at Aberdeen and Dundee, with a total capacity of 133 Mw. generating 228,000,000 units per annum, and a considerable number of hydroelectric schemes with a total installed capacity of 729 Mw. and an estimated average annual output of over 1,980,000,000 units. The major schemes include Loch Sloy (Dunbartonshire). Pitlochry Breadalbane and Lawers (Perthshire), Glen Affric (Inverness-shire), Glascarnoch, Luichart and Torr Achilty (Ross-shire). Garry and Moriston (Inverness-shire), Shira (Argyll) and Shin (Sutherland). A number of other schemes are under construction or survey and it is estimated that the water power resources of the north of Scotland could produce 10,000,000,000 units of electricity per annum.

Atomic Energy. — The U.K. Atomic Energy authority was building at Dounreay, Caithness, an experimental atomic station, housing a fast breeder reactor for research into the economic production of power from nuclear energy for industrial and domestic uses at Chapelcross. Dumfriesshire, a nuclear factory which would provide a by-product output of electricity by 1958. and at Hunterston, Ayrshire, a nuclear generating station which would have an output capacity of 300 Mw.

Gas. — The production and distribution of gas is the responsibility of the Scottish Gas board. In 1956 there were 154 gasworks in production in Scotland, but the number would decrease as gas supplies were made available from larger works by the construction of linkage mains. During 1955–56, 46,678,000,000 cu.ft. of gas were produced at gasworks and 4,320,000,000 cu.ft. of gas purchased from coke ovens. Coal gas accounted for 80.8% of the total gas made and bought; water gas for 8.7%, other gas for 2.0% and coke oven gas for 8.5%.

Iron and Steel. — All the great iron foundries and engineering works are situated in the central lowlands, in close proximity to the shipbuilding yards and coal fields. Formerly iron ore was obtained locally but the deposits are now exhausted and the Scottish furnaces are fed with ores imported mainly from Sweden. Sierra Leone and French North Africa, and with scrap; as a result of the severe world competition for scrap, the need to use proportionately more pig iron production became apparent and the major Scottish producers in the 1950s had developments under way that would increase substantially their pig iron production. A wide range of finished steel is produced but the heavier products predominate, especially shipbuilding plates and sections. The industry suffered severely during the depression of the early 1930s but has prospered since World War II. Output of crude steel in 1955 was 2,343,900 tons compared with 1,601,400 tons in 1938.

TABLE VI.—*Scottish Steel Production, 1929–55*
(in 000 tons)

1929	1932	1939	1943	1945	1948	1950	1951	1955
1,580	550	1,875	2,031	1,747	2,254	2,426	2,115	2,344

The Iron and Steel act, 1953, repealed the Iron and Steel act, 1949, and provided for the return of iron and steel undertakings to private ownership under the general supervision of the Iron and Steel board. Many of the undertakings located in Scotland were as a result returned to private ownership; the remainder were to be returned when suitable arrangements should be completed.

Shipbuilding and Engineering.--Over one-third of the annual output of new merchant ships in the United Kingdom comes from Scottish shipyards. The industry is heavily concentrated on the Clyde, the principal yards being in and around Glasgow (Govan, Scotstoun, Clydebank. Dalmuir) and at Dumbarton, Port Glasgow and Greenock; on the lower firth there are yards at such ports as Ardrossan, Fairlie and Troon. Leading yards on the east coast are at Leith, Burntisland, Dundee and Aberdeen. The Scottish yards maintain extensive facilities for repairs and conversions and there is a substantial marine engineering industry.

Between World Wars I and II the shipbuilding industry suffered periods of severe depression but from 1945 onward the replacement of war losses and the building of tankers to match the increasing world trade in oil brought full order books. The figures of tonnage completed during recent years (in thousand gross registered tons) are as follows: 1949, 513.4; 1950, 534.4; 1951, joo.9; 1952, 454.7; 1953, 477.7; 1954, 564.8; 1955, 507.1. Shortage of steel influenced production during the postwar years. Over one-third of the tonnage completed since World War II has been for overseas owners. At the end of 1955, there were about 33,400 employed on new building in the main yards and about 7,400 on ship repairs.

There has been an increased development of engineering, particularly in the west of Scotland and in many of the larger towns elsewhere. In addition to marine engineering, locomotive manufacture (Glasgow), the making of textile machinery (Glasgow, Dundee and Arbroath), sugar machinery (Glasgow and Greenock), pumps and electrical engineering (Glasgow. Lanarkshire and Edinburgh), mining machinery (Glasgow and Lanarkshire), boilers and boilerhouse plant (Renfrem, Clydebank and Annan) and constructional engineering (Glasgow and Edinburgh), are all well represented. More recent developments in engineering have included the manufacture of aircraft engines, agricultural machinery and fractional engines. Among the metal manufactures are radio and electronic equipment, metal containers, clocks and watches and office machinery. After World War II there was a rapid expansion in the range of products manufactured.

Oil Refining and Chemicals. — In 1851 a refinery was opened for processing the oil shale mined in West Lothian, and others followed. In 1924 a refinery was started at Grangemouth on the Forth for the treatment of imported crude oil. After World War II this refinery was modernized and expanded, and a pipeline built to bring the crude oil across Scotland from Finnart on Loch Long, where it is discharged from tankers. The refinery is linked with nearby chemical plants to which it supplies the raw material for the manufacture of industrial alcohol and organic chemicals required by the plastic and rayon industries and for drugs, dyestuffs and textile manufacturing. Pharmaceuticals, dyestuffs and soaps are also manufactured at Grangemouth; explosives at Ardeer (Ayrshire coast) and chemicals in the Glasgow area.

Textiles. — It was not until the middle of the 19th century when the industry became concentrated in the border towns of the Tweed valley that tweed manufacture assumed its present importance. A sizable modern industry also developed out of the early cottage industry in the Hebridean islands of Lewis and Harris, now famous for their crofter-woven Harris tweed. and in Shetland. Woolens are also manufactured in the Stirling district, Aberdeenshire and at Elgin, Inverness. Dumfries and Paisley. Fingering and many other kinds of woolen yarns are manufactured at Alloa. Hawick is an important centre for hosiery manufacture, a characteristic border industry. Carpets have been made at Kilmarnock since 1723, and other centres of the industry include Elderslie. Xyr. Glasgow and Stirling. About one-third of the carpets made in the United Kingdom come from Scotland.

The manufacture of linen cloth from flax is an ancient process but the industry has gradually declined. Most of the linen is manufactured in Angus, Perth, Fife, Aberdeen, Renfrew and Midlothian. Dunfermline is the principal seat of the manufacture of table and other finer linens. The jute industry was established in Dundee more than 100 years ago and the city now accounts for about the whole of the United Kingdom production. The linoleum industry, based on jute cloth, is mainly centred in Kirkcaldy; in 1948 Scottish firms accounted for about two-fifths of the United Kingdom output.

Cotton was formerly Scotland's chief manufacturing industry, the first cotton mill having been opened at Rothesay in 1779. Changes in fashion and the development of the industry in Lancashire and on the continent in the mid-19th century led to a gradual regression of the Scottish industry. The counties of Lanark (with Glasgow) and Renfrew are the main centres but it is also found in the counties of Aberdeen, Ayr, Perth and Fife. Sewing thread of both linen and cotton is produced in Paisley. Lace and madras manufacture is located in the towns of the Irvine valley in Ayrshire. Silk weaving is carried on at Dunfermline, Paisley and Glasgow. After World War II a number of jute manufacturers in Dundee produced heavy rayon yarn for the making of carpets.

Whisky, Beer and Miscellaneous Manufactures.— Scotland claims a distinctive manufacture in whisky. Whisky is an export commodity of considerable importance. the chief overseas market being the United States. There are four types of malt whisky: Campbeltown, Islay, Highland and Lowland. Grain whisky is produced in the large towns, to which the matured malt whiskies are sent for blending. Brewing of beer has been carried on from ancient times in Edinburgh, where the monks of Holyrood abbey in the 12th century made a much appreciated ale; beer is also brewed at Alloa and elsewhere but Edinburgh is still the main centre, making four-fifths of the Scottish output.

Paper, stationery and printing are industries in which Scotland has always occupied a foremost position. A paper mill was erected in 167j at Dalry, on the Water of Leith, in which French operatives were employed to give instruction! and Midlothian remains the principal centre in Scotland. Ever since it was established, early in the 16th century, the Edinburgh press has been renowned for the beauty of its typography; printing is also carried on extensively in Glasgow. Among other industries are clothing, furniture and wood manufactures, sugar refining (in Greenock), preserves and confectionery (in Dundee, Glasgow and elsewhere) and rubber manufactures (in Edinburgh, Dumfries and Glasgow).

TABLE VII.—*Changes in Distribution of Output and Manpower, 1935–48*
(Establishments employing over ten)

	4 Net output		Average % persons employed	
	1935	1948	1935	1948
Mining and quarrying	11.9	10.3	14.2	10.4
Bricks, cement, glass, etc.	2.1	2.3	2.2	2.3
Chemicals	4.8	3.7	2.2	2.9
Metal manufacture	7.2	7.7	6.7	6.5
Engineering, shipbuilding	12.7	20.1	13.2	20.5
Vehicles	2.3	4.1	3.0	5.1
Metal eoods	1.3	2.2	1.6	2.3
Precision instruments	0.3	0.5	0.4	0.6
Textiles	12.1	9.5	16.9	11.0
Leather, leather goods etc.	0.6	0.7	0.5	0.5
Clothing	2.0	1.7	3.6	2.9
Food, drink and tobacco	14.6	11.7	9.9	8.4
Wood and cork products	2.1	2.4	2.6	2.6
Paper and printing	7.6	5.4	6.5	5.0
Other manufacturing	2.3	1.9	2.0	1.9
Building and contracting	9.5	11.7	12.0	14.5
Gas, electricity and water	6.6	4.1	2.5	2.6
Total	100.0	100.0	100.0	100.0

Industrial Development.— Table VII shows the changes in the industrial scene that took place between 1935 and 1948. and in particular the increased emphasis on shipbuilding and engineering.

A striking feature of recent industrial development has been the establishment of government-sponsored industrial estates, mainly in the central industrial belt. In 1956 there were 340 firms occupying a total of 15,500,000 sq.ft. of factory space and covering a wide range of light industries.

Employment and Unemployment.— The changes that took place in the distribution of industrial manpower between 193j and 1948 are shown in Table VII; the distribution of manpower in Scotland in 1955 is shown in Table VIII.

TABLE VIII.—*Distribution of Total Manpower in Scotland, June 1955**

H. M. forces	81,000	Building and contracting	170,000
g r i c e forestry, fishing	155,000	Gar, electricity and water	28,000
Mining and quarrying	100,000	Transport and communications	188,000
Manufacturing industries:		Distributive trades	290,000
Metals, engineering, shipbuilding and vehicles	386,000	Professional, finanrial'and miircllaneous services	378,000
Textiles and clothing	160,000	Public administration	115,000
Food, drink and tobacco	111,000	Registered unemployed	47,000
Other manufacturing industries	176,000	Total	2,385,000

*These figures include all persons age 15 and over at work or available for work including employers and self-employed persons.

Between World Wars I and II the trend of unemployment in Scotland was similar to that in Great Britain as a whole (see UNEMPLOYMENT). The actual figures, for representative years, calculated in December, mere: 1921. 238 426; 1926, 202,670; 1931, 359,149; 1936, 265,395. The monthly average for eight years following World War II was: 1948, j6 Soo; 1949, 62,100; 1950, 64,700; 1951, 53,400; 1952, 69,300; 1953, 64,100; 1954, 59,500; 1955, 51,000.

Communications.—*Shipping* and Canals.—The principal ports in Scotland are Glasgow. Greenock and Xrdrossan on the west coast, and Leith, Grangemouth. Dundee. Aberdeen and Methil on the east coast. Glasgow is the largest Scottish port and in 1954 handled imports and exports to the value of £263,000,000; of this sum imports accounted for £105,200,000; exports consisted of produce of the United Kingdom valued at £156,800,000 and imported merchandise worth just under £1,000,000. The next largest totals of imports and exports were handled at Leith (£48,230,000), Grangemouth (£45,040,000) and Dundee (£21,200,000). There is also an extensive coastwise traffic between the Scottish ports and ports in England and Wales and Northern Ireland. Large quantities of merchandise are moved between Scotland and England and Wales by road and rail

There are four navigable canals in Scotland, the Caledonian (*q.v.*), the Crinan, the Forth and Clyde and the Union; all are now onned and operated by the British Transport commission. They do not carry much traffic. A fifth canal, the Monkland, which ran between Glasgow and Calderbank, was abandoned for navigational purposes in 1950 as no traffic had passed over it for a number of years.

Railways —The first railway in Scotland for which an act was obtained was that betneen Kilmarnock and Troon ($9\frac{3}{4}$ mi.), opened in 1812 and worked by horses. By 1840 the length of railway lines that had received parliamentary sanction was $191\frac{1}{4}$ mi. The chief companies were the North British which, formed in 1845, developed a network extending from Berwick to Aberdeen and St. Xndrens to Mallaig and including the Forth and Tay bridges; the Caledonian which, formed in the same year, eventually served much of nest and central Scotland; the Glasgow and South-Western, formed by amalgamation in 1850 and. like the North British and Caledonian, running steamers on the Firth of Clyde; the Highland (1865), with a vertical axis running from Thurso to Stanley and a lateral axis from Keith to Kyle of Lochalsh; and the Great North of Scotland (1846), concentrated in the Aberdeen area. By the Railway act of 1921 the companies were merged into the London, Midland and Scottish and the London and North Eastern Railway companies. By the Transport act of 1947 the undertakings of these companies were vested in the British Transport commission and their lines in Scotland were united to form the Scottish region of British Railways. The

Transport act, 1953, provided for the setting up of a railway authority in Scotland under the general financial control of tne British Transport commission; this authority— the Scottish Area board—was set up in 19jj.

Roads.— It was not until the 18th century that the road system of Scotland had its beginning. Under the turnpike acts roads were built in the Lowlands while in the Highlands military roads were constructed to assist in the suppression of the clans. Gen. G. Wade built three main roads. running north from Stirling and Perth and south from Inverness to Fort Augustus and over the Corrieyairack pass (2.519 ft.) to Dalwhinnie. In 18 years at the beginning of the 19th century Thomas Telford made nearly 1.000 mi. of new roads and built 1,117 bridges, under the authority of the Highland roads and bridges commissioners. In 1878 many of the counties were divided into separately rated districts for roadmaking purposes, but the Local Government (Scotland) act, 1929, reduced the landward authorities to one for each county. After World War I the main roads of Scotland, in common with those of Great Britain, became increasingly a responsibility of the national government. In 1936, the minister of transport became the authority for all trunk roads, of which 1,188 mi. were in Scotland; the trunk road mileage was increased to 1,949 under the Trunk Roads act. 1946. In 1956 there mere. in addition, 4,804 mi. of class I road, 3,917 of class II, 6,312 of Class III and 10,451 of unclassified roads, making a total mileage of 27,433. In 1956 responsibility for highway matters in Scotland were transferred from the minister of transport and civil aviation to the secretary of state for Scotland.

Civil Aviation.— Commercial civil aviation began in Scotland in the early 1930s. The first airmail service was inaugurated between Inverness and Kirkwall via Wick in 1934, and the first continental air service between Aberdeen and Stavanger via Newcastle in 1937. Other aerodromes were developed at Edinburgh, Perth and Wick and by the outbreak of World War II a number of air routes were centred on Renfrew and Xberdeen. Prestmick, established by Scottish Aviation Ltd., was enlarged and developed by the air ministry during World War II and became the terminal of the transatlantic air ierry services. Prestwick airport later came under the control of the ministry of civil aviation as Britain's second international airport. It is used by most of the airlines operating on the North Atlantic routes and has services to several northern European capitals. During 1955, Prestwick airport handled 208,450 passengers. Renfrew, airport ior Glasgow, is the focal point ior Scotland's regional air services and handles trunk route traffic to London, Manchester, Birmingham, Belfast, Dublin, the Channel Islands and Paris: Passengers in 1955 numbered 305,600. The airports at Edinburgh (Turnhouse) and Aberdeen (Dyce) are also connected by trunk route services to points in the south. A special ieature of Scottish civil aviation is the air ambulance service which carries patients in need of urgent hospital treatment from landing strips in remote parts of the country to Renfrew, Aberdeen, Wick or Inverness. Since 1956 arrangements have been made ior helicopters oi the Royal Navy or Royal Air Force to move cases of extreme urgency where other means of transport are not available.

Banking and Insurance.— It was fortunate for Scotland that the monopoly granted to its first bank, the Bank of Scotland, on its foundation in 1695 was not renewed when it expired 20 years later. Freedom to issue notes, which in those days was synonymous with banking, made possible the formation of large banks and the spread of branches throughout the country. As a result, the provision of banking services had been concentrated in the hands of a few relatively large and stable institutions even before 1844, when the Bank Charter act began the process of absorption and amalgamation among the small country banks in England. Bank failures were thus a rarity in Scotland. Scottish bank notes provided a cheap and reliable currency during the years when great improvements in agriculture and the development of industry were taking place; and many of these developments were made possible in a country always desperately short of capital, by the "cash-credit" system which was the hallmark of Scottish banking in the 18th and 19th centuries. Cash credits were granted to people who, though short of capital, could command the support of two acceptable sureties, Allied to an unlimited right of note issue, this system, potentially, was highly inflationary in character, and it is a tribute to the shrewdness of the early bankers that overexpansion followed by crisis was so rare. The saving habits of the Scottish people must also be given due credit and it was in Scotland that the first trustee savings bank was formed, by Henry Duncan of Ruthwell, in 1810.

The Scottish banks' still retain the right of note issue but the Bank Notes (Scotland). act, 1845, obliged them to hold gold coins as cover against notes actually in circulation and, with the withdrawal in the 20th century of gold coin from the country's currency, Bank of England notes became the principal covering requirement. These issues, however, still make it possible to maintain branches in small communities where, without them, the provision of banking services would be too expensive.

The following banks now operate in Scotland: Bank of Scotland (1695); Royal Bank of Scotland (1727); the British Linen bank (1746); the Commercial Bank of Scotland Ltd. (1810); the National Bank of Scotland Ltd. (1825); and the Clydesdale and North of Scotland Bank Ltd. (1838).

The business of fire insurance has been transacted since 1719, in which year a company was established in Edinburgh. At first its operations were confined to the insurance oi buildings and it was not until 1767 that goods were insured. The early part of the 19th century saw the establishment in Scotland of several offices, which were quick to extend their fields of operation. By the opening of branch offices, first in the north of England, then in London and in the course of years overseas, Scottish insurance became international in its character and the companies now operate in almost every part of the civilized globe. In 1955 the premium income of the Scottish insurers was: fire insurance, £43,500,000; accident insurance, £59,600,000; marine insurance, £8,700,000. The service given by Scottish offices also covers every phase of life assurance and annuity business including group assurance and group pension schemes for employees of firms or companies. In 19jj the annual premiums received by Scottish offices in this field amounted to £60,790,000. (D. Me.)

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SCOTLAND, CHURCH OF. The purpose of this article is to trace the growth of the Scottish kirk as a whole, defining the views on which it was based and the organization in which they took form. The controversies within the Church of Scotland have not arisen out of matters of faith but out of practical questions of church government and of the relation of church and state. Holding a church theory to which the rulers of the country were for a century strongly opposed, Scotland became the leading exponent of presbyterianism (*see* PRESBYTERIAN); and this note has been the dominant one in its religious history.

Scottish Reformation.— The Scottish Reformation came out of a covenant in which the barons, inspired by John Knox, then abroad, bound themselves in 1557 to oppose the Roman Catholic religion and to promote the cause of the Reformation. When parliament, on Aug. 24, 1560, passed the acts abolishing the papal jurisdiction and the Mass in Scotland, it was able. as Knox had been preparing for this crisis, to sanction a new confession of faith for the Reformed Church. Other documents of the new system were quickly forthcoming. The *First Book of Discipline* set forth the whole of the proposed religious and educational constitution, and this book speaks of "the order of Geneva which is no in use in some of our churches." This order, afterward with some modifications known as John Knox's Liturgy and used in the church down to the reign of Charles I, is a complete directory of worship, with forms of all the services to be held in the church.

The type of religion found in these documents is that of Geneva, the unit being the self-governing congregation and the great aim of the system the pure preaching of the Word; but the *First Book of Discipline* does not set forth any complete scheme of church government. Its arrangements are in part provisional. In addition to the minister, who is its most definite figure and proved to be the most permanent, it recognizes the superintendent, the lay elder and the reader. The superintendent was a parish minister whose added function was to plant churches and place ministers, elders and deacons where required. Whether the superintendents were meant to be permanent in the church is not clear. The lay elder was very much what he is still. The reader was to conduct service when no minister was available, reading the Scriptures and the Common Prayer. A noble scheme of education was sketched for the whole country, but neither this nor the provision made for ministers' stipends was carried out, the revenues of the old church, from which the expenses of both were to be paid, being in the hands of the barons.

The system naturally took time to get into working order. The old clergy, bishops, abbots and priests were still on the ground, and were slow to take service in the new church. In 1574 there were 289 ministers and 715 readers. As the ranks of the clergy slowly filled, questions arose which the Reformation had not settled, and it was natural that the old system with which the country was familiar should creep in again. Presbytery was never much in favour with the crown; and when the crown, so weak at the Reformation, gained strength, encroachments were made on the popular character of the kirk, while the barons also had obvious reasons for not wishing the kirk to be too strong. The first parliament of the regent Moray (1567), while confirming the establishment of the Reformed Church as the only true church of Christ, settling the Protestant succession and doing something to secure the right of stipend to ministers, reintroduced lay patronage, the superintendent being charged to induct the patron's nominee—an infringement of the reformed system against which the church never ceased to protest. Andrew Melville (*q.v.*) came to Scotland at this time, and became the leader of the church in place of Knox. who died in 1572. He brought with him from Geneva, where he had been the colleague of Theodore Beza, a fervent hatred of ecclesiastical tyranny and a clear grasp of the Presbyterian church system. The Scottish Church, hitherto without a definite constitution. soon espoused under his able leadership a logical and thorough presbyterianism, which was expressed in the *Second Book of Discipline*, adopted by the assembly in 1577, and was never afterward set aside by the church when acting freely. It recognizes four kinds of office in the church, and no one can lawfully be placed in any of them except by being called to it by the members. Pastor, bishop and minister are all titles of the same office, that of those who preach the word and administer the sacraments, each to a particular congregation. The doctor is a teacher in school or university; he is an elder and assists in the work of government. Elders are rulers; their function also is spiritual. though practical and disciplinary. The fourth office is that of the deacons, who have to do with matters of property and are not members of church courts. Kirk sessions and presbyteries are not named. but the principles are clearly laid down on which these institutions are to rest.

Presbyterian Principle.— By committing itself to this system the Church of Scotland established between itself and the Church of England a division which became more and more apparent and was the cause of much of its subsequent sufferings. It is no doubt strange that it should have endured so much not for any great Christian principle but for a question of church government. On the other hand, presbyterianism stood in Scottish history for freedom. and for the rights of the middle and lower classes against the crown and the aristocracy; and it might not have been held with such tenacity or proved so incapable of compromise but for the opposition and persecution of the three Stewart kings. The history of the Scottish Church for a century after the date of the *Book of Discipline* is that of a religious struggle between the people and the crown.

For several years after its inception presbyterianism carried all before it. The presbyteries came quickly into existence; that of Edinburgh dates from 1580. In that year it was found that there were 924 parishes in Scotland, but not nearly all supplied with ministers; it was proposed that there should be 50 presbyteries and 400 ministers. A great part of the country, especially in the north and west, had not yet been reached by the Reformation. At this time began the long series of attempts made by James VI in the direction of curbing Presbyterian liberty and of the restoration of episcopacy. For a few years his attitude was different. A Roman Catholic rising threw James into the arms of the kirk; in 1592 the *Second Book* of *Discipline* was legalized and presbytery set up. The church was at the time very powerful, the people generally sympathizing with its system, and its assemblies being attended by many of the nobles and the foremost men. Discipline was strict; the temper of the church was in accordance with the Old rather than the New Testament. On his accession to the throne of England in 1603 James entered on a new set of attempts to assimilate the Scottish Church to that of England. In 1609 two courts of high commission were set up by the royal authority with plenary powers to enforce conformity to the new arrangements. In 1612 the act of 1592 which established presbytery was rescinded, and episcopacy became the legal church system of Scotland.

National Covenant. — In all this it was the position and rights of the clergy that were assailed. The people had been less interfered with; the change of church government involved no change in the conduct of worship. But the Articles of Perth, passed by a packed assembly in 1618, foreshadowed what was soon to be the policy of the crown. During the first years of his reign Charles was occupied in other directions; but when he came to Scotland in 1633 to be crowned William Laud came with him, and though like his father Charles showed himself kind to the clergy in matters of stipend, and adopted measures which caused many schools to be built, he also showed that in the matter of worship the policy of forcing Scotland into uniformity with England was to be carried through with a high hand. A book of canons and constitutions of the church, which appeared in 1635, instead of being a digest of acts of assembly was English in its ideas, dealt with matters of church furniture, exalted the bishops and ignored the kirk session and elders. A liturgy was ordered to be used which had not yet appeared, but which proved to be a version, with somewhat higher doctrine, of the Anglican Common Prayer. The introduction of this service book in St. Giles's church. Edinburgh, in July 1637, occasioned the tumult of which Jenny Geddes will always figure as the heroine. The sentiment was echoed throughout Scotland. Petitions against the service book and the book of canons poured in from every quarter; the committee formed to forward the petition rapidly became a powerful body at the head of a national movement, the action of the crown was temporizing and on Feb. 28. 1638, the National Covenant was signed in the famous scene in Greyfriars church and churchyard. This document recited the covenant, signed by King James and his household in 1580, to uphold presbyterianism and to defend the state against romanism, and then declared a new covenant of nobles, barons, gentlemen, burgesses, ministers and commons to continue in the reformed religion, to defend it and resist all contrary errors and corruptions. The crown was unable either to check the popular movement or to come to any compromise with it, and the Glasgow assembly of 1638. the first free assembly that had met for 30 years, proceeded to make the church what the Covenant required, and effected the "second Scottish Reformation." The assembly contained many influential laymen and was carried on the crest of a great national movement. The Covenant was accepted by parliament in 1639.

The succeeding decennium is the culminating period of Scottish presbyterianism, when it not only was supreme in Scotland but exercised a decisive influence over England. The English parliament sought the alliance of the assembly, while the Independents, though in the event presbytery was as little to their liking as episcopacy, joined in the wish to get rid of the episcopal system. In its period of triumph the presbyterianism of Scotland displayed its character. After the injustice and persecution it had suffered it could scarcely prove moderate or tolerant; it showed a vehement determination to carry out the truth it had vindicated with such enthusiasm, to the full extent and wherever possible. The Covenant, at first a standard of freedom, was immediately converted into a test and made the instrument of oppression and persecution. All policy was to be determined by the Covenant; the king and every official were to be obliged to take it. Those who carried their fanaticism furthest were ready to denounce and to unchurch those who showed any inclination to moderation and political sanity, and the beginnings of schism soon appeared in the ranks of the Covenanters.

In 1643, when the full legal establishment of presbytery had just been consummated, the general assembly, asked by the English parliament to arrange a league to be signed in both countries for the furtherance of reformed religion, agreed, but asked that the league should be a religious one. The result was the Solemn League and Covenant. It did not mention presbyterianism; but the assembly had refused to hear of any recognition of independency; if religion were thoroughly reformed, they considered the result must be presbyterianism in England as in Scotland. In the Westminster Standards also, which were the fruit of the Scottish desire for a religious uniformity, Scotland did not obtain by any means all it desired in its church documents. The Scottish divines in the Westminster assembly were only five in number, while the assembly contained effective parties of Erastians and Independents. The Confession of Faith contains no approval of any system of church government, and when the kirk adopted it in 1647 it gave up its old confession in which the principles at least of true church order are laid down.

In accepting in 1645 the Westminster Directory of Public Worship the kirk tacitly gave up its own liturgy, and committed itself to a bald and uninviting order of worship, in which no forms of prayer were allowed to be used.

Struggle Against Episcopacy. — If the mismanagement of Scottish religious affairs under James and Charles I is a melancholy story, what took place under Charles II is infinitely sadder. From the first Charles showed himself determined to force episcopalianism on Scotland and not too scrupulous in the choice of methods for securing his ends. The attempt was nearly successful. In the greater part of the country little change took place in the religious services. The service book was not read nor kneeling at communion required, and it made no immediate difference to the people that the clergy should be under bishops. The inferior church courts still sat, though not the assembly. At the Restoration it was a question whether the bulk of the population was in favour of presbytery or of episcopacy; but the matter was handled in such a way in the west of Scotland that an extreme Covenanting spirit arose, nourished on intolerable grievances, and the nation as a whole decided against the system which had been promoted by such means.

The Rescissory act of 1661 swept away the legislation of the preceding 20 years, and so disposed of the Presbyterian polity of the church. Episcopacy was restored by a letter from the king on Sept. 5, 1661 (*see* SCOTLAND, EPISCOPAL CHURCH IN). An act requiring all ministers appointed during the period when patronage was abolished to get presentation from their patrons and institution from their bishops was applied in the west of Scotland in such a way that 300 ministers left their manses. Their places were filled with less competent men whom the people did not wish to hear, and so conventicles began to be held. The attempts to suppress these, the harsh measures taken against those who attended them or connived at them or refused to give information against them, the military violence and the judicial severities, the confiscations, imprisonments, tortures, expatriations, all make up a dreadful narrative.

Indulgences were tried, and were successful in bringing back about 100 ministers to their parishes and introducing a new cause of division among the clergy. On the other hand, the Covenanting spirit rose higher and higher among the persecuted till the armed risings took place and the formal rebellion of a handful of desperate men against the ruler of three kingdoms.

When William landed in England in 1688 the scene changed in Scotland. The soldiery was withdrawn from the west, and the people at once showed their feelings by the "rabbling" or ejection of the curates who occupied the manses of the ousted ministers, in which, however, no lives were lost. William would have decided for episcopacy in Scotland, as the great body of the nobles and gentry adhered to it, but only on condition that the Episcopalians agreed to support him and that they had the people with them. Neither of these conditions was fulfilled.

On July 22, 1689, the convention which declared the throne vacant and called William and Mary to fill it declared in its Claim of Right that prelacy and the superiority of any office in the church above ministers had been a great and insupportable grievance to Scotland. Effect was given to this; and in April 1690 the act was passed on which the establishment of the Church of Scotland rests, the Westminster Confession being recognized, the laws in favour of episcopacy repealed, though the Rescissory act remained on the statute book and the assembly appointed to meet. Three years later the formula of subscription, to be signed by all ministers, was fixed.

From this time forward the church, while jealously asserting its spiritual independence, was on the side of the crown against the Jacobites, and became more and more an orderly and useful ally of the state. The difficulties which threatened to arise about the union were skilfully avoided; the Act of Security provided that the Confession of Faith and the Presbyterian government should "continue without any alteration to the people of this land in all succeeding ages," and the first oath taken by Queen Anne at her accession was to preserve it. The Act of Toleration of 1712 allowed Episcopalian dissenters to use the English liturgy. This had not hitherto been done. and the claim of the Episcopalians for this liberty had been the occasion of a bitter controversy. The same parliament restored lay patronage in Scotland, an act against which the church always protested and which was the origin of great troubles.

Patronage Difficulties. — Presbytery, being loyal to the house of Hanover while episcopacy was Jacobite. was now in enjoyment of the royal favour and was treated as a firm ally of the government. But while the church as a whole was more peaceful, more courtly, more inclined to the friendship of the world than at any former time, it contained two well-marked parties. The Moderate party, which maintained its ascendancy till the beginning of the 19th century, sought to make the working of the church in its different parts as orderly and regular as possible. to make the assembly supreme and to enforce on presbyteries respect for its decisions. The Popular party, regarding the church less from the side of the government, had less sympathy with the progressive movements of the age and desired greater strictness in discipline. The main subject of dispute arose at first from the exercise of patronage. Presbyteries in various parts of the country were still disposed to disregard the presentations of lay patrons and to settle the men desired by the people; but legal decisions had shown that if they acted in this way their nominee. while legally minister of the parish, could not claim the stipend. To the risk of such sacrifices the church, led by the Moderate party, refused to expose itself. By the new policy inaugurated by William Robertson (1721–93) the assembly compelled presbyteries to give effect to presentations, and in a long series of disputed settlements the "call." though still held essential to a settlement, was less and less regarded, until it was declared that it was not necessary and that the church courts were bound to induct any qualified presentee. The substitution of the word "concurrence" for "call" about 1764 indicates the subsidiary and ornamental light in which the assent of the parishioners was now to be regarded. It was in the power of the church to give more weight than it did to the feelings of the people; but its working of the patronage system drove large numbers from the Establishment. A melancholy catalogue of forced settlements marks the annals of the church from 1749 to 1780, and wherever an unpopular presentee was settled the people quietly left the Establishment and erected a meeting house

Growth of Dissent. — In 1763 there was a great debate in the assembly on the progress of schism, in which the Popular party laid the whole blame at the door of the Moderates, while the Moderates rejoined that patronage and moderatism had made the church the dignified and powerful institution it had come to be. Nor was a conciliatory attitude taken up toward the seceders. The ministers of the Relief (*see* UNITED PRESBYTERIAN CHURCH) desired to remain connected with the Establishment, but were not suffered to do so. Those ministers who resigned their parishes to accept calls to Relief congregations, in places where forced settlements had taken place, and who might have been and claimed to be recognized as still ministers of the church, were deposed and forbidden to look for any ministerial communion with the clergy of the Establishment. The growth of dissent steadily continued and excited alarm from time to time; and it may be questioned whether the peace of the church was not purchased at too high a price. The Moderate period is justly regarded as in some respects the most brilliant in the history of the church. Its clergy included many distinguished Scotsmen, among them Thomas Reid, George Campbell, Adam Ferguson, John Home, Hugh Blair, William Robertson and John Erskine. The labours of these men were not mainly in theology; in religion the age was one not of advance but of rest; they gained for the church a great and widespread respect and influence.

Revival. — With the close of the 18th century a great change passed over the spirit of the church. The new activity which sprang up everywhere after the French Revolution produced in Scotland a revival of evangelicalism. Moderatism had cultivated the ministers too fast for the people, and the church had become to a large extent more of a dignified ruler than a spiritual mother. About this time the brothers Robert and James Haldane devoted themselves to the work of promoting Evangelical Christianity, James making missionary journeys throughout Scotland and founding Sunday schools; and in 1798 the eccentric preacher Rowland Hill visited Scotland at their request. In the journals of these evangelists dark pictures are drawn of the religious state of the country, though their censorious tone detracts greatly from their value; but there is no doubt that the efforts of the Haldanes brought about or coincided with a quickening of the religious spirit of Scotland. The assembly of 1799 passed an act forbidding the admission to the pulpits of laymen or of ministers of other churches and issued a manifesto on Sunday schools. These acts helped greatly to discredit the Moderate party, of whose spirit they were the outcome. In 1810 the *Christian Instructor* began to appear under the editorship of Andrew Thomson, a churchman of vigorous intellect and noble character. It was an ably written review, in which the theology of the Haldanes asserted itself in a somewhat dogmatic and confident tone against all unsoundness and moderatism. clearly proclaiming that the former things had passed away. The question of pluralities began to be agitated in 1813, and gave rise to a long struggle, in which Thomas Chalmers (*q.v.*) took a notable part, and which terminated in the regulation that a university chair or principalship should not be held along with a parish which was not close to the university seat.

The growth of Evangelical sentiment in the church, along with the example of the great missionary societies founded in the end of the 18th and the beginning of the 19th century, led to the institution of the various missionary schemes. and their history forms the chief part of the history of the church for a number of years. The education scheme. having for its object the planting of schools in destitute Highland districts, came into existence in 1824. The foreign mission committee was formed in 182 j, at the instance of John Inglis (1763–1834), a leader of the Moderate party; and Alexander Duff (*q.v.*) went to India in 1829 as the first missionary of the Church of Scotland. The church extension committee was first appointed in 1828 and in 1834 it was made permanent. It was originally formed to collect information regarding the spiritual wants of the country and to apply to the government to build the churches found to be necessary. As the population of Scotland had doubled since the Reformation and its distribution had been completely altered in many counties while the number of parish churches remained unchanged, and meeting houses had only been erected where seceding congregations required them, the need for new churches was very great. The application to government for aid, however, proved the occasion of a "voluntary controversy" which raged with great fierce-ness for many years and never completely subsided. The union of the Burgher and the Antiburgher bodies in 1820 in the United Secession (see UNITED PRESBYTERIAN CHURCH) added to the influence of the voluntary principle in the country, while the political excitement of the period disposed men's minds to such discussions. The government built 42 churches in the Highlands, providing them with a slender endo ment; and these continued to be known as parliamentary churches. Under Thomas Chalmers, however. the church extension committee struck out a new line of action. The great philanthropist had come to see that the church could only reach the masses of the people effectively by greatly increasing the number of its places of worship and abolishing or minimizing seat rents in the poorer districts. In his powerful defense of establishments against the voluntaries in both Scotland and England, in which his ablest assistants were those who afterward became, along with him. the leaders of the Free Church, he pleaded that an established church to be effective must divide the country territorially into a large number of small parishes, so that every corner of the land and every person, of whatever class, shall actually enjoy the benefits of the parochial machinery. This "territorial principle" the church kept steadily in view ever after. With the view of realizing this idea he appealed to the church to provide funds to build a large number of new churches, and personally carried his appeal throughout the country. By 1840 more than zoo new churches had been built.

The zealous orthodoxy of the church found at this period several occasions to assert itself. John M'Leod Campbell, minister of Row, was deposed by the assembly of 1830 for teaching that assurance is of the essence of faith and that Christ died for all men. He has since been recognized as one of the profoundest Scottish theologians of the 19th century, although his deposition was never removed. The same assembly condemned the doctrine put forth by Edward Irving (*q.v.*), that Christ took upon Him the sinful nature of man and was not impeccable, and Irving was deposed five years later by the presbytery of Annan, when the outburst of supposed miraculous gifts in his church in London had rendered him still more obnoxious to the strict censures of the period (see CATHOLIC APOSTOLIC CHURCH).

The Disruption — and After. — The influence of dissent also acted along with the rapidly rising religious fervour of the age in quickening in the church that sense of a divine mission, and of the right and power to carry out that mission without obstruction from any worldly authority. which belongs to the essential consciousness of the Christian church. An agitation against patronage, the ancient root of evil, and the formation of an antipatronage society, helped in that direction. For the ten years' conflict, which began in 1833 with the passing by the assembly of the Veto act, see the article FREE CHURCH OF SCOTLAND; it is not necessary to dwell further in this place on the consequences of those acts. The assembly of 1843. from which the exodus took place, proceeded to undo the acts of the church during the preceding nine years. The Veto was not repealed but ignored, as having never had the force of law. The assembly addressed a pastoral letter to the people of the country, in which, while declining to "admit that the course taken by the seceders was justified by irresistible necessity," they counselled peace and good will toward them and called for the loyal support of the remaining members of the church. Two acts at once passed through the legislature in answer to the claims put forward by the church. The Scottish Benefices act of Lord Aberdeen, 1843, gave the people power to state objections personal to a presentee and bearing on his fitness for the particular charge to which he was presented, and also authorized the presbytery in dealing with the objections to look to the number and character of the objectors.

The Disruption left the Church of Scotland in a sadly maimed condition. Of 1,203 ministers 451 left it, and among these were many of its foremost men. A third of its membership is computed to have gone with them. In Edinburgh many of its churches were nearly empty. The Gaelic-speaking population of the northern counties completely deserted it. All its missionaries left it but one. It had no gale of popular enthusiasm to carry it fonvard, representing as it did not a newly arisen principle but opposition to a principle which it maintained to be dangerous and exaggerated. For many years it had much obloquy to endure. But it at once set itself to the task of filling up vacancies and recruiting the missionary staff. A lay association was formed, which raised large sums of money for the missionary schemes, so that their income was not allowed seriously to decline. The good works of the church, indeed, were in a few years not only continued but extended.

Agitation on the subject of patronage went on in the assembly from 1857 to 1869, when, by a large majority, patronage as restored by the act of Queen Anne was condemned and a petition sent to parliament for its removal. The request was granted. and the right of electing parish ministers was conferred by the Patronage act, 1874, on the congregation; thus a grievance of old standing, from which all the ecclesiastical troubles of a century and a half had sprung, was removed and the church placed on a thoroughly democratic basis. This act, combined with various efforts made within the church for its improvement, secured for the Scottish Establishment a large measure of popular favour, and in the last half of the 19th century it grew rapidly both in numbers and in influence. This revival was largely the result on the one hand of the improvement of its worship which began with the efforts of Robert Lee (1804–68), minister of Old Greyfriars, Edinburgh, and professor of biblical criticism in Edinburgh university. By introducing into his church a printed book of prayers and also an organ. Lee stirred up vehement controversies in the church courts which resulted in the recognition of the liberty of congregations to improve their worship. The Church Service society, having for its object the study of ancient and modern liturgies with a view to the preparation of forms of prayer for public worship, was founded in 1865; it published eight editions of its Book of *Common* Order, which, though at first regarded with suspicion, was largely used by the clergy. Church music was cultivated and improved in a marked degree; and hymns were introduced to supplement the psalms and paraphrases; in 1898 a committee appointed by the Church of Scotland, the Free Church, the Cnited Presbyterian Church and the Presbyterian Church in Ireland issued The Church Hymnary (rev. ed., 1920).

The Committee on Christian Life and Work was appointed in 1869 to supervise the work of the church, to stimulate evangelistic efforts and to organize the labours of lay agents. It organized young men's guilds and revived the ancient order of deaconesses. The Life and Work committee was later merged in the Committee on Social Service and the organizations instituted by it were transferred in some cases elsewhere. The Young Men's guild was put under the authority of the General Administration committee, as was the Woman's guild. This women's organization had a membership in 1957 of 153,180, with branches numbering 2,2jj.

The order of deaconesses passed under the administrative power of the home board, and its scope was considerably widened. The General Assembly in 1956 approved the appointment of a standing Committee on the Order of Deaconesses and also approved a scheme providing for the training of women with the required qualifications to be commissioned as deaconesses and also to be presented to presbyteries for licence as preachers of the word but without reference to probation for the holy ministry. The church's monthly magazine, Life and *Work*, another project of the original Committee on Christian Life and Work, was put under the care of a special Committee on Publications.

Subscription and **Reunion.**—During the later years of the 19th century the church showed an increased liberality of sentiment and variety of opinion; and for this and other reasons the question of subscription was more or less before the church for many years. The formula adopted by the assembly of 1711 had still to be signed by ministers, and was felt to be much too strict. After debates extending over many years. the assembly of 1889 fell back on the words of the act of parliament of 1693, passed to enable the Episcopalian clergy to join the Establishment, in which the candidate declared the Confession of Faith to be the confession of his faith. owned the doctrine therein contained to be the true doctrine and promised faithfully to adhere to it.

This was accompanied by a Declaratory act in which the church expressed its desire to enlarge rather than curtail the liberty hitherto enjoyed. Ten years later the assembly was again debating the question of subscription. A committee appointed in 1899 to inquire into the powers of the church in the matter reported that the power of the church was merely administrative—it was in its power as cases arose to prosecute or to refrain from prosecuting, but it had no power to modify the Confession in any way. Here the matter might have remained, but that the approach to parliament of the United and the Free Churches after the decision of the house of lords in 1904 (*see* FREE CHURCH OF SCOTLAND; UNITED FREE CHURCH OF SCOTLAND) offered an opportunity for asking parliament to remove a grievance the church itself had no power to deal with. The Scottish Churches bill of 1905 left it to the Church of Scotland to frame a new formula for its ministers and professors. After 1909—when the quarter-centenary of the birth of Calvin brought the assemblies together in a memorial service in St. Giles's and a joint committee on union was appointed—the two bodies moved toward reunion. The leaders of the Church of Scotland twice went to parliament in order to secure acts which might remove the scruples of the other church. The first act (1921) ratified a constitution drawn up by the church declaring its spiritual freedom, with nine articles outlining an acceptable doctrinal basis. The second (in 1925) ratified a financial arrangement between the church and the heritors, relating to the teinds. Finally the general assemblies of the Church of Scotland and the United Free Church, in May 1929, resolved on an incorporating union of the two churches.

The union of 1929 resulted in marked progress in solidarity and in effective administration, particularly in the uniting of charges in areas that were formerly served by two or three churches. The number of such unions totaled 743 in 1957. During the two decades following the union, the church under the leadership of John White accomplished much in the way of church extension, bringing the ordinances of religion to the people in every parish of Scotland through a territorial ministry. The church's continued interest in the social welfare of the people was shown in the work of its Social Service committee, which started homes and hostels for children and young people, as well as homes for the aged, several of them supported by the local presbytery.

Another move toward reunion took place in 1956 when the United Original Secession Synod was reunited with the Church of Scotland, thus harmoniously ending a division which had lasted for 223 years.

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(A. Ms.; T. C.)

SCOTLAND, EPISCOPAL CHURCH IN, a Scottish episcopal church in communion with, but historically distinct from, the Church of England. The 14 historic dioceses (Edinburgh founded by Charles I, the others of pre-Reformation date) are arranged as follows, under seven bishops: Aberdeen and Orkney; Argyll and the Isles; Brechin; Edinburgh; Glasgow and Galloway; Moray, Ross and Caithness; St. Andrews, Dunkeld and Dunblane. The bishops constitute the episcopal synod, the supreme court of appeal, whose president, elected by the members from among themselves, has the style, not the functions, of a metropolitan, being called *Primus*. The legislature is the provincial synod, consisting of the bishops, at whose discretion it is summoned, and a lower chamber of presbyters. The canons have the authority of this synod. The representative church council, including laymen, administers finance. Each diocese has its synod of the clergy. Its dean is appointed by the bishop, and on the voidance of the see summons the clerical and lay electors, at the instance of the *Primus,* to choose a bishop, who is presented to the episcopal synod for confirmation and to the *Primus* for consecration. There are cathedrals at Perth, Inverness, Edinburgh, Cumbrae, Oban, Aberdeen, Dundee and Glasgow. The theological college was founded in 1810, incorporated with Trinity college, Glenalmond, in 1848, and re-established at Edinburgh in 1876.

The bishops of the Episcopal Church are direct successors of the prelates consecrated to Scottish sees at the Restoration. After the Revolution, the Comprehension act of 1695 allowed episcopalian incumbents, on taking the oath of allegiance, to retain their benefices, though excluding them from any share in the government without a further declaration of presbyterian principles. The extruded bishops were slow to organize the episcopalian remnant under a jurisdiction independent of the state, regarding the then arrangements as provisional and looking forward to a reconstituted national kirk under a "legitimate" sovereign. But at length the hopelessness of the Stewart cause and the growth of congregations outside the Establishment forced the bishops to dissociate canonical jurisdiction from royal prerogative and to reconstitute for themselves a territorial episcopate. The act of Queen Anne (1712), which protects the "Episcopal Communion," marks its virtual incorporation as a distinct society. But matters were still complicated by a considerable, though declining, number of episcopalian incumbents holding parish churches. Moreover, the Jacobitism of some of the clergy provoked a state policy of repression in 1715 and 1745, and fostered the growth of new Hanoverian congregations, served by clergy episcopally ordained but amenable to no bishop, who qualified themselves under the act of 1712. These causes reduced the Episcopalians, who included in 1688 a large section of the people, to what was in 1754, save in a few corners of the west and northeast, a minority; but the chief bar to progress was removed by the official recognition of George III on the death of Charles Edward in 1788. Statistics showed 387 churches and mission stations, 338 clergy and 56,658 communicants in 1956.

SCOTLAND YARD was originally an area just off Whitehall, London, and took its name from the palace, dating back to the reign of Edgar (959–975), which stood on the site. Edgar gave King Kenneth of Scotland a piece of ground lying beside the new palace of Westminster for his residence, requiring him to make a yearly visit to London to pay homage for the kingdom of Scotland. The palace built there by Kenneth remained the property of the Scottish kings, where they stayed when visiting London, but in the reign of Henry II, after the rebellion of William of Scotland in 1173–74, it was "resumed into the king of England's hands." Margaret, the widow of James IV of Scotland and sister of Henry VIII of England, appears to have been the last Scottish sovereign to have made use of the palace, living there for a considerable time after the death of her husband in 1513, but by the time Elizabeth I came to the throne it was more or less a neglected ruin.

On the death of Queen Elizabeth in 1603, James VI of Scotland succeeded to the English throne as James I. With the sovereignty of the two countries vested in one and the same person, the purpose of the palace at Scotland Yard became unnecessary and the site, which had come to be known as "Scotland," was divided into two yards, known as Great Scotland Yard and Middle Scotland Yard, and was used for government buildings. These included the official residence of the surveyor of works to the crown, which was at one time occupied by Inigo Jones. Jones's successor, Sir John Denham, died there in 1669. The next surveyor was Sir Christopher Wren, who had offices there and designed a house in Scotland Yard for Sir John Vanbrugh. This house was built from the ruins of buildings in Whitehall which had been destroyed by fire in 1697. John Milton, when appointed secretary for foreign tongues under Oliver Cromwell's Commonwealth in 1649, soon found it convenient to take up official residence at Scotland Yard, where he lived until he moved to Petty France in 1651. Other notable inhabitants of Scotland Yard include Susannah Cibber, the actress sister of Thomas Arne, and Thomas Campbell, the Scottish poet.

Early Police Connections. — The name of Scotland Yard is, however, better known by its association with the metropolitan police force. The first association of police with Scotland Yard appears to have been in 1662, when the first police or improvement commissioners for London and Westminster set up offices there, but these commissioners were more concerned with paving, lighting and cleaning of streets than mith police duties as they are understood today. A further association occurred when Col. Sir Thomas de Veil, the first of the Bow street magistrates, had an office in Scotland Yard, where he acted as an agent for memorials to public departments before moving to Bow street about 1735. But the direct association between Scotland Yard and the metropolitan police started when the force was formed in 1829 by Sir Robert Peel, the home secretary of the time. The newly formed force was to police the area in and immediately around London—with the exception of the City of London, with its area of just more than one square mile, which was not included but which was to form its own police force ten years later—and the headquarters of the metropolitan force were at no. 4, Whitehall place, with a police station at the rear, entered from Scotland Yard itself. Although the proper official address of the headquarters was no. 4, Whitehall place, from the very beginning it was always referred to as Scotland Yard by the press and others. Even officialdom, which started by referring to it either as Whitehall Place or as Scotland Yard in about equal measure, soon dropped the former style of address altogether and Scotland Yard became an expression used throughout the world to denote the headquarters of the metropolitan police force.

At the time of their formation, the metropolitan police were placed under the leadership of two joint commissioners, Richard Mayne (made K.C.B. in 1851) and Col. Charles Rowan (made K.C.B. in 1848), the former "a sensible lawyer" and the latter "a military man conversant with the details of the police system in Ireland." At first the new force met with fierce and bitter opposition from many quarters and was referred to by many uncomplimentary names, including the "raw lobster gang," "Peel's bloody gang" and "the blue devils," but under the wise and able control of Mayne and Rowan they succeeded in overcoming this opposition and by the time of Mayne's death in 1868 (Rowan had retired in 1850) the force had progressed a long way toward establishing the reputation and popularity which it enjoyed thereafter.

Building Development. — As the work and duties of Scotland Yard increased, adjoining premises were taken over and by the early 1880s the headquarters consisted of a number of separate buildings which, apart from the inconvenience, were extremely overcrowded. Important records and papers were crammed into cupboards and piled high on landings, and the provision of a new headquarters had become a pressing necessity. It was generally agreed that the headquarters should be situated in the immediate vicinity of the home office and the seat of government, since the home secretary is directly responsible to parliament for police matters. The only acceptable site was one on reclaimed land made available by the construction of the Thames embankment, which was opened in 1870. On this site of about 70.000 sq.ft., Colonel Mapleson had begun to build a national opera house on a very ambitious scale. The foundation stone was laid in 187j by the duke of Edinburgh and the intended opera house had been partly constructed, between £80,000 and £90,000 having been spent on it, when the scheme fell through for lack of further financial support.

A private offerwas made in 1880 to the deputy surveyor of the police to buy the site as it stood for £25,000, and after very lengthy discussion the site was finally purchased in 1886. Richard Norman Shaw was entrusted with the designing of the building and his design, although adopted, was the subject of much disagreement in official and other circles. By late 1890 the building was completed, faced up to the top of the second floor with 2,500 tons of granite quarried and dressed by the convicts of Dartmoor, and continuing upward in red brick with Portland stone dressings. On May 11, 1941, a high explosive bomb fell on one corner, causing extensive damage and resulting in many tons of masonry and millions of index cards from the registry two floors above to fall into the commissioner's room. No lives were lost and the commissioner was not in his room. Had the building been less substantial far greater damage would have been done.

The move of all the headquarters staff to the new premises took place in Dec. 1890, and the building was officially designated New Scotland Yard. Scotland house (to become known later as New Scotland Yard South), the complementary building occupied by the receiver for the metropolitan police district, to the south of New Scotland Yard and connected by an archway over the road, was added several years later, from Shaw's designs. At the same time the wrought-iron entrance gates mere added. These gates were designed by Thomas Elsley as an exhibition piece and had been exhibited at the New gallery. Shaw found them at Elsley's shop, standing unused, and they were placed in their present position with the addition only of the arms of King Edward VII.

By 1935 the position at New Scotland Yard had once again reached a point where some extension or resiting was very necessary, and it was decided by the commissioners of the office of works to incorporate a new police building in the development scheme for Richmond terrace, Westminster, and a site extending northward from New Scotland Yard was agreed upon. The reproduction of Shaw's design in the new building was found unacceptable on the grounds that it would be difficult to reconcile it mith further developments in the immediate vicinity and that New Scotland Yard itself was considered to be wasteful in planning by modern standards. A building more in relationship with modern ideas was required, and indeed it was even suggested that Shaw's building should be demolished and replaced by buildings with better accommodation and more in harmony with a general development scheme. This suggestion was, however, dropped when questions of finance and the remoteness of such a general scheme were raised. W. Curtis Green was the man selected to design the new extension, which began to take shape, but at the outbreak of World War II in Sept. 1939 the building was still some way from completion. Under increased pressure of war duties, it was found necessary to move some personnel into the unfinished building, and in early 1940 parts were occupied while work was still in progress on the upper part of the structure. By Dec. 1940 the building was ready for complete occupation, but certain parts of it were, as a wartime necessity, used for nonpolice purposes.

The section of the fighting services known as combined operations took up its headquarters in the building in 1940, and occupied part of it until 1945. Admiral of the Fleet Sir Roger Keyes, Vice-Adm. Lord Louis Mountbatten and Maj. Gen. Robert Laycock successively controlled this service from a room on the third floor of the building. It was not until 1945 that the building became completely available for its original purpose. By mid-century it housed the immense telephone switchboard of Scotland Yard, the information room with its emergency 999 service, the forensic science laboratory, the criminal record office, the fingerprint and photography departments and several other branches of the criminal investigation department.

With the completion of the northern extension it became necessary to rename the buildings at the headquarters. At first it was decided to name the new building Richmond house, as the first step in the Richmond terrace development scheme, but on reconsideration it was thought that the title of Scotland Yard had come to have such a special meaning for the metropolitan police that its use should be retained. The new building was accordingly designated New Scotland Yard North, and the official name of Shaw's building was altered to New Scotland Yard Central. Scotland house, the building of the receiver for the metropolitan police district, became officially New Scotland Yard South.

The three buildings on the Thames embankment alone do not, however, constitute what is generally understood by Scotland Yard, although they do form the core of the metropolitan police administration. Apart from the 175 police stations and other police buildings spread throughout the metropolitan police district, there are several other buildings housing departments which are integral parts of the headquarters. but which, mainly for reasons of space, it has been found necessary to house elsewhere. The public carriage office, the police garage and lost property office at Lambeth, the aliens' registration office at Piccadilly place (formerly the well-known Vine street police station) and offices at Walton street, Kensington, and Ramillies place, Westminster, are all working branches of Scotland Yard's headquarters.

Organization.—At its commencement in 1829, the extent of the metropolitan police district controlled from Scotland Yard was approximately 120 sq.mi., with an estimated population of less than 1,500,000 persons; for this area there was a police force of 1,000. Ten years later, in 1839, the area was extended to 699.42 sq.mi., and the strength of the police had been increased to 3,350 for an estimated population of nearly 2,250,000. No further alteration was made to the size of the district until 1947, when, by a readjustment of police boundaries under the Police act of 1946, it was extended to cover 734.88 sq.mi., the strength of the force having by this time increased to 15,610, for a population of 8,391.000.

At the top of the administration of Scotland Yard and in charge of all the police of the metropolis is the commissioner, who is appointed by the crown on the recommendation of the home secretary. In 1953 the holder of this office was Sir John Nott-Bower, who was the first commissioner to have made the police his life career. All the previous 14 commissioners were brought into the police service from outside careers, 10 from the armed services, 3 from civil administrative positions and 1, Sir Richard Mayne, from the legal profession.

Directly under the commissioner, as his right-hand man and deputy, is the deputy commissioner, and below them at headquarters there are six main departments: administration ("A"); traffic ("B"); criminal investigation ("C"); organization ("D"); secretariat ("S"); and the legal department ("L"). The first four of these departments are each headed by an assistant commissioner. Each assistant. like the commissioner and the deputy commissioner, is appointed by the crown on the recommendation of the home secretary. The commissioner, deputy commissioner and assistant commissioners are also justices of the peace for the counties of London, Middlesex, Surrey. Hertfordshire, Essex, Berkshire. Kent and Buckinghamshire, but their functions as justices are limited to executive police matters.

The assistant commissioner at the head of the administration department is responsible for discipline, distribution and other administrative matters in the force and his department includes the women police and mounted branch. Not the least of his important duties is the control of all police arrangements in connection with the many ceremonials in London.

The traffic department deals with all traffic matters, including the very difficult problem of controlling London's traffic, the public carriage office with its licensing and control of cabs and their drivers, and the drivers and conductors of buses, coaches and trolley vehicles in the metropolitan area, police transport, the police motor driving school and the lost property office.

The criminal investigation department deals with all aspects of criminal investigation, including the criminal record office, fingerprint and photography sections. the company fraud squad, the flying squad. special branch, the metropolitan police laboratory and the detective training school.

The organization department is concerned with civil defense. supplies and equipment, first aid. buildings and housing. recruitment and training. police dogs. medical services, communications including the information room, and welfare.

The secretarial department is under the control of the secretary, who is not a police officer but the highest member of the civilian staff of the metropolitan police force. This appointment is made by the home secretary on the recommendation of the commissioner. His special province is the control of the 1,450 civilians employed in the structure of the force. and all its secretarial work, including its vast registry, pay and pensions and the press and information department.

The legal department is headed by a solicitor, whose duty is to advise the commissioner on all legal matters. The solicitor to the metropolitan police district is appointed by the home secretary on the recommendation of the commissioner and is also the prosecuting solicitor to the quarter sessions of London, Middlesex and Surrey (metropolitan area).

In addition to these main departments, a small research and planning branch was established, responsible directly to the commissioner, through the deputy commissioner, for keeping the whole organization under constant review, particularly with regard to the economic and efficient use of manpower and the planning of future developments. (R. M. H.)

SCOTS GREYS, THE ROYAL (2nd Dragoons). This famous corps was raised in Scotland in 1678 and derives its title from the colour of its original coats—stone grey. Its members were also mounted on grey horses for a great number of years and were, with the 1st Royal Dragoons, the last regiment to give up their horses, in Palestine in 1940. As the Scots Dragoons they served under William III in Flanders. In 1702 as the Grey Dragoons they served in the Low Countries. The regiment was at the battle of Blenheim and was also with the victorious army at Oudenarde and Malplaquet.

In 1736 it bore the title of Royal North British Dragoons which it retained until March 1877, when it became the and Dragoons (Royal Scots Greys). At Waterloo Napoleon referred to the Greys as *ces terribles chevaux gris* (those terrible grey horses) because of their fine fighting qualities. Their long roll of battle honours also shows service in the Crimean War, South Africa, 1899–1902, and World Wars I and II, in the latter as an armoured regiment in the western desert, Italy and northwest Europe. They have been called the "household cavalry of Scotland."

SCOTS LAW. At the union of the parliaments of England and Scotland in 1707, the legal systems of the two countries were very dissimilar. Scotland, mainly in the preceding century, had adopted much of the Roman law, as developed and in some senses altered by the jurists of Holland and France, as an important guide. But it is a fallacy to suppose that, as is sometimes said, the law of Scotland is founded on the law of Rome. The Scots only turned to Roman law when there was a gap in their own common or customary law. Certainly, however, there is a considerable infusion of Roman law and not least in the field of nomenclature. English lawyers on the other hand had forgotten or refused to acknowledge the debt owed to Rome both by common law and equity. At the union the law of Scotland had recently been set forth in the *Institutions* of Lord Stair, a masterpiece of lucidity and orderly arrangement. In England the student or practitioner had little to guide him through a maze of precedents and forms of pleading beyond the difficult pages of Coke. But perhaps the most important point of distinction was the fact that Scotland, unlike England. did not separate the administration of equity and law.

What this separation has led to in England in the way of confusion, expense and hardship to litigants may be read in many works, although the separate administration of equity has doubtless contributed to a thorough development of some branches of what may be called generally "law," as for example the law of trusts. But such a conception as, say, the English one of "equitable property" is as completely incomprehensible to a Scottish lawyer as it is to any continental lawyer. The Scottish conception of equity is not, like the English, the conception of a system running parallel to the common law. It is rather: (1) a few fairly simple rules aimed at supplementing the law where to fail to do so would result in hardship: and (2) the relegation of certain remedies to the class of equitable remedies, which the court has a large discretion on equitable grounds to grant or withhold. It may truly be said that the word "equity" in the law of Scotland is never in its meaning removed from the original meaning of the word as it is in England. The Scottish outlook upon this whole topic ranges the Scottish system clearly alongside the continental and not the English system.

It is worthy of note that the tendency since the 1870s is for the English to approach the Scottish model of the administration of law and equity in one court and not vice versa, but there still remains a world of difference.

Historical Development.— The legal history of the centuries following the union shows a considerable measure of assimilation between the two systems, in which for the reasons mentioned below the tendency has been for the English law to affect the other, though there have been many exceptions. It would seem as though assimilation will never be complete. Public opinion in Scotland, even though it be lay opinion, is alive to the great and fundamental differences between the two systems and believes that the Scottish system is that which is best suited to the people of Scotland, as no doubt it is. One main cause of assimilation is that much of the existing law of Scotland depends on statutes applicable to both countries. The house of lords, consisting in its legal aspect until 1876 exclusively of English lawyers acting as the supreme court of appeal from Scotland, had a tendency to apply English law in Scottish appeals, and in some cases seems to have forgotten the distinction between its legislative and its judicial functions. Thus in a case decided in 1790 the house held that the law of stoppage *in transitu* was applicable to Scotland without any evidence that it had ever before been suggested to be the law there. Yet another cause of assimilation is the influence of text writers, some of whom, such as G. J. Bell, have been too much given to treating English law as though it were the law of their own country. The citation, too, of English authorities in court, despite judicial remonstrance, has had considerable effect. Not surprisingly the greatest measure of assimilation has been in the field of mercantile law. In other fields the systems are still widely separated.

Courts of Law.—The scheme of the Scottish courts is completely different from that of the English and once again the greater similarity of the Scottish to the continental pattern is noticeable. The supreme Scottish court (the house of lords, which is not a native court, being for the moment disregarded) is the court of session, instituted by King James V in 1532 largely upon a French model. Despite the interest of its history there is only space here to touch upon its constitution and functions today. The court has two main functions. It has original jurisdiction in a very wide range of cases, which is exclusive in a few matters such as actions affecting status. In its appellate capacity it hears appeals (by reclaiming petition) from the six court of session courts of first instance (called compendiously the outer house), each presided over by a lord ordinary, and also from the sheriff's courts. The appellate court (inner house) sits in two divisions, the first and second prtsided over respectively by the lord president of the court of session and the lord justice clerk. All the judges have the courtesy title of "lord," but are not on that account peers.

While the judges of the court of session are traditionally judges of fact and law, an innovation was made in the early 19th century when the civil jury was introduced, less because it was wanted in Scotland than because the house of lords was weary of the multiplicity of appeals which (since the decision of a jury is not in the ordinary sense appealable) would be drastically reduced by the change. The civil jury has never commended itself to Scottish lawyers and it seems to become less and less popular in England. From the inner house appeal lies in many cases to the house of lords as of right and not, as in England, by leave. How the house of lords, whose position was not dealt with in the treaty of union, came to be the ultimate court of appeal for Scotland is an interesting and rather obscure story which cannot be told here. The right of audience in the court of session is possessed exclusively by members of the faculty of advocates.

The lower civil courts are the sheriff courts. These very ancient courts are to be found distributed by counties throughout Scotland. They are manned by (1) the sheriff principal and (2) the sheriff substitute. The former (who has some administrative as well as judicial functions) is in civil matters an appellate judge only and hears appeals from the sheriff substitutes of his jurisdiction. The latter's absurd title conceals their great importance. For except in divorce and one or two other less important matters their jurisdiction, by a strange arrangement, almost exactly coin. cides with that of the court of session. As a local and comparatively inexpensive court the sheriff court is more popular than the court of session. It will be seen that the sheriff court (which has also a wide criminal jurisdiction) cannot for a moment be compared with the English county court, with its very limited civil jurisdiction and complete lack of criminal powers. The justice court has a limited jurisdiction in small debt actions. The dean of guild court has a quaestorial jurisdiction in questions of building in the towns, the land court in dealing with the relations of landlord and tenant in agricultural districts.

It should be added that the court of session has absorbed the functions of certain ancient courts, the court of exchequer, the admiralty court, the teind (or tithes) court and the commissary court, which dealt with questions of marriage law and executry, while the judges have by statute been given separate duties in a lands valuation court and a registration appeal court.

Land Tenure.—In Scotland as in England the law of land tenure has been greatly complicated by the survival of much of the feudal system. In theory the crown is at common law the ultimate owner of almost all land, which passes from it to others in the first place through a grant. The grantee or "vassal" may make a subaltern grant and so can successive grantees, by what is called subinfeudation, a process forbidden centuries ago in England by the statute *Quia Emptores.* The grantee can also sell his land so as to take himself out of the descending chain and put a purchaser in his place. As in other systems, land can be used to provide security for a loan to the owner of it. This is done by a bond with a disposition of the land in security. Or it may be done by an outright conveyance together with a "back letter" from the lender entitling the owner to recover the land on the loan being repaid. The word mortgage is not used. The consequence of unrestricted subinfeudation has been that the rights of subject superiors—the superior is the person who feus or grants the land —have bulked much more largely in Scotland than in England. A series of statutes, culminating in the Feudal Casualties act, 1914, abolished all payments exigible from the vassal except feu duty, and at mid-20th century it might be said that a feu—the normal tenure in Scotland—was equivalent to an English freehold, subject, in cases where there was a feu duty, to a perpetual rent charge. There is, however, a very important distinction in the system of registration of title, only partially and imperfectly developed in England. In Scotland, since the establishment of the Register of Sasines in 1617, all deeds relating to land may be recorded in that register, and it has for long been established that a purchaser, or a lender on heritable security, is entitled to trust to the register, and is not affected by any conveyance or burden which is not there recorded. This is a state of security not even yet attained in England.

Leases for any period exceeding 21 years, though not unknown, have never been common in Scotland. Legislation, however, has established a system of leasehold in agricultural subjects not exceeding 50 ac., with security of tenure and the right to have the rent fixed judicially by the land court, and in this respect there is no English analogy. In other respects the law of country leases is, in its main aspects, the same in England and Scotland and the Scottish Agricultural Holdings act of 1949 differs only in minor respects from the English act of 1948.

The law of house leases differs markedly from the law of England in a number of ways. For example Scots law demands in most cases that notice of intention to remove be given even if the lease itself provides for termination at a particular date. Failing this the lease will be continued by what is called tacit relocation. Then the landlord is bound to provide premises reasonably fit for the purposes of the let and so to maintain them. Failure to repair may be met by retention of the rent by the tenant. On destruction of the premises both parties are freed from their obligations. Local rates in Scotland are payable partly by the owner of property and partly by the occupier who may, of course, be a tenant. This system has been much criticized.

Rights in Land. — Apart from its theoretical ownership of all Scottish land the crown is an important owner of heritable property; *i.e.,* land and what is built upon or planted in land. Its rights are known as the regalia. Some are *majora* and are inalienable. The minora or lesser rights may be alienated.

The foreshore of the sea may-be alienated but the public rights to anchor boats, embark and disembark and others may not be frustrated. Mention may be made of particular regalia *minora* such as the rights to salmon fishing, to precious metals and to highways. Possession of heritage has some important consequences. Thus a bona fide possessor who unjustifiably takes the produce of the land need not make it good; in contradistinction to the possessor in bad faith, who must pay penal damages. Again a bona fide possessor is entitled to recompense for improvements.

The individual owner of land is entitled in theory to use it as he likes but. as in other countries, there are in Scotland numerous statutory restrictions and disabilities. Among common-law rights, the right of support of land in its natural state by the land of one's neighbours is important. Surface or percolating water may be impounded but water in a stream may not be prevented from descending to lower proprietors. Where the lands of several proprietors adjoin a loch, they have a joint right in it. The right to fish in inland waters and the right to take game are incidents of property. It is open to a proprietor of land to confer upon neighbouring proprietors what is called a servitude: *i.e.,* the right to use the grantor's land in some way (a positive servitude) or the right to restrain the grantor from using his land in some way (a negative servitude). Examples would be, respectively, a right of way given to X over A's land and a right to X of preventing A from building above a certain height on his, A's, land. A public right of way, unlike a servitude, exists for the benefit of the public and not for the benefit of a particular piece of land. A subject of importance in connection with possession of land is the positive prescription. When land is held on a title ex facie valid for 20 years recorded in the register, an unchallengeable title is acquired by prescription. The term prescription has another sense in relation to contract and to rights in movables, as will be seen later.

Husband and Wife: Children. — The enfranchisement of women has placed husband and wife, as in England, upon an almost equal footing in matters of property. Gone are the days when on marriage the wife's whole movable property became her husband's and his assent was needed to any transaction affecting her heritage. In the law of marriage and divorce. too. the two systems have been gradually drawing closer. Thus the celebrated irregular marriage of Scotland has all but disappeared. "Gretna Green" is no more. The Scottish registrar has a new function. Yet in fairness it should be realized that the irregular marriage was as binding as the regular and found a warranty in the canon law. Its abolition. many think, was a misfortune. In the law of divorce, on the other hand, the English law has come closer to the Scots law. In Scotland: divorce was always allowed on the same grounds to each party. Moreover, it was given for four years' desertion as well as for adultery. Today the four years have become three and cruelty, unnatural vice and incurable insanity have. as in England, been added as grounds of divorce. One very important difference between the two systems is that in England "recrimination"; *i.e.,* the answer by a respondent that the petitioner has also committed adultery, is a bar to a divorce unless the court exercise discretion. In Scotland recrimination is no defense and a party himself or herself guilty of adultery is entitled to divorce even if the other party has committed adultery. Cross divorce is the solution. In Scotland a decree of divorce dissolves the marriage at once. In England neither party is free to remarry until six months have expired. In both countries the crown may interest itself in the proceedings as. for example, to discover collusion or, in England, concealment of adultery by the petitioner. In Scotland this intervention is made by the lord advocate. It is rare, probably because the law does not recognize recrimination. There is no queen's proctor. For the matrimonial offenses of adultery and cruelty (including habitual drunkenness) the courts grant, if sought, the lesser remedy of judicial separation. This, if allowed, is normally accompanied by an award of aliment. The property position on divorce is quite different from the English. The guilty spouse is treated as notionally dead and the legal rights exigible on death (see succession. below) are similarly exigible on divorce. This is a capital transaction. There is no award of a periodic alimentary payment.

Children. — Scots law divides minority into two periods: (1) minority proper. from 12 to 21 for girls, 14 to 21 for boys: and (2) pupillarity; up to 12 and 14 respectively. Pupils act by their tutors. normally the father. Minors act with the consent of their curators, normally the father. A pupil can never act for himself. But a minor. if he has no father. need have no curator and can legally treat himself as if he were major. The independence thus allowed to young people is an outstanding feature of the law. But 16 is the lowest age for marriage. Disadvantageous transactions by minors and pupils can be set aside within four years of attaining 21.

Intestate Succession. — In the law of succession the Administration of Estates act. 1923, by establishing a general order of intestate succession in England. has created a fundamental difference between the countries. In Scotland the order of succession in heritable (real) and movable (personal) property remains separate. And Scots law has never admitted absolute freedom of bequest in cases where there is a surviving husband. wife or child. A widow has a legal right. known as *jus relictae*, to one-half of her husband's movable property if there is no surviving child; if there is, to one-third. A widower. by the Married Woman's Property act, 1881, has a similar right in the movable property of his wife (*jus* relicti).

In heritable property a widow has a legal right (terce) to a liferent of one-third; a widower. under certain limitations. has a right of courtesy. which gives him a liferent of the whole of the wife's estate. Children have a legal right to legitim in the movable estate of each parent, one-half if there is no surviving spouse, one-third if there is. All rights may be excluded by antenuptial marriage contract; any particular claim by postnuptial contract between husband and wife, or between parent and child. They cannot, however, be excluded or limited by will, and attempted disregard of this may be successfully challenged in the courts.

Testate **Succession.**—No legacy made orally is valid unless it is of £100 Scots (£8 6s. 8*d.*) or less. This apart. a will must be made by a writing signed and witnessed as a deed (by two witnesses) or by a writing entirely in the testator's handwriting and signed by him. a holograph will. When a testator cannot write. the will may be signed for him by a solicitor, notary, justice or parish minister.

The validity of a will is, in Scots law, not affected by the subsequent marriage of the testator. It may be said that, with considerable differences of detail. the law of wills is not markedly different in the two countries. Undoubtedly, however, the existence in Scotland of "legal rights" to succeed introduces a complication which does not arise in England. (See also WILL.)

Executors and Trustees. — These are persons nominated by the deceased (executors nominate) or appointed by the court (executors dative) who alone are entitled to get in the estate and pay creditors and legatees. Sanction to act is conferred by confirmation; the term probate is a solecism in Scotland. Any other person dealing with the estate is called a *vitious intromitter* and may, unless relieved by the court, incur liability for the debts of the deceased. A special summary process is competent in the case of small estates of a few hundred pounds in value. The heir of an executor does not succeed to his office. The same persons are frequently executors and trustees in estates of any size and especially where life interests have to be carried on. The law of trusts. a subject of great importance, is to be found in its main features in the Trusts (Scotland) act, 1921. It in many respects resembles the law in England but the conception of holdings in trust as a sort of property running parallel to legal property is quite foreign.

A Scottish trust is normally constituted by an act of its creator but it may also arise through implication from circumstances. Writing is not in all cases necessary. Trustees act by a majority. They may assume new trustees and may resign if they provide for the continuance of the trust. A trust may be terminated with the consent of grantor and beneficiaries, but a trust taking effect on its creator's death may not be terminated even with the beneficiaries' consent if its purpose is alimentary; *i.e.,* for the maintenance of the beneficiary. Such a protected trust may be created in favour of a man.

Contract. — In regard to form of contract there are three possibilities: the contract must be in writing (*e.g*, for sale of land); it may be made orally but must be proved by writing (e g., contracts of an unusual nature); or it may be made and proved in any way (*e.g.,* sale of goods). The specialities of the document under seal are unknown, and consideration is unnecessary. Where writing is needed merely by way of proof and none is available, the party desiring to prove the contract may have the other put on oath and called upon to admit the contract. If this fails only part performance can save it. The only drawback to a contract lacking consideration is that it must be proved by writing. It is a peculiarity of Scots law that when a third party, X, is deliberately benefited by a contract between A and B, X has a right to sue A or B if either of them fails to perform the obligation. Where one party has been precluded through some cause beyond his control from performing his obligation, the law of Scotland enforces the return of any advance payment that has been made. (The law of England which refused this had, by mid-20th century, come into line.) There is much in the law of contract in the two countries that is similar. Yet the two are far from being identical. Mention may be made of the negative and short prescriptions, so closely though not exclusively connected with contract. Very shortly, a person who fails to enforce his rights under contract for 20 years is prevented by the long negative prescription from doing so. Shorter periods such as three and six years apply to particular contracts, but these in the usual case merely add the need of writing to the burden of proof, without extinguishing the rights.

A useful conception is that of quasi contract. This means the obligation imposed, not by express agreement, but by force of circumstances. One example is *negotiorum* gestio, which means the obligation to make good expense incurred in intervening to help another in an emergency.

Sale of Goods.--One statute, the Sale of Goods act, 1893. provides a short code of law upon this subject for Scotland and England. There is a background of considerable differences but these were largely reconciled in the act. There remain a few differences, however, of varying importance. Thus the law as to the effect of breach of warranty and condition is different. In English law the remedies of a buyer depend upon whether the seller's failure is concerned with a warranty or a condition. In Scotland the question is whether the seller's failure is in the circumstances a material failure. Again, where the value of goods sold exceeds £10 there must in England be a memorandum in writing; in Scotland oral evidence is in all cases sufficient.

Movable Property. — It is impracticable in a short article even to mention the multifarious aspects of this topic, some of which, however, are referred to under other headings. A few observations upon the origin and use of property are all that can be attempted. Whatever has, never had an owner may be taken and converted into property by occupatio, subject to some restrictive laws. Nondomestic animals are an example, even game, but poached game may be forfeited. Accessio is another mode: whatever is affixed to heritage or grows in it tends to become the property of the owner of the heritage. (Land itself cannot be acquired by occupatio since land in nobody's hands reverts to the crown.) But most property is acquired by transactions such as sale or gift or succession. By other transactions such as liferent, hire, deposit and loan something short of property is acquired, usually possession, which is a concomitant of property. These transactions have their counterpart in heritage, and liferent is of especial importance there. A liferent cannot be created in favour of a person as yet unborn as, for example, by a bachelor in favour of his legitimate grandchild. If this is attempted the person selected becomes the owner.

Liferent confers rights upon the holder so extensive as to render him virtually owner for life. Thus the liferenter is liable for discharge of burdens of all kinds upon the property not in the nature of capital payments; while he is entitled to use the liferented property as he pleases, except that he may not dilapidate it nor dispose of it for a period longer than the duration of his life. One important feature of the Scots law of property is the stress laid upon possession of the subject of a transaction. With exceptions of little importance no security over movables can be created without actual or constructive delivery. Several important differences from English law follow. Thus the bill of sale is unnecessary and unknown and the "floating charge" is incompetent. Security, too, by way of deposit of deeds is out of the question. Gift in Scots law is, in accordance with the same principle, effected only by transfer of the thing given. And before 1893 the property in goods sold only passed on actual delivery.

Delict.—By this word is meant in modern usage a wrong in its civil aspect. The basic rule of Scots law is that whoever injures another in his fortune, his person or his good name either intentionally (delict) or through negligence (quasi delict) is liable to pay such damages as will, so far as practicable, restore the status quo ante. This is known as reparation. Damages are therefore given for injury, pain, damage to property, interference with trade, defamation, wrongful imprisonment and the like. Injury to feelings, as through bereavement, is met by an award of *solatium.* This occurs where near relatives (father, mother, children) or husband and wife are killed. (In England Lord Campbell's act, 1846, is based on the Scots common law, with differences.)

The law of reparation rests upon the existence of culpa or fault and no liability attaches because of mere ownership of an object which causes damage. It is, too, only for the foreseeable results of negligence that damages are given. An important body of case law goes to illustrate the liability of employers for the acts of their servants. In the law of defamation no distinction is drawn between written and spoken words. Utterance to the defamed person himself constitutes publication. It is not necessary in any case to prove special (particular and ascertainable) damage. There is no such thing as criminal libel, and holding up to mere ridicule is not actionable. Whatever the preunion law of Scotland, the crown was in postunion times immune from liability for wrongs done by its servants. In 1947, however, the Crown Proceedings act introduced liability in most cases, thus probably restoring the Scots common law.

Procedure; Diligence; Bankruptcy. — These highly technical conceptions lend themselves in a condensed account to none but the most summary treatment. They all differ greatly from their English counterparts. Civil procedure in the court of session and the sheriff court are similar and only the former is considered here. A summons usually begins the proceedings though petition is also known. All averments of fact must be explicitly answered and each party's legal contentions are contained in numbered pleas in law. Great importance is attached to "relevancy"; *i.e.,* the statements made must if proved import the remedy. Otherwise the case may be dismissed. In civil trial by jury, issues are settled in writing for presentation to the jury. The course of an action is arranged in the procedure roll. It has for centuries been the boast of the Scottish bar that nobody ever lacked their help for want of means.

Diligence is the Scottish equivalent of execution and it takes several forms. Thus, for example, poinding (pronounced "pinding") means taking movables to satisfy the decree of the court. Arrestment involves directing the debtor of the judgment debtor to pay the latter's creditor direct. Adjudication means taking heritage in satisfaction.

Bankruptcy (technically "sequestration") is the state of officially recognized insolvency which follows usually upon unsatisfied diligence. It affects all property of the bankrupt in the British Isles. Various types of arrangements with creditors may avert the disaster. Statutory safeguards prevent abuse by way of fraudulent preference and the like. A bankrupt suffers civil disabilities ceasing on his discharge, which depends upon conduct and satisfactory payments.

Criminal Law.—A crime is a wrong which even if it directly injures an individual is held to be harmful to the community. Pursuant to this view and with the rarest exceptions, prosecution is exclusively a public function carried through by a public prosecutor.

The lord advocate is the head of a system of prosecuting counsel and other officials (procurators fiscal) who prosecute in the high court and the sheriff courts respectively throughout Scotland. Other criminal courts have also public prosecutors. Private prosecution is today virtually unknown although in theory and in the unlikely event of the crown's unjustifiably declining to prosecute, the victim may be given leave to do so. Proof of a guilty intention on the part of the accused, as well as of an overt act, is necessary before a conviction can be obtained save where statute makes an exception or where the court has admitted the vicious principle of vicarious responsibility. Such circumstances, therefore, as youth (no crime under eight), insanity or compulsion will, subject to certain rules, render conviction impossible. The question of the responsibility of the insane is no more satisfactorily settled than elsewhere, but Scots law gives greater exculpatory effect to insanity than English law. The English distinction, in modern times idle and even misleading, between felony and misdemeanour is not made. The field of particular crimes is covered thoroughly as in most systems and no act involving moral delinquency will fail of punishment merely because precedent or a name is lacking.

Nomenclature differs considerably from English nomenclature and the same word (like embezzlement) may point to different offenses. Burglary and housebreaking are not distinguished; manslaughter is culpable homicide; receiving is reset; concealment of pregnancy and not concealment of birth is the crime and so on. The criminality of suicide lacks satisfactory warranty and Hume, the prime authority, shies away from pronouncing even upon attempt. In modern practice the public prosecutor may, but rarely does, prosecute an attempt as a breach of the peace. Almost always such cases, which usually involve insanity, are dealt with administratively after medical examination. It may be said too that the incidence of crime is different north and south of the border and the popular attitude to certain crimes also differs. Thus blackmail is almost unknown. And for many years in the earlier part of the 20th century Scottish juries could scarcely be brought to convict of murder.

Criminal Courts and Procedure.—The high court of justiciary is the ancient supreme criminal court. It consists of the judges of the court of session but in their capacity of lords commissioners of justiciary. Its sittings take place in Edinburgh and on circuit. It tries cases with a jury but has an appellate jurisdiction in summary cases. Since 1926 its judges have had power to entertain appeals against convictions on indictment also. The sheriff court tries both on indictment and summarily. Two years' imprisonment is the maximum. Lower courts are the police courts of the bailies in the towns and justices in the country. There is no coroner. Fatal accident inquiries, however, are held in certain cases and the procurator fiscal investigates every case of suspicious death.

Criminal procedure in Scotland is simple and expeditious, Innocence is presumed and guilt must be proved beyond a reasonable doubt. Proceedings are instituted by the crown officials who decide on form of trial and forum. The police do not prosecute. Juries consist of 15 and may decide by a majority. A verdict of "not proven" is competent and useful. Even in the case of serious crime there is only one public hearing, so that juries can never be prejudiced by the reading of one or two detailed reports of earlier hearings. In the trial itself the last word in every case (subject to the judge's summing up) lies with the accused, never with the prosecution. There is no opening speech on either side.

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SCOTT, ALEXANDER (*c.* 1525–*c.* 1585), Scottish poet, one of the "last of the makaris" of the 16th century, a writer of lyrical freshness and technical skill. Nothing is known of his life, though he seems to have been familiar with Edinburgh and Dalkeith, and he is probably the "old Scott" referred to by Alexander Montgomerie, his younger poetic contemporary, in a sonnet dated *c.* 1584. All his extant poems, about 35 in number, are contained in the Bannatyne manuscript (1568 ; in the National Library of Scotland). Since Allan Ramsay printed a selection of his verse in his collection of old Scots poetry, *The Ever Green* (1724), Scott's reputation as a genuine minor lyric poet has been maintained. He left an amusing burlesque, "*The Justing and Debait vp at the Drum betuix William Adamsone and Johine Sym.*" He also wrote a ceremonial and highly alliterative poem, "*Ane New Yeir Gift to the Queen Mary, quhen scho come first Hame, 1562,*" which gives an interesting reflection of early Reformation Scotland. His best work, however, is to be found in his love lyrics; these show a striking range of mood, from the tender to the coarse, and an admirable metrical suppleness and variety.

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SCOTT, CHARLES PRESTWICH (1846–1932), British editor and journalist, born at Bath, Somersetshire, on Oct. 26, 1846, was the youngest son of Russell Scott. He was educated privately and at Corpus Christi college, Oxford, where he graduated with a first class in 1869. After training under Alexander Russell of *The Scotsman*, he, in 1871, began a long connection with *The Manchester Guardian*, of which his brother-in-law, J. E. Taylor, was proprietor. He himself became editor in 1872, and, after the death of Taylor in 1905, also chief proprietor. He enlisted the services of W. T. Arnold and many of the leading critics of literature, art and music of two generations, so that the paper became one of the foremost journals of the day. Gradually developing from Whiggism to advanced Liberalism, *The Manchester Guardian*, as directed by Scott, was always sober in tone and scrupulous in policy. He retired in 1929.

Always active in local politics, after three unsuccessful contests for the representation of North-East Manchester, Scott was elected Liberal M.P. for the Leigh division of Lancashire in 1895 and sat until 1906.

See J. L. Hammond, *C. P. Scott of the Manchester Guardian* (1934).

SCOTT, CYRIL MEIR (1879–), English musical composer, pianist and author, was born at Oxton, Birkenhead, on Sept. 27, 1879, and studied music at the Hoch conservatorium, Frankfurt am Main. On his return to England, Hans Richter in 1900 produced his orchestral *Heroic Suite* at Liverpool, and an overture to *Pelléas and Mélisande* was shortly afterward played at Frankfurt, but both of these and several of his other early works were afterward withdrawn by the composer as immature. His works include songs, piano and violin compositions, operas, a ballet, choral and chamber music and orchestral works.

Scott wrote verse and an autobiography, My *Years of Indiscretion;* he also wrote *Music: Its Secret Influence Throughout the*

Ages, 5th ed. (1950), and books on mysticism.

SCOTT, DUKINFIELD HENRY (1854–1934), English paleobotanist, the leading authority of his day on the structure of fossil, and especially of Carboniferous, plants, was born in London on Nov. 28, 1854. His early education was by private tutors. In 1876 he graduated from Christ Church, Oxford. He became financially independent when his father died. Soon thereafter, he decided to study botany under Julius von Sachs (*q.v.*) at Wiirzburg where, in 1882, he received his doctorate. He taught at University college, London (1882), and the Royal College of Science (1885) and, in 1892, became honorary keeper of the Jodrell laboratory at Kew. He was elected a fellow of the Royal society in 1894. He left Kew in 1906 and settled at Oakley where he died on Jan. 29, 1934.

Scott's early work was in plant anatomy, but his interests turned to paleobotany when he wrote, with William Crawford Williamson (*q.v.*), three memoirs on the organization of the fossil plants of the carboniferous rocks (1895–96). In 1897 he described the complex cone of *Cheirostrobus.* His paper on *Lepidocarpon* (1901) showed that some Paleozoic lycopods bore "nascent" seeds, and the paper on *Botrychioxylon* (1912) revealed the presence of secondary wood in a Paleozoic fern. In 1904 Scott and F. W. Oliver announced their discovery that the seed *Lagenostoma* belonged to the fernlike *Lyginodendron,* thus bringing to light a new class of seed plants for which the name Pteridospermae was proposed. He wrote *Studies in Fossil Botany* (1900; 3rd ed., 1920–23) and *Extinct Plants and Problems of Evolution* (1924).

See notices in *Ann. of Bot.*, vol. xlix, pp. 823–840 (1935), containing a list of Scott's 154 publications, and in *Nature,* vol. cxxxiii, pp. 317–319 (1934), vol. clxxiv, pp. 992–993 (1954). (J. W. Tr.)

SCOTT, SIR GEORGE GILBERT (1811–1878), English architect of the Gothic revival, whose main work was the restoration of churches and cathedrals, was born in 1811 at Gawcott near Buckingham. Scott was apprenticed to a London architect, filled various staff posts, and designed his first church in 1838. But his real artistic education dates from his study of A. W. N. Pugin's works on medieval architecture. The first result of this new study was his design for the Martyrs' memorial at Oxford, erected in 1840, a clever adaptation of the late 13th-century crosses in honour of Queen Eleanor.

In 1844 Scott won the competition for the new Lutheran church at Hamburg, a noble building with a lofty spire, designed in 14th-century German Gothic. In 1847 he was employed to renovate and refit Ely cathedral, the first of a long series of English cathedrals and abbey churches that passed through his hands. In 1851 he visited and studied the architecture of the chief towns in northern Italy. In 1856 a competition was held for designs for the new government war and foreign offices in London; the work was given to Scott on the condition (insisted on by Lord Palmerston) that he should make a new design, not Gothic, but Classic or Renaissance in style. In 1862–63 he was employed to design and construct the Albert memorial, a costly and elaborate work, in the style of a magnified 13th-century reliquary or ciborium, adorned with many statues and reliefs in bronze and marble. On the partial completion of this he was knighted. In 1873, because of illness caused by overwork, Scott spent some time in Rome and other parts of Italy. The mosaic pavement which he designed for Durham cathedral soon afterward was the result of his study of the 13th-century mosaics in the old basilicas of Rome. He died on March 27, 1878. Scott's volume of *Personal and Professional Recollections* was published in 1879.

SCOTT, SIR GILES GILBERT (1880–1960), British architect, born Nov. 9, 1880, was the son of George Gilbert Scott and grandson of Sir George Gilbert Scott, R.A. Educated at Beaumont college, Old Windsor, he began to practise in London in 1902. His first commission was for the projected cathedral at Liverpool, his designs for which expressed the architect's hope for a revival of Gothic architecture through the true understanding of its spirit and were accepted on the condition that G. F. Bodley, R.A., be associated with him as joint architect in consideration of his youth. In July 1904 the foundation was laid by King Edward and the Lady chapel was completed in 1910. The consecration took place on July 19, 1924, in the presence of King George V and Queen Mary. Designed in Gothic style; it was the first Anglican cathedral built in the northern provinces since the Reformation. The design for the tower was considerably altered in 1924. The exterior is of red sandstone, and its massive bulk dominated the city and the seaway. Later Scott designed many other church buildings including Charterhouse school chapel, the nave of Downside abbey and the Abbey church at Ampleforth.

Scott also was the architect for the new university library and extensions to Clare college, Cambridge. In 1944 he was chosen as architect of the new house of commons chamber, a simplified version of the chamber destroyed in World War II; the building was completed in 1950. He was elected associate of the Royal Academy in 1918, Royal Academy in 1922, and was president of the Architectural association, 1920–21, and of the Royal Institute of British Architecture, 1933–35. He was knighted after the consecration of Liverpool cathedral in 1924 and in 1944 received the Order of Merit. He died in London on Feb. 8, 1960.

SCOTT, JAMES BROWN (1866–1943), U.S. jurist, publicist and educator, one of the leaders in the international peace movement of the 20th century, was born of American parents on June 3, 1866, at Kincardine, Ontario. Graduating from Harvard in 1890 (M.A. 1891), he subsequently studied at Berlin, Paris and Heidelberg, (J.U.D. degree from the last, 1894). Devoting his life to expounding and advocating the application of law and justice between nations through arbitration and judicial settlement, Scott played an important part in establishing at The Hague the Permanent Court of International Justice (1921) and the Academy of International Law (1914). He was one of the founders of the American Institute of International Law (1912), the American Society of International Law and its *Journal* (1906), the first English-language periodical of its kind, of which he was editor in chief. He was author, among other works, of *Cases on International Law,* 2nd ed. (1922), *The Spanish Origin of International Law* (1933) and *Law, the State and the International Community* (1939).

Law school dean (Los Angeles law school [Southern California] and Illinois) and professor (Columbia and Georgetown) from 1896 to 1940, Scott was editor of several casebooks and general editor (1908–15) of the *American Casebook* series begun in 1908 at his suggestion. Solicitor of the U.S. department of state (1906–10) and technical adviser, Scott was counsel to the U.S. agent in the North Atlantic fisheries arbitration and was delegate to numerous international conferences, including the 1907 Hague peace conference, where he urged the establishment of an international arbitral court. He was secretary (1910–40) of the Carnegie Endowment for International Peace and director of its division of international law (1911–40). He died on June 25, 1943, at Annapolis, Md.

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SCOTT, ROBERT (1811–1887), English theologian and lexicographer, was born on Jan. 26, 1811, at Bondleigh, Devonshire, and educated at Shrewsbury school and Christ Church, Oxford.

Scott's great achievement was his collaboration with Dean Liddell in the Greek lexicon (1843), of which a new edition, revised by H. S. Jones and R. McKenzie, was published in 1925. He died at Rochester on Dec. 2, 1887.

SCOTT, ROBERT FALCON (1868–1912), British sailor and explorer, was born at Devonport on June 6, 1868. Educated at Stoke Damerel and Stubbington House, Fareham, he passed into H.M.S. "Britannia" in 1880, and in 1882 became a midshipman on the "Boadicea." In 1897 he was promoted first lieutenant, and two years later he was recommended as commander of the National Antarctic Expedition. On taking up his duties in the "Discovery," in 1900, he was promoted commander. During the four years which followed, Scott proved both an intrepid and able leader, and a competent scientific investigator; and on his return in 1904 he was promoted to the rank of captain. For the next six years he served in the navy, commanding successively, the "Victorious," the "Essex," and the "Bulwark," until, in 1909, he announced his intention of organizing another Antarctic expedition, for the purpose of continuing the work of the "Discovery" and of reaching the South Pole.

Backed financially by the British and Dominion Governments, Scott set sail in June 1910 in the "Terra Nova," and in Nov. 1911, began his southern sledge journey. Though delayed by bad weather, Scott and his four companions reached the Pole on Jan. 17, 1912, to find that they had been forestalled by Amundsen. Sickness, insufficiency of food, and the severity of the weather, made travelling very slow on the return journey, and on Feb. 17, Petty Officer Evans broke down under the strain and died. A month later, Oates, who was too ill to travel further, walked out into a blizzard, hoping, by his sacrifice, to save his companions; but the weather prevented all possibilities of advancing, and the remdinder of the party perished on or about March 27, 1912. On Nov. 12, 1912, a search party found Scott's tent, containing the bodies of Scott, Dr. E. A. Wilson and Lieut. H. R. Bowers, as well as Scott's records and diaries, in which was given a full account of the journey and the deaths of Capt. Oates and Petty Officer Edgar Evans. A memorial service was held in St Paul's cathedral, London, on Feb. 14, 1913, and a Mansion House fund was subsequently raised to make provision for the surviving relatives of the lost explorers The rank and precedence of the wife of a K.C.B. were by royal warrant conferred on Captain Scott's widow.

See R. F Scott, *The Voyage of the "Discovery"* (1905); *L.* Huxley, *Scott's Last Expedition* (1913); E. *R.* G. R. Evans, *South with Scott* (1921); *British Antarctic Expedition (Terra Nova) 1910–1913: Scientific Results* (1914); *Geographical Journal* (1902–13) *passim.*

SCOTT, SIR WALTER, BART. (1771–1832), Scottish poet and novelist, was born at Edinburgh on Aug. 15, 1771. He came of an old Border family, and it was his pride in their real or supposed feudal dignity and their rough marauding exploits that first directed him to the study of Border history and poetry, the basis of his fame as a poet and romancer. His father, Walter Scott, a writer to the signet (or attorney) in Edinburgh—the original of the elder Fairford in *Redgauntlet—was* the first of the family to adopt a town life or a learned profession His mother was the daughter of Dr. John Rutherford, a medical professor in the University of Edinburgh, who also traced descent from the chiefs of famous Border clans.

Scott's health in boyhood was uncertain; an attack of fever in infancy had left him permanently lame, and his nature was so lively and excitable that it was considered dangerous to press him and prudent rather to keep him back. He was therefore left very much to himself in the matter of reading, and began at an early age to accumulate the romantic lore of which he afterwards made such splendid use. At ten his collection of chap-books and ballads had reached several volumes, and he was a connoisseur in various readings. Thus he took to the High School, Edinburgh, when he was strong enough to be put in regular attendance, an unusual store of miscellaneous knowledge and an unusually quickened intelligence. Throughout his school days and afterwards when he was apprenticed to his father, attended university classes, read for the bar, took part in academical and professional debating societies, Scott steadily and ardently pursued his own favourite studies. He was still a schoolboy when he mastered French sufficiently well to read through collections of old French romances, and not more than 15 when, attracted by translations to Italian romantic literature, he learnt the language in order to read Dante and Ariosto in the original. In one of the literary parties brought together to lionize Burns, when the peasant poet visited Edinburgh, the boy of 15 was the only member of the company who could tell the source of some lines affixed to a picture that had attracted the poet's attention—a slight but significant evidence both of the width of his reading and of the tenacity of his memory. But he was far from being a cloistered student. absorbed in his books. In spite of his lameness and his serious illnesses in youth, his constitution was naturally robust, his disposition genial, his spirits high: he was always well to the front in the fights and frolics of the High School, and a boon companion in the "high jinks" of the junior bar. At home he had to behave as became a member of a Puritanic, somewhat ascetic, well-ordered Scottish household, but from any tendency to the pedantry of over-culture he was effectually saved by the rougher and manlier spirit of his professional comrades. They were the first mature audience on which he experimented, and it was to this market that he brought the harvest of the vacation rambles which it was his custom to make every autumn for seven years after his call to the bar and before his marriage. His staid father did not much like these escapades, and told him bitterly that he seemed fit for nothing but to be a "gangrel scrape-gut." But, as the companion of "his Liddesdale raids" happily put it, "he was *makin' himsell* a' the time."

His father intended him originally to follow his own business, and he was apprenticed in his 16th year, but he preferred the upper walk of the legal profession, and was admitted a member of the faculty of advocates in 1792. He seems to have read hard at law for four years at least, but almost from the first to have limited his ambition to obtaining some comfortable appointment such as would leave him a good deal of leisure for literary pursuits. In this he was not disappointed. In 1799 he obtained the office of sheriff-depute of Selkirkshire, with a salary of £300 and very light duties. In 1806 he obtained the reversion of the office of clerk of session, which kept him hard at work, his biographer estimates, for at least three or four hours daily during six months out of the twelve, while the court was in session He discharged these duties faithfully for 25 years, during the height of his activity as an author. He did not enter on the emoluments of the office till 1812, but from that time he received from the clerkship and the sheriffdom combined an income of £1,600 a year, being thus enabled to act in his literary undertakings on his often-quoted maxim that "literature should be a staff and not a crutch."

The Poems.—It was as a poet that he was first to make a literary reputation. According to his own account, he was led to adopt the medium of verse by a series of accidents. The story is told by himself at length and with his customary frankness and modesty in the *Essay on Imitations of the Ancient Ballad,* prefixed to the 1830 edition of his *Border Minstrelsy,* and in the 1830 introduction to the *Lay of the Last Minstrel.* The first link in the chain was a lecture by Henry Mackenzie on German literature, delivered in 1788. This apprized Scott that there was a fresh development of romantic literature in German, and while he was in the height of his enthusiasm for the new German romance, Mrs. Barbauld visited Edinburgh, and recited an English translation of Burger's *Lenore.* Scott was moved to attempt such poetry himself, and the impulse was strengthened by his reading Lewis's *Monk* and the ballads in the German manner interspersed through the work. He hastened to procure a copy of Burger, at once executed translations of several of his ballads, published *The Chase,* and *William and Helen,* in a thin quarto in 1796 (his ambition being perhaps quickened by the unfortunate issue of a love affair), and was much encouraged by the applause of his friends. Soon after he composed *Glenfinlas, The Eve of St. John,* and the *Gray Brother,* which were published in Lewis's collection of *Tales of Wonder* (2 vols., 1801). But he soon became convinced that "the practice of ballad-writing was out of fashion," and his study of Goethe's *Götz von Berlichingen,* of which he published a translation in 1799, gave him wider ideas. Why should he not do for ancient Border manners what Goethe had done for the ancient feudalism of the Rhine? He was engaged at the time preparing a collection of the *Minstrelsy of the Scottish Border,* the first instalment of which was published in two volumes in 1802, and was still hesitating about subject and form for a large original work, when chance at last threw in his way both a suitable subject and a suitable metrical vehicle. The countess of Dalkeith, happening to hear the legend of a tricksy hobgoblin named Gilpin Horner, asked Scott to write a ballad about it. He agreed with delight, and the subject grew in his fertile imagination, till incidents enough had gathered round the goblin to furnish a frame ork for his long-designed picture of Border manners. At the same time a friend of his who had met Coleridge in Malta brought home sufficient reminiscences of the still unpublished poem of *Christabel* to convey to Scott that its metre was the very metre of which he had been in search. Scott introduced still greater variety into the four-beat couplet; but it was to *Christabel* that he owed the suggestion, as one line borrowed whole and many imitated rhythms testify.

The *Lay of the Last Minstrel* appeared in Jan. 1805, and at once became widely popular. Its success finally decided that literature was to be the main business of Scott's life, and he proceeded to arrange his affairs accordingly. Since his marriage in 1797 with Charlotte Cbarpentier, daughter of a French refugee, his chief residence had been at Lasswade, about six miles from Edinburgh. But on a hint from the lord-lieutenant that the sheriff must live at least four months in the year within his county, and that he was attending more closely to his duties as quartermaster of a mounted company of volunteers than was consistent with the proper discharge of his duties as sheriff, he had moved his household in 1804 to Ashestiel. When his uncle's bequest fell in, he determined to buy a small property on the banks of the Tweed within the limits of his sheriffdom. There, within sight of Newark castle and Bowhill, he proposed to live like his ancient minstrel, as became the bard of the clan, under the shadow of the great ducal head of the Scotts. But this plan was deranged by an accident. It so happened that an old schoolfellow, James Ballantyne (1772–1833), a printer in Kelso, whom he had already befriended, transplanted to Edinburgh, and furnished with both work and money, applied to him for a further loan. Scott declined to lend, but offered to join him as sleeping-partner. Thus the intended purchase money of Broadmeadows became the capital of a printing concern, of which by degrees the man of letters became the overwrought slave, milch-cow and victim.

When the *Lay* was off his hands, Scott's next literary enterprise was a prose romance—a confirmation of the argument that he did not take to prose after Byron had "*bet* him," as he put it, in verse, but that romance writing was a long-cherished purpose. He began *Waverley*, but a friend to whom he showed the first chapters decided that the work was deficient in interest and unworthy of the author of the *Lay*. Scott accordingly laid *Waverley* aside. We may fairly conjecture that he would not have been so easily diverted had he not been occupied at the time with other heavy publishing enterprises calculated to bring grist to the printing establishment. In 1806 he collected from different publications his *Ballads and Lyrical Pieces*. Between 1806 and 1812, mainly to serve the interests of the firm, he produced his elaborate editions of Dryden (18 vols., 1808), Swift (19 vols., 1818), the Somers Tracts (13 vols., 1809–15), and the *State Papers and Letters of Sir Ralph Sadler* (2 vols., 1809).

Marmion, begun in Nov. 1806 and published in Feb. 1808, was written as a relief to "graver cares," and was even more popular than the *Lay*. Scott's resuscitation of the four-beat measure of the old "gestours" afforded a signal proof of the justness of their instinct in choosing this vehicle for their recitations. The four-beat lines of *Marmion* took possession of the public like a kind of madness, and the critics, except Jeffrey, who may have been offended by the pronounced politics of the poet, were on the whole better pleased than with the *Lay*. Scott was now *facile princeps* among living poets, and touched the highest point of prosperity and happiness. Presently after, he was irritated and tempted by a combination of little circumstances into the great blunder of his life, the establishment of the publishing house of John Ballantyne and Co. A quarrel occurred between Scott's printing firm and Constable, the publisher, who had been the principal feeder of its press. Then the tempter appeared in the shape of Murray, the London publisher, anxious to secure the services of the most popular *littérateur* of the day. The result of negotiations was that Scott set up, in opposition to Constable, the publishing house of John Ballantyne and Co., to be managed by John Ballantyne (d. 1821), James's younger brother. Scott interested himself warmly in starting the *Quarterly Review*, and in return Murray constituted Ballantyne and Co. his Edinburgh agents. Scott's trust in the Ballantynes, and in his own power to supply all their deficiencies, is as strange a piece of infatuation as any that ever formed a theme for romance or tragedy. Their devoted attachment to the architect of their fortunes and proud confidence in his powers helped forward to the catastrophe, for whatever Scott recommended they agreed to, and he was too immersed in multifarious literary work and professional and social engagements to have time for cool examination of the numerous rash speculative ventures into which he launched the firm.

The *Lady of the Lake* (May 1810) was the first great publication by the new house, and next year the *Vision of Don Roderick* followed. The *Lady of the Lake* was received with enthusiasm; it made the Perthshire Highlands fashionable for tourists, and raised the post-horse duty in Scotland; but it did not make up to Ballantyne and Co. for their heavy investments in unsound ventures. The *Edinburgh Annual Register*, meant as a rival to the *Edinburgh Review*, though Scott engaged Southey to write for it and wrote for it largely himself, proved a failure. In a very short time the warehouses of the firm were filled with unsaleable stock, but, so far from understanding the real state of their affairs, Scott considered himself rich enough to make his first purchase of land at Abbotsford. He had hardly settled there in the spring of 1812, and begun his schemes for building and planting and converting a bare moor into a richly wooded *pleasaunce*, when his business troubles began, and he found himself harassed by fears of bankruptcy. The proceeds of *Rokeby* (Jan. 1813) and of other labours of Scott's pen were swallowed up, and bankruptcy was inevitable, when Constable, still eager at any price to secure Scott's services, came to the rescue. With his help three crises were tided over in 1813.

The Novels.—It was in the midst of these embarrassments that Scott opened up the rich new vein of the Waverley novels. He chanced upon the ms. of the opening chapters of *Waverley* which he had written in 1805, and resolved to complete the story. Four weeks in the summer of 1814 sufficed for the work, and *Waverley* was published by Constable without the author's name in July. Many plausible reasons might be given and have been given for Scott's resolution to publish anonymously. The reason given by Lockhart is that he considered the writing of novels beneath the dignity of a grave clerk of the Court of Session. The secret was an open one to all his Edinburgh acquaintances, yet why he kept up the mystification until the disclosure of the year 1827, is easily understood. He enjoyed it, and his formally initiated coadjutors enjoyed it; it relieved him from the annoyances of foolish compliment; and it was not unprofitable—curiosity about "the Great Unknown" keeping alive the interest in his works. Meanwhile he kept on producing in his own name as much work as seemed humanly possible for an official who was to be seen every day at his post and as often in society as the most fashionable of his professional brethren. His treatises on chivalry, romance and the drama, besides an elaborate work in two volumes on Border antiquities, appeared in the same year with *Waverley*, and his edition of Swift in 19 volumes in the same week. In 1813 he published the romantic tale of *The Bridal of Triermain* in three cantos, enlarged from an earlier poem, printed in the *Edinburgh Annual Register* of 1809. The *Lord of the Isles* was published in Jan. 1815; *Guy Mannering*, written in "six weeks about Christmas," in February; and *The Field of Waterloo* in the same year. *Paul's Letters to his Kinsfolk* and *The Antiquary* appeared in 1816; the first series of the *Tales of My Landlord*, edited by "Jedediah Cleishbotham"—*The Black Dwarf* and *Old Mortality*—in the same year; *Harold the Dauntless* in 1817; the two volumes of *The Border Antiquities of England and Scotland* in 1814 and 1817. No wonder that the most positive interpreters of internal evidence were mystified. Scott's fertility is not absolutely unparalleled; Anthony Trollope claimed to have surpassed him in rate as well as total amount of production, having also business duties to attend to. But in speed of production combined with variety and depth of interest and weight and accuracy of historical substance Scott is unrivalled.

The immense strain of this double or quadruple life as sheriff and clerk, hospitable laird, poet, novelist, and miscellaneous man of letters, publisher and printer, though the prosperous excitement sustained him for a time, soon told upon his health. Early in 1817 began a series of attacks of agonizing cramp of the stomach, which recurred at short intervals during more than two years. But his appetite and capacity for work remained unbroken. He made his first attempt at play-writing (The Doom of Devorgoil) as he was recovering from the first attack; before the year was out he had completed Rob Roy, and within six months it was followed by The Heart of *Midlothian*, which filled the four volumes of the second series of Tales of My Landlord, and has remained one of the most popular among his novels. The Bride of *Lammermoor*, the Legend of Montrose, forming the third series by "Jedediah Cleishbotham," and Ivanhoe (1820) were dictated to amanuenses, through fits of suffering so acute that he could not suppress cries of agony.

Throughout those two years of intermittent ill-health, which was at one time so serious that his life was despaired of and he took formal leave of his family, Scott's semi-public life at Abbotsford continued as usual—swarms of visitors coming and going, and the rate of production, on the whole, suffering no outward and visible check, all the world wondering at the novelist's prodigious fertility. The first of the series concerning which there were murmurs of dissatisfaction was The *Monastery* (1820); but its sequel, The Abbot (1820), in which Mary, Queen of Scots, is introduced, was generally hailed as fully sustaining the reputation of "the Great Unknown." Kenilworth (1821), The Pirate (1822), The Fortunes of Nigel (1822), *Peveril* of the Peak (1822), Quentin *Durward* (1823), St. *Ronan's* Well (1824), *Redgauntlet* (1824) followed in quick succession in the course of three years, and it was not till the last two were reached that the cry that the author was writing too fast began to gather volume. St. *Ronan's* Well was very severely criticized and condemned, yet none of Scott's stories is of more absorbing or more brilliantly diversified interest. There must, of course, always be inequalities in a series so prolonged. The author cannot always be equally happy in his choice of subject, situation and character. Naturally also he dealt first with the subjects of which his mind was fullest. But any theory of falling off or exhaustion based upon plausible general considerations has to be qualified so much when brought into contact with the facts that very little confidence can be reposed in its accuracy. The Fortunes of Nigel comes comparatively late in the series and has often been blamed for its looseness of construction, yet some competent critics prefer it to any other of Scott's novels. An attempt might be made to value the novels according to the sources of their materials, according as they are based on personal observation, documentary history or previous imaginative literature. On this principle Ivanhoe and *The* Tales of the Crusaders (1825, containing The Betrothed and The Talisman) might be adjudged inferior as being based necessarily on previous romance. But as a matter of fact Scott's romantic characters are vitalized, clothed with a verisimilitude of life, out of the author's deep, wide and discriminating knowledge of realities, and his observation of actual life was coloured by ideals derived from romance. He did not exhaust his accumulations from one source first and then turn to another, but from first to last drew from all as the needs of the occasion happened to suggest.

During the years 1821–25 he edited Richard Franck's Northern Memoirs (1821), *Chronological* Notes of Scottish Affairs from the Diary of Lord *Fountainhall* (1822), Military Memoirs of the Great Civil War (1822), and The Novelists' Library (10 vols., 1821–24), the prefatory memoirs to which were separately published in 1828.

Financial Ruin.—Towards the close of 1825, after 11 years of brilliant and prosperous labour, encouraged by constant tributes of admiration, homage and affection such as no other literary potentate has ever enjoyed, realizing his dreams of baronial splendour and hospitality on a scale suited to his large literary revenues, Scott suddenly discovered that the foundations of his fortune were unsubstantial. He had imagined himself clear of all embarrassments in 1818, when all the unsaleable stock of John Ballantyne and Co. was bargained off to Constable for Waverley copyrights, and the publishing concern was wound up. Apparently he never informed himself accurately of the new relations of mutual accommodation on which the printing firm then entered with the great but rashly speculative publisher, and drew liberally for his own expenditure against the undeniable profits of his novels without asking any questions, trusting blindly in the solvency of his commercial henchmen. Unfortunately, "lifted off their feet" by the wonderful triumphs of their chief, they thought themselves exempted like himself from the troublesome duty of inspecting ledgers and balancing accounts, till the crash came. From a diary which Scott began a few days before the first rumours of financial difficulty reached him we know how he bore from day to day the rapidly unfolded prospect of unsuspected liabilities. "Thank God," was his first reflection, "I have enough to pay more than 20s. in the pound, taking matters at the worst." But a few weeks revealed the unpleasant truth that, owing to the way in which Ballantyne and Co. were mixed up with Constable and Co., and Constable with Hurst and Robinson, the failure of the London house threw upon him personal responsibility for £130,000.

How Scott's pride rebelled against the dishonour of bankruptcy, how he toiled for the rest of his life to clear off this enormous debt, declining all offers of assistance and asking no consideration from his creditors except time, and how nearly he succeeded, is one of the most familiar chapters in literary history, and would be one of the saddest were it not for the heroism of the enterprise. His wife died soon after the struggle began, and he suffered other painful bereavements; but, though sick at heart, he toiled on indomitably, and, writing for honour, exceeded even his happiest days in industrious speed. If he could have maintained the rate of the first three years, during which he completed Woodstock (1826); *Chronicles* of the Canongate (1827), which included three tales—"The Highland Widow," "The Two Drovers" and "The Surgeon's Daughter"; *The* Fair Maid of Perth (1828, in the second series of Chronicles of the Canongate); Anne of *Geierstein* (1829); the Life of Napoleon (9 vols., 1827); part of his History of Scotland (2 vols., 1829–30, for Lardner's Cabinet Cyclopaedia); the Scottish series of Tales of a Grandfather (four series, 1828–29–30–31), besides several magazine articles, some of them among the most brilliant of his miscellaneous writings, and prefaces and notes to a collected edition of his novels—if he could have continued at this rate he might soon have freed himself from all his encumbrances. The result of his exertions from Jan. 1826 to Jan. 1828 was nearly £40,000 for his creditors. But the terrific labour proved too much even for his endurance. Ugly symptoms began to alarm his family in 1829, and in Feb. 1830 he had his first stroke of paralysis. Still he was undaunted, and not all the persuasions of friends and physicians could induce him to take rest. "During 1830," Lockhart says, "he covered almost as many sheets with his ms. as in 1829," the new introductions to a collected edition of his poetry and the Letters on Demonology and Witchcraft being amongst the labours of the year. He had a slight touch of apoplexy in November and a distinct stroke of paralysis in the following April; but, in spite of these warnings and of other bodily ailments, he had two more novels, Count Robert of Paris and Castle Dangerous (constituting the fourth series of Tales of My Landlord), ready for the press by the autumn of 1831. He would not yield to the solicitations of his friends and consent to try rest and a change of scene, till fortunately, as his mental powers failed, he became possessed of the idea that all his debts were at last paid and that he was once more a free man. In this belief he happily remained till his death. When it was known that his physicians recommended a sea voyage for his health, a Government vessel was put at his disposal, and he cruised about in the Mediterranean and visited places of interest for the greater part of a year before his death. But, when he felt that the end was near, he insisted on being carried across Europe that he might die on his beloved Tweedside at Abbotsford, where he expired on Sept. 21, 1832. He was buried at Dryburgh Abbey.

Scott's wife had died in 1826. His eldest son, Walter, succeeded to the baronetcy which had been conferred on his father in 1820, and the title became extinct on his death in 1847; the elder daughter Charlotte Sophia (d. 1837) was the wife of his biographer, J. G. Lockhart (*q.v.*); and their daughter Charlotte (d. 1858) married J. R. Hope-Scott, and was the mother of Mary Monica, wife of the Hon. J. C. Maxwell, who in 1874 took the additional name of Scott on his marriage with the heiress of

Abbotsford. Mrs. Maxwell-Scott inherited some of the family literary talent! and among other books wrote two volumes about Abbotsford (1893 and 1897).

BIBLIOGRAPHY.—*The Miscellaneous Prose Works of Sir Walter Scott* (6 vols., 1827) were subsequently printed in 30 vols. (1834–71) and in 3 vols. (1841–47). The collected editions of the novels and tales are very numerous. Among them are that known as the "author's favourite edition" (48 vols., 1829–33), for which Scott wrote new preiaces and notes, and the "Border" edition (48 vols., 1892–94), with introductory essays and notes by A. Lang. His *Poetical Works* were printed in 12 vols. (1820); they were edited by J. G. Lockhart (12 vols., 1833–34); by F. T. Palgrave for the "Globe" edition (1866); by W. Minto (2 vols., 1888); by J. Logie Robertson (Oxford complete edition, 1904). Many of the novels have been adapted for the stage, the most famous of these dramatizations being the libretto of Donizetti's *Lucia di Lammermoor* and the *Zvanhoe* of Sir Arthur Sullivan and J. R. Sturgis. His *Minstrelsy of the Scottish Border* (3 vols., 1802–03) was edited (4 vols., 1902) by T. F. Henderson.

The standard life by his son-in-law, J. G. Lockhart, *Memoirs of tlze Life of Sir Walter Scott* (7 vols., 1837–38), was supplemented by the publication (2 vols., 1890) of Scott's *Journal,* covering the years from 1825 to 1832, and of his *Familiar Letters* (2 vols., 1894), both edited by David Douglas. *See* also James Hogg, *Tlze Domestic Manners and Private Life of Sir Walter Scott* (1834), and *R.* P. Gillies, *Recollections of Sir Walter Scott* (1837). Shorter lives are by R. H. Hutton ("English Men of Letters," 1878); G. E. B. Saintsbury ("Famous Scots" Series, 1897); Andrew Lang ("Literary Lives," 1906); G. le Grys Norgate (1906), and J. Buchan (1925). For the Ballantyne controversy *see* also *The Ballantyne Press and its Founders* (1909). *See* also W. Brewer, *Shakespeare's Influence on Sir Walter Scott* (1925); A. Caplan, *The Bibliography of Sir Walter Scott* (1928); W. S. Crockett, The *Religion of Sir Walter Scott* (1929).

SCOTT, WINFIELD (1786–1866), American general, was born near Petersburg (Va.) on June 13, 1786. In 1805 he entered the College of William and Mary where he studied law. In 1807 he removed to Charleston (S.C.), but as war with England seemed imminent he soon left for Washington and offered his services. In 1808 he was commissioned as a captain of artillery, recruited a company in Richmond and Petersburg, and was ordered to New Orleans. In July 1812, as a lieutenant-colonel of artillery, he was sent to the Niagara frontier and fought at Queenston, where he was taken prisoner. He was exchanged in Jan., 1813, became colonel in the following March, was promoted to the rank of brigadier-general in March 1814, and in July received the brevet of major-general. In the battles of Chippewa (July 5, 1814) and Lundy's Lane (July 25) he took a conspicuous part, and was twice wounded in the Lundy's Lane engagement. For his services he was presented with a gold medal by Congress and with a sword by the State of Virginia.

Among the difficult tasks that he was called upon to perform between 1815 and 1861, for the last 20 years of which period he was the commanding general of the United States Army, were: an expedition to the Middle West in 1832, where, after the end of the Black Hawk War, he negotiated treaties of peace with the Sauk, Fox, Winnebago, Sioux, and Menominee Indians; a journey to Charleston to watch the progress of the nullification movement, and to strengthen the garrisons of the forts in the harbour; an expedition in 1836 against the Seminole Indians in Florida; the supervision of the removal in 1838 of the Cherokee Indians from Georgia, North Carolina, Alabama and Tennessee to the reservation set apart for them by treaty west of the Mississippi river; a visit to the Niagara river in 1838 to put an end to the acts by Canadian insurgents in violation of American neutrality; a similar mission to Maine in 1839 to restore tranquillity between the citizens of Maine and New Brunswick, who were disputing the possession of land along the Aroostook river; and a journey to the north-west in 1859 to adjust a dispute between American and British officers concerning the joint occupation of San Juan island in Puget sound.

His greatest achievement was the brilliant Mexican campaign of 1847. As the senior officer of the army, he was placed in command of the invading expedition, and after capturing Vera Cruz (March 29, 1847), and winning victories at Cerro Gordo (April 18), Contreras-Churubusco (Aug. 19–2 j), Molino del Rey (Sept. 8), and Chapultepec (Sept. 13), he crowned his campaign by the capture, on Sept. 14, of the Mexican capital. In March 1848 he received a vote of thanks from Congress, which ordered a gold medal to be struck in commemoration of his services. His nomination for the presidency by the Whigs had been suggested in 1839 and in 1848, and in 1852 he received it; but the Whigs, divided on the slavery question, gave only half-hearted support to their compromise platform; and Scott made several unfortunate extemporaneous addresses. He received the electoral votes of only Kentucky, Virginia, Massachusetts and Vermont. This defeat, however, detracted nothing from his popularity, and in 1852 the brevet rank of lieutenant-general was created specially for him. At the outbreak of the Civil War, though a Virginian, he remained at the head of the United States armies and directed operations from Washington until Nov. 1861. He then visited Europe for a short time, and after returning wrote his *Memoirs,* published in 1864. He died at West Point (N.Y) on May 29, 1866.

See *Memoirs of Lieutenant-General Scott, LL.D.* (1864); Raphael Semmes, *The Campaign of General Scott in the Valley of Mexzco* (Cincinnati, 3rd ed., 1852); Edward D. Mansfield, *Life and Mzlztary Services of General Scott* (1862); and Marcus J. Wright, *General Scott* (1894), in the "Great Commanders" series.

SCOTTISH LITERATURE. The term Scottish literature cannot be defined with complete satisfaction. It must include writing in Gaelic, which is so important as to merit separate treatment (*see* below); writing in Scots (*i e.,* Lowland Scots or Lallans); writing in standard English; and writing in every possible degree of commingling of English and Scots. There is a strong tendency for the nationality of the Scottish writer to make itself felt, even when he is not using his own language. To this the English prose of Thomas Carlyle is a witness. as is also the Latin verse of George Buchanan; and even where the writer is not of fully Scottish blood it will sometimes be found that Scottish characteristics assert themselves. as they evidently did in Byron. Although, therefore, work done in Scots must claim most of our attention, especially in the period before 1600. works that are wholly or partly in English will also on occasion require to be considered.

IN SCOTS AND ENGLISH

Mediaeval Period.—Apart from poems of doubtful provenance and authorship (*e.g.,* the 13th-century romance *Sir Tristrem* with which Thomas the Rhymer's name is linked) and a few fragments quoted by later writers (such as the well-known "Quhen Alysandyr owre kyng wes dede" included by Andrew of Wyntoun in his *Cronykil*), the earliest extant literature belongs to the second half of the 14th century. No doubt a good deal of literature before this date has been lost, as neither John Barbour's *Brus* (1376) nor *The Pistill of Susan* (*c.* 1360; ascribed to Huchown of the Awle Ryale, but *see* HUCHOWN) can be called fumbling or primitive in technique. It is clear that these poems represent two distinct traditions, the former being in octosyllabic rhyming couplets, its affinities with the French *chanson de geste,* and the latter having that nonsyllabic alliterative rhyming stanza with concluding "bob" and "wheel" which apparently reached Scotland through the Middle English alliterative writers of the north and northnest and which became a very characteristic Scottish poetic form. To the first of these traditions belong Andrew of Wyntoun's *Orygynale Cronykil* (c. 1420); and *The Buik of Alexander* and *Legends of the Saznts,* which belong to Barbour's time and region if not to Barbour. The second tradition developed romance and fantasy rather than history, and includes the poem (sometimes ascribed to Huchown) *The Awntyrs off Arthure at the Terne Wathelyne;* Richard Holland's *Buke* of *the Howlat* (c. 1450); the anonymous *Golagros and Gawane* (c. 1470); *Rauf Coilȝear* (*c.* 1480); and shorter pieces like *Tlze Gyre-Carling,* William Dunbar's *Kynd Kzttok* (if it is by Dunbar), and Robert Henryson's *Sum Practysis of Medecyne.* The rather dry, economical, unadventurous style of John Barbour. suited though it was to his own patriotic narrative, had little influence on later Scottish poetry; the *Brus,* national epic in category if not in value, is an isolated poem. The more flamboyant alliterative tradition, however, which in Scotland was readily employed not only for serious romance narratives like *Tlze Awntyrs off Arthure* but also for delightful "dremys and drevillings" such as the *Buke of tlze Howlat* and for the wild ribaldry of *Tlze Gyre-Curling* or *Sum Practysis,* proved more congenial and had a lasting effect, well beyond the mediaeval period. Satire and fantasy, always strong elements in Scottish poetry, were well served by "thir mokking meteris and mad matere." The alliterative style was also valuable in forging a link between popular and sophisticated verse, which in Scotland was not broken to the same extent as it was in England after William Langland's "rum ram ruf" gave way to Geoffrey Chaucer's decasyllabics.

The **Makaris.**—The great period of the makaris, or the Scottish Chaucerians as they have been inadequately but inescapably labelled, may be taken to be *c.* 1425–1550. It includes the four chief pre-union poets, Robert Henryson (1425?–1500?), William Dunbar (1460?–1520?), Gavin Douglas (1474/5–1522) and Sir David Lyndsay (1490?–1555); and to them must be added the author of *The Kingis Quair* (probably James *I)* and the author of *Schir William Wallace* (traditionally Henry the Minstrel). Scottish poetry has never been so confident. so dexterous, or so varied as it was in the century that produced Henryson's *Testament of Cresseid,* Dunbar's *Tua Mariit Wemen and the Wedo,* Douglas' *Eneados,* and Lyndsay's *Satyre of the Thrie Estaitis.* The rough, swarming, precarious culture which nourished this remarkable literature has often the appearance of a rejuvenated mediaevalism rather than of a premature Renaissance. A fable by Henryson closes with its "moralitas"; Dunbar and Douglas continue and develop the conventional and centuries-old dream-allegory; Lyndsay is a reformer who remains within the church. What was not mediaeval, however—and it is an important element if we are to speak of rejuvenation—was the keen linguistic consciousness, the desire to expand and enrich the vernacular resources by all available means, which followed the political self-determination of Scotland in the 14th century and accompanied the Scottish writer's literary pride in the century after. The elaborate "aureate" style in which the makaris often indulged has been criticized as artificial, and naturally it has its excesses, like those of Polwart who lauds James VI for the "prudent hie precellence" of his "princelie presence superexcellent"; but such excesses, which have their parallel in Elizabethan England, were a necessary stage in the development of a full literary medium. The term "aureate" itself tells only half the story; Dunbar's *Goldyn Targe* cannot be called typical either of him or of his century's poetry. When Gavin Douglas, justifying his borrowings from other tongues in his translation of Virgil, spoke of his desire for "fouth of langage," he was revealing a very Scottish preference. Fouth—copiousness—demanded the encouragement of anti-aureate and popular elements as well as the aureate and the classical; of alliterative as well as Chaucerian tradition. Douglas' powerfully atmospheric descriptions of scenery and weather are almost bursting with words, but the etymological and idiomatic texture is far too rich for the restrictive implications of "aureate diction" to hold any meaning. This is even more true of works like *The Cursing of Schir John Rowll* and *The Flyting of Dunbar and Kennedie,* where commination and *estrif* induce the most uninhibited fouthiness of effect. (For the continuity of this quality, see also *The Complaynt of Scotlande; Polemo-Middinia;* Sir Thomas Urquhart *passim;* Hugh MacDiarmid's *Scots Unbound.*)

Chaucer was to the makaris the eagerly acknowledged "rose of rethoris all," and there is no doubt that they gained from him an ideal of poetic utterance, a rhetoric or a diction, and metrical forms like the decasyllabic couplet used in *Schir William Wallace* and the Troilus stanza used in *The Kingis Quair,* which taken together go far toward confirming the term Scottish Chaucerians. The highly developed uncouthness of Scottish poetry was fascinated by Chaucer's subtleties, just as its love of the incongruous almost succumbed to Chaucer's good sense and order. Nevertheless, it was only one influence among many. Both Chaucer and Dunbar were closely connected with the court circles of their day, and they addressed a courtly and educated audience; yet Dunbar refers with relish to the farcical anonymous fantasies like *Colkelbie Sow* which enjoyed widespread popularity beyond the court. and the grave Gavin Douglas shows his familiarity with *Rauf Coilȝear.* Lyndsay goes further toward meeting "John the Commounweill" halfway, and openly declares in his *Dzalog* "Quharefore to colȝearis, cairtaris, and to cukis, /To Jok and Thome my rhyme sall be direckit." If the two extremely popular poems of Jock and Tom's festival merrymaking, *Christis Kirk on the Green* and *Peblis to the Play,* did in fact originate from James I or James V, as variously surmised, it would be another remarkable instance of this social give-and-take, perhaps not unexpected in a small country that had been only partly and haphazardly feudalized. "A man's a man for a' that" is a recurring statement in Scottish literature, representing a point of rest between outspoken social criticism on the one hand (Henryson, Lyndsay, Burns, MacDiarmid), and all the degenerations of the couthy and the pawky on the other hand *(Whistle-Binkie* and Kailyard, for which *see* below). Apart, therefore, from questions of verse technique, we must supplement the Chaucerian influence by two additions: the vehement, practical, propagandist social satire of a Lyndsay, and (perhaps as a counterpoise) the extravagant daftness of a *Lichtounis Dreme,* with its impractical but equally Scottish occupation of "rostand straberries at ane fyre of snaw."

The golden period of the makaris had something of a Silver Age aftermath in the accomplished but limited love poetry of Alexander Scott, Alexander Montgomerie and William Fowler; the Italian translations and moral reflections of John Stewart of Baldynnis; the impressive plainness and sincerity of Sir Richard Maitland; and single outstanding lyrics from Alexander Hume and Mark Alexander Boyd. Here may also be mentioned the only surviving vernacular drama apart from Lyndsay's *Satyre*—the anonymous *Philotus (c.* 1600), a complicated romantic comedy, coarse in details but vigorously written and certainly amusing.

The 17th Century.—With the union of the crowns in 1603 and the transference of the court to London. Scottish writing became increasingly anglicized; nor was much of it, in this century, of the first quality. Although James VI himself showed that he was capable of turning out a lyric in Scots, the new poets wrote almost exclusively in English. The best of these, William Drummond (1585–1649), was as "well-languaged" as Samuel Daniel, but his lyrics lack intensity and force, and one would gladly attribute the quite un-English *Polemo-Middinia* to him, if only for its bold macaronic gusto., The lyrics of Sir Robert Aytoun and James Graham, marquess of Montrose, are graceful without being distinguished. The sententious and indefatigable Sir William Alexander accomplished nothing that Fulke Greville and George Chapman had not done better. Vernacular poetry, neglected on the literary level, was kept alive in popular songs and ballads, and such literary verse as does guard the thin continuity of tradition between the makaris and Allan Ramsay is equally popular in character, with leanings toward the rustic, the homely and the humorous *(see,* for example, Robert Sempill's *Life and Death of Habbie Simson, the Piper of Kilbarchan).* Whether grim and tragic as in the older ballads, or amusing as in *Habbie Simson,* this tradition mas of the heart rather than of the head, and indeed the absence of an intellectual and critical quality has been a besetting weakness in subsequent Scots verse. The divorce of intellect and feeling was a natural result of the loss of Scots as a complete communicative instrument in the 17th century.

At this point it will be convenient to deal with the somewhat unspectacular history of Scottish prose. which covers (in its extant examples) the approximate period 1450–1630. The earliest work, dated 1456. is Sir Gilbert Hay's *Buke of Armys, Buke of the Order of Knichthede* and *Buke of the Governaunce of Princes;* but these are translations. The first original literary prose appears in the theological tract writing of John of Ireland (*c.* 1490). The prose of these works, written in "the commoune langage of this cuntre," has not yet developed a great variety or flexibility of construction. Early in the 16th century there was an attempt at a more plain, less latinized prose in Murdoch Nisbet's version of the New Testament, but the language is too southern to be quite successfully idiomatic. Some English influence is seen also in the historical writings of John Bellenden. John Lesley and Robert Lindesay of Pitscottie; and to a greater extent in works like John Knox's *History of the Rejormation.* These four writers, however, had a good command of narrative, and Pitscottie and Knox had also the gift of style, which has made passages like Pitscottie's account of the Linlithgow apparition and Knox's interviews with Mary Queen of Scots justly famous. Almost as vivid as Knox's writing is the autobiographical *Historie of the Lyff of James Melvill,* which covers the second half of the century. Standing by itself is the remarkable anonymous *Complaynt of Scotlande* (1548–49), interesting not only as the work of an earnest and well-read Scottish patriot but also as the first work of a Scottish experimenter in prose style, ranging from the most aureate "oncoutht exquisite termis" to the most common and onomatopoeic "domestic Scottis langage." The necessity of reaching an English audience is seen in the writings of James VI: the manuscript of his *Basilikon Doron* (1598) is in Scots, but when published it had been translated into English. William Drummond's *Cypresse Grove* (1623) is in careful, grave, mannered English; and not much Scots prose occurs after that date. A general justification for this turning to English may well be seen in the lucid and forceful 18th-century prose of David Hume, Adam Smith, James Boswell and Tobias Smollett; though on the debit side must be placed the extreme difficulty of all attempts to revive vernacular prose, in a tradition which was so drastically severed. One particular justification is Sir Thomas Urquhart. "the free'st spoke Scot of any," whose translation of Rabelais (1653) and extraordinary original works show a polymathic gorgeousness that would have cracked the moulds of Scots as it did those of English.

The 18th Century. — While Scottish prose writers were preparing to challenge English on its own terms, and while the union of 1707 was suggesting an even closer cultural binding of the two countries than had been possible a century before, a contrary impulse was making itself felt in poetry. Almost in the year of the union appeared James Watson's first *Choice Collection of Comic and Serious Scots Poems* (1706), which contained (among English pieces) vernacular poetry from *Christis Kirk on the Green* and *The Cherry and the Slae* to recent verse like *Habbie Simson* and *The Blythsome Bridal.* This was followed by Allan Ramsay's *Ever Green* (1724) and *Tea-Table Miscellany* (1724 ff.), and by the later collections of David Herd, John Pinkerton, and James Johnson. These anthologies testify to a new national consciousness which began with a deliberate invocation of past achievements and eventually produced original work in the tradition of these achievements. As political identity was lost, cultural differences were increasingly recognized as significant. Educated speech was slowly but surely following written prose into anglicization. In poetry, the heart of the language was still felt to beat, however faintly; as it was also in common speech and in the old songs and ballads which were now being reprinted. Ramsay's own poetry, like that of Robert Fergusson and Robert Burns after him, flourished on a union of these elements: the racy vigour of Scots speech, the musical lilt of the songs, and the poetic forms and techniques, such as the Habbie Simson stanza, the humorous elegy, and the verse epistle, with which recent poets like the Sempills and William Hamilton of Gilbertfield had helped to solder the vernacular tradition. This new poetry lacked the range and also the intellectual power of the makaris' verse. Nevertheless, its own qualities were notable and infinitely attractive: in the love song, with moods from *Duncan Gray* to *O, wert thou in the cauld blast;* in the voice that is given to the joy and pathos of "randie gangrel bodies" in *The Jolly Beggars;* in the unembittered descriptive tartness of Fergusson's *Auld Reekie* and *Butterfly.* Burns excelled both in satires and in love lyrics; in the former he carried on where Dunbar left off, and in the latter he crystallized the floating anonymous songs in forms that mere at once popular and authoritative. Many traditions meet in Burns and his poetry reaffirms, perfects and consolidates existing poetic modes and themes in a way which even in his own lifetime made it apparent that he was going to be a national bard. If any poet had deserved the epithet life-giving it is Burns, and yet by one of the ironies of literary history he proved to be a liberator for the poetry of England, but not for the poetry of his own country.

Among the minor poets of the period, some of the best were women. Lady Grizel Baillie. Jane Elliot. Lady Anne Lindsay and Lady Nairne. Of writers in English, James Thomson in his *Seasons* shares with Gavin Douglas the ability to make winter more impressive than summer, and produces some heavily drawn pictures of "Caledonia, in romantic view." Robert Blair's *Grave* shows a grim churchyard relish that does not lack Scottish analogues. William Falconer's *Shipwreck,* admired by Burns, deserves mention; and James Beattie's *Minstrel* has some historical importance as an early Romantic poem. Here must also be noted three popular and influential works of the time: John Home's tragedy, *Douglas,* Scottish in theme but not in language; the cloudy grandeurs of James Macpherson's Ossianic fragments, which presented Europe with a vision of the noble Gael; and that "bosom favorite" of the young Burns, Henry Mackenzie's tear-strewn *Man of Feeling.*

The 19th Century. — The *Man of Feeling* appeared in 1771, and in that year was born Sir Walter Scott (1771–1832), who was destined to turn prose in a very different direction. The re-emergence of a vernacular prose, mainly within the novel and the short story, is one of the distinguishing features of this period. The writers may be divided into two groups: those who restricted Scots to dialogue and used English for the narrative, and those who employed a form of Scots, or at least a scotticized English, throughout. The former included Scott himself, Susan Ferrier, James Hogg, George Macdonald, Mrs. Margaret Oliphant, William Black and R. L. Stevenson; in the second and smaller group are John Galt, David Moir. and (in the following century) Lewis Grassic Gibbon. A book like William Alexander's *Johnnie Gibb of Gushetneuk* contains so much dialogue as practically to belong to the scotticizers; it is. however, of interest mainly to philologists. The advantage of the method used by Galt in his *Annals of the Parish* (1821), of casting the book as the reminiscences of a Scots-speaking person, was that it secured a homogeneous tone, and the exact but not exaggerated Scots idiom is admirable. Scott, on the other hand, has the wider range that comes from contrast between English and Scots (as, most obviously, when we come to Wandering Willie's Tale in *Redgauntlet),* but the faults of his own English writing. and the restriction of his brilliant Scots dialogue to minor characters, sometimes make the result patchy and unsatisfactory, even if the great sweep of the story carries the reader through. It may certainly be argued that the most Scottish of Scott's stories—*The Bride of Lammermoor,* for instance — are among his best.

A novel that begins "Come oot o' the gutter, ye nickum!" (George Macdonald's *Sir Gibbie,* 1879) is evidently of another type, and it may in fact be claimed as one of the many forerunners of the phenomenon of Kailyard which appeared toward the end of the century in the works of Ian Maclaren (John Watson, 1850–1907), S. R. Crockett (1860–1914) and James Barrie, (1860–1937). (At the same time Fiona Macleod (William Sharp, 1855–1905) in his Celtic stories was creating the "Kailyard of the Gael.") The sentimental viewpoint that vitiates *Beside the Bonnie Brier Bush* and weakens *A Window in Thrums,* the cosy hypocrisies, the idealization of village and humble life, were pitilessly exposed when George Douglas Brown's *House with the Green Shutters* was published in 1901. Brown's brutal tale, nevertheless, had its own exaggerations, those needed for its theme of tragic melodrama, and it had no more than a temporary effect in "sticking the Kailyarders like pigs," as one critic hoped. There is something in Kailyard which is still very acceptable to the Scottish popular temperament.

The history of poetry in this period is very nearly a blank. Two poems of the supernatural keep up an ancient Scottish tradition: James Hogg's *Kilmeny* and William Bell Scott's *Witch's Ballad;* there are some good vernacular lyrics by Scott, Allan Cunningham and George Macdonald; but for the most part, the century after Burns saw merely the proliferation of the maudlin and the jocose in well-worn verse forms, the distortion and coarsening of Burns's gaiety and pathos, and the popularizing of everything in him that was less than first-rate. The widely read mid-century anthologies of verse called *Whistle-Binkie: A Collection of Songs for the Social Circle* mere the poetic equivalent of Kailyard, and their popularity is a comment on the poetic taste of the age. Indeed, during the latter half of the century more interesting poetry was being written in English, by James Thomson ("B.V."), Alexander Smith and John Davidson. What we feel to be lacking in Kailyard and *Whistle-Binkie*—the impact of the contemporary world, of science, of industrialization, of the city, even (one must add) of ideas—gives strength and power to Smith's *Glasgow* (1857), to Thomson's *City of Dreadful Night* (1874) and to Davidson's *Testaments* (1901–08).

The 20th Century.—Prose fiction has developed, with minor variations, mainly within the Scott-Stevenson tradition. The "descriptions of the physical" that Stevenson prided himself on (though it was by no means his only gift), and the reliance on action rather than on psychological subtleties which we find in Scott, are continued in varying degrees in John Buchan, Neil Munro, Neil Gunn and R. B. Cunninghame Graham, the last-named having shown in his *Scottish Stories* a nice use of Scots and a fine command of the macabre. More original are the picaresque, witty and often fantastic narratives of Eric Linklater; the passionately written *Scots Quair* of Lewis Grassic Gibbon. with a remarkable stylistic attempt to sink Scots idiom and vocabulary into the body of a richly descriptive English; and the experiment of a Joycean (and Urquhartesque) punning Scots in S. G. Smith's ribald *Carotid Cornucopius*.

Drama, which had revived to some extent at the hands of Barrie, discovered a more distinctively native voice in James Bridie (O. H. Mavor. 1888–1951); his entertaining and surprising plays, on an unusually wide variety of themes, combine the humorous, the ethical and the supernatural in a very Scottish manner. Plays written entirely in Scots are now frequent and popular on the Scottish stage.

It is to poetry, however, that the term revival is more properly applied. The first steps toward a Scots verse that would more closely represent real experience were made by Stevenson (in *Underwoods*, 1887), Marion Angus, Charles Murray, Violet Jacob, Pittendrigh Macgillivray, Helen Cruickshank and Alexander Gray. In the second decade of the 20th century the explosive personality of Hugh MacDiarmid (Christopher Murray Grieve, 1892–) made itself felt, as the centre and motive force of what has been variously called the Scottish Renaissance movement. the Lallans revival and Synthetic or Plastic Scots. This movement, by re-expanding the Scots vocabulary after its post-Burns stagnation, complacency and "hameliness," aims to restore the intellectual prestige of Scots and to create a medium that would be capable of dealing with the objects and ideas of the modern world as well as with the perennial sources of lyricism. MacDiarmid himself has written the best lyrics since Burns; his sesquipedalian, polyglot, encyclopaedic, polemical, metaphysical verse has not aroused the same enthusiasm, but is interesting and significant. Other members of the movement have included the learned Douglas Young, the love poet S. G. Smith and the wry observer William Soutar (1898–1943). Of poets using English, Edwin Muir with his meditative myth-haunted verse has been the most distinguished; Andrew Young has been noted for his sinewy nature poems; and W. S. Graham, of a younger generation, has shown a craftsman possessed of great verbal energy. The problem of English or Scots is one that has still to be worked out, and its difficulties are a part of the whole cultural situation. The Scottish sense of separateness is too real to be swamped, but English is dominant in prose writing and in educated speech, and the Scottish poet of the 20th century has been therefore like a shaman who must try out many disguises until he finds the one in which he can best prophesy and persuade.

(E. G. M.)

IN GAELIC

The early history of Scottish Gaelic literature, like that of the language, cannot be adequately considered in isolation from the literature and language of Irish Gaelic. Kenneth Jackson demonstrated in his Sir John Rhys memorial lecture (1951) that Scottish and Irish Gaelic were identical until the 10th century, that they proceeded to diverge during the centuries from the 10th to the 13th, but that the language which he conveniently calls Common Gaelic survived as a living tongue until the 13th century. The conservatism of the literary classes ensured that there was a common corpus of literature even after the spoken languages diverged. Thus a distinct Scottish Gaelic period in literature can hardly be said to begin much before the 15th century. The Scottish parliament had made an enactment against the bards in the year 1457, when it was decided to take an inquisition of all "sornares, bairdes, maister-full beggers or feinziet fuiles." This enactment, and some subsequent ones, were no doubt directed against the strolling bards, but the volume of governmental disapproval of the bards and of the Gaelic language and way of life grew, and the policy of centralization, and the gradual de-Gaelicization of the titled and moneyed classes eventually deprived the Gaelic poets of their patrons, bringing both loss and gain to Gaelic poetry. But before looking at the literature of the modern Scottish Gaelic period we must take a glance at what lies behind it.

Earliest Manuscript Remains.—The earliest document containing Gaelic matter which Scotland can claim is the *Book of Deer*, now preserved in the Cambridge university library. This manuscript contains portions of the Gospels in Latin, written in an Irish hand, with illuminations. Inserted in the margins and blank spaces are later notes and memoranda partly in Latin, partly in Gaelic. The six Gaelic entries appear to have been made between 1131 and 1153, although some of them may be copies of earlier, perhaps traditionally preserved, grants of land and other privileges made from time to time to the monastery of Deer, Aberdeenshire. The scribes appear to have been trained, but somewhat imperfectly, in the Common Gaelic tradition of the period.

Another strangely isolated survivor is the Islay charter of 1408. This charter, written in Gaelic, was granted by Donald, lord of the isles, to Brian Vicar Mackay of Islay. It is witnessed and very probably written by Fercos MacBetha, who was one of the famous family of hereditary physicians of that surname.

These MacBeths, Beatons or Bethunes had in their possession a number of important medical manuscripts, some of which are now in the collection of Gaelic manuscripts in the National library of Scotland. The O'Conachers, or McConachers, of Lorn were also hereditary physicians whose manuscripts are in part preserved. These manuscripts translate and paraphrase the works of such men as Bernard Gordon, Galen, Avicenna and Hippocrates, while in their extra-medical digressions they show an acquaintance with the works of Aristotle. Socrates, St. Thomas Aquinas and others. Such various subjects as metaphysics, astronomy and astrology, theology and music are treated. In medical matters the scribes sometimes give their own observations. These manuscripts date mainly from the 15th, 16th and 17th centuries.

There are many other manuscripts, belonging to the common Scots-Irish tradition, which contain versions of heroic tales and sagas, poetry, ecclesiastical writings and miscellaneous matter. One such, the Glenmasan manuscript (no. liii in the National library collection) was probably written about 1500, but may derive from a 13th century original. This contains the famous story of Deirdre and the sons of Uisneach. A part of the manuscript containing the story of *Mesca Ulad* dates from the year 1538. There is also a version of the most famous of Irish epics, the *Táin Bó Cúailnge* (ms. xxxii), and a Gaelic version of Lucan's *Pharsalia* (ms. xlvi), besides poetry written by Irish and Scottish bards.

But from the purely Scottish Gaelic point of view, the most important of the manuscripts from this period is the *Book of the Dean of Lismore*, an anthology of verse compiled by Sir James Macgregor, dean of Lismore in Argyllshire, and by his brother Duncan, between 1512 and 1526. These poems fall into three main groups, (1) poems by Scottish authors, (2) poems by Irish authors and (3) Ossianic ballads. The Irish poems belong mainly to the period 1200–1500. There are 29 poems in the third group. of which 4 belong to the Cú Chulainn cycle rather than the Ossianic one—in all. 2,672 lines. These poems are attributed to various authors, *e.g.* Oisein. Ferghus File, Caoilte Mac Ronain and Conall Ceárnach.

The poems by Scottish authors are interesting historically, linguistically and poetically. Linguistically, the poems have a considerable potential interest. They are written in a semiphonetic spelling. partly based on the spelling of contemporary Scots, and thus provide some evidence as to the pronunciation of the Perthshire dialect of Gaelic in the dean's time. Peculiarly Scottish features of pronunciation, morphology and grammar can be detected in it.

Furthermore, the poems give valuable evidence concerning aspects of the society of their times. As to date of composition, they range from *c.* 1310 to *c.* 1519. Many of them have a Perthshire setting, or are composed to a Macgregor chief, but there are also, for example, poems to MacDougall of Dunollie. Macleod of Lenis, MacNeill of Gigha, and others. The bard who is best represented is Fionnlagh Ruadh, bard to John, chief of Clan Gregor (d. 1519). There are also three poems by Giolla Coluim mac an Ollaimh, who was probably a poet at the court of the lords of the isles. He laments the misfortune which had befallen this proud family in the late 15th century. Other poets who may be briefly mentioned here are the dean of Knoydart (late 15th century). Duncan Campbell, the Good Knight of Glenorchy, who died at Flodden, Giolla Criost Brúilingeach, and two women, Aithbhreac Inghean Coirceadail (mid-15th century) and Isabella, countess of Argyll (probably the wife of the first earl). These last two are satisfying poetically, as is also the work of Giolla Coluim and of Giolla Criost.

The 16th and 17th Centuries. — Very little Gaelic poetry from the 16th century has survived, and most of what there is survived in oral tradition until the mid-18th century before it was written down. We can point to a few poems like An Duanag *Ullamh*, composed in honour of Archibald, fourth earl of Argyll, c. 1556, the lovely lament *Griogal* Cridhe, composed *c.* 1570; *Oran na Comhachaig*, in part no doubt composed in the second half of the 16th century; some poems by Sir John Stewart of Appin; and some by Niall Mór MacVuirich. It is beyond doubt that the poetry recorded in the Book of the Dean of Lismore was not an isolated outburst, but that poetry is an integral part of the society of the time. Much must have been lost, both of the work of the professional bards and of the popular songs. Songs in the rowing and waulking measures survive, again orally, from the earliest years of the 17th century, and we must conclude that these forms have a previous history in the 16th century, although we can see it only through a glass darkly.

In the year 1567 the first book to be printed in Gaelic in Scotland appeared. Bishop John Carswell's *Foirm na Nurrnuidheadh*, a translation of John Knox's Liturgy. Carswell is modest about his ability to write Gaelic, but in fact his prose is written in classical Common Gaelic, and resembles that of the 17th-century Irishman Geoffrey Keating. His prefatory epistle makes lively and pleasant reading.

The 17th century in Gaelic Scotland is a period of great interest. The political, ecclesiastical and social structures of Scotland were gradually changing, and so was the relationship betneen the central government and the Gaelic area. Enough survives of the Gaelic poetry of the period to show that there was a large number of poets of great talent. It is probably not a coincidence that the 17th century is also the great age of the waulking songs and of ceòl mór, or the classical music of the bagpipes. There seems to have been a diffusion of artistic talent such as is scarcely matched in any other period in Scottish Gaelic history. Some of the poetry and prose of the time is contained in three 17th-century manuscripts. The first two of these are the Black and the Red Books of Clanranald, written by members (e g., Cathal and Niall) of the MacVuirich family, hereditary bards to Macdonald of Clanranald. They were probably written for the most part in the 17th century, but they contain poems by earlier representatives of this family of bards. Much of the two manuscripts is taken up with genealogical matter. and with an account of the Montrose wars and of the achievements of Alasdair Macdonald (Mac Cholla Chiotaich). From 18th-century accounts we know that the MacVuirich family had compiled other manuscripts, most of which were carelessly destroyed, although ms xlviii in the National library of Scotland is apparently a MacVuirich poetry manuscript.

The other important 17th-century Gaelic document is the *Fernaig MS.*, compiled by Duncan Macrae of Inverinate between 1688 and 1693. This contains about 4,200 lines of verse, which is mostly political and religious. The poets represented belong to the 16th and 17th centuries, although little of the work of the major 17th-century poets is given. The compiler had Jacobite and Episcopalian leanings, which are reflected in his anthology.

The two best-known poets of the 17th century are Mary Macleod and Iain Lom. The former, known as Màiri Nighean Alasdair Ruaidh (c. 1615–*c.* 1706), was closely associated with the households of the Macleods of Harris and Dunvegan. She seems to have been a member of the household of Rory Mór Macleod, who died in 1626, and to have acted as nurse to successive generations of Macleod chiefs. Those for whom she had the greatest affection were probably Sir Norman Macleod of Bernera and Iain Breac Macleod of Dunvegan. Her earliest poem of certain date is the elegy for Roderick Mackenzie of Applecross. (d. 1646), and one of her latest is the elegy for Sir Norman Macleod of Bernera (d. 1705). Her poems show deep personal emotion. Her imagery, though restricted in range, is sincere and telling, and her style is fresh and natural. She inherits much of the imagery of the bardic poets. but places it in a new setting, and her metres are the comparatively new strophic ones rather than the strict syllabic metres of the classical bards.

John Macdonald, known as Iain Lom, (c. 1620–*c.* 1710), was related to the chiefs of the Keppoch Macdonalds, and he took an active interest and an active part in the events of his time. His life spanned an eventful period in Highland history, and his poetry is full of comment on these events. He composed poems about the battles of Inverlochy (1645), Auldearn (1646) and Killiecrankie (1689), a lament for Montrose (1650). a poem on the restoration of Charles II (1660), several poems dealing with the Keppoch murder of 1663, an elegy for Sir James Macdonald of Sleat (1678), a song to William and Mary (1688), and a song bitterly opposing the union of the parliaments in 1707. He is a royalist and a fervent Macdonald panegyrist. As a Macdonald he lashes the Campbells; as a Roman Catholic he does the Presbyterians less than justice. But the breadth of his interest in national affairs is notable His versification is less melodious than Mary Macleod's, and he has none of her tenderness and nostalgia. But he has that compression and concentration of expression which so much later Gaelic poetry lacks. This may derive in part from the style of the classical bards, as the directness of his utterance may from the popular or folk poetry. He can achieve more at times by understatement than the 18th-century poets can by a plethora of epithets.

We can do little more than mention some of the other 17th-century poets of whose works interesting fragments have survived. Donnchadh MacRuaraidh was-bard to Biacdonald of Sleat, and his best-known poem consists of four calm resigned verses composed on the day of his death (c. 1630). The work of Alasdair Mackenzie and of Murdoch Mackenzie, both of Achilty, is represented in the Fernaig MS. Alasdair is the *laudator temporis acti;* Murdoch sometimes shows a lively interest in action and movement, as in his An *Làir* Dhonn. Roderick Morrison, usually known as An Clarsair Dall (the Blind Harper), was born in Lewis and became harper to Iain Breac Macleod of Dunvegan. Little of his work survives, but the strong texture and poetic intensity of his *Oran Mór MhicLeòid* and his *Creach* na Ciadain are remarkable. Dorothy Brown and Silis na Ceapaich are women poets of great talent, and nith them may be grouped other women, Mairearad Nì Lachainn and Catriona Nic Ghilleathain. Dorothy Brown's poem on Alasdair Mac Colla and Silis na Ceapaich's laments for Lachlan MacKinnon and for Alasdair of Glengarry (d. 1721) are moving and artistic utterances. Eachann Bacach Maclean would be honoured for the one poem A' Chnd *Shamhna* (1648), even did no more of his work survive.

Four other poets mark, in various ways, the transition from the poetry of the 17th century to that of the 18th. These are Lachlan MacKinnon (Lachlann Mac Theàrlaich Oig), John Mackay (Am Piobaire Dall), John Macdonald (Iain Dubh Mac Iain 'Ic Ailein), and John Maclean (Iain Mac Ailein). All four were born c. 16jj–6;. Much of their work lacks the economy of the best 17th-century poetry, and also its richness of imagery. It is a much less ornate, a more obvious poetry. John Macdonald's *Oran nam Fineachan* is not the worst in a series of tedious jingles which we can label clan verses, and which were popular with 18th-century poets. John Maclean shows a great interest in early Gaelic legend, and he composes amusing verses in a mock-heroic strain. He also uses a mixture of verse and prose, as in his *Crosanachd Fhir nan*

Druimnean. John Mackay's *Coire an Easa* is significant in the development of Gaelic nature poetry.

Finally, bardic poetry continued to be composed into the 18th century by two members of the MacVuirich family, Niall and Domhnall.

The 18th Century.—The 18th century in Gaelic poetry has eclipsed the 17th partly on account of the brilliance of some individual achievements, and partly because it is from the viewpoint of the 18th century that we often begin our retrospect of earlier Gaelic poetry. No secular poetry in Gaelic was printed before 1751, and the great bulk of earlier verse was recovered from oral tradition subsequent to that date. The interest in that verse was part of the more general antiquarian revival.

Much of the inspiration of Gaelic printing in the 18th century can be traced to Alexander Macdonald, or Alasdair Mac Mhaighstir Alasdair (*c.* 1700–*c.* 1770), who published a Gaelic vocabulary in 1741 and the first book of secular poetry, his *Aiseiridh na Sean Chdnoin Albannaich* (Resurrection of the Ancient Scottish Tongue), in 1751. On both political and literary issues he showed virtues of independence and leadership which mark him out as a man apart among Gaelic poets of the 18th century. During the '45 rising he was granted a captain's commission by Prince Charlie, and he seems to have regarded the rising as a crusade for the Highlands, or even for the Gaelic way of life. He rallied his fellow-Highlanders to the prince's cause with such poems as *Brosnachadh nam Fineachan Gaidhealach* and *Hi ri rì tha e tighinn,* a song of welcome to the prince.

His poetical range was wide. His songs on the seasons must have been composed near the same time as James Thomson's *Seasons.* Another notable nature poem is his *Allt an t-Siùcair.* His *Urnuigh do'n Cheblraidh* contains an adult statement of the aims of his art. His masterpiece and longest poem, the *Birlinn of Clanranald,* is an extravaganza which is ostensibly a description of a voyage from South Uist to Carrickfergus. A fine poem in a quite different mood is the love poem *Moladh Mbraig.* He also composed drinking songs and bitter satires. He has a rich vocabulary and a strong sense of technique.

Duncan Macintyre, or Donnchadh Bin (1724–1812) was influenced in various ways by Macdonald. He published his poems in 1768, and we can see signs of influence in the subject matter and the metres, and sometimes in the phraseology of certain poems. But his individuality is not lost. The two men were profoundly different in nature and in training. Macdonald had received a formal education; Macintyre could neither read nor write. Macdonald was ambitious, independent and restless; Macintyre had none of these uncomfortable qualities. Macintyre fought on the Hanoverians' side at the battle of Falkirk, and later sang the praises of George III in *Oran do'n Rlgh.* He composed other soldiering songs, and various other set pietes on the clans, the bagpipes, and on the Gaelic language, but his true subjects are wild life and wild nature—the haunts and the habits of the red deer. He had been a forester on the Perthshire-Argyllshire borders in his early manhood, and this is the setting for his greatest poems, *Moladh Beinn Dóbhrain* (Praise of Ben Dorain) and *Coire Cheathaich* (The Misty Corrie). These poems are remarkable for their emotional closeness to nature, their minute and objective detail and their personal and lyrical quality. His most famous love song is *Màiri Bhàn Og,* addressed to his wife. Donnchadh Bin is the best-loved of the Gaelic poets.

There were several other poets of note in the 18th century. John MacCodrum (*c.* 1700–79) was appointed bard to Sir James Macdonald of Sleat in 1763, and his elegy for Sir James is probably the best of his poems. He had a good memory for genealogy and for poetry, and was a known wit. He composed much humorous and satirical poetry. Rob Donn Mackay (*c.* 1714–78) was the bard of the Reay country, and used his gifts of observation and satire in commenting on the life of his district. Characters such as the miserly brothers of Rispond have a quality of universality. There is much social satire in his verse, and some delicate feeling for nature, as in *Cead Fhir Bhìoguis do'n Fhrìth.* William Ross (*c.* 1762–90) is the romantic poet of the group. His poetry is emotional, subjective and at times sentimental. He had an unhappy love affair which occasioned several of his best poems, such as *Feasgar Luain* and *Oran Eile.* Another well-known poem is *An Suaithaeas Bàn,* composed on hearing of the death of Prince Charles Edward in 1788. David MacKellar published his *Hymn on the Creation* in 1752, but the greatest composer of Gaelic religious verse in the 18th century was Dugald Buchanan (1716–68) whose poems were published in 1767. His poems, the *Day oj Judgement* and *The Skull* are impressive and sombre, and show considerable imaginative power. Buchanan assisted Stewart of Killin in preparing his Gaelic translation of the New Testament (1767). Ewen Maclachlan (1773–1822) was librarian of King's college, Aberdeen. He transcribed many Gaelic manuscripts, including the *Book of the Dean of Lismore,* translated more than seven books of Homer's *Iliad* into Gaelic verse, and wrote Gaelic poems on the seasons.

Collections of Gaelic Poetry.—From the middle of the 18th century onward a number of important collections of Gaelic poetry were made. One of the earliest was the Rev. Alexander Pope's, made *c.* 1739. Jerome Stone had collected Ossianic ballads and other verse before 1756, and Archibald Fletcher's Ossianic ballads were memorized by him about this time, although written down later. The Rev. James Maclagan continued to collect material throughout the second half of the century, and his manuscripts rest in Glasgow University library. The Rev. Donald MacNicol's collection also belongs to this period. Dr. Hector Maclean of Mull's manuscript dates from about 1768. In 1776 Ranald Macdonald's *Eigg Collection* was published, and in 1886 Gillies', based on Maclagan's. James Macpherson's notable enterprises, the publication of his *Fragments of Ancient Poetry* in 1760, his *Fingal* in 1762, and his *Temora* in 1763, stem from this new collecting zeal, and in turn reinforce it. Macpherson's work is partly based on genuine Gaelic ballad sources, which can be elucidated, and is partly constructed from borrowed English and Irish sources, and from his own imagination. But it is probable that we owe to Macpherson the collection and in some cases the preservation of valuable oral and manuscript material, as for example the dean of Lismore's manuscript. The Rev. Patrick Macdonald's *Gaelic Vocal Airs* was published in 1781. Important collections of the early 19th century were those of A. and D. Stewart (1804), Patrick Turner (1809), and Alexander Campbell's *Albyn's Anthology* (1816–18). The movement continues with John MacKenzie's *Beauties of Gaelic Poetry* (1841), Donald Macpherson's *An Duanaire* (1868), and the work of the two giants among 19th-century collectors, John Francis Campbell of Islay and Alexander Carmichael. Campbell's four volumes of *Popular Tales of the West Highlands* were published in 1860 and 1862, and his *Leabhar na Féinne,* a great collection of Ossianic ballads, in 1872. The first instalment of Carmichael's great work, *Carmina Gadelica,* was published in two volumes in 1900, and three further volumes have followed. Alexander Cameron's *Reliquiae Celticae* (1892–94) made available in print much valuable manuscript material, such as the *Fernaig* manuscript, parts of the *Books of Clanranald,* and some of the Edinburgh manuscripts, together with Ossianic and other material from various manuscript collections. A collection of Gaelic proverbs had been published by Donald Macintosh in 1785, and this was supplemented and enlarged by Alexander Nicolson in 1881. A new edition, edited by Calum Macinnes, appeared in 1952. Frances Tolmie's fine collection of Gaelic folk songs was published in 1911. Beginning in 1872, we have the valuable series of *Transactions of the Gaelic Society of Inverness,* which has published much material from manuscript and oral sources. The periodical, *Scottish Gaelic Studies,* was launched in 1926.

19th and 20th Centuries.—A fair volume of periodical literature was published in the 19th century and after. For a brief account of this, see the Rev. Donald Maclean's *The Literature of the Scottish Gael. An Gaidheal* is the lineal descendant of some of these periodicals. It has been joined in a scanty field by *a* quarterly, *Gairm.*

These periodicals contain the main volume that we have of Gaelic prose. In addition there is a quantity of translation of religious works. A translation of Calvin's Catechism is said to have been issued in 1631. Fifty of the psalms, together with the

Shorter Catechism, appeared in 1659. Kirke's Psalter in 1684. and the Synod of Argyll's in 1694. Kirke's Irish version of the Bible in Roman type appeared in 1690. James Stewart's Gaelic edition of the New Testament was published in 1767, and John Stewart of Luss and John Smith of Campbeltown published a translation of the Old Testament (1783–1801). The complete Gaelic Bible was issued in 1807, and the first standard revision was that of 1826. Meantime many other religious translations were appearing, of works by Richard Baxter, Thomas Boston. John Bunyan, Philip Doddridge and others, and later volumes of original sermons appeared.

Some notable original prose contributions are Lachlan Maclean's *Adam and Eve* (1837). the writings of the Rev. Norman Macleod or *Caraid nan Gaidheal* (1867), Donald Mackechnie's *Am Fear Ciùil* (1904), and Angus Robertson's *An t-Ogha Mor* (1913).

There was a dearth of vital poetry in the 19th century, when much verse arising out of induced moods was composed. But there are partial exceptions, in some of the work of John Maclachlan of Rahoy (1804–74), Evan Maccoll (1808–98), Neil Macleod (1843–1913), and Mary Macpherson (1821–98). John Morison (1790–1852), the poet-blacksmith of Rodel. composed some elevated and imaginative religious poetry. William Livingstone (1808–70) is full of rebellion and resentment, and he tried, without much success, to clothe Scoto-Norse history in poetic and dramatic dress. Angus Robertson's *Cnoc an Fhradhairc* (1940) is a hard poem to read, but it is rewarding in parts. In recent years a new movement to free Gaelic poetry from oppressive traditional shackles has been inaugurated by Somhairle MacGilleathain's *Dàin do Eimhir* (1943), George Campbell Hay's *Fuaran Sléibh* (1947) and *O na Ceithzr Airdean* (1952), and Ruaraidh MacThómais' *An Dealbh Briste* (1951). In a style partly traditional and partly new is James Thomson's *Fasgnadh* (1953).

Little of permanent value has been done in the drama. The art of the short story has been cultivated spasmodically in periodicals and in Gaelic radio programs. No fully adult Gaelic novel has appeared. The art of essay writing, however. has been pursued with distinction by writers such as the Rev. Donald Lamont and others. (D. S. T.)

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SCOUT, a soldier whose duty it is to obtain information of the enemy's movements or capabilities. He is usually a regular member of the armed forces, not a spy, and is treated as a prisoner of war if captured; but some scouts are irregulars or auxiliaries. Men are usually chosen for duty as scouts because they have special aptitudes such as knowledge of the terrain or ability to speak the language of the country. Scouts normally go out alone or in small groups ahead of the main body of troops and serve as the "eyes and ears" of the main force. During the Indian wars of the United States. the best scouts were white fur traders and friendly Indians who could find their way across the plains, track the enemy through the forest and warn of ambushes. One of the most famous was Christopher ("Kit") Carson (*q.v.*). Native scouts served a similar purpose in the Pacific island campaigns of World War II and were indispensable in jungle operations.

For boy scouting, *see* BOY SCOUTS; for girl scouting, GIRL SCOUTS and GIRL GUIDES. (LN. MS.)

SCRANTON, a city of northeastern Pennsylvania. U.S., the county seat of Lackawanna county. is 134 mi. W.N.W. of New York city and 110 mi. N.N.W. of Philadelphia. It is situated in the Lackawanna river valley on the western fringes of the Pocono mountains at an elevation of 752 to 1,770 ft. above sea level. Pop. (1960) city 111,443; standard metropolitan statistical area (Lackawanna county) 234.531. For comparative population figures *see* table in PENNSYLVANIA: *Population.*

Permanent settlement of the valley dates from 1788 when it was known as Slocum Hollow. In the next few years a gristmill, a sawmill and a charcoal furnace were built along the Lackawanna (Indian for "stream that forks"). but there was little development except for names: the village was called Slocum Hollow, Unionville, Harrison and Scrantonia before becoming Scranton in honour of the New Jersey family which established the Lackawanna Iron and Coal company there in 1840. George W. Scranton (1811–61) and his brother, Selden, bought a large tract (most of the present downtown business section) for $8,000 and began to smelt iron from local ores, using an anthracite hot-blast process. Persistent efforts by the two Scranton brothers and timely financial aid by their cousin, Joseph Hand Scranton, made the venture a success. By 1850 a rolling mill, a nail factory and a steel-rail works were in operation and transportation facilities had been provided. Scranton was incorporated as a borough in 1853 and chartered as a city in 1866.

Even before the iron ore was exhausted, the iron industry was overshadowed by the anthracite industry which has had a profound impact on the history of Scranton. The ethnic diversity of the area and the rapid population growth stemmed from the need for labour for the mines and allied industries. The first wave of immigration brought skilled English, Welsh and German miners but they were soon followed by the Irish: Austro-Hungarians, Poles! Russians and Italians. The wives of these immigrants provided a labour force that made possible the development of silk, apparel and other industries; Scranton has long been noted for its production of Nottingham lace.

Like the other cities of the anthracite coal region in northeastern Pennsylvania, Scranton has been forced to readjust its economy to the decline in the anthracite industry. Coal production valued at $196,908,000, or two-thirds of the combined total of mining and manufacturing in 1948, dwindled to approximately one-fourth of the total value a decade later. During the same period the percentage of workers employed in producing anthracite dropped from 33% to 14%, creating chronic unemployment of 15% to 20% of the total labour force. The "Scranton Plan" was developed to provide more jobs through industrial expansion. In 15 years after World War II over *30* plants and 3.000.000 sq.ft. of new floor space were made possible by the combination of community contributions, private fiiiancial and state aid. These new plants were either leased or sold to industries moving into the area, and the net income was reinvested in more plants. Textile, apparel, electronics and metal products manufacturers are the leading employers.

The economic readjustment brought on by the end of the war and the decline in the anthracite industry was also eased by Scranton's natural position as the centre of a large retail, wholesale and jobbing trade. Railroads. bus lines and airlines (at the Scranton-Wilkes-Barre airport. 6 mi. S. of the city) provide communication with all urban centres in the eastern United States. Three federal highways, and the northeastern extension of the Pennsylvania turnpike and the Pan-Canada international highway system provide the road transportation network of the area.

Educational facilities include the University of Scranton. established in 1888; Marymood, established in 1915; Lackawanna Junior college, organized as the Scranton Business college in 1894, becoming a junior college in 1959; a campus of the Pennsylvania State university commonwealth campus system (of two-year colleges). opened in 1921; the state school for the deaf; and the International Correspondence school, largest institution of its kind in the world. The public library has branches throughout the city and there is a county historical society.

The fine arts form a prominent part of the city's cultural life with a ballet guild, a philharmonic orchestra and an art league. The Everhart Museum of Natural History, Science and Art, located in Nay Aug Park, provides a focus for the appreciation of the fine arts. The park also contains zoological and horticultural gardens and a model mine open to the public. The Pocono mountains provide recreational opportunities as do the many mountain lakes and state parks within the area. (R. D. WI.)

SCRAP METAL. Used metals may be as important as ores as a source of metals and alloys for industrial use. The relative importance of scrap metal increases as the supply of metal in use accumulates and the supply of ores diminishes or the average grade declines. Scrap metals are particularly important in the production of steel, copper. lead, aluminum and zinc. Smaller amounts of tin. nickel, magnesium and precious metals are also recovered from scrap.

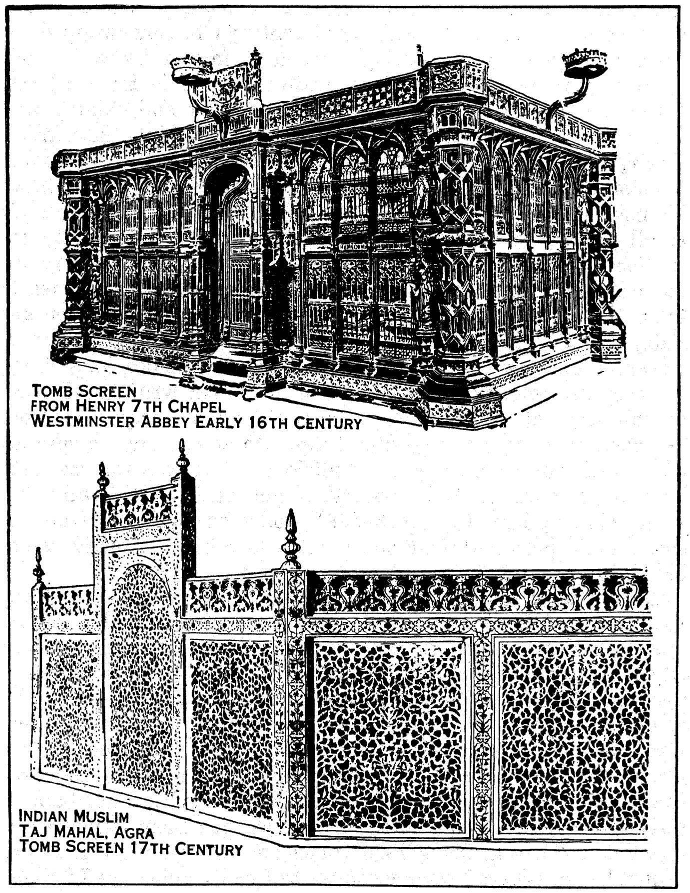
There are two distinct kinds of metal scrap: "old scrap" is metal that has been discarded after use and is returned to the metallurgical industry for reprocessing; "new scrap" is metal from manufacturing operations that has not been used in an end product and is therefore still in the process of manufacture. Metals produced from scrap usually are known as secondary metals as distinguished from primary metals, which are produced directly from ores. No such distinction is made for steel and precious metals. Steel is produced from a combination of scrap iron, pig iron and iron ores. Old scrap is gathered from widely scattered sources by scrap-metal or junk dealers and sold to secondary smelters. New scrap is concentrated in industrial areas and is usually purchased directly by secondary smelters. Many of the larger metal producers who produce secondary as well as primary metals buy back the new scrap from manufacturers to whom they sell primary metal.

Scrap usually is processed by sorting: blending and remelting to produce alloys similar to or more complex than those from which the scrap was derived. Old scrap in particular ordinarily is contaminated with foreign materials. Organic materials such as wood, plastic, paint or fabric can be burned off. Metallic impurities that are beneficial or inert usually are retained in the secondary ingot. Undesirable metallic impurities are diluted to tolerable proportions by the addition of pure metal or are removed by refining, *e.g.,* zinc is readily removed by distillation; lead can be refined by melting with a suitable flux. The price differential between scrap and refined metal permits only simple refining methods to be used. (H. W. S. C.)

SCREAMER *(Palamedea* ***cornuta*)**, a bird inhabiting Guiana and the Amazon valley. About the size of a turkey, it is remarkable for the slender "horn" more than gin. long, on its crown, the two sharp spurs on each wing, and its long toes. Its plumage is mainly greyish-black above with some white and reddish-brown, while the lower parts are white. Related to this bird is *Chauna chavaria,* the "Crested Screamer," a name first bestowed on the Seriema (*q.v.*). This bird inhabits the lagoons and swamps of Paraguay and Southern Brazil, where it is called "Chajá" and is smaller than the preceding, wanting its "horn," but having a crest of feathers; the plumage is mainly grey. Its nest is of dry rushes, having its foundation in the water, and contains six eggs, which are white tinged with buff. The young are covered with yellowish-brown down A singular habit of this bird is that of soaring in circles at an immense altitude in flocks uttering at intervals their far-reaching and melodious cry. They also sing on the ground *(see* W. H. Hudson, *Naturalist in La Plata,* who also records hearing over a hundred thousand burst into song together). The young are often reared by the people to defend their poultry, a duty which is faithfully and, owing to its spurs, successfully discharged. Another curious property of this bird is a layer of air-cells between the skin and the muscles, so that on the body being pressed a crackling is heard. In Central America the darker *C. derbiana* occurs. It is a smaller bird than the others, with slate-gray plumage and white throat.

The *Palamedeidae* are by many authors placed in a distinct order, *Palamedeiformes,* near the *Anseres.* *(See* BIRD.)

SCREEN, in architecture, any one of various types of subdivisions between adjacent portions of the same open space. Thus the colonnades under the great arches in the tepidaria of certain Roman baths formed screens, mainly decorative, between the central space and alcoves or recesses at the ends and sides.



TOMB SCREEN FROM HENRY 7TH CHAPEL WESTMINSTER ABBEY EARLY 16TH CENTURY

INDIAN MUSLIM TAJ MAHAL, AGRA TOMB SCREEN 17TH CENTURY

The term is especially used in ecclesiastical architecture for the railings, barriers or other dividing elements between chapels and the aisle or nave or around the choir. Chapel screens were usually open and consisted of an arcade of tracery or of a metal grille. Choir screens, on the other hand, were, in north and west Europe, largely solid, although relatively small in height, so that the services held behind them could be heard by those in the nave although the clergy and choir remained unseen. Of choir screens of this type, those of the cathedrals of Amiens and Chartres, both of the 15th century, are especially rich; in England, that of York (1475–1505), Canterbury (15th century) and Exeter (first half 14th century) are noteworthy. In Italy the tradition of the early Christian bemas, ambones and low chancel railings dictated an entirely different type of screen; the chancel front of S. Miniato, near Florence, with its elaborately inlaid marble parapet of the late 11th and early 12th century is typical. With the coming of the Renaissance even this amount of separation was abandoned and in the great Renaissance churches of Italy the use of the screen as a separation for the choir disappears. In Spain the high development of ironwork led to the extensive use of that material for both choir and chapel screens. This iron screen work, termed *rejeria* (*q.v.*), constitutes one of the most glorious adornments of the Spanish churches. See JUBE; STALL. (T. F. H.)

SCREENS OF CHINA AND JAPAN

Because of their fragile nature, no screens of great antiquity have survived, but references to them are not wanting in ancient literature. Folding screens were known in China as early as the 2nd century B.C., at which period glass or mica panellings for them are noted as of much value, their transparent nature affording both enjoyment of an outdoor view and shelter from the elements. Then, in the century preceding the Christian era, screens carved and inlaid with jade and other precious materials seem to have been produced. Already in this early period the art of painting screens was practised, for it is recorded that "Figures of Exemplary Women," illustrating the good or evil effects from right or wrong-doing were depicted on a screen. The Chinese artist Ts'ao Pu-hsing (3rd century) having dropped ink upon a screen while painting, turned it into a fly which Sun Ch'üan (A.D. 181–252) tried to brush away. Shih Hu (3rd century) made a folding screen covered with silk and painted with hermits, birds and animals, to which he added a long inscription. Chang Mo (4th century) depicted on screens the Buddhist saint, Vimalakirti, and a scene entitled "Beating Newly-woven Silk." In passing, mention may be made of a 14-fold screen in the scroll attributed to Ku K'ai-chih (4th century), owned by the British Museum, confirming the accuracy of contemporary accounts that screens consisted of numerous leaves, sometimes as many as 40. In the 5th century, Lu T'an-wei painted a lion and Fang Huai-chên the "Paragons of Filial Piety." Landscapes were not unknown in these early centuries as themes for screens, for they are referred to in old poems and other writings. Screens of tapestry, of embroidery, of crystal and of lacquer are also recorded in contemporary literature. Moreover, fine calligraphy inscribing moral teachings or auspicious sentiments was executed on screens from the 5th century, if not earlier. It is said that Fang Hsiiang-ling (A.D. 578–648) collected precepts from all sources and inscribed them on screens which he distributed among his children as reminders of proper conduct.

The T'ang Period.—In the luxurious days of the T'ang dynasty (618–907), screens were in constant demand to adorn palaces and mansions. Those which were bedecked with gold and silver, pearl and tortoise shell, or those of fine textiles woven or dyed, bearing characteristic patterns, must have imparted great splendour to the habitations of rulers and princes. Horses sent from foreign tribes to the imperial stables furnished themes for screens, and a fabulous animal called' *mo* which is supposed to eat bad dreams was deemed an appropriate subject for boudoir screens. Then, too, such noted painters as Pien Luan (who treated flowers and birds), Chang Tsao (pines and rocks), and Chou Fang (court beauties), and such accomplished calligraphers as Li Yang-ping and Chang Hsü all decorated screens. Some emperors had about them screens setting forth worthy and moral deeds performed by men of the past, in order that they themselves, as well as their subjects, might derive benefit from these constant reminders.

But for actual examples of T'ang art on screens we have to turn to Japan where, in the Imperial repository called the Shōsōin, at Nara, are still preserved relics of the art of that golden epoch. This treasure-house contains principally the personal selongings of the Emperor Shōmu, which were given to the Great Buddha of the Tōdaiji by the Empress Kōmyō, in 756. The list of donations mentions, among other objects, 100 screens, to which several more were added, at three different times, between the years 756 and 758. Among this large number of screens were examples of Chinese, Korean or Japanese origin which included paintings of landscapes, palaces, figures and flowers; others of batik and of block-resist dyeing, figuring birds, animals and flowers; and, in addition, some screens on which Chinese ideographs formed the chief decoration. Of these 100 odd screens but few remain at present, in whole or in part, among them no painted screens. Nevertheless, the pictorial accomplishments of the 8th century may still be seen in this collection in a six-fold screen, in each leaf of which is shown a figure of a woman standing under a tree. The subject was originally worked in birds' feathers which have disappeared, leaving only the preliminary drawings. Despite the sketchy nature of the drawings of the figures, trees and rocks, one may detect the mature brush-strokes, the importance of which is so much emphasized in the art of painting in the Far East. The screen is probably Japanese, yet its conception and execution are based upon contemporary Chinese patterns. There are also two six-fold screens in this imperial collection, the chief decorative features of which are Chinese inscriptions in large characters. One contains a precept for a ruler, consisting of 48 Chinese ideographs, each written twice, once in the *chuan* ("seal") style and once in the *hsing* ("running") style. The backgrounds of this screen are of silk dyed in green and red-alternating in the six panels—bearing designs of conventionalized clouds, birds, animals, trees, plants and rocks, all in white reserve. The screen is very likely Chinese, one of many gifts sent to the Japanese court from China, although it is said that at one time there was discovered upon it a Japanese date corresponding to the year 751—a fact lacking substantiation. In the Orient, to use writing on a large scale for a decorative scheme is no less frequent than to employ a picture for the purpose. Indeed, good calligraphy (*q.v.*) is considered an art of as great importance as good painting, both being the result of brush-work and both presenting images of mental conception.

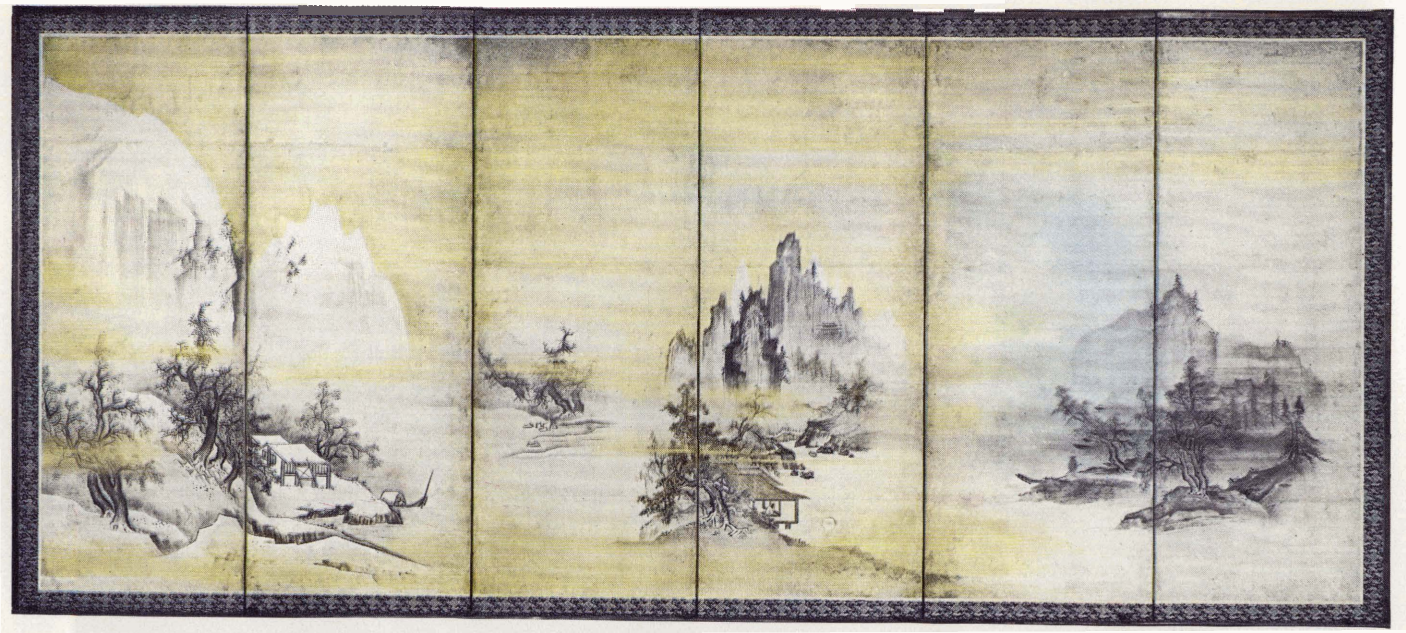
An example of the pictorial art of the T'ang as it is reflected in the art of Japan may be seen in a screen which is preserved in the Buddhist monastery of Tōji in Kyoto. It treats a landscape in pclychrome: among trees surrounded by hills and water is a rustic abode within which sits a hermit who is being visited by nobles with their servants. According to an old tradition, the screen was one of the treasures brought back by Kōbō Daishi from China in 806. However, some authorities now regard the painting as a Japanese production of the 11th century, based upon a T'ang original. For, despite its Chinese design, in it are discernible certain technical peculiarities of the early Yamato-é (literally "Japanese picture") style which was developed during the Fujiwara period (900–1189) and is characterized by over-refinement of drawings. Such a landscape screen was used in the baptismal rituals of esoteric Buddhism which required a pictorial representation of a mountain scene in lieu of the natural setting in which the religious service took place in old India No screens of a secular nature dating from the Fujiwara period are now extant, but literary sources disclose the thousands of screens painted for the use of the Japanese court and for the mansions of nobles. As in the preceding epoch, the need for screens was pressing, because of the peculiar style of the architecture of those days—wide openings on the sides of a building which were closed by wooden doors at night but which during the day needed screening arrangements. Regular and occasional State functions also required special screens appropriate to the events. That a large number of screens was produced may be gathered

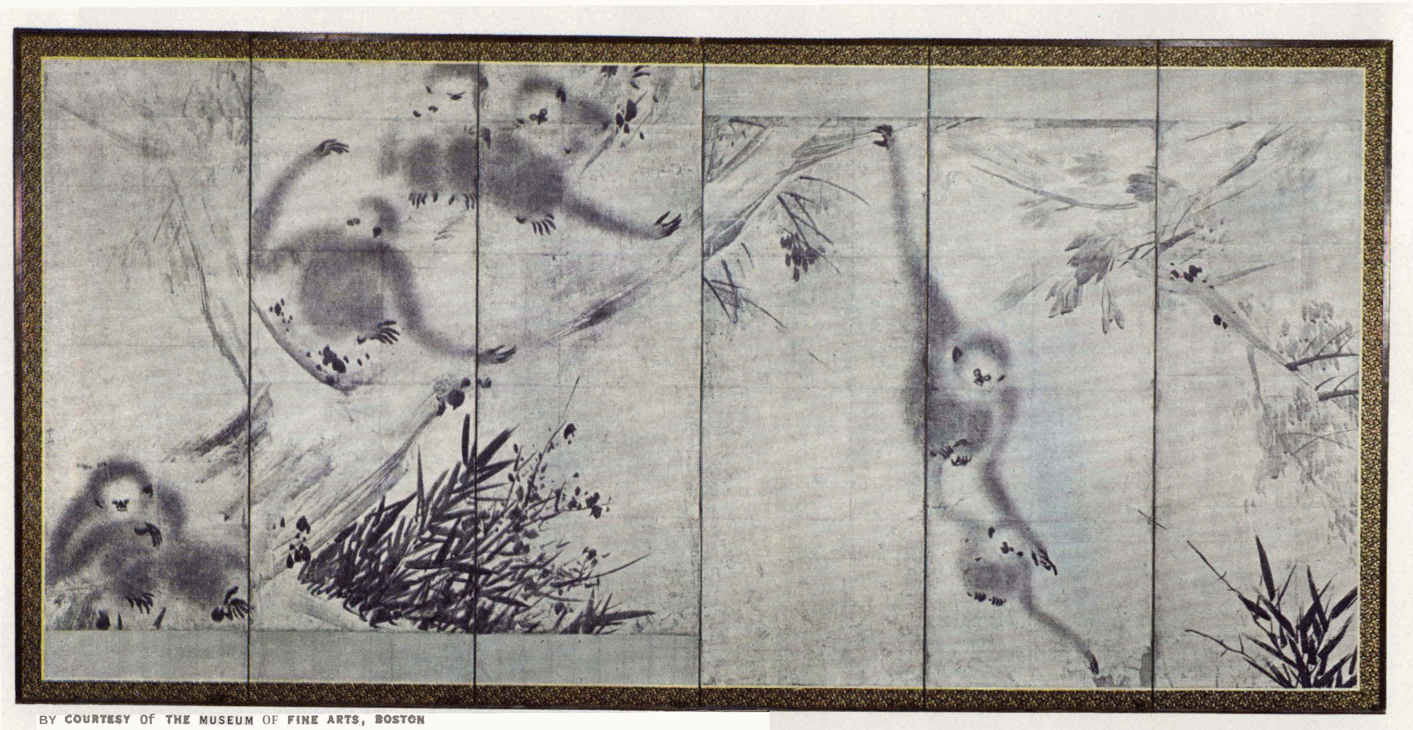
(TOP) BY COURTESY OF PIERRE CARTIER. (BOTTOM) FROM A PRIVATE COLLECTION IN THE UNITED STATES

CHINESE IMPERIAL PALACE SCREENS

Above: Carved and lacquered wooden screen, dated 1673, showing the Imperial Palace ground during a ceremony at which the Emperor Kanghsi is officiating

Below: Porcelain screen of the Ch'ien-Lung period (1736–95). The central panel is painted in famille verte, and the upper and lower in famille rose



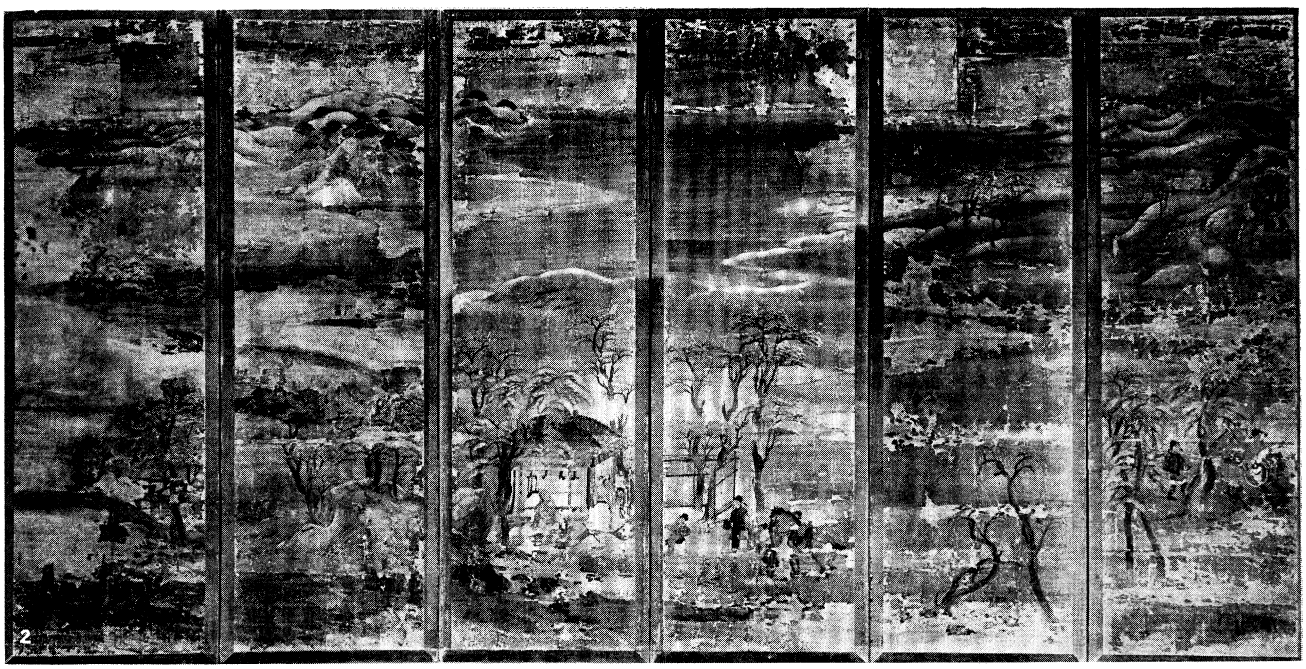


BY COURTESY OF THE MUSEUM OF FINE ARTS, BOSTON

TWO JAPANESE SCREENS

Above: Landscape, by Oguri Satan (1398–1464), painted in monochrome, with gold wash, on paper. It is one of a pair of six-fold Japanese screens in the Fenollosa-Weld collection

Below: Spider-monkeys, by Hasegawa Tōhaku (died 1610), painted in monochrome on paper. It is one of a pair of six-fold Japanese screens in the Bigelow collection



BY COURTESY OF (1) THE DIRECTOR OF THE IMPERIAL HOUSEHOLD MUSEUM. JAPAN (2) (SHIMBI SHOIN, LTD.) FROM "THE MASTERPIECES SELECTED FROM THE FINE ARTS OF THE EAR

A CHINESE AND A JAPANESE SCREEN IN THE T'ANG STYLE

1. Chinese screen of the eighth century painted with a precept in 48 ideographs. each character written both in the "seal" and in the "model" style. The panels, which are joined with cords, are coloured alternately red and green, with designs of clouds and other conventionalized forms in white. From the Imperial Collection in the Shosoin, Nara, Japan

2. Japanese landscape screen of the 11th century, probably after a T'ang original, depicts the visitation of a noble and his servants to a hermit's house set in a landscape of trees, hills and water. The over refinement of the drawings is characteristic of the "Japanese picture" style of the Fujiwara period (900–1189). From the Buddhist monastery of Toji at Kyoto

from the record that Yoshichika (11th century) painted zoo screens on Lord Yoshimichi's order. A story is told about Hirotaka (10th century) who delineated a scene of hell containing a demon who proved so lifelike as to convince the artist that the call to the unknown region was immediate. The subjects, some Chinese and some Japanese, mentioned in this period are varied and numerous: landscapes of the four seasons, monthly observances, trees and plants, falconry, picnics, polo-playing, the paragons of noble deeds, the descent of the Amitābha, the ten Buddhist regions, etc. In Japan, during the Kamakura period (1190–1336), in making screens they followed the preceding Fujiwara in the main, both pictorially and technically.

The Sung Period.—In China itself in the Sung period (960–1279), the practice among prominent masters of painting and inscribing screens was not abandoned. On the contrary, painters like Tuan Yüan, Yen Hsiao, Wên T'ung and Hsü Tao-ning are known to have thus expressed their art; and noted calligraphers applied their brushes after the time-honoured custom. The most significant branch of the art of the Sung period was the so-called Idealistic school of painting which was closely followed by the artists of the Yüan (1279–1368) and Ming (1368–1644) dynasties. Painters of this school attempted to express in their works certain noble thoughts and ideals. A landscape-painting, for example, was an essay which suggested the sublimity of nature and invited the beholder to identify himself with it. The inherent love of nature of the orientals, coupled with the teaching of *Ch'an* (in Japanese, Zen), produced artists who showed remarkable aptitude for depicting natural phenomena. *Ch'an* means "abstract meditation," the chief aim of its followers being to seek to separate the real from the unreal by divesting themselves of earthly thoughts and desires and by communing directly with nature. Inspired by this teaching, the artists developed marked individuality and their paintings were characterized by purity and suggestiveness. For their themes, the painters of the Idealistic school chose, beside landscapes, birds, animals and even withered trees and rocks, all of which ordinarily were treated in monochrome with China ink. Unfortunately there exists no example of the typical art of the Sung as applied on screens, nor are there any screens dating from the subsequent Yüan and Ming dynasties, in both of which it is recorded that painted and inscribed screens were produced. It is possible, however, that some of the paintings coming from these periods, now mounted as single hangings, were once panels of folding screens.

The Ashikaga Period.—Again turning to Japan, one can see an echo of the Chinese art of these three dynasties in paintings by Japanese artists of the Ashikaga period (1337–1573). Sōtan, Nōami, Sesshū, Masanobu and Motonobu are outstanding figures who painted in ink on screens after the Chinese idealists. A screen by Sōtan, who died in 1464, may be taken as a typical specimen of this style. The vigour of the brush, the subtle quality of the ink, the well-carried-out atmospheric perspective—all tell of the master hand which portrays the spirit of majestic nature. This screen is one of a pair which together show landscapes of the four seasons treated as one composition and consequently forming one composite whole. Beside the "Twelve Monthly Observances" and "Landscapes of the Four Seasons," such themes as "Flowers of the Four Seasons," "Farmers of the Four Seasons," "Lives of the 24 Paragons of Filial Piety," the "Eight Taoist Immortals," etc., frequently occur as single designs. The Idealistic school of painting was carried through the next period, the Momoyama (1574–1602), by artists of the Kano, the Unkoku and the Soga schools. In a screen by Tōhaku (1539–1610) we see a remarkable monochrome; the varied shades of China ink being so used as to suggest the presence of colours, yet with no disturbing element of pigments and no sense of monotony.

A new type of screen introduced some time in the 14th century from Korea contributed much toward revolutionizing the general scheme of composition. Heretofore, a folding screen had consisted of *a* group of separate panels, each with brocaded borders, tied together by means of cords passing through holes pierced at the vertical edges of the panels. In the Korean type the leaves were joined by paper hinges which were built into the body of the screen before the silk or paper for painting was pasted, a brocade border extending over the composite whole.

Whereas in the former style the continuance of the design was interfered with by the frame and the brocade borders of each panel, in the latter style the tightly joined leaves made one surface for painting a picture.

Screens characteristic of the Momoyama period, the inherent love of the Japanese for simplicity notwithstanding, are more decorative in type, with backgrounds of gold leaf upon which appear bold designs in solid pigments on a massive scale. Eitoku (1545–90), who was the chief exponent of the style, is said to have supplied 100 pairs of screens for the Momoyama palace of the Taikō. He painted in two styles, ink and polychrome; the polychrome screens are very effective; for example, one of a pair in which are shown foreigners bringing tribute to the Chinese emperor, Tai-tsung, of the T'ang dynasty; the subject—"Barbarians Presenting Tribute"—being symbolic of the peace and prosperity of the country. The popular pictorial motives on Screens at this time were "The Dragon and the Tiger," "Lions," "Old Pine Trees" (respectively symbolizing the conflict between spirit and matter, nobility and power, longevity and fidelity).

The Tokugawa Period.—In Japan during the Tokugawa period (1603–1868), a new movement in decorative painting was developed by Sōtatsu (1576–1643) who preserved the vigorous and broad brush-work practised by the masters in monochrome, but in place of ink used pigments on a gold ground. Even as he adopted the coloring of the old Yamato-é, so he took many themes from old sources, such as the romances of Genji and Isé, the wars of the Hogen and Heiji Eras, the wind and thunder gods. He was also a genius in the impressionistic treatment of flowers and waterscapes on screens. Following Sōtatsu's style, Kōrin (1657–1716) further enlarged upon decorativeness by introducing more brilliant colours and more daring composition. In the twofold screen depicting violent waves is apparent this artist's largeness of conception and power of technique. In the Tokugawa days, artists in all schools—the Kano, the Tosa, the Genre, the Literary, the Realistic—exerted their artistic efforts on screens. In principle. the pictorial scheme for screens by these painters of varied styles had changed little from that of the preceding Ashikaga and Momoyama periods and it is still continued to-day. A bold design is treated in dissymmetry. yet is well balanced and effective; at the same time it hears a certain moral. historical. legendary or auspicious significance. The subjects treated were many and varied. including those which have already been referred to and also such themes as the "Eight Views of Hsiao Hsing." the "Ten Snow-Incidents." the ".A-fang Pleasance:.' the "Four Gray-beards of the Shan Mountain." the "Seven Sages of the Bamboo Grove.': the "Four Accomplishments." "Floating Fans." "Phoenixes." etc. Generally Japanese screens are six-fold. about 6 ft. in height and 12 ft. in width when stretched. and they are usually executed in pairs. Among the smaller type we may count "pillow" screens with brightly coloured pictures. which are placed about beds, and low. two-fold screens with simple decoration, or none at all, which are used in connection with the tea ceremony (*q.v.*).

The Ch'ing Dynasty.—During the Ch'ing dynasty (1644–1911) in China. painting on screens was practised. as indicated by the presence of occasional examples dating from the last few centuries. But it is in screens of applied art that the period excels. It has already been said that the application of the minor arts to screens began in ancient China. The best known among such screens of recent centuries are the so-called "Coromandel screens" which are made of wooden panels finished with a coat of lacquer, through which designs—landscapes, figures. flowers. auspicious emblems, etc.—are incised and filled with various thick, opaque water-colours; a technique known from the Ming dynasty. A large portion, however. of the existing specimens are of the 17th to 19th centuries. "Coromandel" has no bearing upon their provenance. but indicates that these screens of Chinese origin were shipped to European countries from the coast of Coromandel. Other screens in the category of lacquer are those with lacquered panels (sometimes coated with white oil paint) decorated in gold lacquer; and those of red carved lacquer Screens of carved teakwood construction set with jade and porcelain plaques, or panelled with silks, tapestries or embroideries, are occasionally seen.

(See also JAPANESE PAINTING AND PRINTS; CHINESE PAINTING; EMBROIDERY; FLOWER PAINTING; TEXTILES.)

Furniture. — As an article of furniture, the screen is an ornamental frame, usually of wood, but sometimes of metal, for protection from observation, draught or the heat of a fire. Screens are made of all shapes and sizes, and may consist of leather, paper or textile materials fastened to the framework; they may have several leaves or only one — thus a fourfold screen has four leaves. Fire screens are usually small, with a single leaf — indeed in the Georgian period of English furniture they often took the form of a circular, oval, heart-shaped or oblong piece of framed embroidery fixed to a wooden pole or upright, upon which they could be raised or lowered. This variety, which was called a pole-screen, was more effective as an ornament than as a protection. The hand screen was light and portable, as the name implies. At one time fire screens were often of glass set in metal frames; later they were of metal mesh.

The larger type screen, with several leaves, is of uncertain origin, but probably first came into use toward the end of the 16th century. The earlier examples were of stamped or painted Spanish leather or of some rich stuff such as tapestry; at a later date lacquer was extensively used. They were tall enough to conceal the person sitting behind them, and were frequently exceedingly handsome and stately. (K. T.)

SCREW, a cylindrical or conical member uith a helical groove and ridge on it. (For the screws used to propel ships and airplanes, see SHIPBUILDING.) The helix is found in a wide variety of applications, such as screw pumps (the first by Archimedes)

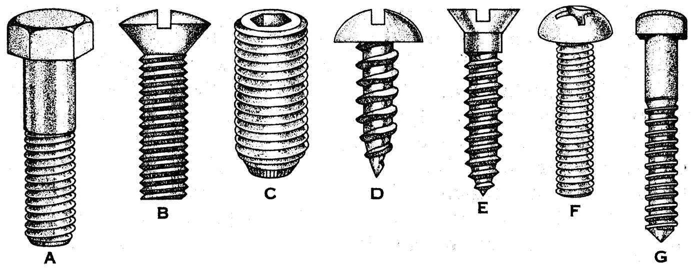


FIG. 1. — SCREWS AND SCREW HEADS: (A) CAP SCREW. (B) MACHINE SCREW WITH OVAL HEAD. (C) SET SCREW WITH HOLLOW HEAD. (D) SELF-TAPPING SCREW. (E) FLAT-HEAD WOOD SCREW. (F) PHILLIPS HEAD SCREW. (G) LAG SCREW

and boring tools for metal, wood, soil, etc. In particular, a screw (without modifying adjective) is a threaded fastening device, without a nut; common examples are the cap screw, machine screw, set screw, wood screw, and lag screw, (fig. 1). The cap screw is machine finished all over and made in sizes of about $\frac{3}{8}$ in. and larger; it generally has a hexagonal head, but may also be made with a hollow head such as shown on the set screw in fig. 1(C).

Machine screws also are usually finished all over but are made in the smaller sizes — up to $\frac{3}{8}$ in. in diameter; various types of heads, nearly always slotted for a screw driver. are used, and patented heads, an example of which is the Phillips head (fig. 1[F]), are common. Set screws are used to prevent relative motion between two parts which tend to slide over one another, as in fastening a small pulley to a shaft; they are obtainable with several different types of heads and points. Self-tapping screws, fig. 1(D), are hardened screws designed to tap their own threads as they are turned into the hole; they are used to join thin sheets of metal, plastics, die castings, etc. Some types are applied with a screw driver, some with a hammer, and they are frequently made with a Phillips head. Wood screws are made in various diameters and lengths; in using the larger sizes, a hole is drilled first in order to avoid splitting the wood and to make the turning easier. A lag screw is a large wood screw, often used to fasten machinery and other heavy objects to wood. It usually has a square or hexagonal head so that it can be turned by a wrench.

Screw Threads. — A thread on the outside of a cylinder is an external or male thread; cut on the inside of a hole, as in a nut, it is an internal or female thread. The purpose in using threaded members may be: (1) to join two or more parts together; (2) to transmit power or force; (3j to obtain a mechanical advantage, that is, a large force from a small one; or (4) to transmit motion either rotary to linear or linear to rotary.

Until about 1841, each manufacturer using threaded fastenings designed the threads for his own convenience. Failure of a screw or bolt resulted in delay, inconvenience and expense because of the difficulty in obtaining a replacement which fitted. Now, however, there is international agreement on some degree of standardization of the form of thread, and general recognition of the desirability of international interchangeability. By interchangeability is meant, for example. that when a large number of bolts and nuts are made to a certain size,and standard, any one of the nuts fits properly on any one of the bolts. In the unified standard of the U.S., fig. 2, which is in accord with an international agreement adopted by English-speaking countries, there are several classes of fits possible. Class 1 is the loosest and cheapest, having the largest tolerances and allowances. Class 2 is about the average fit obtained by ordinary production methods, and is therefore the most common. Class 3 is the closest and most expensive, and would not be used without reason; the specified allowance between bolt and nut is zero. Intermediate classes of fits may be obtained by, for instance, using a class **3** nut with a class 2 bolt.

The largest diameter of a screw thread *(e.g.,* the outside diameter of an external thread) is called the major diameter; the smallest diameter *(e.g.,* the root diameter of an external thread) is called the minor diameter. The top of the external thread is known as the crest, while the crest of an internal thread mates with the root of an external thread.

One fastening thread sometimes used is in the form of a sharp V (fig. 2[A]), but this has disadvantages: the sharp crests are weak and small pieces often break off and the sharp root shape results in a high stress concentration that can lead to failure of the bolt.

Trying to overcome these disadvantages, Sir Joseph Whitworth in 1841 proposed a fastening thread with rounded crests and roots. With an angle between the sides of the thread of 55°, this was the basis of the British standard. In 1864, William Sellers proposed a thread with flat crests and roots and a 60° thread angle (fig. 2[B]), and this later became the U.S. standard and the metric standard.

There are several standard series of fastening threads. The coarse-thread series, with the fewest threads per inch for a particular size, is recommended for general use. The fine-thread series, which has more (and therefore finer) threads per inch, was developed for use in the automotive industry where strength

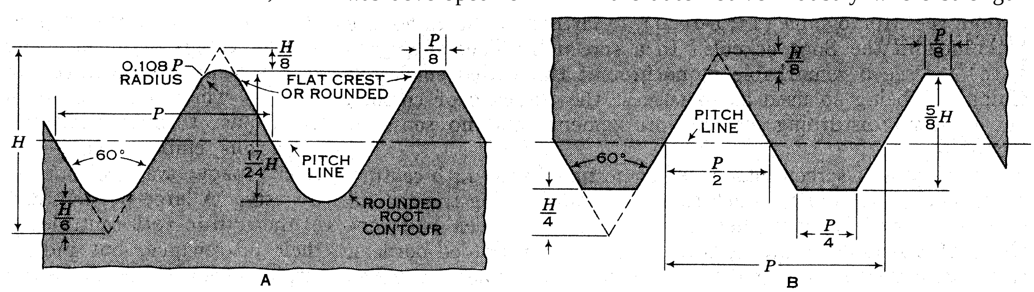


FIG. 2 — PROPORTIONATE DIMENSIONS FOR SCREW THREADS. (A) BRITISH STANDARD. AND (B) U.S. STANDARD. $H = 0.866P$, WHERE P REPRESENTS PITCH

and vibration resistance are important, and where the internal threads are in steel (not cast iron or other brittle material). The extra-fine-thread series of the American standard came about largely in response to the needs of the aeronautical industry. This thread has the maximum root diameter and strength; it is suitable for thinner walls; it is more resistant to loosening from vibration. Fastening screws with these threads are likely to be made of a heat-treated alloy for maximum capacity.

Threads for Transmitting Power.—One of the three forms of threads shown in fig. 3 is usually used for transmitting power or motion. Since the square thread must be cut on a lathe and the Acme thread may be cut with dies, the square thread is more expensive to produce. Not only is the Acme thread less expensive, but it permits use of a split nut with shims between the halves so that wear may be compensated for by removing shims. Ball bearing screws (fig. 4) are used where it is advantageous to have a relatively low input effort and where arrangements with zero backlash are desirable. A worm driving a worm gear may be classified as a screw. often with a thread shape similar to the Acme thread of fig. 3.

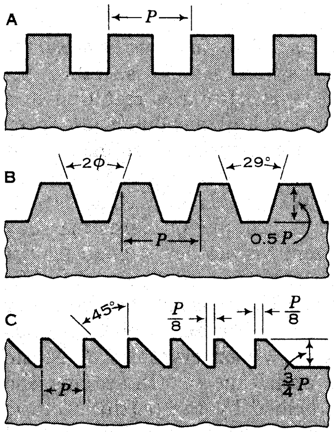


FIG. 3.— POWER SCREW THREADS. (A) SQUARE THREAD. (B) ACME THREAD AND (C) BUTTRESS THREAD. *P*, PITCH; φ, PRESSURE ANGLE AND 2φ, THREAD ANGLE

The pitch P of a thread is the distance between corresponding points on adjacent thread profiles —in inches in some countries, millimeters in countries using the metric system. The number of threads per inch (or per millimeter) is the reciprocal of the pitch. The lead of a thread is the axial distance that the helix advances in one turn, or that a nut will move axially in making one turn. In a single-threaded screw, the lead is equal to the pitch; if two threads run parallel, the lead is twice the pitch (fig. 5). When high mechanical advantage is the prime requisite, a single-threaded screw is best. When high efficiency is essential, as in some worm drives, a large lead (*i.e.,* multiple threads) is necessary. An exception is the ball-bearing screw, which is said to have an efficiency of about 90% at very small leads. However, the efficiency of a screw-and-nut combination depends not upon the magnitude of the lead but upon the slope of the thread at the pitch helix, which is the tangent of the lead angle. The lead angle λ is the angle between a plane perpendicular to the axis of the screw and a line tangent to the pitch helix The pitch helix has somewhat different definitions in different applications, but it is approximately at the mean diameter of the thread. The efficiency also depends upon the thread angle, the degree of lubrication, rubbing speed, materials, alignment and workmanship in general. Some of these factors are accounted for by the coefficient of friction.

A value of the coefficient of friction equal to 0.05 is easily obtained in well lubricated worm drives; a value 0.15 corresponds to a situation at slow rubbing speed with the surfaces merely damp with lubricant.

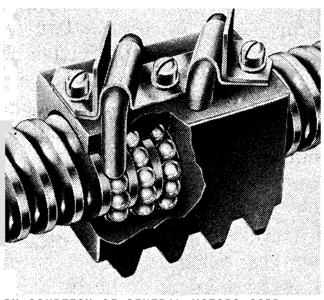


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FIG. 4.—BALL BEARING SCREW; BALLS ROLLING ON EXTERNAL AND INTERNAL THREADS COMPLETE THEIR CIRCUIT THROUGH TUBES AT TOP

Methods of Cutting Screw **Threads.**—The methods of cutting external threads may be described in six categories: turning, die threading, chasing, milling, rolling and grinding.

Turning, a process still used occasionally, employs a single-point cutting tool of the same shape as the space between threads. The member to be threaded (that is, the work) is mounted in a lathe. The change gears on the lathe are arranged so that the work and the lead screw of the lathe turn with the proper relative speed to give the desired number of threads per inch on the work. If the work and lead screw turn at the same angular speed, the number of threads per inch on the work is the same as that on the lead screw; fewer threads are cut if the work turns slower than the lead screw, more if the work turns faster.

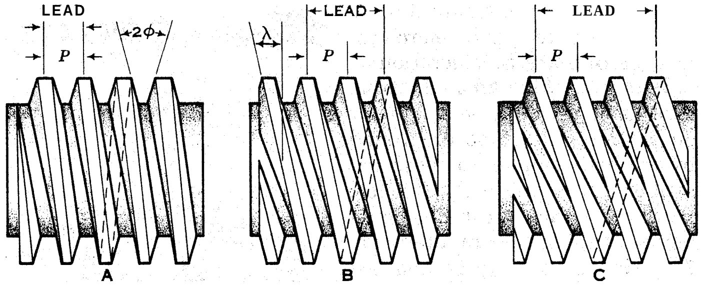
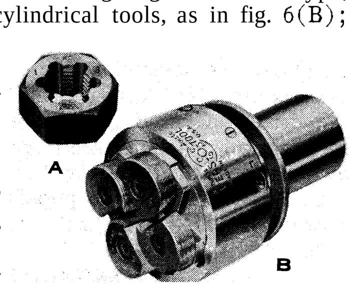


FIG. 5.— DIAGRAM SHOWING RELATION OF PITCH TO LEAD. φ, PRESSURE ANGLE: 2φ, THREAD ANGLE AND λ, LEAD ANGLE

Dies for cutting threads are made with internal cutting edges of the proper shape, size, and pitch (fig. 6[A]). Manual operation of thread dies is common for cutting small pipe threads on the job, but the dies are also used in machines, including automatic thread-cutting machines. On small threads and at slow speed. the die can be depended on to follow its own helical path with reasonable accuracy. On large threads and at high-production speeds the relationship between die and work must be positively maintained.

For machine cutting of threads. the rate of production is improved if the die automatically opens, allowing the work to be directly withdrawn (not unscrewed).

Chasing is the same in principle as die threading. The difference is in the configuration of the cutting edges. In one type, the cutting edges are on small cylindrical tools, as in fig. 6(B); in another type the cutting edges are on flat pieces mounted with the tops of the cutting edges tangent to the root of the threads being cut.



BY COURTESY OF (LEFT) NATIONAL ACME COMPANY (RIGHT) GREENFIELD TAP & DIE DIVISION OF UNITED GREENFIELD CORPORATION

FIG 7—(A) THREAD-CUTTING DIE; (B) CIRCULAR THREAD CHASERS ON REVOLVING HEAD

Milling of threads is done on a standard milling machine, or one especially built for this work, using a milling cutter with a profile the same as the space between threads. In one type of machine, the cutters rotate on their axes and revolve about the work. Milling is especially useful in producing large, accurate threads.

Rolling produces threads by rolling the work between flat or cylindrical dies. Because the rate of production is high, the process was first used to manufacture cheap stove bolts, but it has been improved until bolts and screws of superior quality can be produced in this manner. The die has hardened parallel ridges whose profile is the same as the desired thread profile and whose slope produces the correct lead of the screw. The shank to be threaded has a diameter approximately equal to the pitch diameter. As the blank is rolled between the dies under great pressure, it is indented and metal flows to the root of the die grooves (forming the crest of the thread). The cold working of steel during this process improves its strength, and the resulting surface finish is excellent.

The accuracy that may be obtained depends upon the accuracy of the dies and of the machine. When cylindrical dies are used, there are three of them. and of course the forces exerted by the rollers must be sufficient to cause the metal of the work to flow completely into the valleys of the roller threads.

Grinding can also be used to make threads by gri'nding with a wheel whose form matches the space between the threads. Grinding usually is used as a finishing operation,, especially after heat treatment, for producing threads in hardened steel, and where cost is not a primary consideration.

Internal Threads.—Internal threads may be cut on a lathe or on a milling machine or ground by methods similar to those described for external threads. However, the most common method is by means of a tap (fig. 7). Hand taps may be adapted to low-speed machine work. The taper tap is used first and it is the only one needed for a through hole.

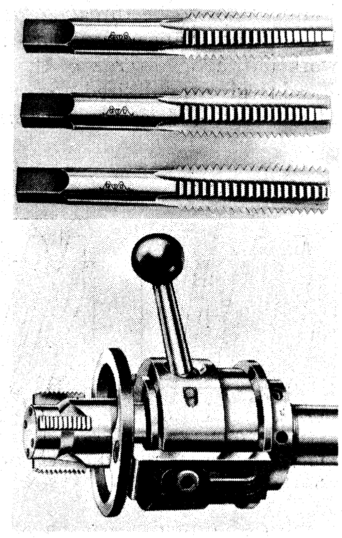


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FIG. 7.—TAPS: (ABOVE) HAND TAPS FOR CUTTING INTERNAL THREADS AND (BELOW) COLLAPSING TAP

If it is desired to have good threads all the way to the bottom of a blind hole, the taper tap is followed by the plug tap and then by the bottoming tap. There are different kinds of collapsible taps suitable for high production: after they have completed the tapping, they automatically collapse and withdraw quickly. (V. M. F.)

SCREW DRIVER, the tool which drives screws, must be made of good steel and suitably tempered so it will not snap off through being too hard, or twist or bend through being too soft.

The chief interest in 'this connection in manufacturing processes and repairs attaches to the mechanically operated screw drivers which vastly speed up the rate of removing or inserting screws. Some are driven by a flexible shaft actuated from a cord and pulley, the shaft being maneuvered about anyhow to suit the situation of the screws. Or a pneumatic or electric drill is fitted with the blade, and held in the hands anywhere required. Some small articles demanding the use of numerous screws are placed under a fixed screwdriving machine, the spindle of which carries the driver blade, pressed down by a lever. In woodworking, screwdriving machines are largely used in mass production For hand use only the ratchet and the spiral types are very convenient.

SCREW PINE, the popular name for plants of the genus Pandanus, which are shrubs or trees of peculiar habit, having a main stem and a few branches at the ends of which is a tuft of long, stiff, narrow leaves closely arranged in three strongly twisted lines. The stem forms stout roots some distance above the ground: they grow obliquely downward to the soil and, because of the decay of the lower part of the stem, the plant is often supported merely by these strong proplike roots. The ripe fruits are borne in very large spherical or cylindrical heads. which are often extremely hard. The genus is the principal one of the family Pandanaceae, a small family of monocotyledons, which is widely distributed through the tropics of the old world, especially in the islands of the Malay archipelago and of the Indian and Pacific oceans.

EDGAR AUBERT DE LA RÜE

SCREW PINE (PANDANUS) GROWING ALONG THE COAST OF THE ISLAND OF EPI, THE NEW HEBRIDES. PACIFIC OCEAN

SCREWWORM, the larva of Cochliomyia americana of the family Calliphoridae of the order Diptera (*q.v.*); so-called because of its tapering body bearing rings of spines resulting in a screwlike appearance. The larvae develop in wounds of sheep and other animals and may cause severe myiasis, which may result in death. See BLOWFLY. (C.H. CN.)

SCRIABIN, ALEXANDER MICHOLAEVICH (1871–1915), Russian composer, was born at Moscow on Christmas day 1871 (O.S.). His father was a lawyer; his mother, a good pianist and pupil of Leschetizsky, died when he was one year old. His schooling was received in the Moscow Cadet corps, but he never showed any liking for the military career for which he was intended, and at 18 entered the Moscow Conservatoire of Music where he was a pupil of Safonov and Taneev. On leaving the conservatoire Scriabin was greatly helped by the patriotic music publisher Belaiev, who brought out his earlier works and arranged a European piano recital tour for him. At 20 he returned to Moscow and joined the conservatoire staff. Later he again travelled, this time for six years, visiting the United States among other countries In 1914 Scriabin visited England. giving two piano recitals, playing his own concerto and appearing as pianist in his Prometheus. He was then suffering from a tumour of the lip, from which, soon after his return, he died, April 27, 191j. As a composer, Scriabin represents what may be called the classical-romantic school carried forward to its most advanced point. The form of his sonata and symphony movements he derives from Mozart, through Beethoven; however bewildering these may at first sound, they will be found, on further hearing, to be laid out on essentially the Mozart-Beethoven lines. In his pianistic idiom and general pianistic qualities of style, Scriabin derives largely from Chopin, of whose work he was a great admirer. All this then indicates a conservative side to his composition, but he was more radical in his harmonies, and it was, probably, largely the novelty of these that retarded appreciation of his later works. It is said that Scriabin gradually evolved a synthetic scale of upper partials or "mystic" chord of superposed 4ths. (C,D,E,F#,A,B♭, or as a chord, C,F#,B♭,E,A,D). One's actual impression, however, of his harmony is of an almost ceaseless chromaticism and of an almost unbroken use of the dominant chord with the flat 7th, 9th, 13th, sharpened 4th, and most frequent of all, the sharpened 5th (or flattened 6th). It is seldom one recognizes his chord of superposed 4ths as such, excepting at times the characteristic two perfect 4ths at the top. In his later work he makes still further harmonic excursions, notably with sharp 7ths or flat 2nds. The hint of this new harmonic scheme may be seen in the earliest compositions, and its development was fairly regular and consistent, until it came to dominate his later output. In his later works he discards entirely the old key signatures. In his orchestration Scriabin calls for a large force, and uses it very freely: his scores are exceedingly contrapuntal in texture, the various instruments moving very independently and weaving together their respective themes: muted brass plays a large part in his orchestral colour scheme. In the first symphony a chorus is used in the finale; the Poem of Fire also uses a chorus, but in an orchestral way, no words being supplied. For the last-named work the composer also wrote an optional part for a "Tastiera per luce," or keyboard of light, the intention being that varying colours should play upon a screen as the work was being performed. The composer was greatly interested in theories as to a correspondence between the musical scale and the scale of colours. In his great Mystery (left unfinished at his death) music, dance, speech, perfume and colour were to be combined; this work was to be rather a work of ritual than of art, and was to express its author's idealistic mysticism through the medium of 2,000 participants.

It is usual to look upon Scriabin's musical work as largely the expression of theosophical views, and undoubtedly much of his inspiration was drawn from the works of Blavatsky and others. He was not, however, a close reader or a careful thinker. Seizing the main idea of a book or a creed, he would neglect the details, and then his imagination would quickly develop a huge scheme of thought having little relation to what he had read. The titles of many of his works and of their separate parts, and the marks of expression affixed to particular passages, indicate plainly the existence of a spiritual "programme." The emancipation of the human soul through ceaseless striving, and its achievement of self-expression, may be said, very roughly, to represent the general sense of the spiritual basis of Scriabin's musical works.

The works of Scriabin have been variously classed into periods. A logical classification is into four periods as follows: 1st period, with a strong Chopin influence; the dividing line between this and the 2nd period runs through the first symphony, and the 2nd period shows some Wagner and Liszt influences; the dividing line between this and the 3rd period runs through the fifth sonata, and a 4th period begins with the Poem of Fire.

Among Scriabin's principal works are the following. For orchestra: Reverie, op. 24; first symphony, op. 26; second symphony, op. 29; third symphony (or *Divine* Poem), op. 43; fourth symphony (or Poem of Ecstasy), op. 54; Prometheus (or "Poem of Fire"), op. 60. For piano: ten sonatas, together with a very large number of preludes, Ctudes, impromptus, mazurkas, poems, etc., including the great Vers la *Flamme* poem and the much-discussed last work, the Five Preludes (op. 74). For piano and orchestra: Concerto, op. 20. No songs or chamber music are included in Scriabin's output. (P. A. S.)

SCRIBE, AUGUSTIN EUGÈNE (1791–1861), French playwright, an outstanding dramatic craftsman who dominated the Parisian stage for some 30 years, was born in Paris, Dec. 24, 1791. He chose as his medium the vaudeville, a popular form of satirical comedy with rhymed and sung couplets. which he soon began to transform by replacing its conventional characters with characters observed from contemporary society (*Une Nuit* de la garde *nationale,* 1815) and by introducing elements of the comedy of manners, as in Le Charlatanisme (1825). His first real comedy was Le Mariage *d'argent* (1827), but though without sung couplets. this play retained the dramatic structure of the vaudeville. Scribe maintained that his sole aim was to amuse; addressing the Acad-Cmie Française, to which he was elected in 1836, he denied that the theatre's purpose was to depict society.

He had a facile pen: working alone or with collaborators, he wrote over 400 theatrical works, including a ballet—Manon (1830)—and opera libretti: Fra *Diavolo* (1830), Robert le diable (1831), Les Huguenots (1836) and Le Juif errant (1852). His best-known plays are Le Verre d'eau (1840), Bertrand et *Raton* (1833) and Adrienne Lecouvreur (1849). His plays, which appealed to middle-class tastes and prejudices, brought Scribe a fortune.

Scribe died in Paris, Feb. 20, 1861.

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SCRIBES, a group of Jewish scholars frequently mentioned in the Gospels, often together with the Pharisees (*q.v.*) and sometimes together with the high priests. The word "scribe" is used in the English versions of the New Testament to translate the Greek word grammateus (plural, grammateis), which in turn was used to render the Hebrew word *sopher* (plural, sopherim) or sofer. In early biblical Hebrew *sopher* usually designated an important court official, but during the first two-thirds of the period of the second commonwealth (from about 400 B.C. to A.D. 1), when Judaea was successively a province of the Persian, Macedonian and Roman empires, *sopher* meant an interpreter of scripture. It was in this capacity that Ezra (about 400 B.C.) was called a scribe. In the early part of the 2nd century B.C. Jesus ben Sirach, the head of a school of wisdom in Jerusalem, celebrated the intellectual and moral pre-eminence of the *sopherim* or scribes (Ecclus. xxxviii, 24–xxxix, 11). During the last three centuries before the beginning of the Christian era the *sopherim* were the professional interpreters and teachers of biblical law and ethics. Since the Jewish community enjoyed cultural autonomy under foreign rule, it was permitted to govern itself by its own constitution (called *politeia* in the ancient Greek sources), namely the Pentateuch. However, the Mosaic laws required interpretation and expansion to meet the needs of this later age and the work of interpretation was undertaken by the sopherim. The two leading religious-political parties, the Pharisees and Sadducees, both had their professional scholars or scribes, but as the Pharisees enjoyed greater influence among the Jews as a whole, it was the Pharisaic scribes whose interpretation of the law was considered authoritative by later rabbinic scholars. It is the Pharisaic scribes who are meant in most of the Gospel references to grammateis. It should be noted also that the Gospels treat this word as synonymous with nomikoi, "jurists" and *nomodidaskaloi,* "teachers of the law" (*i.e.,* biblical law). The chief Jewish legislative and judicial body meeting in Jerusalem from about 200 B.C. to A.D. 70, known as the great Sanhedrin (*q.v.*), was made up of scribes of the Pharisaic party as well as the scribes and priests of the Sadducaean party. Which party was in the majority throughout this period is not known, but sources indicate that on certain matters the opinions of the Pharisaic scribes prevailed. However, there was a difference in the usage of the word "scribes" between the Jewish and Christian writings of the first two centuries A.D. The rabbinic sources of this period apply the word "scribes" (sopherzm) to the biblical interpreters and jurists of the period between Ezra and their own time, while the Pharisaic scholars or rabbis of their own period are generally called sages (hakamim), though they performed the same functions as the *sopherim.* The latter term was usually applied in the Hebrew writings of the first two centuries A.D. to less eminent persons, such as writers of legal documents, copyists, notaries and teachers of elementary schools. When the Gospels speak of scribes (*grammateis*) as contemporaries of Jesus, they mean the jurists and teachers who had earlier been called *sopherim* but were now generally called *hakamim.*

The chief functions of the scribes throughout the greater part of the period of the second commonwealth were: (1) to interpret the biblical law and to provide new legislation by the construction of the written text or on the basis of the tradition of the elders (*i.e.,* the oral law); (2) to give instruction in all fields of knowledge relevant to the study of Scripture; (3) to act as legal advisers to judges and those who administered the law.

See Emil Schiirer, Geschichte des *jüdischen* Volkes *im Zeitalter* Jesu Christi, 3rd ed., vol, ii, pp. 312–328; G. F. Moore, Judaism, vol. i, pp. 39–40. (RA. Ms.)

SCRIPPS, EDWARD WYLLIS (1854–1926), U.S. newspaper publisher, who inaugurated the newspaper "chain" in the U.S., was born on a farm near Rushville, Ill., June 18, 1854. Educated in the district school and a private one conducted by his half sister Ellen, Scripps in 1872 joined the staff of the Detroit Tribune, then partly owned and managed by his half brother, James Edmund Scripps, who in 1873 started the Detroit Evening News, on which Edward was a reporter and finally city editor. He left his job in 1877 to tour Europe with his half brother George, and on his return began the *Cleveland Penny* Press in 1878. Buying or establishing papers, first in the midwest and later on the west coast, Scripps before his death expanded his chain to 34 newspapers in 15 states. (See NEWSPAPER: United States: "Chains" and Consolidations.)

His papers were low-priced (originally penny papers), written for the "95 per cent," *i.e.,* the common people, politically independent, liberal and prolabour.

In 1897, with George and Milton Alexander McRae, who were partners in the chain, he organized the Scripps-McRae Press association, ultimately combined with another independent service as the United Press. He also organized the Newspaper Enterprise association, the first newspaper syndicate created to serve a chain of newspapers.

In 1922 he transferred his interests to his son Robert. Scripps died on board his yacht in Monrovia bay, Liberia, on March 12, 1926.

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SCROFULA, the general name formerly given to tuberculosis (*q.v.*), "scrofulous," "strumous" and "tuberculous" being nearly interchangeable. The particular characteristics associated with "scrofula" have, therefore, varied at different periods when the real nature of the disease was misunderstood; but essentially what was meant was tuberculosis of the bones and lymphatic glands, especially in children, and it is in this sense that the word survives. The old English popular name was "king's evil," so called from the belief that the sovereign's touch could effect a cure. This superstition can be traced back to the time of Edward the Confessor in England, and to a much earlier period in France. Samuel Johnson was touched by Queen Anne in 1712.

See also KING'S EVIL.

SCROGGS, SIR WILLIAM (*c.* 1623–1683), lord chief justice of England, was the son of a butcher of sufficient means to give his son a university education. Scroggs went to Oriel college, and later to Pembroke college, Oxford. There is some evidence that he fought on the royalist side during the Great Rebellion. He was called to the bar in 1653, was appointed a judge of the common pleas in 1676, and two years later was promoted to be lord chief justice. As lord chief justice Scroggs presided at the trial of the persons denounced by Titus Oates for complicity in the "popish plot," and he treated these prisoners with characteristic violence and brutality, overwhelming them with indecent sarcasm and abuse while on their trial, and taunting them with savage mockery when sentencing them to death. He may at first have been a sincere believer in the existence of a plot; at all events he did nothing to test the credibility of such perjured witnesses as Oates, Bedloe, and Dangerfield. At the trial in Feb. 1679 of the prisoners accused of the murder of Sir Edmund Godfrey he gave a characteristic exhibition of his methods, including a tirade against the Roman Catholic religion. But Oates' next move, accusing the queen's physician, Wakeman, seemed to be going too far, and in the succeeding trials Scroggs impugned the testimony of Bedloe and Oates, thereby incurring great unpopularity in the country. Oates and Bedloe now arraigned him (1680) before the privy council for misconduct of the Wakeman case, but he was acquitted. The same year he discharged the grand jury to save the duke of York from trial as a popish recusant. In Jan. 1681 he was impeached; dissolution saved him, but he was removed from the bench. He died on Oct. 25, 1683.

Scroggs was perhaps the worst of the judges who disgraced the English bench at a period when it had sunk to the lowest degradation; and although his infamy is less notorious than that of Jeffreys, his character exhibited fewer redeeming features. Scroggs was the author of *Practice of Courts-Leet and Courts-Baron* (1701), and edited reports of the state trials over which he presided. He was the subject of many contemporary satires.

See W. Cobbett, *Complete Collection of State Trials*, vol. i.–x. of *State Trials*, 33 vol. (1809); Roger North, *Life of Lord Guilford, etc.*, ed. by A. Jessopp, 3 vol. (1890), and *Examen* (1740); Narcissus Luttrell, *A Brief Relation of State Affairs, 1678–1714*, 6 vol. (1857); Anthony & Wood, *Athenae Oxonienses*, ed. by P. Bliss, 4 vol. (1813–20); *Correspondence of the Family of Hatton*, ed. by E. M. Thompson, 2 vol., Camden Society 22, 23 (1878); Lord Campbell, *Lives of the Chief Justices of England*, 3 vol. (1849–57); Edward Foss, *The Judges of England*, 9 vol. (1848–64); Sir J. F. Stephen, *History of the Criminal Law of England*, 3 vol. (1883); Henry B. Irving, *Life of Judge Jeffreys* (1898).

SCROPE (skrōōp), an old English family of Norman origin. Sir William le Scrope, of Bolton, in Wensleydale, Yorkshire, had two sons, HENRY (d. 1336) and GEOFFREY (d. 1340), both of whom were in succession chief justice of the king's bench and prominent supporters of the court in the reign of Edward II. Henry was father of RICHARD LE SCROPE, 1st Baron Scrope of Bolton (*c.* 1327–1403), chancellor of England, an active adherent of John of Gaunt. Having been knight of the shire of Yorkshire in the parliament of 1364, he was summoned to the upper house as a baron by writ in 1371, when he was made treasurer and keeper of the great seal. In 1378 Lord Scrope became chancellor; he attempted to curb the extravagance of Richard II., and was dismissed in 1382.

His eldest son WILLIAM (*c.* 1350–1399) was created earl of Wiltshire in 1397 by Richard II., and he bought the sovereignty of the Isle of Man from the earl of Salisbury. In 1398 he became treasurer of England. His execution at Bristol was one of the first acts of Henry IV., and the irregular sentence of an improvised court was confirmed by that monarch's first parliament. Wiltshire's father, Lord Scrope, and his other sons were not included in the attainder, but received full pardon from Henry. Scrope, who was the builder of Bolton Castle, his principal residence, died in 1403. He was succeeded in the barony by his second son, Roger, whose descendants held it till 1630. On the death of EMMANUEL SCROPE, 11th baron (1584–1630), who was created earl of Sunderland in 1627, the earldom became extinct.

SIR GEOFFREY LE SCROPE (d. 1340), chief justice of the king's bench as mentioned above, uncle of the first Baron Scrope of Bolton, had a son Henry (1315–1391), who in 1350 was summoned to parliament by writ as Baron Scrope, the designation "of Masham" being added in the time of his grandson to distinguish the title from that held by the elder branch. HENRY LE SCROPE, 3rd Baron Scrope of Masham (*c.* 1376–1415), was a favourite of Henry V., by whom he was made treasurer in 1410 and employed on diplomatic missions abroad. But in 1415 he was concerned in a conspiracy to dethrone Henry and was executed at Southampton, when his title was forfeited. It was, however, restored to his brother John in 1455; and it fell into abeyance on the death, in 1517, of Geoffrey, 11th Baron Scrope of Masham, without male heirs.

See Sir N. H Nicolas, *The Scrope and Crosvenor Controversy* (2 vol., 1832), containing much detailed information about the various branches of the Scrope family; J. H. Wylie, *History of England under Henry IV.* (4 vol., 1884–98); Edward Foss, *The Judges of England* (9 vol, 1848–64); G P. Scrope, *History of the Manor and Ancient Barony of Castle Combe, Wilts* (1852); G. E. C., *Complete Peerage*, vol. vii (1896).

SCROPE (originally THOMSON), **GEORGE JULIUS POULETT** (1797–1876), English geologist and political economist, best known for his study of volcanoes, was born in London on March 10, 1797, the second son of John Poulett Thomson. He assumed the surname of Scrope on his marriage in 1821 to the daughter of William Scrope. Educated at Harrow and St. John's college, Cambridge, he visited Naples, Italy, as an undergraduate in 1816–17, where his interest in volcanoes was stimulated by the actions of Vesuvius. In 1821 he examined the extinct volcanoes of the Auvergne and collected material for his work *On the Geology and Extinct Volcanoes of Central France* which he published in 1827.

Scrope commenced his researches at a time when the doctrines of Abraham Gottlob Werner (*q.v.*) were still in the ascendant, but his studies were soon to play a part in their overthrow. His first work, *Considerations on Volcanoes* (1825), is to be regarded as the earliest systematic treatise on volcanology, being the first attempt to frame a satisfactory theory of volcanic action and to show the part volcanoes have played in the earth's history. He early appreciated the important part played by water in igneous action and he effectively disposed of the elevation theory of craters.

In his work in the Auvergne he demonstrated the volcanic origin of the basalts and the formation of the valleys of the region by river action. He was elected a fellow of the Royal society in 1826.

Soon after his marriage, Scrope settled at the family seat of Castle Combe, Wiltshire, eventually devoting his attention largely to social and political questions. He was a member of parliament from 1833 until 1868 and published a long series of pamphlets and reviews advocating free trade and social reforms, especially with regards to the poor law.

Scrope died at Fairlawn, near Cobham, Surrey, on Jan. 19, 1876. (C. E. T.)

SCROPHULARIACEAE, a family of seed plants belonging to the sympetalous section of Dicotyledons and a member of the series Tubiflorae. It is a cosmopolitan order containing about zoo genera with about 2,600 species; the majority of them occur in temperate regions, the numbers diminishing rapidly towards the tropics and colder regions. About 30% of the species are annual herbs, such as eyebright *(Euphrasia officinalis)*, cow-wheat (*Melampyrum*), and species of *Veronica;* more than 60% are biennial or generally perennial herbs and undershrubs, such as species of *Veronica,* mullein *(Verbascum),* foxglove *(Digitalis purpurea)*, etc., while shrubs and trees are rare; *Paulownia,* a native of the mountains of Japan, a tree with large leaves and handsome panicles of violet flowers, is grown in European gardens.

The stem is sometimes prostrate and creeping, as in ivy-leaved toad-flax *(Linaria cymbalaria)* and some of the native British Veronicas, but generally erect as in foxglove, figwort, mullein, etc.; a few are climbers as *Rhodochiton* and *Maurandia.* The South African genera *Hyobanche* and *Harveya* are parasites almost devoid of chlorophyll with scale-like leaves; and many genera are semiparasitic, having green leaves, but attaching themselves by root suckers to roots of grass, etc., from which they derive part of their nourishment; such are *Euphrasia, Rhinanthus, Pedicularis,* etc. A few genera are aquatic, e.g., *Limnophila* (Old World Tropics), and have much divided submerged leaves and entire aerial leaves. The flowers are solitary in the leaf-axils, as in *Mimulus,* species of *Linaria,* etc., or form spikes or racemes which are terminal as in foxglove, species of *Veronica,* etc., or axillary, as in *Veronica (Chamaedrys* section). The flowers are hermaphrodite, hypogynous and zygomorphic in the median plane, being often more or less two-lipped, and having five sepals joined below and persisting in the fruiting stage, five petals uniting to form a corolla of various shape, generally four stamens, the fifth (posterior) being suppressed or represented by a rudiment, while the anterior pair are longer than the posterior, and two generally equal carpels in the median plane forming a two-celled ovary containing numerous anatropous ovules on a thick axile placenta, and bearing a simple or bilobed style.

When a terminal flower is present it becomes regular as in toad-flax, where radial symmetry is produced by development of a spur to each petal—such flowers are termed peloric; all the flowers in a spike are sometimes peloric. In *Euphrasia* and many species of *Veronica* the posterior sepal is suppressed. The form of the corolla shows great variety, depending on the length and breadth of the tube—which in *Veronica* is almost obsolete, while in foxglove it is large and almost bell-shaped—and the development of the limbs, which are spreading in *Veronica,* small and almost erect in figwort, or form a pair of closed lips as in *Linaria* and *Antirrhinum.* In *Verbascum* the five segments are almost equal, forming a nearly regular corolla; the approach to regularity in the corolla in *Verbascum* is associated with the presence of five fertile stamens, but the three posterior are generally larger than the two anterior. In *Veronica, Calceolaria* and other genera only two stamens are present. Honey is secreted by a disk surrounding the base of the ovary or by special nectaries below it. *Verbascum* and *Veronica* with a short-tubed corolla represent an open type of flower with more exposed nectar; in foxglove the honey is at the base of the long tube, and a bee crawling to reach it will rub with its back the anthers or stigmas which are placed on the upper side of the bell. The closed flowers of *Linaria* and *Antirrhinum* can be visited only by insects strong enough to separate the lips.

The fruit is generally a capsule surrounded at the base, or sometimes as in yellow-rattle *(Rhinanthus)* enveloped in the persistent calyx; it opens by two or four valves, or, as in *Antirrhinum,* by pores. Occasionally it is a berry. In *Linaria cymbalaria* the fruit becomes buried by the stalks bending downwards when ripe.

The family is divided into tribes by characters derived from the number of fertile stamens present and the form of the corolla. It is well represented in Britain by 13 genera, viz., *Verbascum* (mullein), *Linaria* (toad-flax), *Antirrhinum* (snapdragon), *Scrophularia* (figwort), *Limosella, Sibthorpia, Digitalis* (foxglove), *Veronica* (speedwell), *Bartsia, Euphrasia* (eyebright), *Rhinanthus* (yellow-rattle). *Pedicularis* (louse-wort) and *Melampyrum* (cow-wheat). The best known representatives in North America are *Verbascum* (mullein), *Pentstemon* (beard-tongue), *Mimulus* (monkey-flower), *Veronica* (speedwell), *Gerardia, Castilleja* (painted cup), and *Pedicularis* (louse-wort). Common in cultivation are European species of *Antirrhinum* (snapdragon), *Digitalis* (foxglove), and *Linan'a* (toad-flax). Several genera are well known in gardens; such are *Calceolaria, Collinsia, Pentstemon* and *Mimulus* (musk).

SCRUBBIRD, the name applied to species of an Australian genus of birds and especially to *Atrichornzs clamosa.* This bird is brown above, each feather barred with a darker shade; the throat and belly are reddish-white and there is a black patch on the throat; the flanks are brown. It inhabits the thickest "scrub" and the males are noisy and imitative. A second species, *A. rufescens,* from New South Wales, is brown all over. They form the family *Atn'chornithidae* of the perching birds (Passeres).

SCRUTIN DE LISTE, a system of election of national representatives by which the electors of a department vote for all the deputies to be elected in that department, comparable to the "general ticket" in the United States (Fr. *scrutin,* voting by ballot, and *liste,* a list). It is distinguished from the *scrutin d'arrondissement,* under nhich the electors in each arrondissement vote only for the deputy to be elected in it. *See* also REPRESENTATION.

SCRUTINY, careful examination or enquiry. The word is specifically applied in the early Church to the examination of the catechumens or those under instruction in the faith. They were taught the creed and the Lord's Prayer, examined therein and exorcized prior to baptism. Scrutiny also indicates a method of electing a pope in the Roman Catholic Church, in contradistinction to two other methods, acclamation and accession. *(See* CONCLAVE.) In the law of elections, scrutiny is the careful examination of votes cast after the unsuccessful candidate has lodged a petition claiming the seat, and alleging that he has the majority of legal votes.

SCUDERY, GEORGES DE (1601–1667), French writer, was born at Havre, on Aug. 22, 1601. He first served in the army but conceived a fancy for literature before he was thirty, and during the whole of the middle of the century he was one of the most characteristic figures of Paris. He gained the favour of Richelieu by his opposition to Corneille. He wrote a letter to the Academy criticizing the *Cid,* and his play, *L'Amour tyrannique* (1640), was patronized by the cardinal in opposition to Corneille. He was appointed governor of the fortress of Notre-Dame de la Garde, near Marseilles in 1643, and in 1650 he was elected to the Academy. During the troubles of the Fronde he was exiled to Normandy, where he made his fortune by a rich marriage.

He was an industrious dramatist, but *L'Amour tyrannique* is practically the only piece among his numerous tragi-comedies and pastorals that has escaped oblivion. His other most famous work was the epic of *Alaric* (1655). He lent his name to his sister Madeleine's first romances, but did little beyond correcting the proofs.

Scudéry died at Paris on May 14, 1667. His swashbuckler affectations have been rather exaggerated by literary gossip and tradition. Although possibly not quite sane, he had some poetical power. a fervent love of literature, a high sense of honour and of friendship.

SCUDERY, MADELEINE DE (1607–1701), French novelist, sister of Georges de Scudéry (*q.v.*), established herself in Paris with her brother. She was at once admitted to the Rambouillet coterie, afterwards established a *salon* of her own under the title of the *Société du samedi,* and for the last half of the 17th century, under the pseudonym of "Sapho" or her own name, was acknowledged as the first blue-stocking of France and of the world. She formed with Pellisson a close friendship only terminated by his death in 1693. Her lengthy novels, such as *Artamène, ou le Grand Cyrus* (10 vols. 1648–1653), *Clélie* (10 vols. 1654–1661), *Ibrahim, ou l'illustre Bassa* (4 vols 1661). *Almahide, ou l'esclave reine* (8 vols. 1661–1663) were the delight of all Europe, including persons of the wit and sense of Madame de Sevigné. With classical or Oriental personages for nominal heroes and heroines, the whole language and action are taken from the fashionable ideas of the time, and the personages can be identified either really or colourably with Mademoiselle de Scudéry's contemporaries. In *Clélie,* Herminius represents Paul Pellisson; Scaurus and Lyriane were Paul Scarron and his wife (afterwards Mme. de Rlaintenon); and in the description of Sapho in vol. x. of Le *Grand* Cyrus the author paints herself. It is in *Clélie* that the famous Carte de Tendre appeared, a description of an Arcadia, where the river of Inclination waters the villages of Billet Doux, Petits Soins and so forth. The interminable length of the stories is made out by endless conversations and, as far as incidents go, chiefly by successive abductions of the heroines, conceived and related in the most decorous spirit, for Mademoiselle de Scudéry is nothing if not decorous.

In that early day of the novel prolixity did not repel. "Sapho" had really studied mankind in her contemporaries and knew how to analyse and describe their characters with fidelity and point. Moreover her novels had the interest always attaching to the *roman à* clef. She was a real mistress of dialogue. She had a distinct vocation as a pedagogue, and is compared by Sainte-Beuve to Mme. de Genlis. She could moralize—a favourite employment of the time—with sense and propriety. Though she was incapable of the exquisite prose of Mme. de Sévigné and some others of her contemporaries, her purely literary merits were considerable. Madeleine survived her brother more than thirty years, and in her later days published numerous volumes of conversations, to a great extent extracted from her novels, thus forming a kind of anthology of her work. She outlived her vogue to some extent, but retained a circle of friends to whom she was always the "incomparable Sapho." She died on June 2, 1701.

Her Life and Correspondence were published *at* Paris by MM. Rathery and Boutron in 1873. An amusing sketch of her is to be found in vol. iv. of Sainte-Beuve's *Causeries du lundi.* Georges de Scudéry is sketched by Théophile Gautier in his *Grotesques.* See also V. Cousin, La *Société française au XVII^e siècle,* vol. ii.

SCULL, a light oar with blade more concave than the ordinary racing oar and with shorter helm, thus allowing the user to hold one in each hand. *See* ROWING.

SCULPTURE is the art of representing observed or imagined objects in solid materials and in three dimensions. The field of sculpture is too vast to be conveniently covered in a single article. Therefore this short survey has been divided into sections under epochs and countries and the names of living sculptors have been omitted.

PRIMITIVE PEOPLES

Ages before the dawn of history Magdalenian cave dwellers worshiped the supernatural, and modelled animals in clay perhaps to exercise sorcery over the hunted prey. These have been preserved in the innermost recesses of the caverns of Tuc d'Audoubert in Southern France. Man, since he first smoothed the handle of his club or rubbed sharp the point of his spear, has felt the impulse to make pleasing surfaces or to render in form his impressions of the life seen about him. He made and decorated utensils, implements, vessels and ritual images.

The similarity of the primitive artisan's approach to his problems and technique in the use of the same materials leads to a related sculptural treatment in widely separated countries. Geometric forms based on the circle and the square are common to the art of all primitive peoples. The whirl, the zig-zag, the meander and the wave are elementary in nature as they are in design. The symbolization of fire, water. earth and air are found within the rhythms of these forms. The hand of man, the tool and the observation of nature, as well as physical contacts and spiritual impulses, all combined in the making of a universal pattern..

The taste of primitive man for symmetry of design. whether of Asia, Europe, Africa or America, was closely related. The carvings of a Maori canoe and the decorations on Carolingian objects in Central Europe have a resemblance in rhythmic feeling. Characteristics of sculptural symmetry and pattern crossed Asiatic seas and relate the carvings and totems of Polynesia and New Zealand to the Indian sculptures of the Americas from Alaska to Peru.

The sculptural art of primitive peoples is much appreciated in modern times. The student and connoisseur turn to it as to a fountain-head from which streamed an art, ageless in simplicity and virility. Negro sculpture from the Ivory Coast. Benin and other parts of West Africa is influencing sculptural trends in schools of art today The powerful stele sculptures, carvings from ruined temples of Mexico, Honduras, and Guatemala, and Central American pottery figures have aesthetic appeal Terra-cotta masks from Vera Cruz in some cases suggest, by subtle modelling and facial expression, the smiling angel of Reims. Chimu pottery sculptures of Peru convey impressions of amazing vigour and portraitlike reality. All these types of art appeal because of their nai've genuineness, energy and originality and are in contrast to the complex tendencies of European art. Objects which a generation ago were considered of ethnical interest only are now taking a prominent place in art collections.

EGYPT

The spiritual approach of the Egyptian sculptor-builder to his problems was influenced by the environment in which he lived; the austerity of the mountains and the vast bleakness of the desert affected his conception of form. His material approach was tempered by the hardness of the granite in which he worked and the limitation of his tools. The treatment of surface became an established formula for the working of all sculpture and even small figures carved in soft limestone or wood had surfaces characteristic of hard-material monumental sculpture.

During more than three millenniums of Egyptian culture, art obeyed the rigid dogmas of ritual representation. Based on solid geometrical conceptions, nature was expressed in architectonic form relationship within the limits of the block of granite or other material; so in the "Colossi of Memnon" on the Plain of Thebes the seated figures of the Pharaohs conformed to the rectangular shapes of the stones, while the same general formulas applied to the gigantic Sphinx by the great Pyramid. Sculpture was characterized by simplicity of form with four-sided relief surface treatment. Human proportions were adhered to with remarkable truth and the accuracy of detail accorded with the demands of a race of hieroglyph carvers. The consistent scale of the parts to the whole gave to the small statue, by proportions1 geometrical relationship, the sense of grandeur and dignity possessed by the colossal statue of the same subject.

In pre-Dynastic Egypt, sculpture was well advanced as a form of expression, developed in response to practical and religious demands. It was the custom from prehistoric times to bury with the dead, articles of domestic usage and sculptured images. The tombs of the Old Empire contained portraits of the deceased with accompanying figurines of servants and domestic animals. Examples of these interesting objects are preserved in many museums. The most important collection is in Cairo.

In the vicinity of Memphis and on the western bank of the Nile are the remains of the Old Empire pyramids, where the kings and nobles were buried. Stone structures were built above their sarcophagi. structures which, in the course of generations, evolved into the final form of the pyramid.

It was at Saqquara as early as the Third Dynasty (30th century B.C.) that sculptured reliefs on the walls of the tombs revealed naturalistic drawing of high excellence, work which was characterized by freedom of spirit, good humour and the delight of the artisan in his craft. These showed processions of slaves, men at work in the field or in the barnyard, animals, wrestlers and hunters, sail- and row-boats. Schematic rhythm of surface pattern lent dignity to the composition. These reliefs were painted in strong local colour and the carved contours served to intensify the design and the rounding of the surfaces helped impart a three-dimensional reality. In cases where the tomb was unimportant the wall was decorated in colour only and the carving dispensed with; similar to the instances in the Middle Ages when painting served to replace mosaic or more permanent and expensive materials. A stone figure of Queen Nofret of the same dynasty conveys a feeling of sensuous realism. Plaster masks from life in the Museum at

Cairo prove the desire to imitate nature. The "Seated Scribe" in the Louvre Museum is a limestone figure combining vitality and symmetry of composition. He looks up from his tablet with keen alertness, his eyes are inlaid with rock crystal, alabaster and black stone with realistic effect and are set with silver eyelids. The surface treatment of the famous "Shekh-el-Beled." the wooden image of a fat functionary, is that of hardest stone. save that the arms are made separately and attached to the body. Here again the eyes are inlaid.

The sculpture of this epoch seems to presage the attainment of artistic liberation, but the development which had reached its fullness at Saqquara was to stop with the formal conventions imposed upon it by the dictates of dogma, from whose confines it was not again to escape except for a brief moment during the period of religious revolution of Ikhnaton.

During the Middle Kingdom (2160–1090 B.C.) the wealthy kings promoted temple building on a magnificent scale. In the hypostyle hall of the Temple of Amon at Karnak the Egyptians achieved a vast and enduring form of construction, a manifestation of supremacy over materials unsurpassed in the world. The unity of the whole depended on the harmonious relationship of the parts, in which painting, sculpture and architecture were indissolubly blended. In tremendous figures the form was impressive and monumental, but the vivacity and freshness had diminished. Walls were covered with polychromed reliefs picturing kingly conquests and supernatural configurations. From the Temple of the Nile the processional avenue was flanked with closely set heroic rams in which monumental sculpture complemented stern architecture.

At Abu Simbel on the Upper Nile, Rameses II (about 1250 B.C.) cut in the living stone a temple. the facade of which conformed to the face of the cliff in which it was carved. Four gigantic figures of the king, 65ft. high, flanked the central entrance. It was incredible and marvelous and a triumph of art and engineering skill. The ceiling of the great hall of the interior was supported by colossal figures of Rameses and, true to tradition, the walls were engraved with the glories of the king and gods.

MESOPOTAMIA

In the valleys of the Tigris and Euphrates, there grew rich, martial civilizations based on agriculture—first the Sumerian, followed by the Babylonian, Assyrian, Chaldean and Persian Empires.

The excavations at Ur of Ancient Sumeria have revealed interesting sculptures of the Fourth Millennium B C. In the University of Pennsylvania at Philadelphia and in the British Museum are finely executed objects in beaten copper from Ur. representations of men and animals strikingly lifelike and of forcefully conventional form. The use of inlaid stone, bricks, metal and carved wood was common.

The Age of Sargon in the 28th century B.C., and the Babylonian Empire under Hammurabi produced pomerful and simple sculpture, disclosing an understanding of great principles of form harmony by which the human figure was rendered with dignity and robust realism.

At Nineveh the capital of Assyria (885–612 B C.) the Palace of the Kings was richly sculptured Stone friezes on the walls were carved with banquet scenes. processions of warriors. tribute bearers, incidents of battle, royal hunting parties in which dogs and lions, horses and men were rendered with virile clarity of design. Relief sculptures excax-ated from the Palace of Ashurbanipal are among the most powerful and vivid expressions of this type of art ever produced Mighty monolithic granite groups of winged bulls with human heads flanked the great entrance stairs of the palaces.

Within the limits of a geometrically shaped mass the established conventions of sculptural art were a language eloquent with authority and simplicity. The grammar of form was uncomplicated and comprised a series of simple rules and recipes for the interpretation of anatomy and the delineation of the body.

Sculptured friezes of warriors and life-like animals in stone and glazed terra-cotta at Persepolis were admirable Lions in full colour against a blue ground were modelled with swift moving lines and sensitive form, but lacked the rugged energy of the Assyrian and Babylonian work. The characteristics of design and treatment of form in these latter Southwestern Asiatic sculptures influenced the artistic taste of the Greeks.

GREECE

The civilization of Mycenae and Crete flourished from the 19th to the 12th century B.C. leaving monuments which influenced the Doric artists. The impressive Lion Gate at Mycenae shows relationship to the art of Babylon, and the excavations at Knossos have yielded treasures of small sculptures in faïence, ivory and metal. There is a famous gold cup showing men and bulls in violent action, done with a naturalistic feeling associated with sophisticated art.

A newly liberated and expanding intelligence, born of a phenomenal spirit of enterprise and curiosity in the laws of science and nature, and spurred by competitive individualism, produced a new art expression in Greece. Sculpture was its noblest flower. Architecture dealt with the problems of utility and the appropriate use of materials; in it the poetry of rhythmic form was limited to the abstractions of geometrical composition. The temple was the jewel case, the setting and frame for the glorified form of the deity it enclosed and the edifice became a vehicle for sculpture and painted decoration.

The rise of culture in Greece was extremely rapid and developed a sculptural art as remarkable as any the world has known. From crude beginnings in the 7th century B.C. in less than two centuries it attained the perfection of the Golden Age of Pericles. This beauty of expression and fulfilment may well be compared to that which occurred in the Isle de France in the 12th and 13th centuries with the fruition of Gothic art.

There was similarity between the Greek archaic frontal type sculpture and its prototype in the Valley of the Euphrates or Egypt. The sculptor had not learned to liberate the arms from the body, nor yet to turn the head on the neck or give movement to the pelvis or shoulders. Standing figures of the early 6th century B C. had a severe architectonic feeling as though carved from columns, but it was not long before the freedom-loving Greek artist reached out to solve the problems beyond which Near-Asiatic and Egyptian art had not advanced Although imitating the style and the technical procedure of their predecessors, Greek archaic sculptors later in the century gave movement to their figures and new concepts of composition appropriate to their advancing intellectual and social liberation.

The abundance and beauty of the marble of Greece, Ionia and the Islands of Paros and Naxos, veritable mountains of marble, gave the sculptors a material the working of which they soon mastered.

With the building of the Siphnian Treasury at Delphi (530 B.C.) sculptural decoration of architecture advanced in originality of conception and freedom of style, though still archaic and not completely liberated from Asiatic traditions. The caryatids which support the entablature of the facade are statues of luxurious rhythms and sensuous forms. The building, although small. is a rare masterpiece of harmonious unity in which sculpture complements the abstract beauty of the architectural proportions. The frieze of the entablature carries figures of gods, horses, chariots and warriors and is one of the great sculptural compositions surviving from that age The drawing of the horses has movement, virility and essential feeling of nature; the design has clarity, spirit and distinction in its ensemble, as well as consummate rendering of detail The ornamental motifs on the mouldings are carved nith the same consideration for beauty of form as the figures themselves. Belonging to the same type as the caryatids of the Siphnian Treasury are the "Smiling Maidens" of the Acropolis of Athens, which were presumably erected as votive offerings and date from the time immediately preceding the sacking of Athens by the soldiers of Xerxes They are of a robust beauty and charm, though archaic and belonging to the class of frontal figures.

Archaic sculptors yearned to give their figures a sense of reality which their limited form conventions restricted, so they added colour, and many early statues were embellished with earth pigments, leaving the flesh parts in the warm tones of the marble, in effect very much like the vase figure paintings of the period. In some marble images there is evidence that the ears were pierced to receive metal earrings. These sculptures seem animated with an inner life, testimony of the struggle within the artist to liberate himself from the limitations of static and geometrical abstractions and to achieve within the planes of his material the aspects of reality. The application of polychromy to attain naturalism was common to the primitive sculpture of America, Egypt, China and Romanesque Europe When imitation of nature had been mastered, the sculptor dispensed with these accessories.

The sculptors of the pediments of the Temple of Aphais at Aegina (500 B.c.) though still of the archaic period, emancipated themselves to the extent of being able to turn bodies in any desired position and give them attitudes of activity and struggle. It was in the rendering of facial expression that the archaic mannerisms persisted.

After the defeat of the invading Persian armies of Darius and Xerxes (490–479 B.C.) the exaltation of Greek genius knew no bounds and found expression in masterpieces of art, poetry, philosophy and science. Rapid colonial and economic development brought wealth which furthered the building of sumptuous temples, of which the Temple of Zeus at Olympia and the Parthenon at Athens were the most magnificent.

Pheidias, director of art and an indelible influence upon the Athens of Pericles, created for the sanctuary of the Parthenon a colossal statue of Athena (chryselephantine) made of various coloured materials—ivory and gold predominating—a mighty jewel, majestic in conception, noble in execution and masterly to the smallest detail. It was destroyed centuries ago but was described by Pausanias and is known to us in feeble copies. The pedimental architecture of the temple was the frame wherein gods were humanized and heroes deified in compositions of eternal beauty. The groups of the metopes and the continuous reliefs of the friezes were accents and ties in the great rhythms of abstract architectural and natural sculptural forms. In all these the genius and controlling spirit of Pheidias are felt. The harmonious carving of mouldings and architectural details attest the perfect collaboration of all the workers The head of a statue, the detail of a foliated moulding or the fluting of a column were carved with harmonic appropriateness like that of great musicians playing in a noble symphony.

Ancient commentators considered the Olympian Zeus of Pheidias the finest fruit of his genius and the greatest masterpiece of Greek art. The statue, seven times life size, executed in gold and ivory and seated on a throne elaborately sculptured and inlaid, was the embodiment of benign majesty. Unfortunately, it has been destroyed. In the opinion of many, the pediment groups of the Temple of Zeus at Olympia, together with the great figure within the structure, were the highest peaks of achievement which Greek sculpture attained, combining consummate knowledge, nobility of characterization and unity of form rendered in harmony with the materials in which they were worked. Within the compositions of the pediments and metopes marble figures moved in noble posture, detailed but harmonious in relationship; each item took its place in the rhythm of the ensemble. Figures of gods and men, centaurs, lapiths and amazons moved in varied attitudes of complete emotional appropriateness. The human body has never been more nobly conceived or more imaginatively and intelligently interpreted, all rendered in three-dimensional plastics, powerfully simple and with the feeling of inner life.

The cult of bodily perfection found expression in physical culture and athletic contests. Bronze and marble figures of athletes were typical of Hellenic art and of a race which exulted not only in athletic prowess, but in the study of anatomy and the mysteries of nature. The "Charioteer of Delphi," a life sized bronze figure, part of a group erected in commemoration of a Syracusian Olympic victory (462 B.C) is one of the most perfect examples of bronze craftsmanship from any period or country and comparable in technical skill to those of the great periods of Chinese art. The hands and feet are realistic to a degree and the posture of the body suggests subtle movement, the folds of the long garment fall in lines like the fluting of a column. It is exquisitely finished in every detail. The eyes are inlaid and the eyelashes are executed in separate hairs of bronze, while the ribbon around the head is inlaid with a silver meander. Far from diminishing the feeling of simplicity or giving a sense of over-refinement, this elaboration enhances its beauty. As early as the 6th century, Doric artists produced figures of the discus thrower, a type which was later carried to noble heights by Myron, whose "Discobolos" is an outstanding masterpiece. Primarily a worker in bronze, Myron's statues have survived in Roman marble copies. He was a contemporary of Pheidias (middle jth century B.C.) as was Polycleitus, another of the renowned sculptors of the athletic school.

Praxiteles (b. about 380 B.C.) carried sculptural freedom to personal and emotional heights. Form mas suavely and loosely modelled. Marble was rendered with soft and delicate naturalism. Elegance and sensuous grace replaced the rugged virility of the preceding century, as the slender and ornate Corinthian order, feminine in its beauty, contrasted with the sturdy Doric column, masculine and simple. In the "Hermes with the Infant Dionysus" at Olympia the world possesses an original marble by Praxiteles of greatest beauty.

The Hellenistic period following Alexander the Great (323 B.C.) saw the direction of sculpture continue in the path to flamboyant freedom-exemplified by the Altar of Zeus at Pergamon (175 B.C.) now at Berlin, in which grandiose and contorted deities and giants srruggle in controlled composition. As with the sculptors of Baroque Italy, marble presented no problems but was made to obey complicated emotional and physical design. Technique had mastered the material and thereafter the decline of art was rapid.

ROME

At the time of the Roman conquest Greek art had lost its vigour. Centres of Greek culture were looted and hundreds of bronze and marble statues were sent to ornament the gardens and palaces of Rome. Greek artists were put to the employ of Roman masters, whose lower cultural standards were easily satisfied. Native Roman carvers imitated the Greek manner and produced copies of Greek masterpieces. Quantities of portrait statues and busts were made which under the emperors attained a degree of merit in that field. The sensitive appreciation of form relationship and design was gone. The marble sculpture was colourful with deep cut folds of drapery, oftentimes of complicated composition and lacking structural solidity. The cities of the Roman Empire were elaborately decorated mith sculpture as attested from excavations. In the minor arts, Pompeiian bronze statues reveal considerable humour, charm and delicacy.

INDIA

Great periods of art were born of the mystical forces of religion —Christianity in Europe and Buddhism in Asia—while in Greece the urge was not only that of religion, but of spiritualized adventure searching for nature's truths and those of art, harmony and beauty.

Alexander's conquest of northern India left in its wake a Hellenistic imprint of technical mannerisms which were superficially assimilated in the prevailing style, noticeable especially in the sculptures of Gandhāra and the excavations in Afghanistan (Guimet Museum, Paris). The latter were Graeco-Buddhistic, strangely reminiscent in many details of form and facial expression of florid European art. Together with that Hellenistic feeling grafted to the Aryan Hindu stem was the branch derived from the Persian.

Characteristic of Hindu art was the translation into stone of structural forms which originally must have been suggested by wood construction. Forms were richly undercut and rounded and gave the impression of having been produced in a soft material, even though carved in hardest stone.

Early examples of this style were the gates of the Sanchi Stupa (3rd century A D) in which the story of Buddha was carved in relief with figures of men and women, elephants and lions, winged beasts, birds, trees, architectural motifs and plant ornamentation. Not only in richness of decoration was the fertility of Hindu nature felt, but also in the sensuous treatment of individual figures and forms. The female figure was rendered with voluptuous fullness rather than with the idealized contours of Greek art or with the cold impersonality of the Egyptians.

The idealistic theology of Buddhism was gradually lost in the renascent faith of the Trimūrti (triple aspect God—Brahma, Vishnu and Śiva). Aryan invasion brought their racial legends to the uplands of India and the epic stories of the Mahābhārata and the Rāmāyaṇa became incorporated into the pantheism of Indian faith and constituted a rich section of the background of Hindu art, comparable to that of the epic poems of the Iliad and Odyssey in Greece.

Typical of racial or religious art expressions in all great epochs is the dominance of formulas on the attitude of the sculptor toward his material and technical approach to his subject matter. The strict reproduction of natural forms was not usual in India, but emphasis was placed upon the interpretation of spiritual values. The human figure was rendered in canons of proportion conforming to the abstract requirements of religion and philosophy. So the seated Buddha may be represented in profound meditation, or in a gesture of cosmic serenity in which the sculptural treatment is one of extreme simplification of form. The shoulders are broad and the waist slender; the head arbitrarily ovoid and the expression of the face benign and introspective. The Buddha may be draped with a delicate tracery of folds closely adhering to the body, suggested rather than materialized. Anatomy is reduced to essentials. Again the figure may be seated against a stele-like background on which are lightly carved symbols of his divinity and small-scale Bodhisattvas in postures of placidity with the attributes of the progressive stages to the attainment of Nirvana.

Indian sculpture reached great heights in the Saivaites cave temples. The Saivaites were believers in the ascetic ideal and their rock-hewn temples of Ellora, Elephanta and Ajaṇṭā, dedicated to Śiva. were monuments of incredible human effort. Living rock was carved inside and out in great architectural ensembles. Their temples of the 5th to 8th centuries are overwhelming in the elaboration of figures and ornament, revealing a magnificent conception of their deities. Granite walls vibrate with figures in violent gesture or seated in calm repose; attendant maidens and adorers observe the dance of the titanic Śiva, executed in high relief. The mysticism of the Indian world found expression in vast creative power. mastery of material forms and the spiritualization of the elements of nature. On the sides of gigantic rocks at Miimallapuram sculptors carved in imposing disorder a myriad of figures depicting episodes from the Mahābhārata; figures in all conceivable postures; spirits of the world beyond; fearsome monsters and wild beasts; great elephants and birds; gods and demons —materialization of the imaginings of a race nho looked for their inspiration to the spirit rather than to the incidents of external fact. A just relationship was maintained between the spiritual realm and the material universe. Unknown sculptors u-ho fashioned these works in the living granite equalled in power of visualization and bold technical skill any monumental achievement of man. Though executed with ritual formalism, they are full of creative vigour and have none of the over-elaboration and flaccid detail characteristic of later periods of Indian art

At Koṇārak in Orissā and Mudhera in Gujarāt (11th to 13th centuries) the Vaishnava cult built great sun temples to Vishnu. Although in a state of ruin they are magnificent monuments of architecture and sculpture. Heroic stone elephants and war horses stand by the Temple of Koṇārak, executed in rotund conventionalized masses and mark the eminence to which animal sculpture was carried by the Hindus. The luxuriance of nature's forms is reflected in art, and sculptural groups and figures throng the temples with the orderly profusion of the crowds in the market place. Temples of the 16th and 17th centuries abound in exaggerated decoration, hosts of superimposed sculptural figures adorn their edifices and, as in the case of the decadent periods of all great art movements, technical facility replaces inner spiritual significance.

The Indians attained great mastery in the working of bronze, while they retained the superficial conventions and mannerisms of stone and wood sculpture, the ad antages of the tensile strength of metal was skillfully employed and in bronze chasing they carried elaboration to the ultimate degree.

As a result of India's colonization of Java, a peaceful state far removed from the strife of the mother country, Buddhistic sculpture reached maturity exemplified in the great shrine at Borobudur (9th century). It is described as the most magnificent monument of Buddhistic art in the whole of Asia. The central motif is surrounded by terraces and galleries sculptured with a wonderful series of bas-reliefs, the total length of which is nearly three miles. This work must' have occupied hundreds of artists over a period of several generations; it depicts scenes from the life of Buddha and the legends of his reincarnations—more than 200 panels in all. The subject matter is sympathetically rendered and the simple, straight-forward artistry of these reliefs may be compared to the best in Gothic art. The figures are small in size and sculptural detail is treated with reverential care. The whole great work emanates a spirit of eternal peace, contrasting in gentleness and grace with the more turbulent art of India. The compositions are not formally arranged! but seem to be the inspired result of spontaneous exuberance.

The city of Prambanam in Java was famed for its prosperity and about the 11th century a great temple was dedicated to Vishnu. The malls of the courtyards were carved with legendary scenes from the Rāmāyaṇa. Although a masterpiece of Indian art, it lacks the compelling simplicity of the sculptures at Borobudur. In Cambodia, Khmer sculptors created monumental groups and covered vast walls with animated reliefs: stories of the Mahābhārata, on the magnificent temples at Angkor (9th to 12th centuries).

CHINA

Sculpture occupies a most important part in the vast field of Chinese art. The objects remaining from the ancient culture of the Shang and Chow dynasties are for the most part ritualistic objects, libation urns, ceremonial bells and vessels, rather than figure sculpture. Many European and American museums possess fine examples of Chow bronze sacrificial urns; often in the form of animals. The ornamentation of the vessels or bells sometimes carries abstract representations of the birds and beasts of Chinese mythology. In surface treatment these objects are remarkable and in the realm of bronze sculpture nowhere has the mastery of material been brought to a fuller and more perfect expression of detail. This technical excellence and pride of workmanship persisted from the earliest periods of Chinese art to recent times, but the inspired perfection of the early Chow vase has remained unsurpassed in spirit or quality.

Art is measured by waves which rise and fall depending upon appreciation of the particular type of culture and the purity of its expression; thus is charted the rise and decline of Egyptian, Greek or Gothic art and the millenniums of culture in China have been marked by corresponding waves of artistic achievement. The sculpture of the Six Dynasties and the T'ang period carried the crest to its highest point of spiritual exaltation and artistic excellence.

The Han period (2nd century B.C. to 2nd century A.D.) produced many masterpieces of sculpture, among nhich are tomb bas-reliefs in stone showing mythological figures and animated scenes of contemporary life; strange animals leaping at high speed, men on horseback or in chariots, depicted with realism and fertile imagination. Objects of preciously wrought metal; bronze inlaid with gold and silver; carvings of abstract design; animals and fantastic dragons; finials of ceremonial staffs and decorations of chariots, indicate the creative imagination and high artistic standards of the time.

The element of time in the production of the work of sculpture was of no great importance as compared to that of quality of execution. The sculptor spent years working a block of jade, transforming it into mythological figure or beast or a composition of abstract design.

With the spread of Buddhism from India to China in the jth century, stone sculpture received powerful religious stimulus. Buddhist monks carved the walls of the grottoes at Yun Kang and Lung Men with myriads of figures of all sizes from the colossal to the miniature, representing Buddha and his attendants and the world of unreality. In this movement sculptural art developed highly in one part of China and remained relatively stiff and archaic in another.

Chinese art was subjected to Indian form conventions, Buddhistic philosophy and ideographic symbols. The benign serenity of the images of Buddha and his attendants is akin in Indian and Chinese sculpture. The Alexandrian influences upon Indian sculpture found their way via Gandhāra, across the Gobi Desert and the mountains and valleys to be reflected in the art of China. The imprint of a remote, indigenous tradition was apparent in the imagery of mythological scenes, in the fantastic forms of contorted dragons, in the rendering of flames and clouds and in that of mountains and water. This sculptural symbolism in the 6th and 7th centuries was vital and impetuous and in spiritual significance was comparable to 13th century Gothic.

The Chinese did not idealize the physical development of the human form as did the Greeks or the masters of the Renaissance. but rather symbolized through abstractions those qualities to which man aspired—qualities of the soul and imagination rather than of palpable fact. At the same time the sculptor was most ingenious in solving the problems of representing nature. He knew how, without destroying the basic form of a cube or rounded mass, to construct within its confines fantastic animals, moving in broad curves from side to side and composing harmoniously from every point of view. In his mastery of the medium of terra-cotta, the T'ang sculptor arrived at amazingly unrestricted freedom of expression. Realistic life-sized pottery figures of sages, glazed and in full colour, are among the masterpieces of this period. Terra-cotta horses, men, camels and grotesque animals, executed with an audacious sense of reality, were buried in tombs.

Emperors and great generals raised monuments to their followers or to commemorate a victory. Typical of these were the battle horses in bold relief on slabs of dark stone set into the tomb of the Emperor Tchao-Ling, and avenues flanked by heroic monolithic images of animals and men lead to the tombs of the emperors.

The sculpture of the Sung Dynasty (960–1280) represents advanced investigation into naturalistic treatment in which the rugged virility of early forms was softened and replaced by a calmer and more charming expression. Interest in technical proficiency was substituted for religious zeal with its sterner silhouettes and harder carving Sculpture was produced as an essential part of the cultural life of the people and in great quantity. Stone, terra-cotta in uhich colour was happily used, bronze of fine finish, and jade and semi-precious materials lent themselves to highly polished surfaces in which the patient Chinese delighted.

The great tradition persisted with ever-diminishing force and quality until but a shadow remained of one of the finest and longest art manifestations the world has known. The machine age and quantity production will doubtless change its form and may destroy its soul.

ROMANESQUE AND GOTHIC

During the Dark Ages which followed the dissolution of the Roman Empire, sculpture was little practiced and such examples of that period as remain are interesting for their crude simplicity. Under the Byzantine Empire in Asia Minor the art was principally that of bas-reliefs in beaten metal and carved ivory for church decoration.

In 11th century Europe, as the church grew richer, its buildings became more important and with the development of architecture based on crude interpretation of Roman structure, a need was felt to humanize and embellish the masonry. French sculptors were developing skill in handling the materials of their craft. The subject matter, dictated by the church, was influenced by the graphic style of manuscript painters. The treatment of form, as in all primitive sculpture, concerned itself with simple masses and low relief surface carving.

Along the great pilgrimage route from Tours in France to St. James at Santiago de Compostela in Spain a series of shrines and churches were erected (12th century). The marked similarity between the carvings on these edifices is evidence that the same sculptors worked in various localities and went from one country to another.

The sculpture of Spain and Southern France was influenced by Moorish sources, especially noticeable in the interesting monastery at Silos, where the handicraft of the individual carvers showed itself on the capitals in the cloisters. These were rarely duplicated in design and many showed Saracenic tracery and pattern. At Moissac (A.D. 1100) in France the capitals also varied in subject matter from boldly executed Old Testament figures to grotesque animals, birds and interlaced foliated ornament with evidence again of Saracenic craftsmanship. The southern portal of the Moissac church is remarkable for the imaginative beauty of its carving In the tympanum, Christ nith symbols of the Evangelists and the Elders of the Apocalypse are modelled in bold relief with nobility and variety of attitude. The effect is at once pictorial and decorative, as well as sculpturally solid. The lintel of the portal is supported in the centre by a column or trumeau richly carved and crossed with lions and figures The sculptor had freed himself to a considerable degree from technical restraints and was learning to interpret tangibly his emotional urge. Forms were rhythmical, decorative and powerful, although still somewhat abstract and conventional. Artists mere striving to achieve the realities of nature.

Religious enthusiasm animated the sculptors working in Burgundy to create the stirring compositions on the Cathedrals at Autun (1130) and Vezelay. The figures of the tympanum at Autun are drawn with a strange elongation in the manner of the illuminators and calligraphers, or suggesting the style of Buddhistic stele sculpture Drapery is draun with long sweeping parallel or fluted folds, carved in fine harmonious masses and detail, expressive of elegance combined with crude strength. The style was free and aspiring, though held uithin the dogma of Catholicism. Always searching for new and more revealing forms, the sculptors sought to correct their limitations of style and expand their knowledge in the pursuit of truth.

Christian fervor expressed in the ecclesiastical buildings in Western Europe found its counterpart in the great wave of religious enthusiasm which swept toward Islam with the first crusade (1095) and monks and clergy returning from the nars brought new ideas of architectural forms and decorative motifs.

In the third quarter of the 12th century France saw the building of the great cathedrals at Chartres and Bourges. With the religious fervor of the people, architecture sought to surmount the limitations of primitive construction; artisans worked joyfully for the glory of God with pride in their creations; they strove to surpass in nobility and beauty churches previously erected; sculptors banded together in guilds and worked in happy co-operation. In the cathedral of Chartres, as in the Parthenon at Athens, there was the intelligent collaboration of the sculptor, the painter and the architect, united by a common impulse. Art arrived at its noblest expression under the exaltation of spiritual or religious inspiration, as in Buddhist China and India, in Greece and Egypt, and then in 13th century Christian Europe.

The western portal of the Chartres cathedral was of late 12th and early 13th century construction and the figure sculpture obeyed the laws of primitive stylization; it was inspired and decorative. but not yet freed to conform to the proportions of nature. Drapery in long vertical folds echoed the rhythms of fluted columns. Architects were learning that the pointed arch allowed them to build more lightly, higher and stronger, but their masonry mas still earth-bound by the restraints of Romanesque tradition. The carving of friezes on lintels and of figures on arches and tympanums had, within the limitations of archaic forms, living structural unity and beauty of detail. The sculptors sought to outdo each other in inventing new forms, giving new gestures to their figures and enlivening the facial expressions.

Enthusiasm for the beautification of the church structure together with competitive achievement in artistry, contributed to the fulfilment of Gothic art. That culmination was developed in tno or three generations and became manifest in the north and south porches of Chartres cathedral where eventually 10,000 figures were carved or painted; in the sculpture of the cathedral of Notre Dame in Paris (1163–123j); in the cathedral of Reims (1211–90) and in the cathedral of Amiens (1220–88).

Together with the usual subject matter of the church, the sculptor devoted himself arduously to the study of nature and in some of the figures of the western portal at Reims there was a reality and suavity of movement comparable to that of the great art of Greece. Mouldings and capitals were carved with elaborately designed foliated motifs in widely varied application.

The influences of French architecture and sculpture of the 13th century spread throughout Europe to Germany. Belgium, England and Spain. It was conspicuous in the churches of Bamberg, Bruges and Wells, also in Burgos and the south portal of the Leon cathedral in Spain. Figures were carved in lively attitudes, freely translating the movements of the human body into stone.

In the sculptural carvings of the cathedral at Reims were figures from the scriptures and legends of the saints; of men and women toiling at seasonal agricultural occupations; the personifications of the virtues and vices as well as allegories of the arts and sciences; fantastic representation of mythological animals, and decorative elements derived from plant life. There was a wealth of subject matter harmonized to architectural decoration, unsurpassed except by the lavish temple embellishment of the Hindus and Chinese. Hundreds of artisans were employed in the execution of the rich adornment of the cathedrals. Aside from ecclesiastical sculpture the artists created many beautiful tombs and memorial statues in wood, ivory, bronze and marble.

ROMANESQUE AND RENAISSANCE IN ITALY

Italy is the country of Europe most rich in sculpture. The galleries and museums in its cities abound in treasures; its churches from mediaeval times to the present are adorned with statues; and in remote villages and forgotten byways unexpected relics of the Middle Ages and the Renaissance amaze and delight the traveller.

The builders of churches in mediaeval Italy turned to the ruins of temples and buildings of ancient times as quarries from which to procure materials; columns and entablatures were transported to new settings and it followed that the carver. wishing to carry on the embellishment of the building, imitated the character of the ancient fragments already incorporated. The development of this Romanesque architecture persisted through the centuries, for the Italians rarely made their buildings integrally Gothic.

Outstanding constructions of the late 12th and early 13th centuries included the cathedral at Pisa, decorated about 1180 with fine bronze doors by Bonano Pisano, in which the conception was Romanesque in spirit and the style of composition apparently inspired by that of the mosaicists. It is a combination of high and low relief, with panels nailed to the wood door framed with ornamental bands rich in decorative play of form.

A generation or two after the anonymous sculptors of the magnificent portals of Reims and Chartres. Niccola Pisano, called the Father of Renaissance sculpture, imposed a contemporary Gothic spirit upon the forms of a complicated and decadent Roman art. In his carvings of the pulpit in the baptistery of the cathedral of Pisa (1260) he incorporated in his design figure panels in high relief, in which the subject matter conformed to the requirements of Christian theology, but the composition and style of his carvings mere taken directly from Roman sarcophagi.

Pisano's son, Giovanni (1250–1320), while continuing to work in the traditions of his father. departed to a degree from the imitation of Roman forms and developed more in the style of northern contemporary art.

On the south doors of the Florence baptistery Andrea Pisano (c. 1270–1348) created 28 panels dedicated to St. John, bronzes of great elaboration and high technical finesse, admirable in decorative feeling and rich surface treatment. At this period the development of sculpture swung high on the upward curve to full flower of the Renaissance

The beautiful Pisanesque reliefs on the façade of the Orvieto Cathedral (about 1300) were the blossoming of the Gothic branch grafted to the trunk of Italian tradition.

Giotto (1267?–1337) was architect, painter and sculptor. He built the Campanile in Florence and with Andrea Pisano carved many of the figure panels on its sides. These panels are beautiful, sensitive and pure in religious feeling.

Andrea Orcagna (d. 1368) made the wonderful tabernacle in the Florentine Or San Michele, an outstanding example of consummate craftsmanship in richly-combined coloured materials and mosaic background, with bronze effectively employed in the surrounding grille.

Jacopo della Quercia of Siena (1374–1438) evolved from the tradition of the Pisani. His works were original, robust and imaginative. His sculptural compositions inspired Michelangelo in a later generation to the fulfilment of the Renaissance. He carved figures of transcendent beauty in the fountain at Siena and especially in the monument of Ilaria del Caretto in the Cathedral of Lucca. The relief panels of the portal of San Petronio in Bologna had an intensity and breadth of modelling which marked them as masterpieces of the period when the late Gothic style merged into the Renaissance.

Lorenzo Ghiberti (1378–1455) made the north and east bronze doors of the Cathedral at Florence. The first pair were panelled in the balanced pattern of the Pisano tradition, though freer in line and richer in movement. The second ones, considered by Michelangelo worthy to be the "Gates of Paradise," were outstanding masterpieces of the Renaissance and represented great achievement in the art of bronze sculpture. Starting at the age of 47, he devoted 27 years to their creation. In spirit with the prevalent scientific research, Ghiberti solved in the panels of the doors, many problems involving figure composition and perspective. They were pictures in relief of graphic scriptural scenes idealistically interpreted with accessories of rocks, trees and edifices receding within the frame. While lacking the clarity of the earlier style, their dramatic intensity carried art to a new perfection.

The proficient Donatello (1386–1466) vastly enriched the world by his genius. He dominated the early Renaissance. His consummate technical mastery, together with his impulsive and adventurous nature gave him full freedom of expression; his gay and wholesome imagination, his power of visualization and sense of movement are qualities which combined to make him comparable to the Greek Myron. He went to Rome with his friend Brunelleschi to study the classics and dig in the ruins of antiquity and returned to work with him in the building of Florence's great cathedral; but his studies of the works of the ancient sculptors did not in any way hamper his personal style, for he loved nature and understood it intuitively. Donatello embellished the cathedral with vitalized statues and carved a singing gallery with a frieze of dancing putti, gay, original and spontaneous. In many of his works children are used as main themes or accessories, in which he captured their joyous purity, emotion and charm and established a precedent to which later Renaissance sculptors turned but never surpassed. Of the statues made for niches of the façade of Or San Michele, the marble St. George is an eternal masterpiece.

The Renaissance Tuscan school produced many fine sculptors. Desiderio da Settignano (1428–64) was conspicuous for the subtlety of his surface modelling and the charm which he gave to facial expressions. Realism, delicacy and vivacity characterized the work of Mino da Fiesole (1431–84) and Benedetto Rosellino (1427–78). One of the most distinguished artists of the school of portrait sculpture was Francesco Laurana (about 1425–1502) whose works reached heights of beauty and realism. Splendid examples of this period are in the Bargello Museum in Florence. Contemporaneously the inheritors of Donatello's more vigorous style were working in Florence. Antonio Pollaiuolo (1429–98) and Andrea Verrocchio (1435–88) were forceful sculptors. Their work was characterized by nervous contours and muscular movement. Verrocchio's masterpiece was the bronze equestrian statue of Colleoni in Venice. The martial rider arrayed in the sumptuous armour of the period is mounted on a powerful stallion in forward stride. The bronze is a splendid example of elaborate finish of detail upon boldly modelled forms, monumental and imposing in its ensemble and is considered one of the finest equestrian groups of all time. The pedestal which it surmounts is an excellent example of appropriate architectural setting.

The sculptor of the Renaissance was generally architect and painter; hence the perfection with nhich he developed the settings for his statues, whether the base of a portrait bust, the pedestal of an equestrian statue or the architectural background of a tomb The design and execution of architectural detail was done with the same care and feeling as the important sculptural element. With Florentine sculptor-architects, backgrounds often became overcharged with elaborate mouldings, festoons and ornate carvings which reduced the scale of detail to make the architectural parts seem covered with lace; the vigorous stem of the plant had become obscured in the richness of the foliage.

Luca della Robbia (1400–82) carried the new technique of glazed terra-cotta to a high development, specializing in ecclesiastical and architectural decoration. His nephew, Andrea, with his sons, also worked in this sculptural material and hundreds of pieces were produced in their studios.

Art through the Gothic period had been practical in its application. Statues were rarely made which did not serve as decoration of churches or other edifices, or objects for utilitarian purposes. In the Renaissance, Greek and Roman literature were translated into Italian; antique statues and monuments were excavated; princes made collections of paintings and sculptures; scientific investigation and broadened mental vision engendered skepticism and pagan subjects increasingly replaced episodes from the Scriptures and the lives of the saints. With the gathering of ancient art works, collectors began to stress purely aesthetic considerations and "Art for Art's sake" came into being. Sculptors made small decorative groups, charming in their imagery and good humour, in which they delighted to demonstrate their skill in composition, their knowledge of anatomy and ability to render mythological and romantic themes.

Michelangelo (147j–1564) was brought up in the studios attached to the court of Lorenzo dei Medici and worked as a boy under Verrocchio. The collections of Lorenzo inspired the youth to study and imitate the antique, yet his "Pieta" in St. Peter's was a masterpiece of Gothic sculpture, in which the details of drapery were executed with the technical recipes of that style; but his "Bacchus" and "Cupid," statues of the same early period, were conceived in the classical manner. His heroic marble "David" done at the age of 26, was a triumph of anatomical knowledge executed with the mannerisms of local traditions with a superimposition of antique influence, plus his own indomitable personality. This impatient and impetuous genius quickly assimilated the lessons of his masters; his versatility in the arts was such that he comprehended the perfect relationship of detail to ensemble and one medium to another. He was as great a draftsman as the world has known, if draftsmanship means the ability to represent that which the mind envisages, co-ordinated with the hand as perfect instrument. He quickly grasped the possibilities of movement within the human figure, with him never a literal rendering but always heroically ennobled His scientific mind understood the complicated anatomy of drapery and of the body, of engineering as well as the structure and subtleties of architecture. His mighty intellect was subordinate to his emotions. His nature was turbulent, his temperament audacious and his imagination fertile. Though physically powerful, the conflict of these qualities and external circumstances prevented his carrying out his many dreams and projects and so in sculpture he has left many unfinished masterpieces. He completed several figures on the tomb of Pope Julius II, an elaborate commission, but only sketched others. The "Slaves," details of this work, are most honoured treasures in the Louvre Museum in Paris. The marble "Moses" (S. Pietro in Vincoli, Rome), also part of this composition, is vibrant with emotion and of noble gesture and majestic mien It seems to pertain to the realm of the supernatural. The statues of "Juliano," "Lorenzo dei Medici," "Day," "Night," "Morning" and "Evening" were idealized representations of supermen and heroic women and were part of the incompleted Medici Tomb in Florence.

The magnetic influence of Michelangelo's genius created a host of imitators. With them muscular development became inflated exaggeration and the heroic gestures of the master oftentimes became bombastic and artificial.

The period of Baroque art was in full career. The new school led by Michelangelo derived its architectural forms from classical Roman examples. The pointed arch was despised. Flamboyant Gothic of the preceding period had become overcharged with detail and weakened in structural lines. Sculptur had lost its spiritualizing religious impulse and had become mere decoration carrying elaboration to extreme and meaningless detail. The new classical style demanded a simpler architectural and sculptural ensemble, composed of fewer and larger elements. As architect of St. Peter's in Rome, Michelangelo increased the scale of structural orders to heroic dimensions and surmounted the massive edifice with a dome worthy of the materialism of the period and the grandiose aspirations of the designer. The size of the sculpture was augmented to harmonize with the proportions of the building. Baroque sculptors delighted in creating a world of marble giants.

Benvenuto Cellini (1500–71) was primarily a goldsmith and metal worker. His bronze figure of "Perseus" in Florence demonstrated his great artistry.

THE BAROQUE

Gothic and Renaissance taste demanded adherence to the canons of established proportions, both in architecture and sculpture, in which the scale of figures and detail maintained sizes proportionate to those of man. The sculptured saints and personages who decorated the facades of the Christian edifices were intimate and personal conceptions related socially and culturally to the people of the locality.

The shape of the block was sensed in figure sculpture of the early periods, but the expansive spirit of the 17th century seemingly disregarded the organic structure of marble. The path to artistic freedom had been cleared by Michelangelo, whose heroic energy had removed restraint from individual expression. Fewer decorative elements were used in architecture but the size of these was enormously increased and exaggerated depth of carving and undercutting gave dramatic emphasis and strong effects of chiaroscuro.

Giovanni da Bologna (1524–1608) was a classicist of the school of Michelangelo and an artist of vivid imagination as well as a technician of remarkable excellence. He treated form with rich fullness and vigour and was successiul with the problems of spiral composition. The suriace of his sculpture mas finished with a sensuous suavity comparable to the best of Hellenistic art. Characteristic examples of the heroic art of this sculptor mere the marble groups the "Rape of the Sabines" and "Hercules and Centaur," in Florence, and his "Neptune Fountain" at Bologna.

Giovanni Lorenzo Bernini (1598–1680) was the genius who carried the Baroque style to its fullest expression. He was architect as well as sculptor of the magnificent exedra of the Piazza of St. Peter's in Rome. Its colonnade is surmounted by a series of 162 figures of saints, according in dramatic flamboyance with the grandiose architecture which they crown. His marble portraits reflect the pomposity of the period while imbued with vitality and impressive qualities of resemblance. In his group "Apollo and Daphne," executed at the age of 17 with unbelievable mastery over marble, he made the figure seem to move freely in space. The realities oi material structure were skillfully concealed in disregard of an ancient principle that a marble carving to be properly expressed within the block, should be able to roll down hill without breaking any part and that the modelling should be contained within the marble to recognize the structure of the material. Bernini depicted "Daphne" turning into a laurel tree, whose naturalistic leaves were largely detached from one another, with a technique appropriate to metal, such was his desire to demonstrate his complete mastery of medium. The "Fountain of the Four Rivers" in Rome was a triumph of fantastic imagination and superb technical achievement in which dramatic effect was paramount and the elements of composition ireely organized. Marble draperies fly about his figures in flamboyant folds, deeply cut to give violent shadows. His art expression lacked sobriety and the material supplanted the spiritual. The technique of art became an end unto itself, whereas in periods of sculpture's noblest manifestation excellence of craftsmanship was subordinate to the spiritual impulses of the race or religion. Bernini worked in Paris for Louis XIV, where the taste for the Baroque was current. However, in France that style was not carried to the extreme reached in Italy and the classical Renaissance tradition evolved with minor distortion and exaggeration.

16TH-17TH-18TH CENTURY FRENCH SCULPTURE

Jean Goujon (1520–66) carved the "Fountain of the Innocents" in Paris in the gay spirit of the late Renaissance. Charm of feeling, delicacy of modelling, sensitivity to decorative relationships, rhythm and grace were the qualities which marked his sculpture.

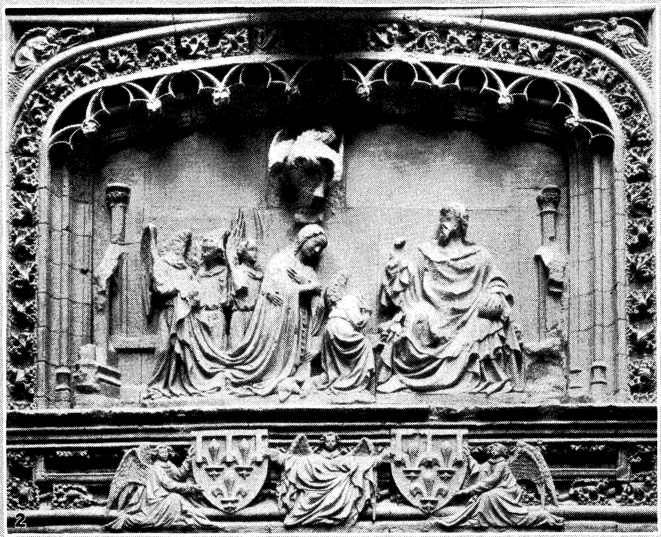
Puget (1622–94) and Girardon (1628–1715) worked in the Baroque manner of Bernini and executed many admirable portraits and figure compositions in marble.

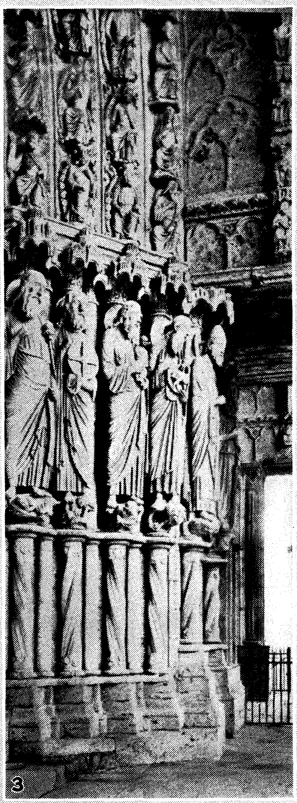
In the middle oi the 18th century, art returned to greater sobriety. The style of Jean Antoine Houdon's (1740–1828) sculpture was unpretentious, though influenced by the traditional Baroque mannerisms.

BY COURTESY OF THE METROPOLITAN MUSEUM OF ART, NEW YORK

GREEK BRONZE, BELIEVED TO BE OF ATTIC OR SOUTH ITALIAN ORIGIN

The statuette, 15 13/16 inches in height and 14¼ In length, is believed to have been made about 470 B.C. Although there is uncertainty about the identity of the artist, the beauty and grace of the conception of the design point to the possible workmanchip of Calamis, a well-known Athenian sculptor. Indeed, there is considerable basis for the conjecture that this statuette is a part of a miniature model of the charioteer group which Calamis was commissioned to execute by the Syracusan tyrant Deimonides. The tail, parts of the legs and one ear, and the eyes, which may have been inlaid, are missing. It is cast solid, weighing 25½ pounds





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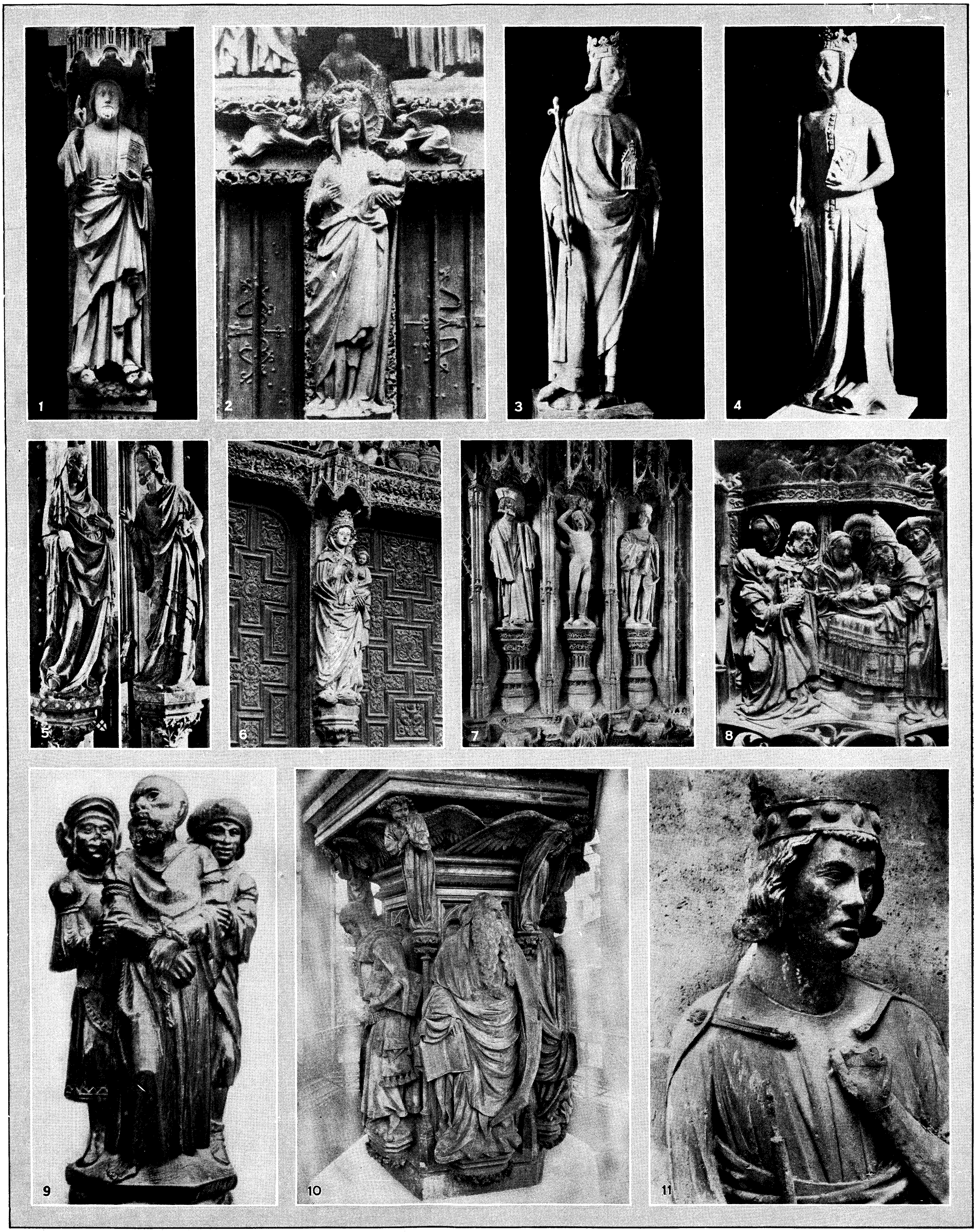
GOTHIC ARCHITECTURAL SCULPTURE

1. Tympanum above the left portal of the façade of Notre Dame, representing the entombment of Christ and coronation of the Virgin, 13th century. (Cathedral severely damaged in World War II)
2. Bas relief from the Chateau de la Ferté-Milon, 14th century
3. Right side of the central door, North Porch, Chartres cathedral, France. The figures, admirable examples of 13th century northern France Gothic, represent Isaiah, Jeremiah, Simeon with the Child Jesus in his arms, John the Baptist, and Peter
4. Statue of King Solomon and the Queen of Sheba, formerly at Corbeil, now at St. Denis
5. Statues of Edwy (Eadwig) and Edward the Martyr, kings of England, on the front of Wells Cathedral, part of a group of ten kings and princes in an exterior decoration scheme of statuary comprising 180 figures, many life size, executed in polychromed stone. First half of the 13th century

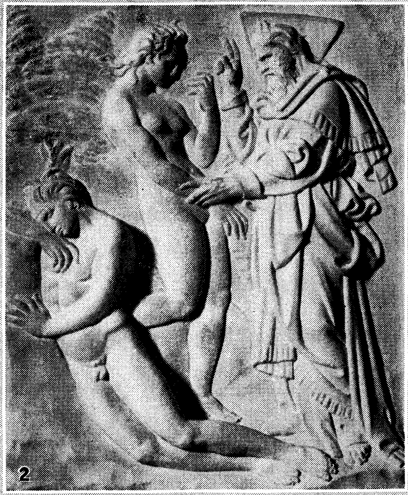


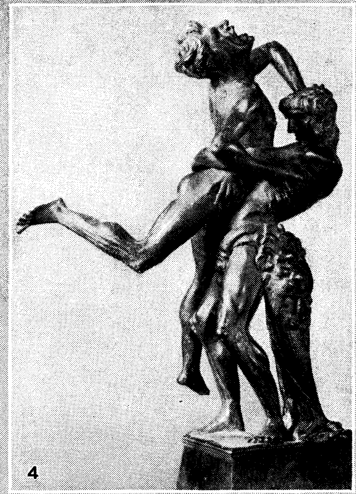
BY COURTESY OF (7) THE CONTROLLER OF H. M. STATIONERY OFFICE; PHOTOGRAPHS, (1, 3, 4) GIRAUDON, (2, 8, 9) REGNAUT, (6) CLIXÉ ARXIV, "MAS," (10) LEVY AND NEURDEIN, (11) COLLECTION ARCHIVES PROTOGRAPHIPUES; FROM (5) FRIED LUBBECKE, "DIE GOTISCHE KOLNEW PLASTIK" (HEITZ AND MUNDEL)

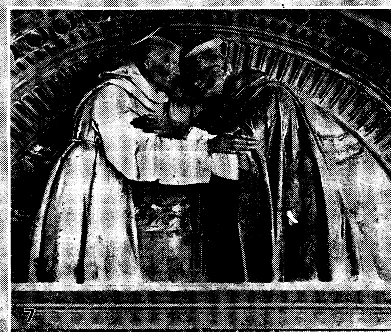
GOTHIC SCULPTURE

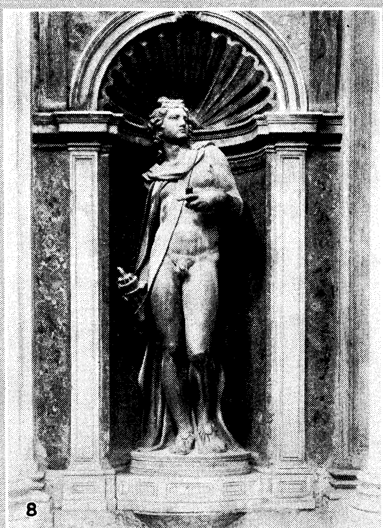
1. Statue of Christ (Beau Dieu) on central portal of Amiens cathedral, 13th century. 2. *La Vièrge Dorée* on south transept portal of Amiens cathedral. 3. Charles V. of France, 14th century, portrait statue. In the Louvre. 4. Jeanne de Bourbon (d. 1378) at St. Denis. 5. Mary and Christ. German. 6. Nuestra *Señora* la *Blanca* on the portal of the south transept of Leon cathedral, 14th century. 7. St. Sebastian, in the Chapel of Henry VII. (built 1502–20) in Westminster Abbey. 8. One of 400 carvings on the choir stalls of Amiens cathedral, 1508–19. 9. Wbod carving, Amiens cathedral. 10. "Moses' Well," pedestal by Claus Sluter and Claus de Werver, 15th century. 11. St. Louis, Reims cathedral

SCULPTURE





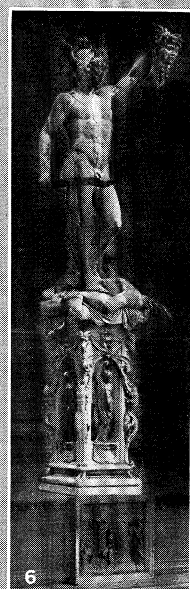




PHOTOGRAPHS, (1, 4, 7, 8) ALINARI, (2) POPPI, (3) W. F. MANSELL, (5) EWING GALLOWAY (9) COLLECTION ARCHIVES PHOTOGRAPHIQUES (6) F. BRUCKMANN

SCULPTURE IN ITALY AND FRANCE FROM THE 13TH TO THE 16TH CENTURY

1. "Madonna and Child," the earliest known work of Giovanni Pisano (1250–1320), a forerunner of the Gothic in Italy. In the Campo Santo, Pisa
2. "Creation of Eve" by Jacopo della Quercia (1374–1438), Italian; on the door of the Baptistry, Bologna
3. "David" by Donatello, Italian sculptor (1386–1466); the first nude statue of the Renaissance, executed in bronze about 1430 during the artist's classic period
4. "Herakles and Antaeus," a bronze statuette by Antonio Pollaiuolo (1429–98), Italian realist. In the Bargello, Florence
5. "Moses" by Michelangelo (1475–1564); designed between 1513 and 1516 for the mausoleum of Pope Julius; now in the church of S. Pietro in Vincoli, Rome
6. "David" modelled in bronze in 1476 by Andrea del Verrocchio (1435–88), Italian realist
7. "Meeting of Saints Francis and Dominic," an enamelled terra cotta lunette by Andrea della Robbia, nephew and pupil of Luca della Robbia, the first artist in Italy to apply the art of glazing terra cotta to monumental sculpture. Executed between 1490 and 1495 in the loggia of the Hospital of S. Paolo, Florence
8. "Apollo," one of four statues by Jacopo Sansovino (1486–1573) surmounting the arches of the Loggetta dei Cavalieri, Venice
9. "Diana and the Stag," a fountain designed by Jean Goujon (c. 1520–c. 1566) for the château d'Anet. Now in the Louvre



PHOTOGRAPHS, ALINARI

ITALIAN SCULPTURE, FROM THE 14TH TO THE 19TH CENTURY

1. St. John tho Baptist by Donatello (1386?–1466). In the Museo Nazionale, Florence
2. Bronze fountain figure of boy holding a dolphin, by Andrea Verrocchio (1435–88). In the Palazzo Veochio, Florence
3. Statue of Victory by Michelangelo (1475–1564). In the Palazzo Vecohio, Florence
4. Mercury by Giovanni Bologna (1524–1608). In the Museo Nazionaie, Florence
5. Pauline Bonaparte by Antonio Canova (1757–1822). In the Museo della Villa Borghese, Rome
6. Perseus with the head of Medusa, by Benvenuto Cellini (1500–71). In the Loggia dei Lanzi, Florence

SCULPTURE

BY COURTESY OF (4, 6, 8) THE METROPOLITAN MUSEUM OF ART, NEW YORK, (5) THE THORWALDSEN MUSEUM, COPENHAGEN; PHOTOGRAPHS, (1) ALINARI, (2, 3, 9) GIRAUDON, (7) ANDERSON

RENAISSANCE AND MODERN SCULPTURE IN EUROPE AND AMERICA

1. "Rape of the Sabines" by Giambologna (1529–1608), Italian. In the Loggia dei Lanzi, Florence. 2. "Milo" by Pierre Puget (1622–94), French. In the Louvre. 3. "Mercury" (putting on his sandals) by Jean Baptiste Pigalle (1714–85), French. In the Louvre. 4. "Clytie" by William Henry Rinehart (1825–74), American. 5. "Night with her children Sleep and Death," a bas-relief in marble by Bertel Thorwaldsen (1770–1844), Danish. 6. "California" by Hiram Powers (1805–73), American. 7. "Perseus with the head of Medusa" by Antonio Canova (1757–1822), Italian. In the Vatican. 8. "Nymph and Satyr" by Clodion (1736–1814), French. 9. "Jeanne d'Arc" by François Rude (1784–1855), French. In the Louvre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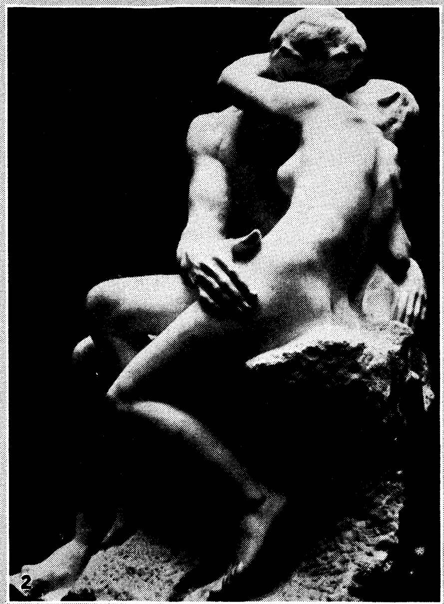
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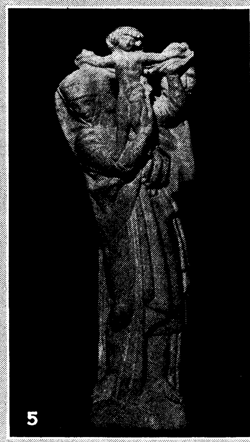
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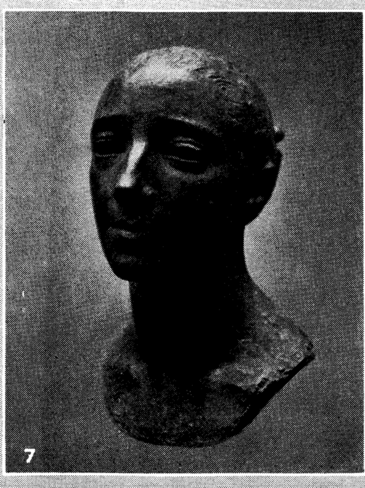
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BY COURTESY OF (4, 6) THE METROPOLITAN MUSEUM OF ART, NEW YORK, (5) THE PHILLIPS MEMORIAL GALLERY, (8) LIBRAIRIE DE FRANCE; PHOTOGRAPHS, (1, 2) GIRAUDON, (7) CARL KLEIN, (9) EWING GALLOWAY

SCULPTURE OF THE 19TH AND 20TH CENTURIES

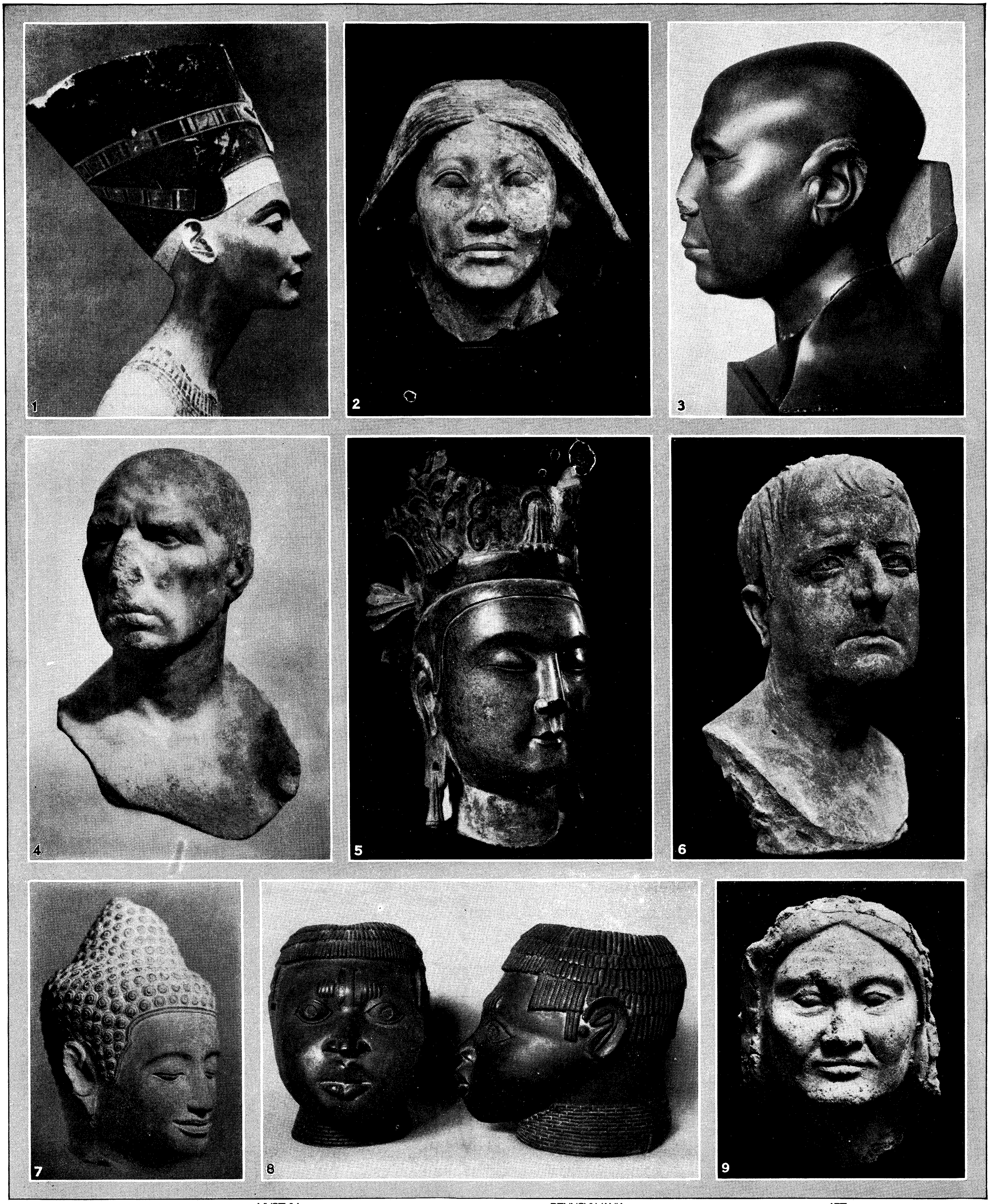
1. "Ugolino and his Sons" by Jean Baptiste Carpeaux (1827-75). Formerly in the Jardin des Tuileries, now in the Louvre
2. "The Kiss," a marble group by Auguste Rodin (1840–1917) representing Paolo Malatesta and Francesca da Rirnini. First exhibited 1898
3. "The Hewer" by George Grey Barnard (1863-1938)
4. "Lion and Snake" by Antoine Louis Barye (1796–1875). Now in the Metropolitan Museum of Art
5. "Madonna of Alsace" by Emile Antoine Bourdelle (1861-1929)
6. "The Millmore Memorial," also known as "Death and the Sculptor," by Daniel Chester French (1850-1931)
7. Portrait of Mme. Warroquier by Charles Despiau (1874–1946)
8. "Baigneuse Acoudée" by Aristide Maillol (1861-1944)
9. Puritan Statue by Augustus St. Gaudens (1840-1907) representing Deacon Samuel Chapin, one of the founders of Springfield, Massachusetts

SCULPTURE

PHOTOGRAPHS. (1-6, 8, 9, 11) COLLECTION ARCHIVES PHOTOGRAPHIQUES; PHOTOGRAPHS, (7, 10) ALINARI

RENAISSANCE GARDEN SCULPTURE AT VERSAILLES AND FLORENCE

1. Fountain of the Pyramids executed in lead by François Girardon (1628–1715) from drawings by Claude Perrault (1613–88). In the Parterre du Nord, Gardens of Versailles
2. Springtime by Simon Mazière (1649– ?). In the Gardens of Versailles
3. The river Achelous by Simon Mazière. In the Gardens of Versailles
4. Ceres by J. B. Poultier (1653–1719), one of a row of marble statues near the entrance to the Lawn in the Gardens of Versailles
5. One of the 22 leaden vases forming part of the Fountain of Neptune, a great semi-circuiar fountain in the Gardens at Versailles, begun by André Le Notre (1613–1700), and Jules Hardouin Mansard (1646?–1708), architects of the park, and completed in 1740
6. The River Dordogne by Charles Antoine Coysevox (1640–1720), cast in bronze by the Keller brothers (1635–1700 and 1638–1702), one of eight statues representing the principal rivers of France. In the Gardens of Versailles
7. Fountain by Alfredo Paragi in the Boboli Garden, Florence, a park laid out by Tribolo in 1550 for Cosimo I.
8. The Garonne river by Charles Antoine Coysevox, cast in bronze by the Keller brothers. In the Gardens of Versailles
9. The Lyric Poem, marble statue by Jean Baptiste Tubi (1635 or 1630–1700) (with C. A. Coysevox). In the Gardens of Versailles
10. Fountain of Venus by Giovanni Bologna (1524–1608) in the Royal villa of Petraja, Florence
11. The Heroic Poem, marble statue by Jean Drouilly (1641–98). In the Parterre du Nord of the Gardens of Versailles



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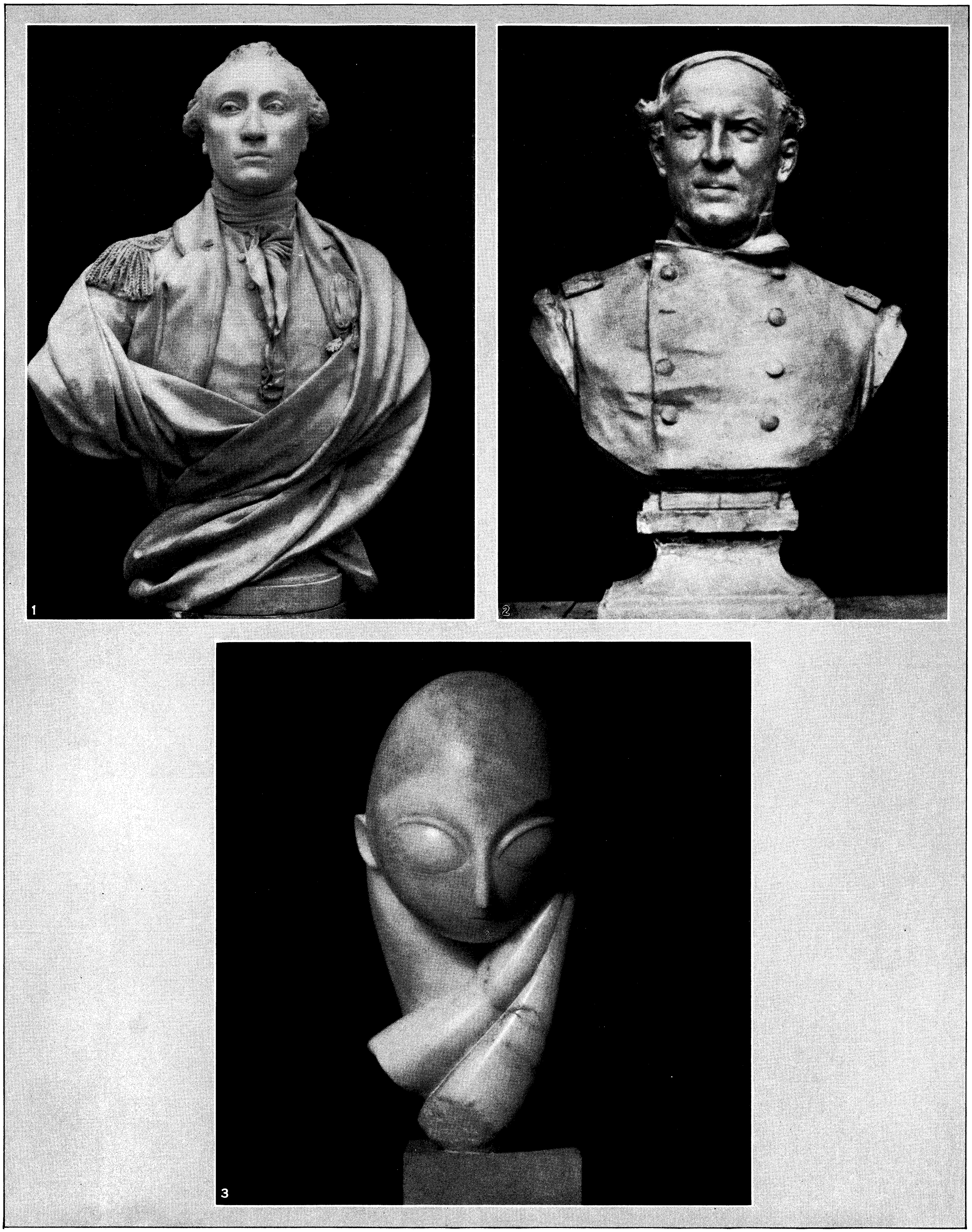
EARLY PORTRAITURE FROM VARIOUS PARTS OF THE WORLD

1. Portrait of Queen Nefertiti, an example of painted sculpture in Egypt about 1370 B.C. 2. Painted limestone head of an Egyptian official showing realistic treatment about 2750 B.C. 3. Portrait called "The Green Head," an example of simplified form, Egypt about 600 B.C. 4. Roman portrait, showing form and construction treated in a way that emphasizes the man as an individual. 5. Stone head of a Bodhisattva, late 6th or 7th century A.D. showing characteristic conventionalized treatment. 6. Roman terra cotta head; an example of details drawn or etched on the modeling. 7. Cambodian head, showing conventionalization, especially in the treatment of the coiffure. 8. Bronze conventionalized heads from Benin, West Africa. 9. Gypsum mask, an example of realism in Egyptian art about 1370 B.C.



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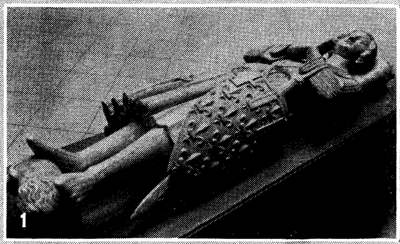
REALISM AND CONVENTIONALIZATION IN RECENT PORTRAITURE

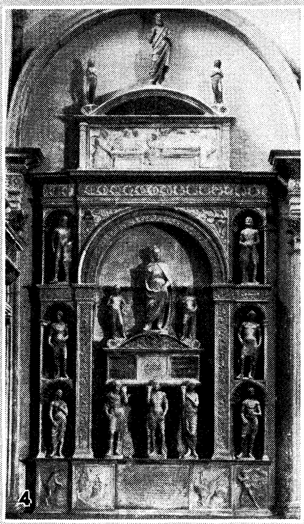
1. Portrait of Lafayette by Jean Antoine Houdon (1741–1828)
2. Portrait of Admiral Farragut by Charles Grafly (1862–1929)
3. Portrait of Madam Pogany by Constantin Brancusi (1876–1957)

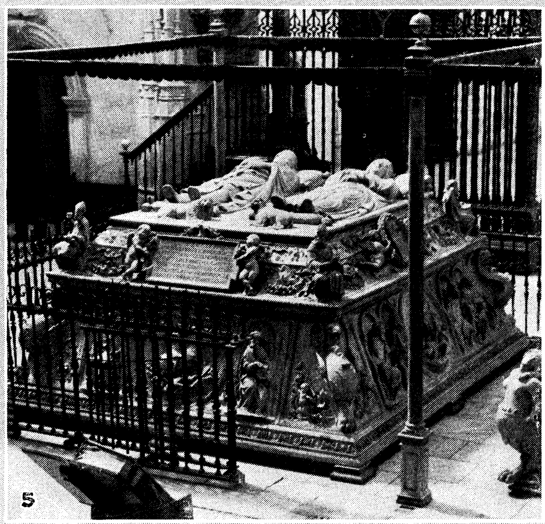
HEADS BY CHARLES GRAFLY ILLUSTRATING SUBTLETIES OF CONSTRUCTION AND COLOUR

1. Sketch showing how a smile affects the construction of all features. 2. Portrait which gives an impression of the size of the man by the careful treatment of the neck and shoulders. 3. Portrait showing treatment of fluffy blond hair. 4. Portrait showing treatment of dark hair turned gray

SCULPTURE







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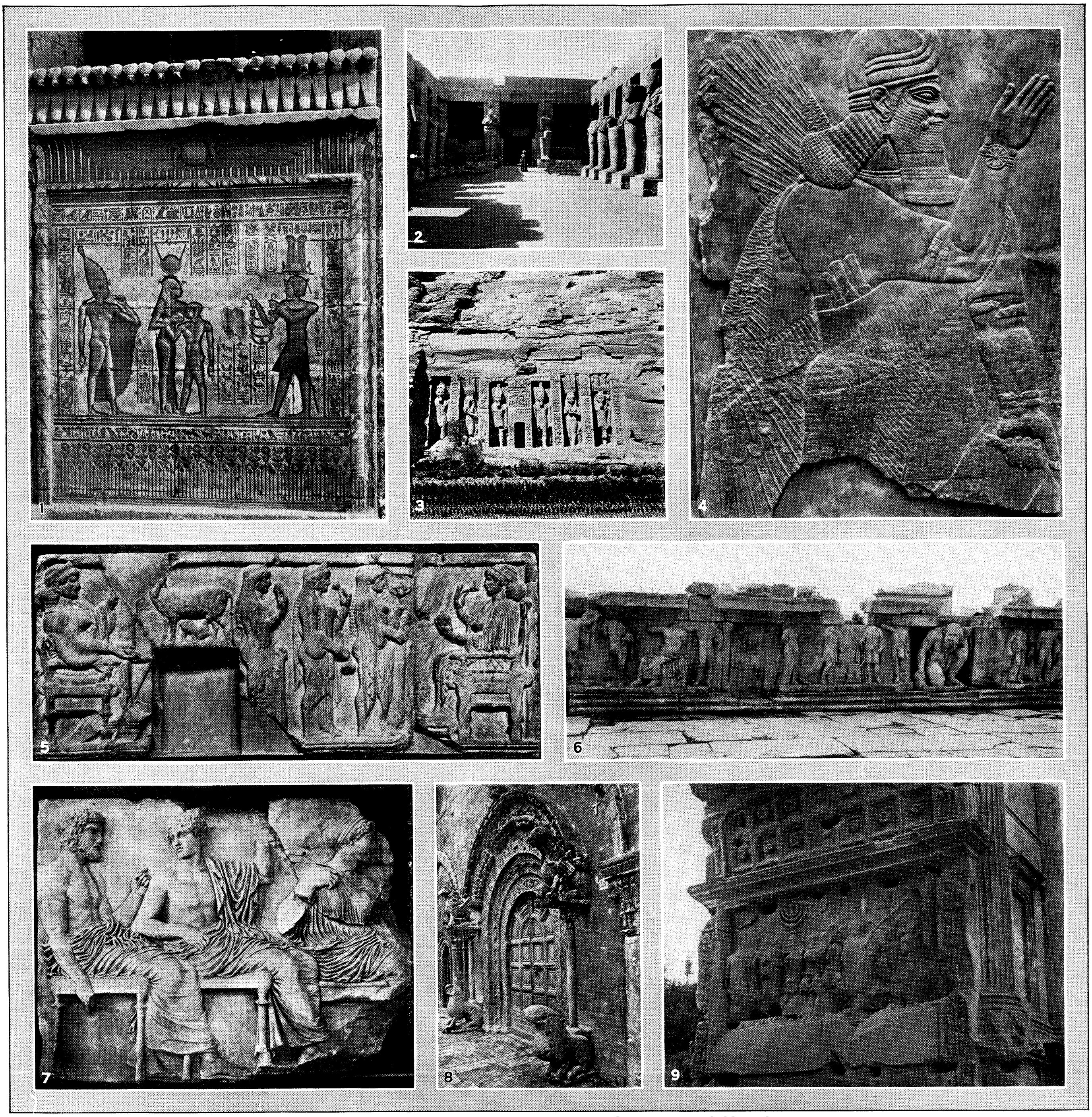
SCULPTURE ON TOMBS

1. Tomb of Robert d'Artois in St. Denis Cathedral, France
2. Tomb of Cristoforo Felici, in the church of S. Francesco, Siena
3. Tomb of Philippe Pot now in the Louvre
4. Tomb of the Doge, Pietro Mocenioo. in the church of SS. Giovanni e Paolo, Venice
5. Tomb of Ferdinand and Isabella at Granada. Spain
6. Tomb of Cardinal d'Amboise in Rouen Cathedral
7. Tomb of Comte d'Harcourt in the Cathedral of Notre Dame, Paris
8. Tomb of Richelieu by Bouchardon in the Sorbonne, Paris



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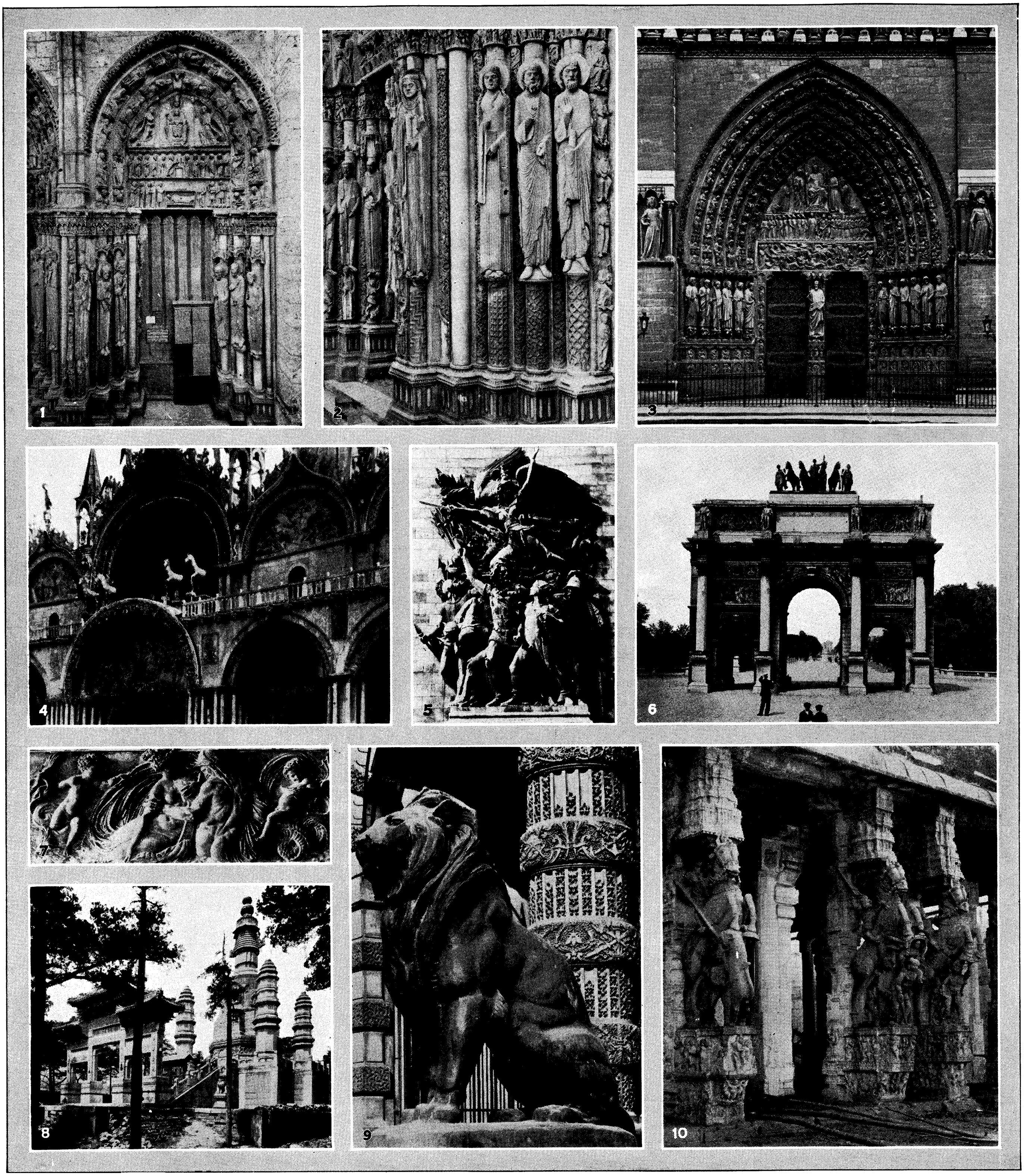
ANCIENT ARCHITECTURAL SCULPTURE

1. Relief panels on the birth house of Isis at Dendera, Egypt, depicting Isis feeding her son Horus, the father Osiris, and Ra, the highest God offering a gift
2. Massive carving in the Mortuary Hall of Rameses II., at Karnak, Egypt
3. Carvings adorning the wall of the Temple of Hathor at Abu Simbel, Egypt, as they appear when viewed from the Nile
4. Relief from the palace at Ashur Nasir, 9th century, B.C., Assyria
5. Relief from Harpy tomb in Xanthos, predecessor of many other Lycian tombs of the 4th and 5th century
6. Complete frieze of the Theatre of Dionysus at Athens, Greece
7. **Relief from the frieze of the Parthenon, Athens, Greece**
8. Portals of a 13th century cathedral in Italy
9. Detail of the Arch of Titus at Rome. The relief show [illegible] branched candlestick from the Temple at Jerusalem



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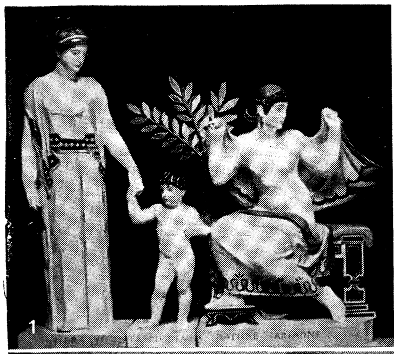
ARCHITECTURAL SCULPTURE OF EUROPE AND THE ORIENT

1. The Porte Royale, or central doorway of the Cathedral of Chartres, adorned with statues of royal saints. 12th century. 2. Kings of Judah, a group of 16 figures on the gallery above the Porte Royale, Cathedral of Chartres. 3. Middle portal of the fapade of Notre Dame Cathedral, Paris. With the exception of the modern figure of Christ on the central pillar, the sculpturing (partly restored by Viollet-le-Duc) is early Gothic. 4. Detail of the fapade of the Basilica of St. Mark, Venice, showing the famous bronze horses modelled by a Greek artist of the 3rd century. The fapade, which is divided into two tiers of 5 arches each is pillared with marble and inlaid with scenes in mosaic. 5. The "Marseillaise" by Jean Franpois Rude (1784–1855), on the east façade of the Arc de Triomphe de L'Etoile, Paris. 6. The Arc de Triomphe du Carrousel, Paris, erected (1806–07) by Pierre F. Fontaine (1762–1853) and Charles Percier (1764–1838) in commemoration of Napoleon's victories of 1805. Forty-eight feet in height, it is a reduced copy of the arch of Severus at Rome. 7. Panel by Jean Goujon (*c.* 1520–c. 1566) from the Fountain of Innocents, erected by Pierre Lescot (*d.* 1578) in 1550. In the Louvre. 8. View of the Huang Ssu (Yellow Temple), Buddhist monastery in Peking, China, showing the Pan Ch'an Lama Memorial built by Chien Lung in the 18th century. Designed on Thibetan lines, its marble sides are elaborately sculptured and it is surmountea by a cupola of gilded bronze. 9. Lion by Antoine L. Barye (1796–1875) in the Tuileries gardens. 10. Eauestrian statue of the four princes in the great temple of Sri Rangam (built 11th–16th century A.D.) near Trichinopoly, South India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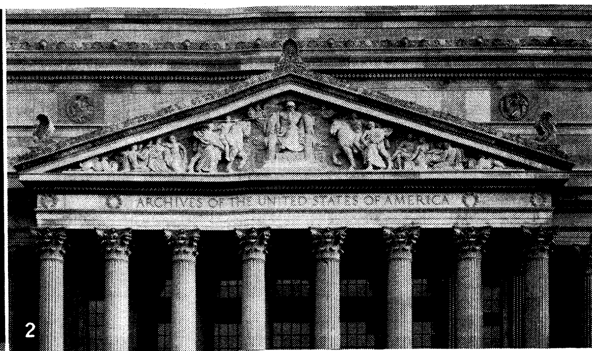

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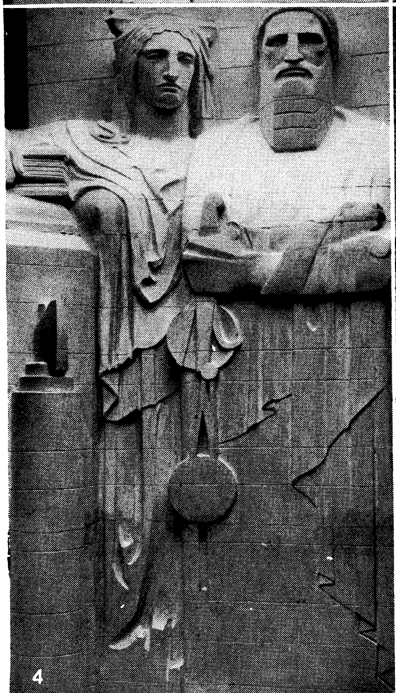
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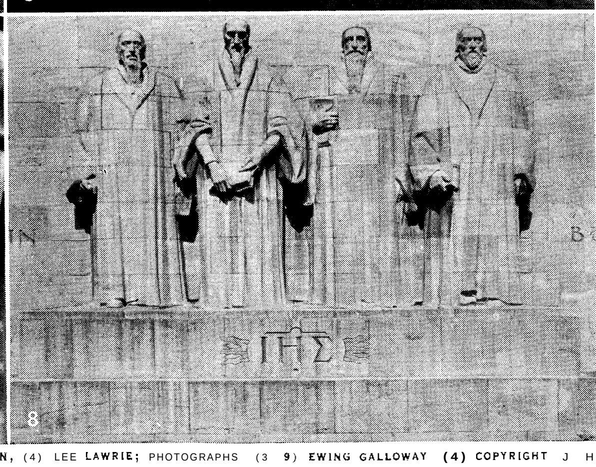
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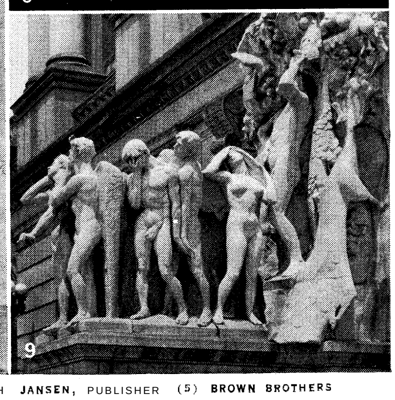
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EXAMPLES OF ARCHITECTURAL SCULPTURE

1. Group in glazed terra cotta by Carl Paul Jennewein (1890–) for the pediment of the Philadelphia Museum of Art. This is part of an unusual exterior decoration scheme in polychrome in the manner of the ancient Greeks, conforming with the classic design of the building
2. **Pediment by Adolph Alexander Weinman (1870–1952), north façade,** U. S. Archives building, Washington, D. C.
3. Statue in front of the Custom House of New York city. Executed by Daniel Chester French (1850–1931)
4. Buttress figures, "Wisdom and Justice" for Nebraska State capitol, Lincoln, Neb., by Lee Lawrie (1877–)
5. Ornamental clock for the New York Central building in New York city. By Edward McCartan (1878–1947)
6. **Statue of George Washington** by Alexander Stirling Calder (1870–1945) on Washinaton's Arch at Washington Square, New York city
7. "Music" by Emile Antoine Bourdelle (1861–1929) for the Théâtre des Champs Elysées, Paris, France
8. Central group representing Farel, Calvin, Bèze and Knox, designed by Henri Bouchard (1875–) and Paul Maximillian Landowsky (1875–1961), for the Reformation Monument at Geneva, Switzerland. Laverriere. Monod and Taillens, architects
9. "The Burden of Life and Labour" by George Grey Barnard (1863–1938). On the capitol at Harrisburg, Pennsylvania

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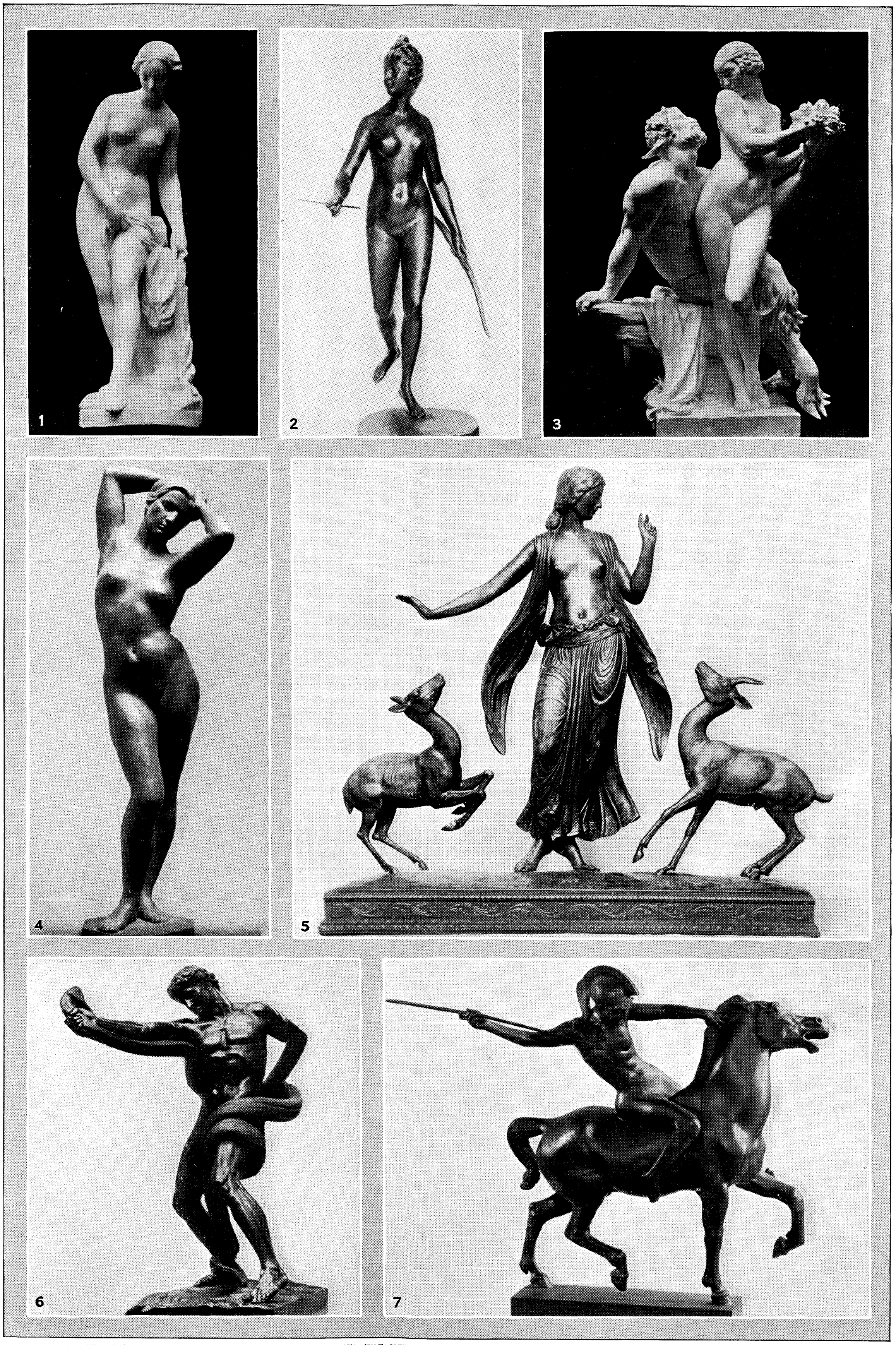
EXAMPLES OF EARLY DECORATIVE SCULPTURE

1. Carved prow of a Maori canoe
2. Egyptian lion, 4th century, now in the Vatican Museum, Rome
3. Grotesaue aquamanile (water ewer) of bronze representing St. George and the Dragon, 13th century, England
4. Copper figure of Siva (post-Vedic god of Hindu Mythology), 18–19th century, South Indian
5. Bronze griffin, Campo Santo, Pisa, Italy
6. Crozier of carved ivory, French, 14th century
7. Saint Nicaise and the angel called "The Smile of Reims," two of more than 500 statues that form part of the decorative sculpture in the 13th century cathedral of Notre Dame at Reims. The statues are shown in restored condition after having been damaged during the World War
8. "The Descent From the Cross," a group in the Louvre, Paris
9. Ivory statuette "Virgin and Child," Gothic, end of 13th century



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TYPES OF DECORATIVE SCULPTURE

1. "Baigneuse," an example of decorative sculpture by Falconet (1716–91), French. In the Louvre. 2. "Diana," by Houdon (1741–1828), French. Now in the Louvre. 3. "Nymph and Satyr," a group by E. McCartan (1378–1947), American. 4. "Dawn," a bronze statue by Arthur Lee (1881–1961), American. 5. "Dancer and Gazelles" by Paul Manship (1885–), American. In Cleveland Museum. 6. "Athlete Struggling With Python" by Lord Leighton (1830–96), English. In Tate Galleries. 7. "Mounted Amazon" by Franz von Stuck (1863–1925), German. In Metropolitan Museum of Art

SCULPTURE

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DECORATIVE SCULPTURE OF THE 20TH CENTURY

1. "Mare and Foal." bronze statuette group by Herbert Haseltine, English animal sculptor
2. "Deposition," wood relief by Ivan Mestrovid (1883-1962). Yugoslavic
3. "Horse" by Carl Milles (1875-1955). Swedish
4. "Danae," bronze figure by Aristide Maillol (1861-1944). French
5. "Black Panther," by Mateo Hernandez (1888-1949), Spanish animal sculptor
6. "Hounds." by Wilhelm Hunt Diederich (1884-1953). American
7. "Woman at Her Toilet," bronze statue by Jane Poupelet. French
8. "Heracles Drawing His Bow Against the Stymphalian Birds," a group in bronze gilt by Emile Antoine Bourdelle (1861-1929). French
9. "Diana," bronze statuette (24 in. high) by Charles Despiau (1874-1946). French

He went to America to execute his famous portrait of Washington and his busts of notables were outstanding and of great historic interest. Among those were Benjamin Franklin, John Paul Jones, Lafayette and Voltaire.

NEO-CLASSIC AND 20TH CENTURY SCULPTURE

The so-called neo-classic period of the 18th and early 19th centuries came as a result of renewed interest in Roman archaeology and especially in the finds from the excavations of Pompeii and Herculaneum.

Canova (1757–1822) based his style upon that of Praxiteles and imitated many of the mannerisms of the late Hellenic school. He was master of the rendering of the human body to whose lines he gave classic elegance More intellectual than emotional, his work lacked spontaneous warmth of feeling. His work was very popular during his lifetime and he executed many important commissions.

Thorwaldsen (1770–1844), a Dane who worked in Rome, was a follower of Canova who adapted the themes of Graeco-Roman art to his personal expression. There is a collection of his work in Copenhagen.

Also of the neo-classical school whose work savored of archaeological reconstruction, though tempered with personal idiosyncrasies, were Flaxman in England and Danneker and Schadow in Germany.

In France sculpture carried on the indigenous tradition and, while influenced by academic classical tendencies, characteristic creations of the first half of the 19th century had vigour and the sculptors went largely to nature for inspiration. François Rude (1784–1855) a classicist in treatment of form, endowed his figures with powerful gestures, based upon intense observation of nature. His "Marsellaise" of the Arc de Triomphe in Paris stands as one of the most forceful compositions of 19th century sculpture, which, while dominated by the romanticism of the period, is imbued with life. Other notable works by this master are his portrait statue of Marshal Ney and those collected in the Museum at Dijon.

David d' Angers (1789–1856), a master who excelled in portraiture, has left an interesting series of medallion profiles of notable men of his time.

Antoine Barye (1796–1875) the animal sculptor, was an individualist of enormous energy who, while affected by the current classical manner, found in intense study of nature the fulfilment of his aesthetic dreams. Egypt, India, China, Babylon and Greece have left noble monuments of the sculptors' observdtion of animal life. The cat in Egyptian sculpture was a synthesized realization of generations of artists working with the same conventions on the same subject and were impersonal masterpieces. No sculptor has understood anatomical construction of animals better than Barye. Taste in art and the manner of interpreting it changes with each generation and it is difficult to judiciously appraise his creations without the perspective of time.

Carpeaux (1827–75) was of liberalized neo-classic tradition. His groups of dancing figures are notable decorations to the façade of the Opera in Paris.

Falguière and Frémiet belonged to the group of sculptors who revolted against the soft mannerisms of the classical school. They were followers of the style of Barye and executed many animal groups. Frémiet's monumental equestrian statue of "Joan of Arc" marks him as a vigorous personality who based his conception of form upon observation of nature. A notable example of his work is the "Sea Horse Fountain" in the Observatoire, Paris.

Auguste Rodin (1840–1917) was primarily a modeller in clay; the subtleties of the soft medium characterized his style and he enveloped form with a sense of atmosphere. An ardent student of nature, his standing "Statue of a Youth" (Bronze Age) was so real that it seemed to have moulded from life, such was his ability to imitate the appearance of the model. The "Burghers of Calais" were impressionistic, vital and pictorially graphic, while his portraits were often astonishingly real and fluently modelled. Rodin came at a time when art was seeking liberation from the cut-and-dried formulas of the Academy and his commanding personality left a strong influence upon a large group of students in the early years of the 20th century.

Antoine Bourdelle (1861–1929) was a student of Rodin and there is evidence in his work of much of the latter's facility in the handling of clay, but upon this background is superimposed the influence of early Greek and French Gothic masters. He too has largely swayed the modern French school.

Constantin Meunier (1831–1905) was the outstanding 19th century Belgian sculptor. He has left many admirable statues of the workers of his country, executed with powerful directness, sympathy and honesty.

The romantic and classical school of English sculpture is represented by Alfred Stevens (1818–1875) and Lord Leighton (1830–96).

In Germany Max Klinger (1857–1920) was a notable exponent of the academic school with a fine basis of naturalism. Adolf von Hildebrand (1847–1921) and Lehmbruck (1881–1919) created works full of individuality and emotional energy.

Nineteenth century sculpture in America has left many fine monuments. Henry Kirke Brown (1814–86) created the magnificent equestrian statue of George Washington, New York. John Quincy Adams Ward's (1830–1910) standing figure of Washington, New York, is dignified and monumental.

Augustus Saint-Gaudens (1848–1907) studied as a youth in France. He was an unassuming but brilliant modeller and his work strongly influenced the American school of sculpture of the late 19th and early 20th centuries. His statue of Abraham Lincoln in Chicago is an outstanding and noble conception of the Great Emancipator. His many relief portraits, impressionistic and pictorial, are admirable. Other fine monumental works are his statues of Admiral Farragut, the equestrian General Sherman in New York, and the Adams Memorial in Washington.

Daniel Chester French (1850–1931) carried on the American neo-classic traditions of Ward. His rich, creative career has left many fine monuments, conspicuous among which are his four great groups of the façade of the New York Customhouse. His "Death Staying the Hand of the Sculptor" is a work of noble sentiment, combining figures in the full round against a background modelled in low relief.

George Grey Barnard (1863–1938), a sculptor of powerful imagination, was educated in the French impressionistic school. His figures are imbued with a feeling of nobility and inner life.

Present day (1940) tendencies in sculpture are diverse and seem chaotic. There is a survival of the impressionistic academic school of Rodin in which form is interpreted through the medium of soft clay. Using the same medium, but with a severer architectonic treatment, are the followers of Bourdelle. In contrast to that tendency there is the group which carves directly in stone, working either on a solid geometric basis or in the impressionistic manner. Abstractionism expresses itself in various ways. Non-representational forms are in vogue in certain schools, expressed in cubes, spheres and ovoid forms which are carried to infinite variations and combinations. Symbolic abstractions are invented and forms which in nature are convex may be conceived in the fantasy of the sculptor's mind in concave inversion based on emotional impressionism. Surrealism and psychopathic introspection influence sculptural trends, as well as those of painting. The archaeological tendencies are ever-present, expressing themselves in neo-classicism or reflecting Egyptian, Babylonian, archaic Greek and Gothic art or sources of Oriental derivation and those from Negro and South Sea Island sculpture. Modern architecture demands new conventions and formalizations. Investigations into the possibilities of these are many and interesting.

The machine age and standardization influence craftsmanship and tend to remove the sculptor from popular contact. His art has become generally eclectic and has lost the essential and spiritual basis of folk or religious expression.

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GARDEN SCULPTURE

Strictly speaking garden sculpture is not in a class by itself. Very often we may find in a garden a figure taken from the ruins of some old Gothic cathedral which makes a perfect piece of garden sculpture, or again we may see a fragment of a Greek statue or even an old Chinese idol which when given just the right setting seems to be a necessary part of the garden in which it is placed. Not all sculpture, however, is suitable for a garden decoration even though it be very fine sculpture from the point of view of composition or modelling or the expression of an idea or an emotion. Therefore, it would be well to consider here the things which make a piece of sculpture take its proper place in a garden or park.

One of the first requisites of a successful garden decoration is that it be something that will make a pleasing spot and be part of the ensemble. It may be an old well-head or a great stone or terra-cotta vase which will serve the purpose best; it may be a great jet of water shooting straight up from a pool or simple basin; it may be a statue in stone, lead or bronze. Regardless of what it is, in order to take its proper place in a garden it must have just the right scale and colour.

This question of colour is a very important one. Quite often a fine statue in bronze placed against a background of thick dark foliage is completely lost and counts for nothing as a decoration, whereas a statue in stone on just the right scale, though it may be crudely executed, will be much more successful as a decoration because it counts as a spot of colour where the dark bronze was lost as a silhouette against the trees or shrubbery. Where bronze is used it should be shown silhouetted against the sky or against a garden wall or terrace where the dark bronze will be in contrast to the lighter background, for even though the bronze be light in colour when first placed out of doors it will soon lose its original patina, and gradually grow darker in colour. It is practically impossible to give to bronze an artificial patina which will not change colour when exposed to the elements. Marble or stone, on the other hand, when placed out of doors will most often take on a beautiful mellow tone which is in perfect harmony with the landscape and at the same time make a perfect silhouette against the green.

When placed in the open, lead will also take on a very pleasing colour, a soft warm grey which always makes an agreeable spot. Lead is especially suited to fountain figures, and very often when seen in the moonlight it takes on a beautiful silvery tint, an effect which can be obtained by the use of no other material.

There are, of course, various forms of landscape gardening, each requiring a different treatment with regard to its sculptural decoration, but they divide themselves into two general classifications. First, there is the large formal garden or park with its long straight paths, its carefully planned vistas and beautifully kept lawns; then, there is the small informal garden with its nicely arranged flower-beds and its small intimate nooks. One thinks of the park in Versailles or of some of the beautiful old gardens of Italy which were designed as settings for the villas of aristocracy in the time of the Renaissance as fine examples of the large formal garden. At Versailles there is a profusion of sculpture all taking its proper place in the surrounding landscape and though the work was done by several different men there is no lack of harmony in design or execution and each figure is simply a part of a beautifully planned ensemble. Where they placed rows of statues against a heavy mass of foliage bordering some broad grassy avenue they always used stone; when they placed statues out in the open where they were silhouetted against the sky or against the water of some great pool they used bronze or lead, with the result that the sculpture always counts as a spat of colour and adds greatly to the beauty of the ensemble. One may feel that a piece of sculpture which is to be placed in the open should be rugged in treatment and massive in design. This may be true in regard to sculpture to be placed in a large open square or plaza of some big city, or of a monument or a group for some great building, but a single figure or group for a garden must have a certain refinement of detail and elegance of design such as nature has given to the flowers and trees, and all the things with which to make the garden a thing of beauty.

One may again feel that a piece of sculpture should be more or less of a solid mass free from holes which pierce the composition. This may be true of certain kinds of sculpture, but in garden sculpture where the single figure or group in stone is silhouetted against the dark green of the trees it is sometimes well to have carefully designed holes which will give to the group a certain lightness and freedom which is in keeping with the design of the trees where the branches sometimes part and allow a glimpse of the sky beyond.

While the small informal garden requires a different type of sculpture from that of the large formal garden the same principles of scale and colour should he applied here as in the larger gardens. If the setting calls for a statue. say, 3 ft. high, it does not necessarily mean that any statue 3 ft. high, however charming, will suit the place. A statuette which may look well indoors is clearly lost when placed outdoors because its mass and details are out of scale with the things of nature which surround it.

While the subject matter of garden sculpture is not perhaps of first importance one nevertheless feels that there are certain subjects more suited to the garden than others. One is inclined to think of the mythical woodland creatures and of subjects that are joyous and which have to do with life in the open. However, whether the statue be a small chubby child or a goddess done in a fine architectural style it must first of all be a thing which takes its place in the garden and is in harmony with the trees and flowers which are its neighbours.

Thus it is that many garden decorations though crudely executed make pleasing spots when seen from a distance and are therefore in a way successful, but the really successful garden decoration is the one which makes a good spot when seen from a distance and which at the same time is designed and executed in such a manner as will repay anyone who comes near enough to inspect it as a work of art. (See also LANDSCAPE ARCHITECTURE; SCULPTURE TECHNIQUE.) (E. McC.)

PORTRAIT SCULPTURE

Good portrait sculpture has remained essentially the same throughout the ages. Only its trappings and its ornamentation have undergone changes, just as conventions of dress have changed periodically, characterizing a particular epoch. Thus we may recognize an Egyptian portrait bust by the indication of its wearing apparel or its mode of arranging the hair, while excessive attention to personal adornment indulged in the late 18th and in the 19th centuries leaves its stamp also upon the portraiture of that period.

In essentials, however,—in the fundamental construction of the human head,—the fine portraiture of these remotely associated periods remains the same. You see on the city streets to-day types that coincide exactly, except for the non-essentials of dress, with the types richly revealed in the best portraiture of the Egyptians and of the Romans. This fact leads back to the very foundations of portrait sculpture and of human construction. Everyone knows, for example, that the nose is in the centre of the face and that, accepted as the centre, it can give the alignment of the other features. Yet many portrait busts neglect this simple first principle, and, in consequence, destroy the normal perfect balance of the head.

GEOMETRIC BASIS

The fundamental law of head construction is, in consequence. as much a truism as a law in geometry and must be accepted without reservation by the portraitist. If it were actually reduced to mathematical principles it could be indicated'by a line drawn down through the centre of the head from the apex of the skull to a point marking the centre of the mass attaching the neck to the body. This imaginary line might be described as the "flow" of the mass (A–B, fig. 1).

In order to complete the geometry of portrait bust construction a straight line may be drawn at right angles to the general line of the "flow" running from the eye to the back of the skull and centring eyes and nose (C–D, fig. 1).

Structure and Likeness.—Once this framework of fundamental construction has been produced the matter of obtaining a likeness is comparatively simple, and the features with their individualizing characteristics are at once seen to be ornaments on the general flow of the head construction just as buttons or embroidery are ornaments on the coat or dress.

The sculptor who has spent years studying the human head knows well that good portraiture is concerned with the individuality of the simple head construction as indicated by the "flow" of the mass rather than by the meticulous copying of the features, He knows from studying the work of his fellows that there are two types of portrait sculpture, one type preoccupied with features and the other with the fundamentals of construction. There is a unity in the bone structure uhich he perceives is not built brick on brick as is a man-made work of architecture and which if grasped in its entirety lends a semblance of life; a quality of convincing sureness which cannot otherwise be obtained.

It is quite possible to achieve a likeness without adhering to fundamentals, but as the years pass and the subject dies the portrait bust must rest on its merits as a work of art and not as a likeness. The Romans who posed for some of the finest examples of ancient portraiture have long since passed from the land of the living. No one living to-day has an interest, sentimental or otherwise, in the tilt of the ancient's nose or the dear and familiar lifting of the ancient's eyebrow. The personal element in portraiture is stripped from consideration by the impersonal passage of time, and the work is left to stand or fall on its value as a piece of head construction. It is not at all improbable that some of the ancient portraits preserved to-day as the finest relics of antiquity in the museums of the world won less acclaim in their own era than other works more effective as Likenesses than as art.

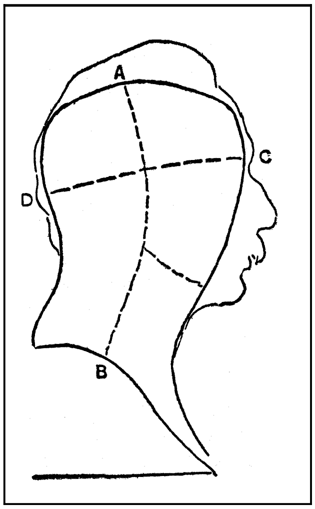

FIG. 1.—DIAGRAM SHOWING FROM A TO B THE PLANE OF THE STRUCTURAL MASS OF THE HEAD; FROM C TO D A SECOND LINE PASSING AT RIGHT ANGLES, CENTRING EYES AND NOSE WITH BACK OF SKULL

GOOD PORTRAITURE UNIVERSAL, NOT RACIAL

Granting the fundamental principle upon which the human head is built it follows naturally that good portraiture is universal and not racial. Because a portrait is primitive African or Egyptian or Chinese does not mean that it is any better as a portrait than a bust produced in Rome, Paris or New York. Racial differences occur from the frontal bone to the chin and do not affect the real mass structure of the head.

By the same reasoning it would be a thankless task to establish the superiority of any one period of portrait sculpture over another. The factor of time is unimportant. A portrait that was good in the days before Christ is good to-day and takes its place with the best portraiture produced by the succeeding ages down to the present time.

The fundamental construction of a head, while of paramount importance in its valuation, is less striking to the layman than external characteristics It is difficult, for example, to appreciate the structural kinship between a highly conventionalized portrait bust of an Egyptian king and a work emphasizing the individuality of a less exalted personage. Yet the difference between the highly individualized and the highly conventionalized portrait may lie solely in the treatment of externals.

Externals Establish the Period. — It is the outer convention rather than the inner structure that brands a portrait bust as the work of some particular period.

The mode of life, the customs and manners and environment of the age invariably affect the outer appearance of the individual.

Sometimes the mode of dress or the coiffure establishes what might be considered a symbol of the time. and this symbol or convention finds echo in the nork of the portrait sculptor.

A study of Cambodian heads or those produced in Egypt and in Rome shows the influence of the current mode on the work of art. The Cambodian portraitist in particular followed a definite symbolism in the rendering of the hair, while the popular coif of other lands is repeated with more or less conventional emphasis in the fashioning of the portrait bust.

Thus, although the individual was an individual in ancient lands quite as much as in the Europe and America of to-day, certain characteristics of dress stamp him with the life of a definite period.

Conventionalization and Realism in Portraiture. — It is interesting that many periods of art production showed equal interest in conventionalization and in realism. The 20th century tendency to reduce all forms to their simplest essentials is no new thing. It merely serves to emphasize and accept the principle of fundamental construction, and to publish to the world that details are merely details and have very little to do with the basic character of a work of art. Conventionalization of human forms and simplification with the resultant absence of personal characterizing details may be found in portrait sculpture from earliest times to the present era.

In Egypt, as well as in China, India and Cambodia, the conventionalization of forms was particularly favoured. Many of the fine renderings of kings and queens are so highly conventionalized that the personal characteristics are lost or obscured.

If one may judge by the mass of portraiture that has come down to us the high dignitaries of the religious and governmental life were placed on a plane above human characterization and were considered more as symbols of the church and state than as individuals. Yet, paralleling the conventional in portraiture there was a wealth of individual representations indulged usually in subjects of lesser rank, but presenting a definite individual character with all the eccentricities, all the imperfections of the ordinary man.

Realism in the development of the portrait bust began almost with the first known portrait and marched triumphantly through the centuries, cropping out in unexpected places even in the great cathedrals of the middle ages where, carved on choir stools or as incidental architectural decoration, there are hundreds of little portrait busts characterizing the artisan or the ecclesiast or even the aristocrat of the time. Occurring as they did in an epoch devoted not to portrait sculpture but to architecture, they serve to demonstrate the tremendous urge of the human race toward the perpetuation of the individual.

There is a slight shade of difference in viewpoint between conventionalizing and idealizing the human head. In conventionalizing the sculptor chooses the characteristics of subject and period and reduces them to decorative forms and symbols.

Thus we find the hair of the African or the coiffure of the Cambodian expressed not realistically but by means of conventionalized decoration.

It remained for Rome, however, to lay final stress upon the individuai as an individual. The long succession of portraits that issued from that city in the centuries of its world dominion show clearly the swing of the art pendulum from idealization and conventionalization to the frank acceptance of human imperfections. Sculptors delighted in these imperfections, these marks of personality, and expressed them with a realistic force that is as powerful to-day as it was in the long ago. Realism so held the portraitist in its grip that he often forgot the dress of a man and centred his attention upon the fundamental characterization of his subject as a timeless individual. The finest of these heads are. in consequence, forever modern as they reveal the human being stripped of period identification.

The Decline of Portrait Sculpture.——For many years after the Roman era portrait sculpture declined with the other arts. appearing only incidentally through the middle ages, and not returning to prominence much before the 18th century when as in the past, it mirrored in its externals the modes of the elaborate elegance, following through almost two centuries an overornate career, yet, under its outer trappings, producing some fine examples of sculptural portraiture.

The 20th century is witnessing a return to the general simplicity found in the portraiture of the ancients.

DIFFERENCES IN VIEWPOINT AND MODELLING

A study of portrait heads produced throughout the ages reveals a rich variety of viewpoints and of modelling. Everyone is familiar with the unanimated face. You see it sitting opposite you in the public conveyance. Its expression has settled to that of hopeless, inactive monotony. For purposes of characterization it might be termed a "streetcar face." This aspect of portraiture may have a variety of underlying causes. The sculptor may be frankly bored with the subject. He may lack understanding of the subject and be unwilling to exert himself sufficiently to establish mutual sympathy.

He may be faced with a personality that refuses to give that sympathy. Or, through lack of experience and inability to handle his medium, the sculptor may neglect the life-giving structural essentials.

In his effort to achieve simplicity a sculptor often gives the big essentials of head construction but so covers them with a general modelling that the richness of surface is lost. This type of portraiture reminds one of a figure neatly enveloped in a veil. or generalized by the use of tights. It is the antithesis of rich form sculpture in which detail is held in perfect scale to and is supported by the mass.

At the other pole is the portrait head that achieves likeness and individuality by thinness of form, as if the artist were working with a drawn line upon the clay, emphasizing detail rather than construction, a type of work implying a pen and ink mental approach and readily defined as "pen and ink sculpture."

The exaggeration of individual characteristics with extreme emphasis upon striking details supplies another classification under the head of caricature (*q.v.*).

PRODUCING A LIVING PORTRAIT

To produce a portrait bust that gives the impression of life the sculptor must have behind him a wealth of experience. He must know that a man does not laugh nith his mouth or his eyes alone but with his entire head, and that when he smiles there is a concerted movement of all the features.

Every subject has a definite life flavour that reveals itself in some individual characteristic or series of chararteristics. The successful portrait head discovers these characteristics Needless to say, the sculptor who has personal knoaledge of his subject can produce a more living bust But he is seldom called upon to execute a portrait of an intimate friend The portrait commission concerns itself almost exclusively with the perfect stranger, and when faced with such a sitter the sculptor must draw largely upon his knowledge of human nature and his ability to rend facial characteristics in the light of the subject's environment and profession. What he does and is contributes largely to the basis for character analysis.

When the sculptor gropes unsuccessfully for this revelatory contact he produces the unanimated street-car face, visualizing the man on the model stand as impersonally and monotonously as he would the man beside him in a tram The features are there; the likeness may be there also, but the personality, the life-giving quality of understanding between subject and artist, is absent

Sculptor and Sitter. — In many respects a portrait head created from memory may have more life than one executed after many sittings. Sitters vary greatly in what they give of themselves. Some are sympathetic and establish at once a bond of sympathy with the sculptor, thus enhancing his creative power. Others sit through hours without a spark of understanding It is often true that more can be gained by talking to a subject during rest periods and by studying the reaction of the man when he is unconscious of a pose than when he sits through the long hours on the stand After a time the expression of any face sets, and there is danger of reproducing a deadened countenance.

One of the most difficult tasks that a portrait sculptor is called upon to face is the commission to make the head of someone no longer living. Many busts of historical personages are created solely from contemporary prints, photographs or portraits, the character of the data varying according to the period in which the individual lived. Seldom is there adequate material from which to work. If the portrait desired is that of some notable who lived many years ago the artist may wield a freer hand and use his own knowledge of the human head and his conception of the msn's character without being forced to meet the criticisms and suggestions of relatives or friends whose impressions of the individual may be vivid but conflicting. The one hope of success in this task lies in the sculptor's knowledge of construction and in the wealth of his experience as a portraitist, and with this knowledge and experience he must portray that intangible quality known as character. It is no task for the novice.

Studying Colour in Portraiture. — The experienced portraitist understands many subtleties of construction that are missed altogether by the literal copyist. He appreciates, for example, the structural differences between the blonde and the brunette. He knows that dark hair and light hair fall in different masses and that even when dark hair whitens with age it still preserves the mass quality of its original colour. Thus hair of different colours is essentially differentin form.

Black hair falls in heavier masses and gives a solid effect. Where it separates and one lock appears distinct from another the separation is sharp and produces a strong shadow. Blonde hair, on the other hand, has very few solid masses It is fluffy and light in effect and does not possess either the solidity or the sheen of dark hair. The difference between blonde and brunette indicates at once the need for a corresponding difference in the modelling of each type.

Forms that are definite and that produce definite shadows give a brunette colouring while blonde colouring is obtained through a negation of the shadows and by the modelling of subtle, less well defined forms.

How Colour Impression Is Produced. — The portrait bust of the past few centuries has relied for colour quality almost entirely upon gradation of shadow produced by modelled form. Dark skin, light skin; dark eyes, light eyes; dark hair, light hair, — such colour differences are translated in terms of light and shade.

This sculptural interpretation of pigments was aided by the ancients through actual colour application as seen in many a portrait discovered on Egyptian soil. Chinese portrait heads were also coloured, while a similar tradition reappeared in the ecclesiastical heads of the middle ages. It was possible for the Egyptian portraitist to paint on the bust the elaborate necklaces and jewel arrangements that give a clue to the mode of dress and of life. Crowns and head-dresses, first expressed in terms of form, were then painted in designs and colours characteristic of the period.

When the actual application of colour fell into disuse it became necessary for the portraitist to indicate pigments and design solely through the modelling of form. Folds of the toga might appear in Roman portraiture, while the coiffure of the lady of antiquity, changing with the style of each succeeding era, writes its chapter in the conventions of the portrait head.

The Influence of Externals on Portraiture. — The elaborate over-decoration of the 18th century and the heavier decorative trend of the 19th found echo in the accessories of dress used by the portrait sculptor in his effort to establish the individual in point of time as well as in point of character.

Externals thus leave their stamp upon the portrait bust as it marches through the ages, but externals have never made the portrait a finer work of art. It stands or falls by virtue of its construction, its modelling and the artist's own knowledge of human nature.

THE CHOICE OF MATERIAL

The modelling of a portrait head and the choice of size, whether life-size or over, is largely conditioned by choice of the material in which the head is to be cut or cast.

Wood, stone, metal and terra cotta provide a range of choice for the portrait sculptor, and each of these materials has its own technique. In Egypt stone was a favourite material, and the great simplicity of many an Egyptian portrait head may be due to the fact that the sculptor chose porphyry as his material for expression. Porphyry presents its own problems in the matter of carving. It is very hard, and necessitates the simplifying of surface treatment and the reduction of forms to their basic essentials. In Greece and Rome, on the other hand, where marble was so largely used, the sculptor had more opportunity to display his skill in the handling of intricate surfaces with greater attention to detail

The control of the material over the modelling and even over the general conception of the work undertaken may be readily understood if a porphyry head of the Egyptians, with its simple forms, is placed side by side with a Gothic group of the middle ages, carved from Caen stone or from some other soft stone material. No such flowering of detail and intricate design in sculpture would have been possible had the carvers of the middle ages and the Renaissance been confined to the use of a hard, unyielding stone.

The hard stone thus lends itself to conventionalization, urging the sculptor on to express form more or less symbolically, while the soft stone allows him to indulge his fancy for absolute realism and for intricate ornamentation.

The Effect of Material on Size.—The sculptor who wishes his portrait bust to assume life-size proportions must, again, understand the material in which the head is to appear. If the portrait is to be cast in bronze it must be modelled slightly larger than life. Bronze shrinks $\frac{3}{16}$ in. equally in length, breadth and thickness, to the foot, and the heavier the bronze employed the greater the shrinkage.

Terra cotta, or dried clay, shrinks 1 in. to the foot, and does not shrink equally unless the model is so constructed that the shrinkage shall be equal. When the sculptor does not understand the terra cotta material the Darts shrink unequally and the original model is either distorted, cracked, or both. Distortion of terra cotta pieces that have come down to us from antiquity may often be attributed to this cause.

In dealing with the portrait head carved in wood the sculptor must appreciate that a solid block of wood checks or cracks. Many African and Chinese portrait carvings show serious cracks. This tendency, however, can be controlled if the wood is built up by dove-tailing or glueing together smaller blocks to produce the required volume, or by boring and excavating the interior of the large solid block.

The Material May Aid Characterization.—It is not impossible that, in studying the character of the individual the sculptor discovers forms or traits that may be best expressed in some one particular material, thus utilizing the material as a direct agent in the characterization.

The artist who feels for his material understands that it requires a technique in keeping with its nature, and does not attempt to force upon it some alien treatment. For example, the beauty of wood lies in the fact that it is wood, and the sculptor who uses it as a carving basis should treat it as wood and not give it a surface peculiar to the nature of marble. If, on the other hand, he desires for characterization the surface of wood as a base, he should not choose marble.

PORTRAYING STATURE IN THE PORTRAIT HEAD

The portrait sculptor must indicate in the head alone the characteristics of his sitter. He is, therefore, faced with another interesting and difficult problem. How can he impart through the head the movement and form of the body? How can size, weight and stature be indicated in the bust?

Incidental decoration can do little to achieve this goal. The stature of an individual is a basic thing and conditions all parts of the body from the head to the feet. In fashioning a portrait statue it is a simple matter to indicate size and weight. In the portrait head, however, such characteristics can be suggested in the setting or base. A portrait head, for example, must end somewhere and when ended must be mounted upon a block or base.

The Treatment of the Base.—The sculptor who studies the stature of his subject completes his portrait bust with a general form indicating the bulk of the sitter. If he happens to be a tall, thin person, the artist creates a tall, thin base. It he be a short, heavy-set man, the base is wide and broad. Any such setting goes back to a fundamental appreciation for form sensed by the ancients, and almost entirely forgotten in the over-ornate art of the 18th and 19th centuries.

GOOD PORTRAITURE TIMELESS

To-day, therefore, the sculptor stands as he stood thousands of years ago, face to face with the same problems of natural form that conditioned the portraiture of Egypt and of Rome. He has passed through centuries of experimentation during which his art became incrusted with extraneous and often meaningless details. Busts of this nature belong so exclusively to a certain period in the world's development that they give the impression of being out of date. They provide a gauge for the study of their own contemporary modes of dress, and because they are so localized they appear less modern than portraits executed thousands of years before by the sculptors of antiquity.

Many a fine portrait head created in Egypt or in Rome and produced purely as a study in structural forms and resulting life is ageless and periodless in its adherence to the universal principles of the sculptor's art. Conventions of dress, conventions of execution have come and gone, but the art of the portrait bust, in its fundamental aspect, has changed not one whit from the first efforts of a master hand to reproduce its kind.

(D. GRY.)

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MONUMENTAL SCULPTURE

By monumental sculpture is meant that sculpture which is intended to perpetuate the memory of a person or an event. Included in this definition are all types of memorials in which sculpture is the important part, even though architecture or mosaic or some other art may play an important part in the composition; but it is not intended to include that sculpture which forms merely a decorative accessory in a building such as the sculptures in temple pediments, in the portals of a cathedral, or on the piers of a triumphal arch even though these adorn a memorial structure. Sculpture of that type will be defined as architectural sculpture or as decorative sculpture. (See other sections of this article.) In the definition of monumental sculpture we include all public memorials that are sculptural in quality and intended to commemorate historic, literary or scientific events such as military victories, the signing of treaties, the discovery of new lands, or a mechanical invention; all memorials to persons—to statesmen, soldiers, poets, martyrs; all sculptural monuments intended to decorate a city; and all funerary sculptures, whether built within the walls of a cathedral or in the open air.

Monumental sculpture, to serve its purpose as memorial, must be permanent, and must clearly express the character of the person or event that it is meant to honour. Enduring materials, such as bronze or granite, so arranged as to be in perfect equilibrium and so modelled as to minimize the possibility of fractures would seem to be essential to this art; and it would seem obvious that these modelled forms should be those of men and women and should recall, either by direct representation, by association or by the more subtle emotions which may be evoked by arrangements of mass and line, the qualities or the significance of the thing commemorated. Heroic scale and simplicity, because they lend both dignity and permanence, are the most frequent attributes of monumental sculpture, and that idealization of forms and of attitudes which leads to the elimination of all that is ephemeral or mean is an almost universal characteristic. More than any other form of plastic art, monumental sculpture strives to express those qualities of structural truth, of harmony in mass and movement, which good architecture also embodies. A realistic or pictorial treatment, although often used for the decoration of memorials, is apt to be less effective for monuments which are intended to illustrate, not accidental or trivial aspects of nature but rather those heroic qualities of the human spirit that attest its enduring greatness. A romantic or symbolic treatment which depends upon knowledge or upon understanding for its appreciation and a purely decorative style which offers only sensual delight, are also unsatis-

fying in a memorial. That monumental sculpture is best that imposes upon natural human forms the architectural logic of mass and structure.

The desire to leave some record of his sojourn on earth seems to have been instinctive with man from the beginning, and no doubt this instinct is closely associated with his desire to represent the human form in stone or wood. From the earliest ages man *seized upon the hardest and most enduring materials in which to carve representations of his own form.* With *the development of the first civilization, in Egypt, Chaldea, Mexico, these instincts found expression in a wide range of monumental sculptures*

Ancient **Civilizations.**—We *shall omit a detailed description of the monumental sculpture of Egypt, Mesopotamia, Greece and Rome, since this is described elsewhere. (See* EGYPT: *Archneology and Art;* GRLEK ART; ROMAN ART.) *Both the Egyptians and the archaic Greek peoples set up in the precincts of their temples sculptured memorials which are concise and solid in character. After the end of the 6th century these monuments shared the growing naturalism of all Hellenic art: the memorial set up in Athens to "Harmodius and Aristogiton"* (514 B.C.—copy *in Naples) is an example. An equilibrium between naturalism and idealism is characteristic of the finest Greek memorials, such as the "Victory of Samothrace," set up in 306 B C. to celebrate a naval victory. In the later phases of Greek sculpture, realism, to which are added dramatic and narrative qualities, becomes dominant, as the "Dedication of* Attales *I."* (241–179 B.C.) *at Pergamum, commemorating a victory over the Gauls, attests.*

In Rome, memorial sculpture is almost always an accessory of architecture; but it is, nevertheless. almost *wholly pictorial in character. The vigorous and realistic frieze which envelops in a superb spiral the column of* Trajan *(a war memorial set up* in AD. 113) *is an example, as are also the fine reliefs of the arch of Titus* (AD. 71), *set up to celebrate the capture of Jerusalem The sculpture of the* "Ara Pacis *Augustae" (13 B.C), one of the few monuments set up to commemorate a peace, are more idealized, as is also the contemporary "Augustus of the Prima Porta," one of the finest achievements of Roman monumental art.*

The **Middle** *Ages.—No sculptors understood more profoundly the principles and technique of monumental sculpture than the sculptors of the* middle *ages, particularly those of the* 13th *century in France, but since their greatest achievements were the sculptural ensembles of the cathedral portals, it will be more convenient to discuss their work at another place. (See section on Architectural Sculpture;* also **GOTHIC** *ART.) We shall* **speak** *here* only *of a phase of their art less dependent on architecture: the execution of sepulchral effigiesand tombs.*

From the beginning the Christian Church marked the graves of her apostles and her martyrs with a stone or bronze memorial. The character of these did not at first differ from other contemporary memorials except by the occasional use of Christian symbols. The vast number of sarcophagi in Rome, executed for the most part after the reign of Constantine, illustrate the development of this Hellenistic art, in which classic forms and drapery, not without dignity and grace, are united intricately with the conventional decorative motives of orientalized Antioch or the genre detail of Alexandria. After the 5th century they share the technical decadence of Rome.

The revival of the arts under Justinian—and later under Charlemagne—found a wide expression in intimate sculpture such as ivory carvings and architectural ornament, but left few examples of monumental art. The bronze Easter column, set up it is said by St. Bernard, in the cathedral at Hildesheim is little more than a piece of constructed ornament. It was not until the 10th *and* 11th *centuries, when the sculptor was called upon to decorate the new monastic buildings, that the monumental spirit was once more revived. Developed in the abbey doorways, where the sculptor had to learn anew the technique of stone carving and of rendering the human figure, this spirit gradually entered once more the sepulchral art of Germany and France. It is felt first perhaps in that form of tomb in which a sculptured figure of the deceased is cut or moulded on top of a sarcophagus or on the sepulchral slab let into the floor of abbey or cloister. Although these figures continued for a long time to be only flat reliefs scratched into the flat surface of the stone they are idealized and simple forms.* When, *after the* 11th *century, they begin to be carved in bolder relief and finally in the round, the figure is still conceived, as in the incised reliefs. in a standing posture, but iaid on his back. The form is rigid, the head erect, and the draperies, unaffected by the change in position, drop in stiff, thinly cut folds from shoulder to feet. Germany was the centre for the production of these grave reliefs, which show a progressive development in technique. The relief grows higher and higher, the figure and the features gain steadily in idealism and in dignity, and the draperies show an increasing beauty of pattern and line The series of* effigies at Ovedlinburg, *representing the abbesses of that monastery, illustrate this* evo*lution.*

The sepulchral effigies of the 13th *century share those ideal and simple qualities which are manifest in the cathedral doorways, but the preoccupation of the sculptor with architecture prevented a wide or sustained development in this field That development had to await the* 14th *century when the decoration of the architectural structure of the cathedrals seemed gradually less important than their embellishment with furniture,* with retables *and chapel screens, and with* tombs *wherein an individual patron, rather than a community, might be commemorated. This new patronage, which removed the sculpture from the geometric lines of the building, accelerated the growth of naturalism which can be traced more continuously in the tomb figures than in any other field. The body, laid at full length on the stone slab, begins to lose its rigidity. Its forms are clearly defined below the drapery which flows over it in an increasing complexity of fold. The features attain first a realism that approaches portraiture and then, as the influence of St. Francis permeates religion, they take on an emotiona! or sentimental quality. Accessories, symbols, details of costume and heraldry are rendered with greater and greater elaboration.*

The tombs in the Abbey of St. Denis, *near Paris (1264) built by St. Louis for his ancestors and his sons* are *characteristic examples of* 13th *century tombs. In these the figure is modelled not in relief but in the round. Each figure, represented as in early manhood, and rendered as a standing figure laid upon the ground,* is graciously *idealized. Each has a simple architectural framework,* low *in relief, and each is placed on a base embellished with pictorial reliefs. The expression is calm and benign and the draperies straight and simple with long clearly incised lines. The tombs for Rollo and William* Longue-Epée, *in the cathedral of Rouen (c.* 1270), *the bronze figures of Geoffrey* d'Eu, *in the cathedral at Amiens, are other interesting examples of these austere effigies.*

Characteristic of the 14th *century is the tomb of Charles V., at St.* Denis *by* André *Beauneveu;* where *the advancing realism of the century expresses itself in accurate portraiture* and *in more flowing and natural draperies. The figure is portrayed in the stiffness of death, and about him are grouped representations of his relatives in the costumes and attitudes of mourners. The fine tombs of the popes at Xvignon—one of which is elaborated with a canopy—and the* effigy *of Robert* d'Artois *at St.* Denis, *clad in full* armour *with a lance in his hand, are other examples which illustrate the growing interest in actuality. In the 1 jth century, when this principle reached its widest acceptance, Flanders and Germany became the most important centres for sepulchral art At Tournai there was developed the type of tomb in which the figure of the deceased, no longer dead and recumbent, kneels before the* Virgin *or some religious object; and these tombs, the production of which amounted to an industry, were exported to all parts of England,* France *and Germany, and widely imitated. The "Monument to* Isabella *de Bourbon" in the cathedral at* Antwerp *(c. 1465) and the "Tomb of Louis de* Male, at Lille" (1455), *both of which are of bronze, are characteristic examples of this Flemish art in which the elaboration of detail and the representation of action and of personality are clearly the preoccupation of the sculptor. Burgundy, which after the beginning of the Hundred Years'* War *became the sculptural centre of Europe, produced a funerary art not less realistic than that of Flanders The famous Tomb of Philip the Bold (completed* 1411) *is an elaborate example of this art, in which the recumbent figure* of *the king is placed on a* high pedestal elaborately decorated with traceries and with the modelled forms of draped mourners. The effigy is clothed in ample and flowing robes and at his head are the kneeling forms of two angels. German tombs, after the 13th century, are notable for their profusion of accessory and for the occasional introduction of narrative and action into the sculptured figures. Escutcheons are developed in Germany into elaborate decorations and early in the 15th century the baldachino or canopy makes its appearance there as in Italy. Ornate canopies are also common in 15th-century England as are also the, multiplication of angels, heraldry and symbolic ornament, and the realistic trend is so far developed as to lead to examples wherein the base of the tomb is left open to reveal the corpse within.

The custom of placing the tomb in a niche in the wall received wide acceptance in Spain and in Italy in the 15th century. In Spain these niches, framed in wide arches. received a lavish embellishment in which Moorish ornament frequently appears. The "Tomb of the Two Knights" in the church of S. Esteban at Cuellar and the "Monument to Archbishop Lope de Fontecha" in the cathedral at Burgos are examples. In the elaborate "Tomb of Juan de Padilla" by Gil de Siloé, acquired by the museum at Burgos, the effigy kneels before a relief of the *Pietà* against a background of delicate tracery. In Italy the influence of the antique and the example of Nicola d'Apulia is shown in the substitution of a sarcophagus, covered with figure carvings, for the northern tomb base. The effigy, lying on this sarcophagus, is revealed by angels who pull aside sculptured curtains. In the more sumptuous examples a great baldachino or marble canopy, supported by four piers, surmounts the tomb and is covered with a wealth of Gothic ornament. The three "Tombs of the Scaliger Family" (1350–74) in Verona, where the canopy is surmounted by a bronze equestrian statue, and the "Tomb of Mary of Hungary" (1325) in Naples are examples of these canopied monuments.

The Renaissance. — The tombs of 15th-century Italy are among the most perfect examples of that exquisite fusion of decorative architecture and classic sculpture which characterized this century. Although often greatly increased in size as compared with their Gothic prototypes, and most profuse in detail, they seldom attain a truly monumental character; they are. rather, accumulations of ornament. schematically arranged in a great niche set in the wall of a church. The vast Gothic churches of the Franciscans and Dominicans — S. Annunziata in Verona, S. Croce in Florence. SS. Giovanni e Paolo in Venice, for example — are lined with these tombs — the work of the Lombard ornamentalist — that contrast strangely with their laconic architecture.

A characteristic design for these tombs is that of an enframement of marble architectural forms — of arabesqued pilasters delicately wrought; with moulded and carved archivolts, entablatures and bases — enriched with statues placed in niches or in a pediment and surrounding a sarcophagus upon which rests the effigy of the deceased. All parts of this enframement are exquisitely carved.

The "Tomb of Pietro Mocenigo" (c. 1462) by Pietro Lombardi in the church of SS. Giovanni e Paolo, Venice, is a superb example of this sepulchral art. The doge. in his robes of state, stands upright upon the sarcophagus, which is borne on the shoulders of three soldiers clad in classic armour. The "Tomb of Christolphe Felici" (1486) by Ambrose Lorenzetti in Siena; the "Tomb of Leonardo Bruni" (1444) by Bernardo Rossellino in S. Croce. Florence; the "Tomb of Carlo Marsuppini" (1455) by Desiderio da Settignano. also in S. Croce, are other examples of this art that attains at its best a perfection of technique never surpassed.

In the 16th century the Italian tombs lose this exquisite ornament. A more sober and studied style in which scale, dignity and classic correctness are the ideals sought appears. The new feeling is foreshadowed in the almost perfect "Tomb of Ilaria del Carretto" (1405) by Jacopo della Quercia in the cathedral at Lucca. The 16th-century master of tomb design is Andrea Sansovino, whose "Tomb of Ascanio Maria Sforza" in the church of S. Maria del Popolo, Rome. takes the form and dignity of a Roman triumphal arch. The "Tombs of the Medici" (1523–34) in San Lorenzo, Florence, and the "Design for the Tomb of Julius II," only partly executed, both of which are by Michelangelo, are the greatest examples of the mature and powerful art of this century. (See MICHELANGELO.)

The monumental sculpture of Renaissance Italy was not, however. confined to tombs. Donatello revived the equestrian statue in his "Statue of Gattamelata" (1443–53) in Padua, bringing monumental sculpture into the open air and giving it once more a civic rather than a religious significance. The "Statue of Colleoni" (1465) by Verrocchio in Venice and the "Designs for a Statue to Francesco Sforza" (1506–10) by Leonardo da Vinci followed. Michelangelo set his heroic figure of the nude David (1501) in front of the Palazzo Vecchio of Florence, while Niccolo' Tribolo, also a Florentine, created the precedents in fountain design which were to be developed into the monumental fountains of the next century.

In France the Renaissance created many decorated tombs of the greatest beauty among which the "Tomb of Cardinal Amboise" (1525) in Rouen cathedral, the "Tomb of Francis II of Brittany" (1507) by Michel Colombe in the cathedral of Nantes and the "Tomb of Francis I" (1525) at St. Denis by Pierre Bontemps are perhaps the most celebrated. Jean Goujon, the greatest of French sculptors. has given an example of his vital and gracious style in the "Fountain of the Nymphs," Paris; and Germain Pilon, whose work exemplifies the noblest classic tradition, achieves in his "Effigy of René Birague" in the Louvre a most perfect balance between a sympathetic naturalism and monumental restraint.

The splendid "Tombs at Brou" (1505–26) near Bourg, built for Margaret of Austria by Konrad Meit of Worms, are characteristic of the somewhat ornate Renaissance of Germany, where the Thirty Years' War greatly limited the production of monuments. In Spain an army of Flemish and Italian ornamentalists, attracted by the prosperity which followed the discovery of America. embellished with sumptuous tombs the newly built Gothic cathedrals and founded with their Spanish pupils a school of decorative art which lasted well into the 16th century. "The Tombs of the Catholic Kings, Isabella and Ferdinand" (1517) by Dominico Fancelli of Florence and "Doña Juana la Loca y Don Felipe el Hermoso" (1j20) by Bartolomé Ordofiez, both of which were preserved in the splendid Capilla Real of Granada cathedral, are two of the finest sepulchres of Europe. Other examples are the "Tomb of the Infante Don Juan" (1512) in the church of Santo Tomas, Avila; the "Tomb of Bishop Gorzalo de Terma" (c. 1525) by Diego de Silve in Burgos cathedral; and recessed "Tomb of Enrique II and Catherine of Lancaster" (1534) by Alanso de Covarrubias, in Toledo cathedral.

The **Baroque.**—No field was more congenial to the spirit of baroque art than sculpture carried out on a conspicuous scale. The baroque mas a large style, delighting in impressiveness of heroic mass and deep shadow even when, in its effort to achieve a dramatic effect, it ignored not only structure and the laws of equilibrium but also that repose and dignity which in most ages have been considered the first essentials in monumental art.

The tombs of Bernini are magnificent dramas in which symbolic figures, clothed in sweeping draperies. with rhetorical gesture and expressive features, share in some emotional experience, theatrically depicted. An example of this virile art is the "Tomb of Alexander VII" in St. Peter's, Rome. The pontiff, set in a great apse, kneels on a high pedestal about which Charity. Truth, Justice and R'isdom weep disconsolately while Death, a skeleton, raises the great draperies of polychrome and gold that veil a darkened doorway. The "Fountain of the Triton" in the Piazza Barberini, Rome. from which all clarity of profile or of shadow, all definiteness of plane, are removed, is also characteristic of Bernini's style, widely imitated throughout Italy.

The baroque monuments of France, less agitated and more gracious?than those of Italy, are illustrated by the "Tomb of Richelieu" by François Girardon, in the Church of the Sorbonne, Paris. The dying cardinal, lying on his sarcophagus. is upheld by Religion and mourned by Science. The three figures, united by the lines of skilfully arranged draperies, are informed by a solemn and touching sentiment. The famous "Tomb of the Comte de Saxe" by Jean Baptiste Pigalle, equally allegorical, embodies in a more theatrical composition, less sentiment and more symbolism. About the erect, dignified figure of the general, Death, France, Hercules, Eros and the Lion of England enact a spirited drama that overflows the architectural boundaries assigned to it.

The "Monument to the Great Elector," by Andreas Schlüter, a realistic and robust equestrian statue, is representative of the German baroque, as is also the periwigged "Apotheosis of Prince Eugene," by Balthasar Permoser in the Barok museum of Vienna. The baroque in Germany attained at times astonishing vitality and elaboration of form; the Trinity column, in Vienna, is an example. In England the baroque spirit is less understood. Of the many baroque monuments in Westminster Abbey, the best one, the "Tomb of Lady Nightingale" is by the Anglicized Frenchman, François Roubillac. Characteristic of the more fervid devotional sentiment of Spain is the "Pietà," by Gregorio Hernandez.

The 19th Century. — The 19th century witnessed an almost feverish activity in the building of sculptured monuments. A new type of memorial, that of a statue placed in a public place, replaces the intramural sepulchre, as the devotional and intellectual spirit of the baroque centuries gives way to the more national and sentimental feeling of the Victorian age. The neo-classic purity and coldness which dominates the first phases of 19th century art is slowly modified by realism and romance. France remains to the end of the century the centre of sculptural art.

"The Tomb of Clement XIV.," by Canova, in the church of SS. Apostoli, Rome, is a good illustration of early 19th century classicism. The composition is that of Bernini — the draped figure of the pontiff seated on his sarcophagus and mourned by Charity and Peace — but the dramatic action is replaced by a dreamy mournfulness, which is made impersonal by the generalized features, by classic draperies, and by the definite geometry of the architectural forms. The "Tomb of Nelson," by John Flaxman, in St. Paul's, London, while remotely derived from Pigalle, shares the dignity and classic restraint of Canova, which now become characteristic of all sepulchral art. The "Tomb of Queen Louise," in Charlottenburg, by Christian Rauch, is one of the loveliest of these neo-classic tombs.

The equestrian statue of Joseph II., in Vienna, by Franz Zanner, depicting the Austrian kaiser in the armour of a Roman general, illustrated the return to classic prototypes in street memorials. The "Cities of France," seated around the Place de la Concorde, in Paris; the graceful "Victories" which guard the tomb of Napoleon at the Invalides; the "Wounded Lion," at Lucerne, by Thorwaldsen; and the "Statue of General Washington," by Greenough, at Washington, in which the father of his country, half-naked, takes the pose and expression of Zeus, are other examples of neo-classic taste in monuments.

The nationalization of classic types, which was attempted by Thorwaldsen in his later works, illustrates that desire for national expression which the patriotism of the 19th century demanded. David d'Angers, called upon to create in the streets of French cities many representations of famous Frenchmen, not only gave these a contemporary costume but also gestures and expressions in harmony with their characters and activities. His "Corneille" at Rouen, "General Drouot," at Nancy, and "Thomas Jefferson," at Washington, are examples. François Rude shared this effort to nationalize French sculpture, as his "Marshal Ney," in Paris, demonstrates. Rauch, in his famous equestrian "Frederick the Great," in Berlin, not only renders realistically the costume and features of the king, but surrounds the pedestal with the portraits of his contemporaries. In America, John Quincy Adams Ward, in such monuments as the "Washington," in front of the sub-treasury in New York, succeeds admirably in adding a touch of national feeling to figures essentially classic.

The search for nationalism led inevitably to the revival of national styles. Carpeaux, in his spirited "Fountain of the Four Races," in the Luxembourg gardens, recaptures the pictorial warmth of French baroque masters; Jules Dalou, in his "Triumph of the Republic" and his "Silenus Monument" carries these tendencies still farther. Henri Chapu recalls in his "Tomb of Regnault," École des Beaux-Arts, Paris, the exquisite grace of Goujon, and the "Tomb of General Lamoricière," in Nantes, by Paul Dubois, illustrates also this tendency to turn to the national renaissance—a tendency equally noticeable in Germany and in Italy. In America this movement found expression in such admirable monuments as General Sherman in New York, by Augustus Saint-Gaudens.

Contemporary Monuments. — The period since 1875 has been prolific in commemorative art. This has been due, in part at least, to the development of realism and to the romantic and pictorial, and therefore popular, character which sculpture assumed towards the end of the 19th century. The growing tendency towards naturalism in monumental art, exemplified by the work of Rude, Carpeaux and Bayre, culminated in Rodin, whose "Monument to the Eurghers of Calais" is the negation of classic form. The realism of this monument, which recalls that of the 15th century Gothic and its narrative and emotional power, have made it the prototype of a world of memorials both in Europe and in America. "The Monument to Victor Hugo" is less literal and achieves something of the strength of Michelangelo. The impressionistic technique and the "popular mysticism" which this monument exemplifies have also been widely imitated. Bartholomé in his fine "Monument to the Dead," in the Cemetery of Père Lachaise, Paris, embodies not only his freedom from the Hellenic rule, but also the realism, and the mysticism, the pictorial treatment, which Rodin had made popular. The monuments which continue the tradition are innumerable: the "Fountain of Time," in Chicago, by Lorado Taft; the "Burden of Life," in Harrisburg, Penn., by George Grey Barnard; and the lovely "Bacchanale," by Malvina Hoffman, are American examples. (See also EFFIGIES, MONUMENTAL; MONUMENTS AND MEMORIALS; TOMB; SCULPTURE TECHNIQUE.) (J. HUD.)

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ARCHITECTURAL SCULPTURE

Architectural sculpture originated not only from the fact that something ornate was desired, but because practically all sculpture in the beginning had a symbolic meaning. Images of gods were wrought, or the story of some great man's life was done in pictorial fashion, in bas-relief; and, as temples were built to enshrine these deities, and near deities, lesser symbols were gradually introduced to surround and protect the focal point. Man used these sculptures to enhance architecture with beautiful shapes and spacing.

Egyptian.—An interesting example of symbolic sculpture, known from the earliest periods to the present time, although its meaning seems to be lost, is the Gryphon, representing the elements. The wings, fins, blazing eyes of the owl, feet and body of the lion, symbolize air, water, fire, and earth. It was very often placed on the corners of the temples, evidently meaning that the elements surround all. Among the finest pieces of Egyptian sculpture representing the deities were Ra, Isis, Osiris, and, of course, the Sphinx. This is sculpture, architecture, and symbolism knit together in a highly artistic and decorative manner. All these Egyptian works were powerful, massive, and beautifully fitted to architecture, and to the great scheme laid out by the architects of that period. Their scale plan was enormous. Scale is one of the most important elements with which en artist has to deal. This does not mean only the proportion of one thing to another; rather, the immensity of scale gives the onlooker a feeling of awe as well as beauty, whereas the small scale may simply appeal to his sense of beauty. The Egyptians felt how important it was to make their works of art in enormous scale. The Pyramids and the Sphinx carry what the designer wished to convey even after thousands of years. The Egyptian artists left probably the most impressive and awe-inspiring monuments yet erected in the world. The shape of the Pyramid at a small scale, say, 4 or 5 ft. high, has no element to make it impressive or particularly beautiful, but executed in the size of Cheops, it is awe-inspiring. Another example of the importance of scale is the Washington Monument, very striking in its present proportion, but which at small scale would not be impressive or particularly beautiful. The same thing may be said of a small hill that is the exact shape of a mountain; the mountain is impressive but the hill is insignificant.

The Egyptians made small sandstone models wirh the idea of carving the full size in granite, and these models were studied with that point in mind. Thoughts of carving were controlled by materials, and it is not usually realized what an impor ant part material and tools play in the making of a national art. All primitive peoples have had very poor facilities for the making of things artistic, and this has left a decided stamp, usually of strength, simplicity and beauty, not alone in sculpture and architecture, but in rugs, vases and utensils. Egypt's great carvings are, as a rule, in granite or porphyry, the hardest of materials, which made it next to impossible to cut depths or to model suavely with the tools at their command; the result was the solid mass and beautiful architectural form that the stone more or less held after being roughly shaped. The difference is readily noted between the Egyptian and Greek carvings of capitals over the columns, the simplicity of the Egyptian and the growing complicated Greek orders from the Doric to the Corinthian. The natural idea in the beginning was to follow the known order of Egypt, but the material, being easy to manage, led to new forms of less simplicity and a corresponding elegance, which, however, lost in power and fundamental beauty.

An advantage that .the Greeks and Egyptians had over the northern sculptors was in the fact that they could work constantly outdoors in loggias and patios. Bfichelangelo made the Medici tombs in the Loggia dei Lanzi, an ideal place to study the effect of light and shade, with the direct outdoor light falling on the figures. The light in that particular spot can best be studied where there is now placed the group called "The Rape of the Sabine Women."

Archaic Greek. — The Archaic Greek period was most fascinating and delightful; it had a certain wonderful grace, primitive and grotesque. It was playful, light in vein, and beautifully adapted to architecture; it seemed to fill a required space with a flowing incomparable richness of design, as in the pediments of the temple of Zeus at Olympia, for instance. although the modelling in itself does not approach that of the Parthenon groups, many years later. In the Olympian pediment, the massing of the volume of sculpture was placed beautifully over the capitals, allowing the darks to follow the shadows between the columns. The figures were interwoven in such a manner that there was a constant flow of light from one mass to the other, not a perfectly fiat light, but a gradual tapering effect of light and shadow making a wonderful play of colour through the design. This moving effect followed from the end of the pediment straight up to the centre from both sides where figures standing erect stopped the movement. and gave a perpendicular feeling from the centre of the pediment through the centre of the façade. This same effect was carried out in the Parthenon, according to the drawings of Carrey, with a like result.

Greek. — From the Archaic there was a gradual development into the period which we know as the greatest in Greek art; at Athens, with its Parthenon and Erechtheum, many other wonderful works were being built. The Erechtheum is one of the choice bits of architecture of the world, with its superb caryatids, figures possibly the most closely allied to architecture of all the Greek period. Another superb decoration used on Greek buildings, which is now a criterion. is the acroteria, which gradually developed into a most beautiful form. It is founded on a plant basis, and has a beautiful sense of proportion. subtracting all realism and creating a motif that is one of the greatest inventions of all sculptural decorations.

Three of the most wonderful pieces of sculpture used in connection with architecture that have ever been produced are the so-called "Ilissos," "The Fates" and "Theseus." The "Ilissos" is undoubtedly the greatest piece of modelling that has ever been produced by man. It may not have carried architecturally as well from a distance as some of the groups in the Olympian pediment, but one can hardly question the high standard of taste of that period and it was very likely perfect from all standpoints. The figures known as "The Fates" with their wonderful draperies are marvellous, beautifully designed and yet solid and monumental, and surely make a superb shape in the spaces for which they were designed. The two connected figures of the three "Fates" are infinitely superior in workmanship and more beautiful than the detached third figure. It seems that only here and there one sees the touch on this figure of the master hand that did the other two. The group of two is so marvellously massed in plane and volume, and yet so perfectly drawn and designed that the layman might look at the group without realizing its geometric shape. It is made with three broad planes, practically flat, with the carving extending in and out in a very slight degree. hlichelangelo has used this same method, cutting a block into triangular shapes, making a group of figures by drawing them on the three surfaces of the plane and carving into those surfaces, but leaving parts of the figure (draperies, etc.), to touch the surfaces in all the planes. This is particularly noticeable in his group, "Descent from the Cross." All great sculpture seems to have this feeling of volume, mass and geometric shape. It would seem that "Ilissos," "Theseus" and "The Fates" were the work of one man, but it is difficult to believe that they were done by Phidias, the several works known to be done by Phidias having a much more rigid character. There is a replica of a sketch which is called "Athene of the Parthenon," and was evidently a working model. This is tremendously robust and powerful in volume, but lacks that wonderful beauty which the previously mentioned figures have to the last degree. The sculpture of the Parthenon pediments varied greatly and must have been the work of numbers of artists.

From that period on, sculpture gradually became less virile and less fitted to architectural settings. Evidently the sculptors felt that they wished more realism and even went so far as to show textures in draperies, an unknown thing until this period. The Romans obtained Greek sculptors and required them to make copies of some of the finest of the Greek works of art. Many discoveries of such figures are still being made in Italy — a fortunate thing for the art of the world.

Italian. — Except for portraits, Roman sculpture was less interesting in every way than the Greek, and there was a lessening interest in architectural sculpture, which again came to the front with the Italian Renaissance period; and here again we have examples of some of the greatest pieces of sculpture known to the world. Such names as Della Robbia, Donatello, Michelangelo, Verrocchio are among the greatest, and the work they produced is close to the high-water mark. At this period, two of the greatest equestrian statues were made, the Colleoni and the Gattamelata. It is extraordinary to relate that undoubtedly these two men would have been entirely forgotten to the world if Donatello and Verrocchio had not made them live forever in enduring works of art. The statues, "Night and Day" and "Morning and Evening," on the tombs of the Medici by Michelangelo are among the greatest pieces of sculpture existing.

Gothic. — In all of the periods mentioned, sculpture followed the prevailing type of architecture: the long and low, or horizontal; the Egyptian, Greek or Renaissance type. A direct contrast to this style of architecture is found in that of the Gothic period, which, instead of following the line of the earth, reached into the heavens, and with the architecture the sculpture followed. Gothic sculpture is particularly attenuated and extended, the necks, body and legs of the figures being thin and long, but when viewed from the ground at a height of 50 or 60 ft., the figures seem to reassemble themselves and appear in perfect proportion. Apparently the figures were modelled by men who understood how they would look at a height, or possibly modelled in place, or at least tried in the position in which they were to be seen. In no other period has sculpture played a more important part than in Gothic architecture. It was used to embellish and colour, to give light and shadow to doorways and spires, and, in fact, the most powerful effects of broken shadows were brought out by sculpture. Figures, animals and gargoyles were used as symbols as well as decorations in the Gothic scheme as they were in the Egyptian or Greek religions. A strange motif was the gargoyle, grotesque, with a sense of humour and a realism in spite of the fact that it is perfectly architectural in ensemble.

As an example of fine description of Gothic architecture, the following is quoted from Victor Hugo on the Cathedral of Notre Dame:

Its front showed in succession and together: three ogive carved-in great doors; the embroidered and lace-worked ribbon-band of its twenty-eight niches for the statues of kings of Israel and Judah; an immense rose window flanked by two side-windows, as a priest is by his deacon and subdeacon; the high, frail gallery of trefoil arcades carrying a heavy platform on its slender colonnades; and finally, the two black, massive towers with their sloping roof-sheds. All these were the harmonious parts of a magnificent whole, piled up one above the other in five gigantic storeys, broadening out before the eye without confusing it with all their countless details of statuary, sculpture and carving, all powerfully "drawn in" to help along the quest of grandeur of the whole building. It was a vast symphony in stone, so to say, the colossal work of one man and one people, a complete composite whole like the "Iliad," whose sister it is. The prodigious product of a union of all the forces of an age, on whose every stone we see stand out in a hundred ways, the fancy of the workman disciplined by the genius of the artist. In a word, it is a human creation as strong and as fruitful as the divine creation from which it seems to have borrowed its double nature; variety and eternity. And what has been said of the whole church, of the Cathedral of Notre Dame, applies to all these Christian churches of the Middle Ages. All is contained in this, developed out of itself, logical and well-proportioned. If you measure the giant's big toe, you have measured the giant!

French. — Apart from French Gothic, we have a wonderful period of sculpture in France related to architecture. For a time there was a decided tendency to keep the sculpture from being at all realistic, resulting in a type that was very wooden in character. It was actually more architecture than sculpture, and there is always a moment when architecture and sculpture clearly meet. Sometimes they overlap; architecture becomes sculpture and sculpture becomes architecture, as in the case of the work of some of our present day modernists. "The Dance," for instance, on the facade of the Grand Opera House in Paris tends toward the realistic, yet it has perfect balance. The other groups on the façade are stiff and wooden in comparison. There is a story to the effect that when "The Dance," by Carpeaux, was put up, it was so hated that acids and ink were thrown over the marble. Discoloration can be seen to the present day.

The two types of sculpture are manifest in the Arc de Triomphe. The marvelous group of "The Marseillaise," by Rude, is very realistic in its movement and modelling, superb and courageous in its design, but it still holds its place in its architectural balance with such perfection that the other groups seem rigid, and so much like architecture itself that the fine, relieving note is lost. Yet, at the time these works were set in place, the less beautiful groups were admired as much as, if not more than, the Rude group. Now, there is no question in the minds of the artists and laymen which group of the Arc de Triomphe is the greatest.

The Louvre has its succession of fine pieces of architectural sculpture, among them some lions by Barye, and a beautiful pediment group by Carpeaux called "Flora." The bridges over the Seine in a later period come in for their share of architectural sculpture, but few of them have the solidity and power of the Rude and Carpeaux groups. They seem to be rather of the explosive type of sculpture, with broken silhouettes and flaring lines which weaken the groups to such an extent that they seem meagre and poor — particularly those of the Pont Alexander III. and also the groups on the Grand Palais near the north end of that famous bridge.

Rodin, one of the greatest French artists, was a superb modeller, with once in a while a sense of power and volume that tended toward making sculpture particularly architectural, but he was more often lacking in the sense of sculpture fitted to architecture. His "Gates of Hell" are famous mostly for the beautiful bits of modelling and design rather than from a sense of their fitness to architecture. It may be said of Rodin that he constantly demands that sculpture shall express moods and conditions which more properly belong to other arts.

Modern **Tendencies.**—At the present time a type of sculpture is being used which more nearly forms a unit with architecture than anything that has been done for a long period. In America St. Gaudens had a fine sense of the relationship of sculpture to architecture. He was really a sculptor of monuments before anything else. His Adams memorial in Rock Creek cemetery, Washington, was fitted to architecture, although as a matter of fact it may be said that the architecture is fitted to the sculpture; as a whole it is a perfect combination. In front of the Custom House in New York city there are four groups by Daniel C. French. One called "Africa" is original and unusually architectural in its form, and is a high mark in sculpture.

It is interesting to note the changes in types of architecture. This has many causes, such as utilitarianism, climate, religion and geography. In New York it may be attributed to the fact that spaces are small and elevators are used so extensively. The buildings are carried into the air rather than along the ground, and the results have been a new type of sculpture. Other examples are the Nebraska State Capitol, the Kansas City war memorial, and nearly all city buildings. The sculpture seems to grow from the architecture into realistic forms of living things, either plant or animal, tending toward the modernistic types. Bas-relief is being used much as it was used by the Egyptians. This keeps sculpture and architecture on the same plane, but it thereby loses in richness and a difference of plane which was sought after by architects and sculptors of the past. Even the figures which are supposed to represent sculpture in the round are flattened in parts, with the torso, arms and heads growing into the full round. Other evidences that architecture is meeting sculpture and that sculpture is growing into architecture is shown in the fact that architecture is becoming more fluid and sculpture more rigid. This may lead to something that has never been done before, but more likely this sameness of treatment will be detrimental to both architecture and sculpture.

With the possibilities that concrete brings to architecture and sculpture, there is only the hope that good taste will prevail to such an extent as to prevent art from succumbing to the ease with which this material can be used, making a period approximate to the one after the invention of the jig-saw, when all facades and front porches were made of ginger-bread design, owing to the facility with which the work could be accomplished. This tendency to merge architecture and sculpture presents the likelihood of missing something fine in not adhering to what Shakespeare speaks of as "excellent differences."

Composition is subtle and almost incomprehensible, but there are in all great sculptural pieces certain vital requirements. The first is volume, including form; the second is the intricate lacing of the parts in rhythm; and the third and most vital is perfect feeling, or the co-ordination of the body into a whole. The brain can think one thought at a time; that thought makes the body one rhythmic gesture under the same central thought control. This follows through groups of people, as shown by the fact that the controlling person in a party is the moving power of all others; otherwise the individuals that compose a group of people are not perfectly harmonious. In an equestrian statue the horse must be dominated and controlled by the spirit of the rider. The great difference between the Colleoni and the Gattamelata is that the rider of the one is filled with verve and energy, which is reflected in the horse, whereas the rider in the other is philosophic, quiet and dignified, qualities also depicted in the horse that he rides. Any one of these vital points left out of the composition would mean that the work was not a masterpiece.

There is no end to the varietv of conceptions if these themes are adhered to. What has been done in sculpture, as well as the other arts, is merely a scratch on the surface; those who say that everything has been done cannot visualize the untold possibilities of sculpture in its relationship to architecture. *(See* other sections of this article, such as *Decorative Sculpture; Monumental Sculpture:* also articles under SCULPTURE TECHNIQUE.) (J. E. FR.)

DECORATIVE SCULPTURE

Under the general heading of decorative sculpture is included all sculpture made primarily as decoration or part of an architectural scheme, or which is so designed as to fit into an architectural setting, or which, though not designed for any particular place, is yet so considered in its form relationships and harmonies of line and mass, that it becomes an abstraction in form of the object or subject represented. Thus it may be a work crested in the artist's studio of the expression of some sculptural idea or emotion alone. It may be a large or a small work, a "Perseus Decapitating the Gorgona" by Cellini, a "Narcissus from Pompeii," or a small sculptured work from the Orient. It is rather a question, in the broadest sense, of the consideration of the subject of decorative sculpture, that it is the treatment of the form of the subject represented, the formalization or conventionalization of natural forms, rather than a strict reproduction of the forms of nature themselves that renders sculpture decorative Thus it follows that all good sculpture is in a certain sense decorative, or at least has a large percentage of this decorative element in its conception. This discussion, therefore, does not involve so much a classification of a certain kind of sculpture as it does an element which should be present in all good sculpture. The sculpture of the Egyptian monument depicting gods, men and beasts is always fundamentally decorative. Each line and form is conceived in its relationship to those about it and to the architecture on the surface of which it is placed. It becomes at a distance a pattern taking its place in detail on the mass of the architecture, yet it may be emotional and dramatic in its intent, depending upon the imagination and the vigour of the sense of visualization of the artist. So, too, with the architectural sculpture of the Greeks. The pedimental groups and the frieze of the Parthenon are so beautifully proportioned to the architectural setting as to become an essential part of the architecture itself, and withal, a nobly expressed idea of high emotional quality, combining a spiritualized representation of natural forms such as has hardly been known in art. Gothic art (*q.v*) is always decorative, whether it is of carved stone panels, tympana or figures of a 13th century cathedral, or the delicately chiselled bronze or ivory statuette. With Chinese sculpture (*q v*) it is practically the same and the carvings of primitive people are a formalized and therefore decorative representation of the chosen subject-matter.

Sculpture Arrangements.—A work of art always looks best when it is properly shown in the correct setting and when isolated and set off by appropriate surroundings. Our modern museums recognize this fact and their curators carefully study the lighting conditions, the texture and general quality of the background, as well as the association of one art object with another. So it is with a small bronze figure done by a sculptor of the Renaissance, not necessarily designed with a definite setting in mind, and though the sculptor did not know exactly what background was going to set it off, still he did so clearly have before him the general type of table, furniture or pedestal of the style of the period on which his sculpture was to be placed, that he could not well go astray. So a painter of that period painted a portrait or a subject piece for a patron without knowing the exact wall or place in which it was to go, yet he was careful to design the frame to surround it and make it in harmony with the picture The sculptor designed the base or pedestal of his marble or bronze statue or statuette. The painter and the sculptor were generally architects as well, and the artists of this time began their training in what may be termed the applied arts. Thus the great artist was the flowering of natural genius which was to begin with natural craftsmanship and which had been trained in the application or association of art.

Sculpture was rarely created during the Gothic age except for a definite purpose or place and it was only with the period of Italian classical revival of the 15th century that began the flair of what is called "art for art's sake." Princes became collectors of art objects and it was not long before they began ordering painted or sculptured representations of mythological or other subjects and to build galleries to hold their collections. Even after this influence of the collector-connoisseur had been felt, decorative sculpture flourished in Europe through the baroque period and into the 18th century, where it found beautiful expression, especially as applied to garden sculpture, of which that at Versailles in France and of the Villa D'Este and at Frascati in Italy are examples. The decorative tendency continued on during the classical revival of Napoleonic times, but after that comes a period which lasted down to the 20th century, during which nature was copied in a photographic manner rather than formalized and interpreted, and the decorative sense in sculpture was to become almost completely lost.

Schools of Art.—In our own time comes a reaction against the naturalistic school and the beginning of a new classical revival, the Viennese secessionist movement being one of the leaders in this direction, and in Scandinavia, Germany and more recently in France, it is of vital moment. In this connection it would be well to mention the Decorative Arts Exposition held at Paris in 1925, the Paris Exposition of 1937, and the San Francisco and N.Y. World's Fairs. 1939, in which decorative sculpture was extensively used and revealed new talents and tendencies related to current simplified architectural style. This classical revivalist effort has not been especially coherent as it has lacked the direct traditional tendencies of the former periods of this nature because of the conditions of modern life which surround it and also because of the various other revolutionary tendencies toward which modern art is diverging. Sur-realism and abstractionism have left their strong influence, and the fact that until recently and since the middle of the 19th century sculpture has been conceived and carried out as the interpretation in stone or bronze of a clay model rather than in the final material itself. Only now is coming the reaction against this tendency and there is an important school of sculptors who are working directly in the final materials of their art.

One of the factors at work in the world of modem art is the wide-spread appreciation of primitive art. Negroid sculpture, Polynesian woodcarving or Alaskan carvings in wood and slate have taken their place beside the ancient art of Egypt, China, India and elsewhere and have created definite impressions on certain schools of modem sculpture. These impressions are the result of the great publicity given lately to the interesting discoveries of what has heretofore been inaccessible. Naturally, in the handicraft of all primitive peoples the decorative element is strong. (*See* ART: *Prehistoric and Early Near Eastern Styles.*) Conservative art museums are devoting space to the exposition of these early decorative objects to a degree formerly unknown. Art dealers are exploiting it and critics are devoting much consideration to its qualities. A multitude of books devoted to the illustration of the objects has appeared within the last few Years and the appreciation of primitive art has in some circles seemed to supersede that of the more highly developed classical kind.

There is a tendency toward a certain chaotic condition in some schools of modern art due to many causes, of which may be mentioned the lack of well defined rules of limitation, which bring about a mood of endless personal experimentation. Though sometimes interesting and promising of great things to come, and, in the hands of an artist of great talent, much sought after and appreciated, yet, because of their remoteness to tradition or because of their peculiar qualities, it is difficult to place these creations advantageously and make them fit into settings of modern life and appear in terms of what has heretofore been considered beautiful. For after all, and in the long run, art exists and will survive because it is beautiful, and when the contrary is the case the movement which brought it about will change or be short lived. Other tendencies of this lack of relatedness are caused to an extent by the fact that art is not as essentially a part of the life of to-day as it was in former times. It is a thing apart and not integral to our social order Machine-made objects take the place of hand-made ones and the development of handicraft is not on the increase Quantity production and standardization are a bugbear to the man who loves the beautiful artisan-created object. The variety and somewhat accidental qualities of hand-made work have a charm that the machine-made ones cannot reproduce, and a decorative work, though of original beauty of design and of value as a unique piece, becomes undesirable when reproduced mechanically by the thousands—the Venus de Milo loses her charm as a cigarette advertisement.

Modern Tendencies.—Architecture, termed the parent of the arts, is beginning to arrive at a crystallization of certain well defined styles, more especially in America where restriction laws have dictated many of the new forms, and where the great height of the buildings has made it possible to use ornamentation in a new form. Self-imposed rules are coming into being and decorative sculpture is beginning to feel the influence toward an elimination of unnecessary detail and a reduction to pure line and form.

Other influences are being felt in modern art and sculpture in particular, as in the appreciation of the fleet lines brought into being by the swift moving automobile and the aeroplane lines of speed. It is the reflection of the spirit of our day in the language of the day, and it is ever changing and always fundamentally optimistic.

To sum up, let us say that the elements which are most essential to decorative sculpture are composition involving a pleasing distribution of masses, inherent beauty of line and form, and in which the open spaces between forms are as carefully considered for justness of shape as the forms themselves, and a rhythmic feeling between all associated parts from all points of view. These qualifications are age-old and have been appreciated by men from generation to generation.

Great sculpture is inherently decorative and in a truly great statue the inspirational or imaginative force that impels the artist to create and to give actuality of life to his work is that quality which arrests our imagination and makes us feel the spirit that is contained forever within the form of the marble. It is then that marble holds a throbbing soul and inner force. Afterwards the cold eye of appreciation is turned to the surface of the statue and knows the qualities which go to make up its superficial beauty and harmony, knows why the hand wants to touch it—for one of the primary appeals of sculpture is to the sense of touch and therein is one quality which painting has not as it appeals only to the eye. We conclude that in great sculpture the emotional and inner life quality comes first, then follows the sensuous feeling for form with its outward expression of harmony and decorative rhythms, which is always of secondary importance in the work of art.

MATERIALS

Terra-Cotta.—The sculptor of to-day works with materials very similar to those that have always been used. Terra-cotta or baked clay in one form or another is perhaps one of the earliest substances which man has attempted for artistic expression. Primitive races have made use of small clay figures. In Egypt and Greece, in India and China, the earliest civilizations have known this art and many beautifully modelled figures, glazed or unglazed, have come down to us through the centuries. The early Greeks executed sepulchral figures and sarcophagi in terra-cotta, of which a fine example is in Villa Pope Julius in Rome as well as a heroic group from Veii of Hercules, Apollo, and Hermes. Of these only the figure of Apollo is intact. The Metropolitan Museum of New York has heroic sized painted terra-cotta figures of 6th century B.C. Terra-cotta or pottery was used in a masterful way by the sculptors of the T'ang and Sung dynasties in China. From Della Robbia all the way down through the ages to that flowering of masterpieces in this art of the 18th century many different styles and schools have brought it to a beautiful perfection. In primitive America the sculptured art of the Aztecs, the Mayas and the Incas was in a large part terra-cotta. *(See* SCULPTURE TECHNIQUE: *Terra-cotta.)*

Why is it that this substance has persisted throughout the ages and what are its advantages? First of all, it is easily modelled and sculptors who are practising their art of difficult and tedious technique have been anxious to make use of a material which lends facility to their work. Another great advantage which terra-cotta has is that after being baked it becomes, with proper handling, one of the most durable of substances, not subject to erosion or corrosion. Finally, it undoubtedly appeals because of its possibilities in colour. The use of various toned clays and the possibility of the decorative effect arrived at by coating it with a brilliant or soft-toned glaze in a great variety of colours has appealed to many sculptors who feel the limitations of their art as practised in other materials in regard to colour. *(See* POTTERY AND PORCELAIN.)

Bronze.—Bronze *(q.v.)* is a material which, though not used quite as early as the clays, came into the hands of man thousands of years ago. The Egyptians used bronze in making statues. It was also a favourite material of the Minoan civilization and the Chinese were masters of it in the third millennium B.C. As a material it has advantages similar to those of terra-cotta for the sculptor can make his original model in clay, in the same method as that used for the making of terra-cotta, and the process of casting is very little more difficult than that of firing terra-cotta. Moreover, bronze lends itself to easy and approximately perfect reproductions of the original model so that a number of copies can be made from the original. But perhaps the greatest advantage to the sculptor in the use of bronze lies in its tensile strength which lends itself to certain forms of expression quite impossible in stone, terra-cotta or any other non-metallic material. For instance a running figure may be so modelled as to touch the base with only the toes of one foot. Equestrian statues or figures of deer or other animals with slender legs can be beautifully treated in bronze and are strong and sustaining. An excellent example of this typical treatment may be seen in the statue of "Mercury" by Giovanni di Bologna or in a Quadriga group where the horses' reins and the finest of detail are executed in bronze. In addition to the advantages of this tensile strength are the advantages of finish permitting of the finest detail and considerable range of colour from pale brilliant gold or silver-like tones through the various greens, browns and even reds of the patinas which are natural to this substance.

Stone.—Marble and stones have often been thought of as the natural materials in which sculptors work, perhaps because of the fact that so many great masterpieces have been executed in them. *(See* SCULPTURE TECHNIQUE: *Stone Carving.)* Stone sculpture, though difficult in execution, has the quality of permanence which appeals in itself, and in addition it readily associates with architecture which makes such a considerable use of the same material. To the trained sculptor it is possible to make much more beautiful forms from a resisting material than from a soft one. The very resistance makes it necessary for the artist to have a more complete and well defined mental picture of that which he is executing. Soft material lends itself to the changing of volume but not to the perfection of vital form itself. It is undoubtedly this quality of hardness in jade which has led the Chinese to carve so many beautiful objects from it, and the Egyptians did their most beautiful work in the hard basalt and granite. These materials all have a fundamental structure which impose upon the artist considerations of compactness of mass and unity of form which in the final conception impress with their qualities of beauty.

Marble or stone also exists in many beautiful colours and represents better than any other substance the quality of human flesh. Its surface texture and its translucency as well as its colour make it the natural material in which to execute portraits of women or children where bronze because of its heavy colour would be inappropriate. It is especially too the material for garden groups or figures where it is desirable that the statuary stand out in contrast to a setting of verdure. *(See* section on GARDEN SCULPTURE.)

Wood and Ivory.—Due to the vulnerability of wood and ivory to climatic changes these materials can be successfully employed as a rule in comparatively small and compact arrangements, yet generally in Europe and in India and China, as well as with the primitive peoples, beautiful sculpture has been created in both materials. Of course, though those materials are easier to carve, the grain imposes another difficulty with which the sculptor must contend and it is in the turning of this grain to the purpose of the design and its execution that the artist must think. These substances lend themselves to polychromatic effects and to the application of gilding to their surfaces. *(See* SCULPTURE TECHNIQUE: *Ivory Carving* and *Woodcarving.)*

Polychromy in Sculpture.—One of the important elements in arriving at decorative effects in sculpture is the application of colour to its surface. In ancient times sculpture was generally polychromed. The savage people of practically all countries have liked to apply colour to statues of their deities, to the carvings used in connection with their religious rites, and to the masks worn in their ceremonials as well as to their architecture in general. The polychromy was usually in the nature of opaque earth colours, the principal tones used depending upon the country where found and the substances available, but with red and black dominating and white, yellow and green or blue used. The colour was applied in flat tones with usually no attempt at mixing or blending, and the quality of the vivacity of the idol or mask or other object was heightened by its use and the decorative effects of the ensemble intensified.

In Egypt, colour was generally applied to sculpture, and in particular was a feature of relief work. It was rather the colour effect that dominated in the picture than the shadow of delineation of the carving. In fact, one is inclined to consider the relief rather as a painting in which the drawing was made permanent by the carved and rounded outline. Here, too, unmodulated colours were used and often patterns and ornamentation were picked out with the brush rather than carved with the chisel. The sculptors of Greece followed the tradition of Egyptian polychromy and until Hellenistic times used colour in their statuary. Ornamentations in architecture were also painted but it was in tht great chryselephantine statues by Phidias that the art of the use of coloured matter in sculpture reached its greatest expression. Here flesh parts were executed in ivory while an intarsia of gold and silver and ebony made up together with other materials the rest of the statue or group. It is master craftsmanship in the hands of genius of artistic expression. Early Greek bronze statuary was oftentimes gilded and silver was inlaid in the ornamentation of a robe or a fillet around the head of a statue. The eyes were generally done in colour of inlaid materials, giving an expression of great liveliness. With Hellenistic times in Greece and the increased tendency towards naturalism in sculpture, painting gave way and the Romans made less use of polychromy than the Greeks, although many statues have come down to us composed of different coloured marbles. The Gothic sculptors liked to paint their statues and the interiors of churches of that period were generally rich in colour. This tendency towards painting of statuary was maintained until the time of the Renaissance. But after the finding of excavated marbles from ancient times in Rome, which were usually without colour, and the general popularizing of collecting of antiques, sculptors gave up the practice which had formerly been usual. Chinese sculpture has always been characterized by its use of colour. One is sometimes inclined to think that they preferred to a greater extent the use of colour on their statuary than on their paintings themselves.

With the general influence on the modems of the primitives in art it remains to be seen how and what will be the reaction. Indications are that interesting use will be made of the lessons learned and the ways indicated. And hand in hand with the most ancient of methods come those of the most modern. Chrome steel, nickel and aluminium are metals, the use of which has considerable decorative value. New methods of applying glazes and paints are in use in the industries of to-day and new paints and enamels influence our artists. New materials are being frequently invented which find beautiful use in the automobile industry, in the making of radio apparatus, and in many fixtures and objects of utilitarian purpose. Those serving the use of artistry and in the hands of the new school of craftsmen sculptors, it is to be hoped, will give to the coming age a brilliant addition to the use of polychromy and coloured materials in our art. (P. MAN.)

SCULPTURE, SEPULCHRAL, a term descriptive of the figures of persons commemorated by sculpture or by linear cutting or by engraving on stone or metal slabs, either at floor level or on raised structures. The whole commemorative work may be a cenotaph or may contain or cover an interment. Among the many ancient types of sepulchral monument the Etruscan form of the 6th and 5th centuries B.C., represented in the Flavian period by the Ulpia Epigone, is the nearest forerunner of the later Christian type in 15th-century Italy. There are good examples of Etruscan tomb monuments in the British museum but full-scale recumbent effigies of the dead were not a feature of Greek and Roman commemoration.

Medieval Effigies.—Full-scale recumbent effigies did not reappear in Europe until toward the end of the 11th century, uhen very interesting examples were iound in Germany. There is a fine bronze grave slab of 1080 at Merseburg cathedral. and the dignified effigy of Wittekind, duke of Saxony, at Rielefeld, is late 11th century. Other interesting early examples of this period are at Quedlingburg and Magdeburg (1100–1300). There are three fine grave slabs of abbesses showing stiff and highly stylized drapery with long, hanging sleeves, at Quedlingburg. These slabs have delicate and well-carved conventional borders and their dates are between 1130 and 1150.

Among the very early ecclesiastical effigies in the cloisters at Westminster abbey is that of Abbot Crispin who died in 1117. It is of black Tournai marble and is believed to be the oldest recumbent effigy in England. Westminster abbey is extremely rich in the finest examples of most styles and periods, and the range of monumental art in and after the middle ages makes it the best single church in the world for the study of the subject.

In all countries and periods the figures representing kings, nobles, ladies ecclesiastics. warriors, children, merchants, etc., are of the utmost value in the study of contemporary costume and armour and are only rarely archaic presentations of earlier styles; enthusiasm for antiquity revived Roman armour, togas, etc.. in the 17th and 18th centuries. Early history is that of the gradual emancipation from the flat slab shape which gave way to progressively higher relief toward the later 12th and mid-13th centuries; there are many examples in Germany and fewer surviving in Italy and France. but the much restored although still important series of royal tombs in the abbey of St. Denis, north of Paris, shows a further advance toward natural attitudes and finer treatment of drapery.

Germany was more conservative in adherence to the slab type but the English evolved splendid and vigorous figures of ecclesiastics. worked often in Purbeck marble, and also the famous mail-clad warriors sometimes in attitudes of partial activity or even of spirited action. The crossing of the legs has been wrongly supposed to be connected with the crusaders. There are fine examples of 12th- and 13th-century effigies at Ely. Salisbury, Wells and at other cathedrals, abbeys and parish churches.

In Italy. the Cosmati family made elaborate tombs with architectural canopies inlaid with mosaic and marble: beneath these. on a tomb-chest or a structure formed like a sarcophagus, there was often a recumbent presentation of the dead person coloured to show rich vestments. In 13th-century England the decoration was not achieved by mosaic but by painting and this became general by about 1300.

In France, apart from St. Denis, the medieval tomb-effigies are considerably rarer than in England. English canopied tombs, with the effigies raised on a tomb chest or rectangular structure for adding dignity to the design, are sometimes of quite elaborate architectural form; good examples are Archbishop de Gray at York and Bishop Giles of Bridport at Salisbury.

The 14th century was a period of great charm in sculptural developments and the richer tombs became soaring, pinnacled structures forming canopies over finely worked effigies in stone, wood or fine alabaster; magnificent examples are at Canterbury. York, Gloucester and. above all, at Westminster. Most medieval effigies have appropriate animals at their feet.

The opening of the century gave the superb royal effigies in gilt bronze in the Saints' chapel at Westminster; their contrasts with the Italian Renaissance figures of Henry VII and his queen in the same church and in the same material are important in the study of the different art forms. Another magnificent later example in bronze is Richard Beauchamp, 1454, at Warwick dated between the early Westminster bronzes and the Henry VII tomb by Torrigiano.

There are good examples of warriors in Exeter (1320) and

Bristol (1300) and of ladies at Alnwick (1330) and at Westminster. Brasses abound and there is an especially fine group at Cobham, Kent. An English sculptor was employed for a papal tomb at Avignon. Very beautiful examples in stone are at Ewelme and in the Holland monument which was moved after World War II to St. Peter ad Vincula in the Tower of London.

The later effigies in the period are recumbent with the hands together in prayer, but there are a few interesting exceptions as at Tewkesbury where the effigy of Lord Edward le Despencer (1375) kneels with the hands in prayer under a high canopy on the roof of a chantry chapel. The removal of late coats of paint and varnish by R. P. Howgrave-Graham shortly before and after 1940 revealed a completely natural figure with fine lifelike face colouring and the eyes directed toward the altar. The attitude is unique at such an early date in England. In Bakewell, there is a very unusual wall monument showing only the upright busts of a knight and his lady in a canopied niche.

Weepers, sometimes representing relatives, must be included as effigies and were in some cases portraits. as seems probable in the gilt bronze statuettes on the tomb of Edward III at Westminster. These weepers surround monuments in standing attitude but are not necessarily shown mourning. About 1400 was produced the highly ornate tomb of Philip the Bold, duke of Burgundy, now in the Dijon museum, where intensely dramatic professional weepers were introduced (c. 1411) for the first time by Claus Sluter.

The tomb of Philippe Pol, seneschal of Burgundy, in the Louvre, is in painted stone and brings into monumental sculpture the element of motion; the armoured effigy lies in the quiescent attitude of prayer on a slab which is supported on the shoulders of bearers hooded and gowned as mourners and seeming to march in a funeral procession. They carry shields of arms. The date of this is about 1480.

The Renaissance. — In 15th-century Italy the architectural format of the Cosmati was transformed into a vehicle for relief sculpture of subtle and gentle beauty by such men as Agostino di Duccio; yet the same century, so curiously marked in much of its art by morbid insistence on death and bodily decay, emphasizes this with dramatic grimness, especially in northern Europe. The dead person appears in the full pomp of active life on a hollow architectural structure with openings making visible inside a cadaver, that is, a lean and emaciated figure or skeleton with decayed and shrunken flesh attached and with reptiles and worms infesting it. The contrast is enhanced by the dimness of light and the placing of the cadaver almost at floor level. The cadaver monuments are almost wholly confined to ecclesiastical dignitaries.

Classical grandeur and elaboration in monuments was developed fully in Italy long before anything comparable to it appeared elsewhere. Rich and costly marble was easily available and was of the utmost value in Renaissance exuberance. Symbolism and allegory appeared early in Italy in the Renaissance period, and the monument of Francis II, duke of Brittany, and his duchess (1502–07) in Nantes cathedral is a fine French example. The effigies on it are delicate in treatment and appear to be portraits. Very fine statues at the four corners symbolize Justice, Force, Prudence and Temperance.

In Italy, the monuments of the great attain to extraordinary magnificence and the effigy tends to be a glorification of the man, sometimes without much of the earlier religious solemnity and devotion. He may even be seated on a life-sized horse raised high on, and within, elaborate erections of marble.

At the end of the 16th century and early in the 17th century, the fantastic and opulent splendour of Elizabethan and Jacobean monumental art was based on classical motives and the effigies were brightly painted as to faces and hands, armour and costumes being also highly coloured. The great and wealthy as well as ordinary merchants and citizens in England and France may kneel on their tombs: man and wife on opposite sides of a lectern below which the family of boys and girls pray, ranged in two rows of graduated size according to age, the boys on one side and the girls on the other. Each of these figures is a true monumental effigy and in some cases may be a portrait. Some of the grandest examples are in Westminster abbey where the tombs in the aisles of Henry VII have been brought back to their original almost gaudy splendour.

The whole concept of the treatment of monumental sculpture was changed by the powerful incidence of Michelangelo in the Medici chapel in Florence where the two figures sit in niches above and symbolic figures recline on broken pediments. While old forms continued, the new concepts gained ground in northern Europe. A bust of the deceased in a niche was common and as time went on the figures would sit. like Bernini's popes, recline on one elbow, swoon, stand or float heavenward encouraged and supported by lachrymose female figures or mourned by "well-to-do cherubs" weeping small bunches of marble tears.

A new symbolism surrounds the effigy which is often a finely sculptured and realistic portrait but may be reduced to a mere low-relief medallion cherished by a tearful female figure. Sculptural symbolism emphasizes death, loss and grief and is seldom religious in feeling, though epitaphs may be full of genuine piety.

The Neoclassical Revival. — In the neoclassical revival, represented in Italy by Canova (1757–1822), in England by Flaxman (1755–1826) and in Denmark by Thonvaldsen (1770–1844), there was a chastened sobriety and increased reserve. (The 19th century, however, while giving examples of dignified and reverential treatment with careful portraiture, was often distinguished by vapidity and poor sentiment.)

The depth to which the sculptured effigy could sink in the 18th century is seen in the Westminster monument of Sir Cloudesley Shovel; but Westminster contains a wealth of fine sculpture by famous 17th- and 18th-century artists who are fully dealt with by K. A. Esdaile (see Bibliography).

Portraiture in Monumental Effigies — The earliest occurrence of portraiture in monumental effigies has been a controversial subject, and opinion has tended toward the belief that all tomb effigies were merely conventional until the 14th century was well advanced.

It may be assumed that early portraiture was confined to the great and wealthy and that the numerous effigies turned out commercially from sculptural workshops were made to pattern, with minor variations as in the monuments on which they were placed. Notable disputed instances of early date are the superbly designed English effigies in cast bronze of Henry III who died in 1272 and of Eleanor of Castile (1291), both made by Jorel, a London goldsmith. The king's face is full of characterization which harmonizes with his known personality and, allowing for some stylization, it seems to show very clear elements of portraiture. Against this is the argument that it was made long after his death, but this is invalidated by the discoveries made about 1950. These discoveries were made during the restoration by Howgrave-Graham of the earlier funeral effigies that lay in state for royal obsequies in England and France and had always been accepted as the unimportant conventional handwork of craftsmen.

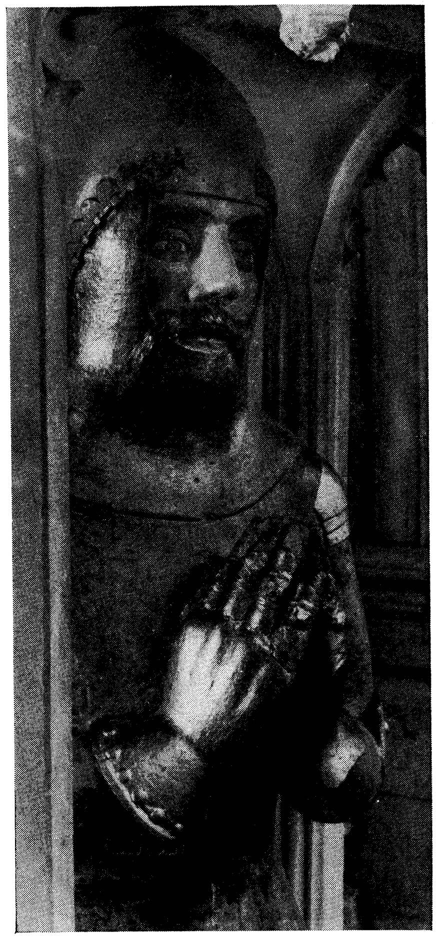
It was found that the faces of these effigies were of two kinds, two being casts from molds taken from the actual face very soon after death. The others were carved in wood from such death masks and all were finished and painted to simulate full life. At Westminster, these effigies were kept by the monks and so were available to the makers of the monuments and would naturally be used as models.

The French effigies were preserved in a similar way by the monks at St. Denis, where the monarchs were buried. The view of Sir W. St. John Hope that a funeral effigy of Henry III was made would seem to suggest that it was the basis for Jorel's bronze and that the tomb effigy is a somewhat stylized portrait in which his drooping eyelid was naturally ignored.

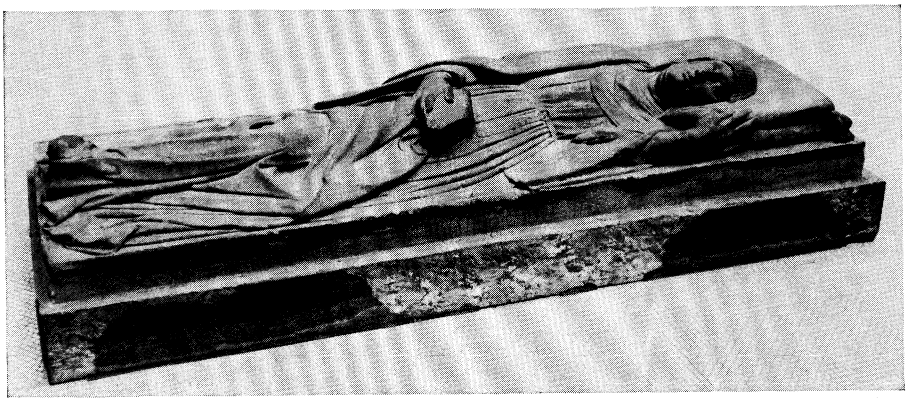
Portraiture seems likely in the effigy of Edward II in Gloucester cathedral, and the probability of portraiture as a frequent aim, at least of the great and the wealthy, is enforced by the skill and the interest in physiognomy found in portrait-corbels of 15th-century craftsmen in Lincoln and Durham cathedrals, in Westminster abbey and elsewhere.

In early monumental brasses, where the effigy is purely linear, portraiture is rare but it seems more usual in the incised stone and marble slabs that were made in northern France and are re-

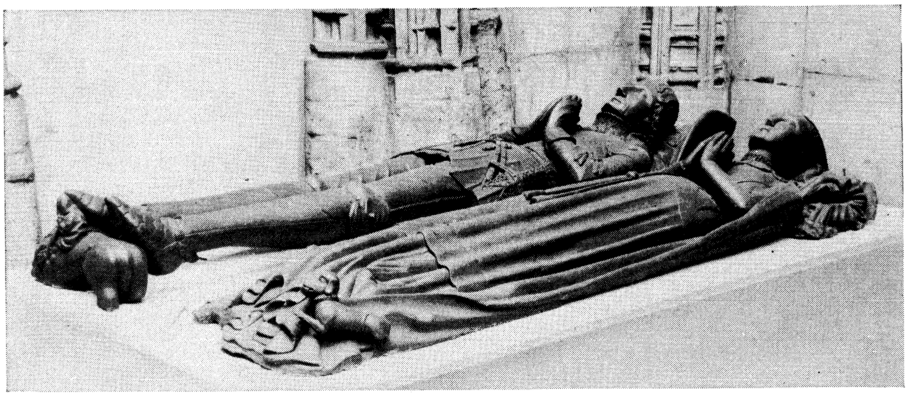
Tomb of Bertrand du Guesclin (d. 1380), French soldier. In the Abbey church of St. Denis, near Paris



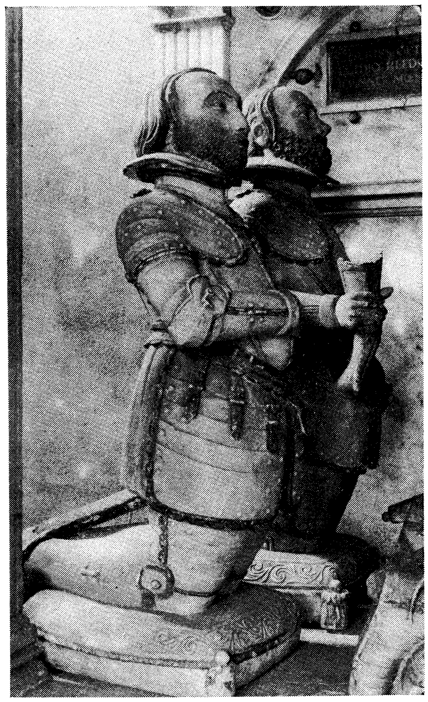
Kneeling effigy from the chantry tomb of Edward le Despencer (d. 1375), English



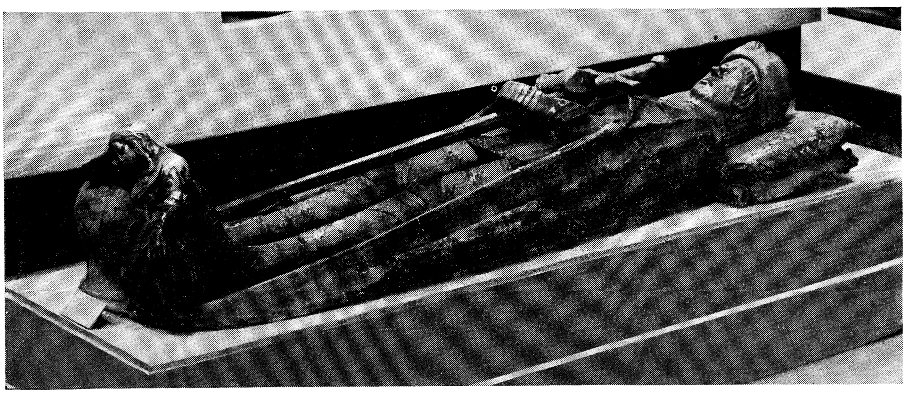
Effigy of a lady. Neapolitan, 16th century; done in the style of Tommas Malvico (Malvito). Victoria and Albert museum



Alabaster casts of Sir Ralph and Lady Elizabeth Fitzherbert. Originals in Norbury church, Derby., Eng. c. 1450. Victoria and Albert museum



Two of the sons of Giles Reed (d. 1611), English. Monument at Bredon church, Worcs.



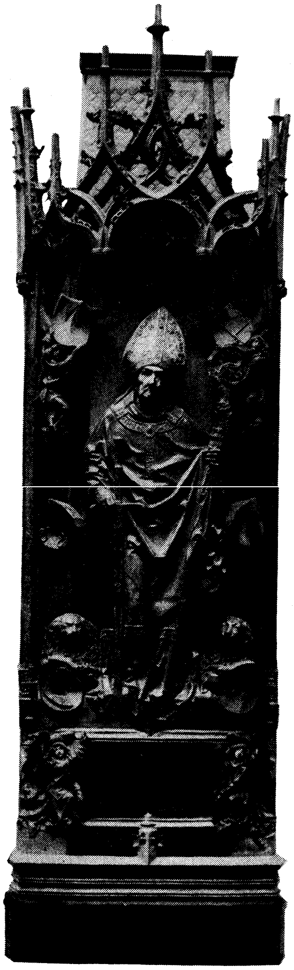
Don Rodrigo de Cardenas. Spanish. Late 15th century. probably by Gil de Lilo. Victoria and Albert museum

TOMB AND MONUMENTAL EFFIGIES, 14TH–17TH CENTURIES

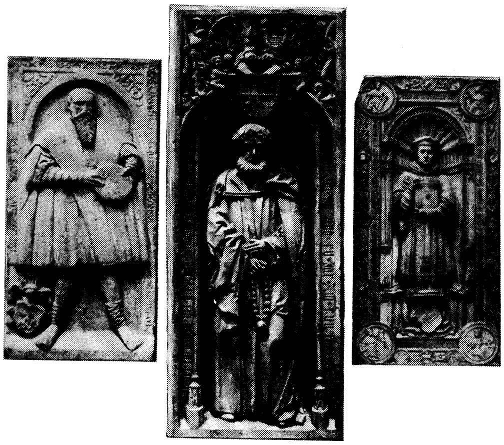
BY COURTESY OF MRS. B. E. HOWGRAVE-GRAHAM

SCULPTURE, SEPULCHRAL

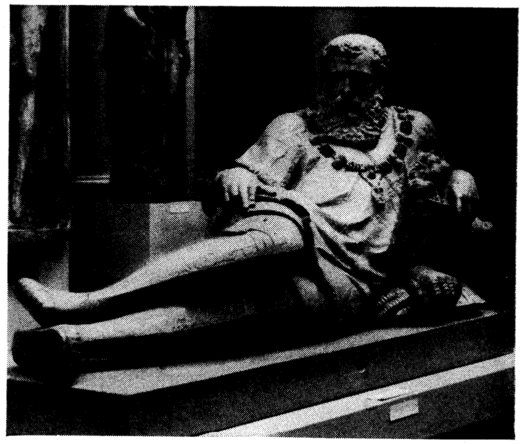
Queen Berengaria and Richard I of England; 13th century



Rudolf von Scherenberg, prince-bishop of Wurzburg (d. 1495). Effigy by Tilman Riemenschnei-



Three German effigies of the 16th century. Left to right: Lucas Cranach the elder, John Adelman, Levin von Veltheim



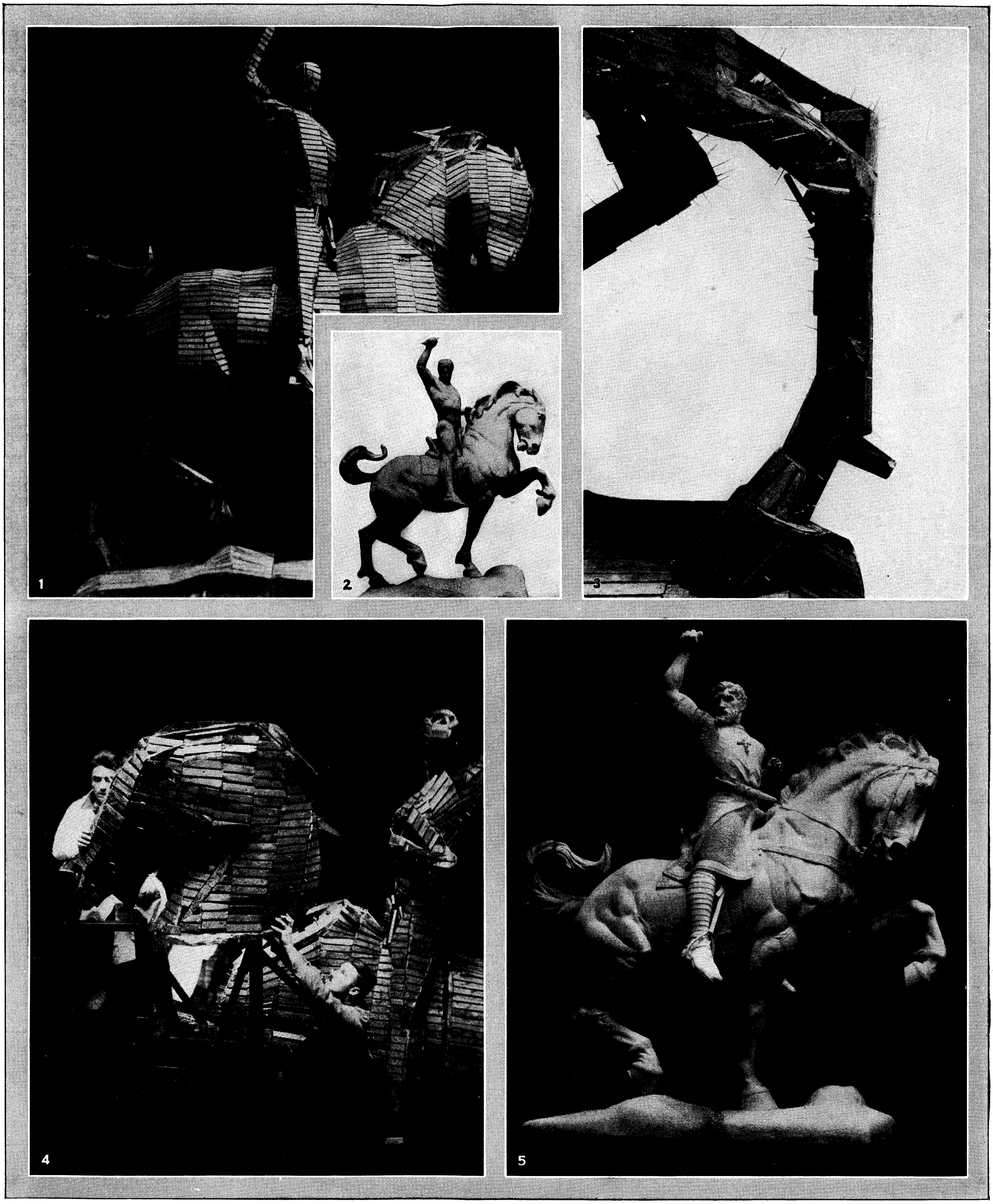
Philippe de Chabot (d. 1543), French admiral. Attributed to Jean Poujon; about 1545

Richard Busby (d. 1695), British scholar. In Westminster abbey; by Francis Bird

Monument of John Donne (d. 1631), British poet. In St. Paul's cathedral

GERMAN, FRENCH AND ENGLISH EFFIGY SCULPTURE

BY COURTESY OF MRS. B E HOWGRAVE-GRAHAM. ALL ITEMS EXCEPT BOTTOM LEFT AND RIGHT ARE CASTS IN VICTORIA AND ALBERT MUSEUM



BY COURTESY OF THE ETTL STUDIOS

THE CONSTRUCTION OF A LARGE ARMATURE

1. Completed armature ready for clay
2. Artist's small model from which the large armature was made by a system of points
3. Detail of the left hind leg. The end of each wire which projects from the wood indicates the position of a point taken from the small model and so governs the thickness of the clay
4. Putting the horse's head of the armature in place
5. Plaster cast of the finished full sized statue

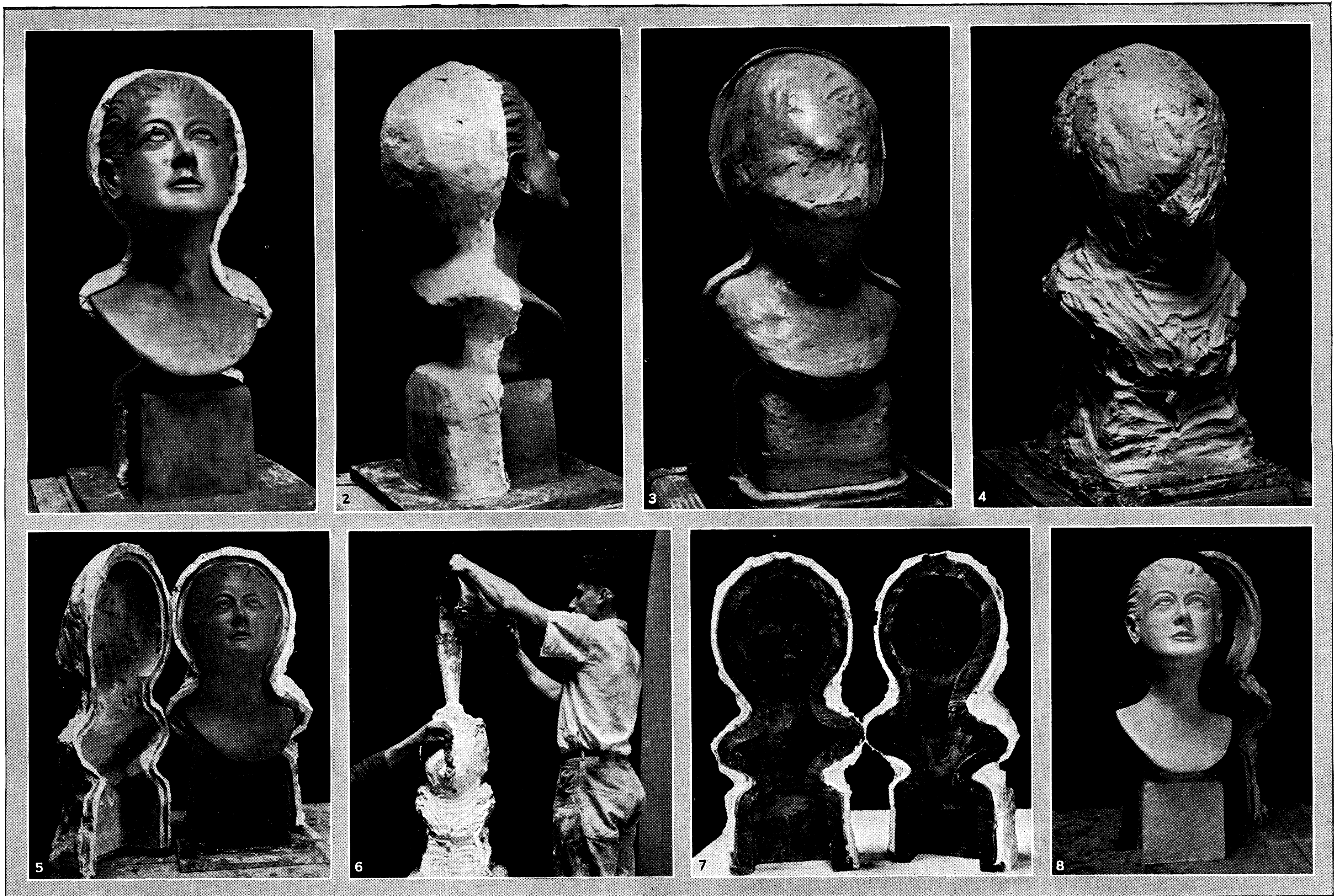
BY COURTESY OF THE FOX FILM CORPORATION

STAGES IN THE PROGRESS OF MODELLING A PORTRAIT BUST IN CLAY

1–3. Blocking out head with the clay. A moist mass of clay about the size of the figure to be constructed is built up on an armature, and the head and shoulders blocked out

4–6. Head roughed out with the clay. Upon completing the geometric construction of the head the sculptor begins the individual details, working from full view, profile and three-quarters view

7–9. Getting the action. With the external likeness established, the sculptor now attempts to give movement to the portrait bust—a characteristic pose or expression that will interpret the personality of the model and make the clay figure a living portrait



BY COURTESY OF THE Eml STUDIOS

THE **GELATINE** MOULD PROCESS OF CASTING

1. Model partly covered by clay filler. 2. Model partly covered by clay filler, seen from the side. 3. First **step** completed, entire model covered with clay filler. Ridge dividing front from back provides additional thickness where casing will be cut. 4. Plaster casing laid over clay filler, casing to be divided into halves where extra thickness of clay projects part way through it. 5. Front half of casing removed and clay filler cleaned out. 6. Gelatine being poured into casing after all of clay filler has been removed and the casing has been replaced around the model. Clay is placed over the vents which permit the air **to escape** as the level of the gelatine reaches them. 7. Finished mould with the clay model removed. 8. Finished plaster cast with front half of mould removed

PLATE IV

SCULPTURE TECHNIQUE

BY COURTESY OF THE PATHE EXCHANGE, INC.

STEPS IN THE PROCESS OF CASTING A STATUE IN BRONZE

1. The sculptor's original model in plaster
2. Making gelatine moulds from the original, which has been first carefully divided into sections
3. Pouring heated wax into the prepared gelatine moulds
4. Assembling the wax model
5. Attaching wax pipes which will serve to carry off the melted wax and fumes during baking
6. The wax model encased in plaster for baking
7. Putting a thick layer of fire-clay outside the plaster
8. Bricking up the kiln after the model has been placed inside
9. At the end of a few days the wax has melted and been carried off through the pipes leaving a final mould of plaster. This mould is placed in a pit and solidly packed with earth
10. Pouring the molten bronze, heated to a temperature of 1,900°F into the mould
11. Removing the mould after the bronze has set
12. Finishing the completed model with a blow torch; applying chemicals in liquid form to obtain different colours (patine)

markably plentiful in the cathedral at Châlons-sur-Marne. *(See* SARCOPHAGUS; TOMB; SCULPTURE.)

Death **Masks.**—A death mask is a wax or plaster cast of a mold taken from a dead face. Death masks are true portraits, only requiring the correction of postmortem changes in the eyeballs. From ancient Egyptian times they have been made as aids to portrait-sculptors. and latterly as mementos of the beloved dead.

In medieval France and England actual death masks were used for the royal funeral effigies that lay in state, but the Westminster abbey series is unique, as the revolutionaries destroyed those in France. Some at Westminster served as models for wood carvers, hut K. P. Howgrave-Graham's discoveries show that two are actual masks applied to the effigies.

The mask of Henry VII is probably the finest in existence, while that of Edward III is the earliest European example; it records the facial distortion due to his fatal stroke and shows that he was left-handed. From the 13th century death masks provided models for the sculptors of tomb effigies.

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SCULPTURE TECHNIQUE. The following article treats all the various mechanical techniques involved in the art of sculpture, including *Wood-Carving, Stone Carving, Ivory Carving* and *Terra Cotta.*

Wood-Carving discusses the special problems of this method. the techniques which must be acquired, the necessary tools and the woods used for the various types of wood-carving. This section also touches on the decline of wood-carving in modern times.

Stone Carving takes up the properties of marble, the technique for beginning a statue and the methods of sculpting stone or marble in classical. medieval and modern times.

The section on *Ivory Carving* deals principally with the source and structure of ivory and the tools used to turn a tusk into a piece of sculpture.

Terra Cotta covers the composition of the material. its uses. the preparation of the basic clay and the construction of the sculpture. Firing, a necessary step in working with terra cotta. also is discussed.

Modelling, Practice and *Modelling, Theory,* are separate sections that deal with such aspects as materials, conception, armatures, relief and enlargement. The development of modelling techniques through the ages is also covered.

This article also includes sections on the theory of sculpture techniques, casting and finishing and piaster casting.

A final section *Patina* discusses the purposes. the artistic qualities and the durability of natural patinas and the methods of producing artificial patinas.

Further material will he found under the separate articles on IVORY CARVING; TERRA COTTA; WOOD-CARVING; as well as the shorter articles on ENGRAVING! LINE; LEADWORK; REPOUSSÉ; etc.

The theory of technique is treated under the individual sections of the article SCULPTURE *(Garden; Portrait; Monumental; Architectural;* and *Decorative Sculpture)*; and it is necessary for the student to consult this article as the techniques vary somewhat according to the application of the sculptor's work.

Fhrther study of technique may be pursued in the articles or sections of articles on GREEK ART; CHINESE SCULPTURE; JAPANESE SCULPTURE; INDIAN ART; etc., as many of these articles, though written from an archaeological viewpoint, do nevertheless treat upon the techniques involved in the practice of these ancient arts.

WOOD-CARVING

Wood-carving consists entirely in a sort of elimination of parts obscuring the desired image. Although the mechanical process is simple, the training required by the carver before he can put it into practice is by no means simple. Firstly, the carver must have a clear idea of what he is about to carve; its shape and form have to be studied before he makes a cut. He must have long practised the use of his various tools; he must know how to conquer the very serious difficulty which the grain of the wood presents in every inch of his work. Many years of laborious practice at last enable him to master all these problems. Of course there are many cases in which such skill and knowledge are neither to be found nor expected, as for instance in the case of primitive work, where a kind of child-like naïveté compensates for the lack of skill. The more sophisticated carver is not content to stop at this stage; he experiments with new forms, invents new tools, and slowly builds up a coherent manner of work which embodies both knowledge of form and skill in the use of his tools. From beginner to master, from generation to generation, this goes on, and so shapes itself into a dignified art—an art which demands a keen love of beautiful form and a constant pleasure in the use of the creative faculties.

Acquiring Technique.—Two kinds of knowledge therefore are essential to the wood-carver. **A** knowledge of form and a knowledge of and skill with his tools. The beginner must learn to cut before he invents anything for himself. The grain of all kinds of wood runs in a fairly straight direction, but the cuts made by the tools go in every possible direction. This difficulty has to be cunningly mastered by subtle movements of the tools; it takes at least two years of constant practice before one has thoroughly mastered the art of "cutting."

When a carver begins to learn the use of beautiful forms those forms are to him never the precise counterpart of nature's forms. He has been long enough at his craft to have learned that purely natural shapes and forms are inexpressible in wood, and that his only chance of making his subject readable is to adopt the traditional "convention" in his treatment, wherein he must simplify all his forms: arrange them in agreeable groups and make the very most of the strong contrast between light and shade of which his subject may admit.

Up to this stage the carver has been learning what may be called the technicalities of his craft, and perhaps exercising his mind in getting a useful knowledge of form. In this respect there is probably no difference between the education of a mediaeval and a modern carver, but here the modern carver is often expected to remain satisfied, and to go on carving, not what he would himself like to do, but what he is told to do by others. An architect. "builder," or some patron of art may give him a "design" to follow—none of them, probably, knowing anything about the use of carving tools. A handicap like this puts a full stop to the progress of the craftsman; he ceases to think of his craft in any other way than as a source of livelihood, and thus the innate talent of our wood-carvers is lost. This was not so in the case of the mediaeval carvers. There can be no doubt that there was someone to guide the work going on in the shop. This would be in all probability the master carver who controlled but did not fetter. This will be clearly seen by a reference to the illustrations, showing work of 14th and 15th century carvings. Such work could not have been done by fettered hands. Here fancy is seen to play within well kept bounds—the best treatment for a given position has been decided by actual experience, be it under a *miserere* seat, on a stall division, or the orderly arrangement of a rood screen. This delightful playfulness of fancy has disappeared from our workshops, and instead of invention, spontaneous and living, we get miles of some stupid kind of "ornament" generally copied mechanically. It would be rash to look for an early change for the better in this respect, but there are some signs of improvement.

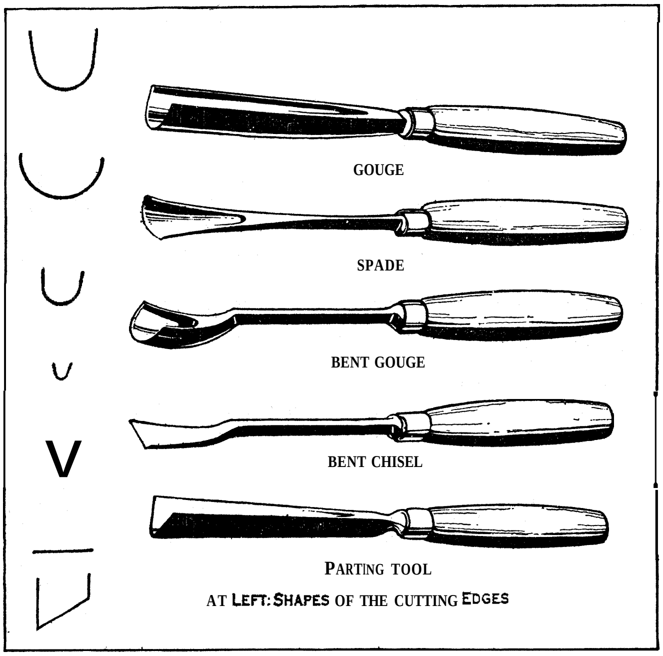


FIG. 1.—A FEW OF THE MORE COMMON SHAPES OF CARVERS' TOOLS WHICH ARE MADE IN MANY SIZES AND SWEEPS OF EDGES

Many architects are now trusting their carvers with more liberal freedom in the execution of their instructions, a movement which must have a good effect on all the workmen in the shop, where, as a rule, the manual dexterity of the carvers is in every way equal to that of their ancient predecessors, but where they seldom find much encouragement for their inventive faculties.

The Wood-carver's Tools.—The tools most commonly in use consist for the most part of chisels and gouges. They vary in size and shape. The gouges may run from $\frac{1}{16}$ in. to over an inch in width and have a variety of "sweeps" or curve of cutting edge: the chisels likewise are of different widths, and they are in three or four different forms, "straight," "bent" and "corner" (*see* fig. 1). The number of tools which may be used by a carver varies of course in accordance with the work he is doing; sometimes he will use half-a-dozen, sometimes more, these being a selection from his whole set which, in itself, may amount to several hundred. When the tools are in use, they are laid beside the carver with their cutting edges towards him in order that he may quickly pick up the one he wants.

These tools have to be kept very sharp and this requires great skill and care on the part of the carver. Blunt or mis-shapen tools cannot be used with effect. The stones he uses for this purpose are of various kinds. Some use "Turkey." some "Washita," but there are many more, including artificial stones such as Carborundum. Fnr the inside of gouges "slips" of these stones are used shaped to the curves required, and for fine or very small tools a slip of "Arcansas" is used, a thin slip of very close texture. As a rule, soft wood like pine, requires a sharper tool than the hard woods like oak. Therefore tools used for this kind of wood are sharpened with a more acute edge Both sides of a carver's tools are rubbed to a bevel, that which rests on the wood being the longest bevel. The inside only receives enough rubbing to produce a clean cutting edge. Some other tools are shown in fig. 2. The mallet is used for the heavier kind of work, where forcible blows are wanted, but mostly, for the lighter use of his tools. the carver uses the palm of his hand as a mallet when such is required. The bench screw is passed through the top of the bench and screwed into the lower side of the wood, which can thus be turned about on the bench; the use of the cramp is obvious, but there is a larger one known as a "bench holdfast" for thick wood which cannot be cramped to the bench. A carver's bench must be of very firm construction to remain steady under blows and sideway pressure. It is generally about 3 ft. 2 in. high and of a length and width suitable to the space he has at command: it should have the light in front of it, never over it. The benches in a carver's shop are often of considerable length as much room is required for long pieces of wood.

Woods Used in Carving.—The woods in common use are oak, yellow pine, and limewood, but many others are used in a less degree such as mahogany, walnut, chestnut, and for small articles box, pearwood and cherrywood. Teak is sometimes carved but it does not compare well with oak. The choicest kind of oak for the carver is English oak, as its texture is hard and close and its colour is beautiful. Next to this comes the Austrian oak which cuts freely but is not so close in its grain. The American variety is not so good for the carver's purpose; it is caney in texture and unpleasant in colour. Chestnut is not much used for carving but it might have a wider acceptance because it is very like oak and cuts well under the tool. This, of course, is the "Spanish" or "sweet" chestnut. variety. Mahogany likewise is not much used, except for very inferior work, where it is always French-polished. Mahogany, though, may be very useful wood if properly treated; if it is left unpolished, or simply waxed, it in time takes on a very beautiful colour but passes through stages of unpleasantness before that arrives. It is a good wood for figure carving which is intended for painting and decorating. For furniture or other work which comes close to the eye there is no better wood than Italian walnut; the most delicate carving may be done upon it. The "American" walnut and "French" walnut are much used for smaller work, but are not very amenable to the more delicate touches of the carver. Limewood is mostly used for figure work which is intended for decoration, although sometimes left in its natural state, as in the work of Grinling Gibbons.

Methods.—Having drawn the outline of the work in hand upon the wood the carver proceeds to make a groove all round this outline with a gouge of small size called a "fluter." Then he takes up a fairly large gouge of quickish curve and with it digs out all the wood between the standing parts until he approaches the depth he

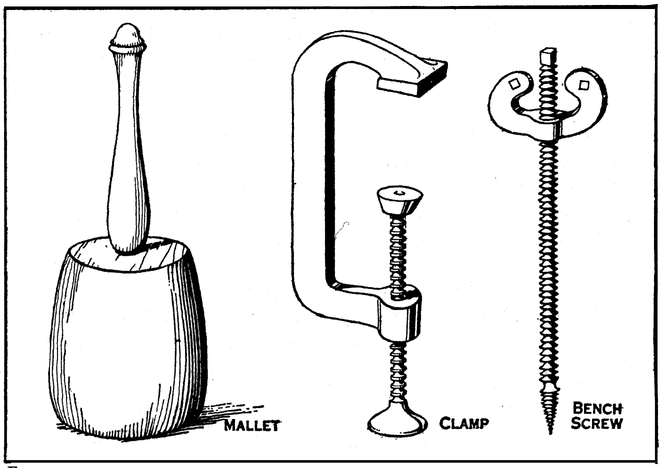


FIG. 2 — WOODEN MALLET, USED ONLY FOR HEAVY WORK: CLAMP AND BENCH SCREW USED TO HOLD WORK FIRMLY ON BENCH

requires. Then with a gouge of flatter curve he cuts down the sides of the projecting parts until they are nearly upright. His next movement is towards a more complete realization of his design. He begins to indicate the positions of veins, lower parts to their respective planes, and in general tries to put in the first stage of any detail such as the articulation of a leaf, berries, tendrils, etc., but all in a tentative way, leaving sufficient wood around every part to allow of little amendments as the work develops. This process, up to the point he has reached, is called "bosting in." that is, getting his work into a rough state of readiness for the "finishing." This is considered the most important part of the work of a carver. The work, when it has been through this process of "bosting in," should be so suggestive of the final stage that it is not difficult for a skilful carver to realize completely all that is meant by the more or less rough details in it. The "finishing" is the clearing up of details by completing the contours, levelling the ground, making mitred corners, and should, if properly done, include securing a pleasant texture which may display the quality of the wood.

The foregoing applies to work in moderate relief. Low relief carving or very high relief requires a somewhat different treatment. Low relief requires in the carver a very high level of knowledge in the matter of drawing, because it depends so much upon the way in which its leading lines are disposed. Not less important is the management of the surface contours, and as in low relief not one of them can be even approximately true to the real form of the object represented, it follows that the contours must be delicately graduated so as to suggest roundness where it does not exist (at least to the same extent). All this means in the carver good draughtsmanship, and a very keen sense of form. In low relief, therefore, there is very little to do in the way of "bostjng in." It is mostly sharp cutting and drawing with the tools.

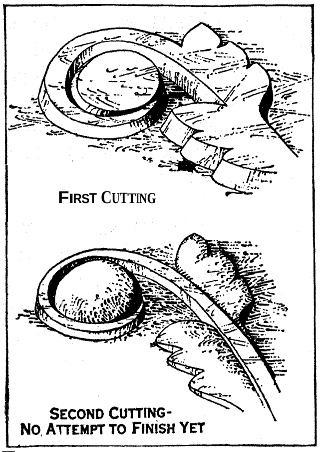


FIG. 3. — STEPS IN CARVING A DESIGN: ABOVE, DESIGN OUTLINED AND WOOD AROUND IT CUT AWAY; BELOW, MODELLING STARTED

High relief carving, or carving in the round, demands much knowledge of form on the carver's part. Let us suppose that he is carving a head; he must know to a nicety and by heart the exact proportions, the position of each feature and he must find these details by a process of clearance which is very confusing. Figure carving in a modern shop is often done as a divided labour: that is to say, one man makes a model and another man carves it. This is done by means of an instrument called a "pointer" which is so made that a measurement can be taken on any part of a modelled surface and transferred to the wood in exactly the same relation to a registered mark on each. By this means little points are made all over the surfaces which have previously been "blocked out," that is, carved down to within a quarter of an inch of the true surface. When some hundreds of these points have been made the whole surface is carved true between them. Such mechanical workmanship cannot have the most interesting results, but it saves time and eliminates the chances of failure and so is much in favour.

A word or two may be said here as to figure-carving in general. There can be little doubt that when figures were being carved for the decoration of churches in ancient days they were carved with the full intention of completing them by covering them with paint and gold. That this was so, many examples testify and often where the painting has disappeared traces of such still remain. So many met with this misfortune that it gradually became the custom for carvers to copy them as they saw them, that is, without decoration. so that in modern times figures have seldom been decorated in the old way. The result is that they are not often seen in such a good light that their lines or features can be properly distinguished. Wood always has a way of hiding itself if the lighting is not very strong, but the moment it is covered with gold and paint it reappears in all its details even in a dark recess. Nearly all the carved woodwork of ancient times was decorated with paint and gold; that is, of course, in all cases where it was safe from rubbing. Stalls or other church fittings which were liable to rubbing were never painted.

Modern Decline. — The outlook, from a woodcarver's point of view, cannot be said to be very encouraging at the present time. Ever since the beginning of the 19th century, the output from the carver's shop has steadily declined. It has ceased to be used on household furniture, and for domestic architecture such decoration is no longer required. Shops, railway stations, restaurants and some public buildings still make use of wood-carving, but of no artistic merit. The church seems to be the only sanctuary of the art, and there a better kind of carving may be seen, though never on the scale of importance which it once had. No doubt the cause of the decline is to be found in the increasing use of machinery and the enormous advance in the cost of labour. It is difficult to see in the face of these formidable facts what can be done to preserve the craft. It is not an art that can stand by itself; detached pieces of wood-carving, however good, are no more than toys. The danger in making such a use of wood-carving lies in the fact that it is under no restraint; there is no necessity for discipline, and such unlimited freedom leads mostly to a mere seeking after novelty, both as to motive and execution.

(G. JA.)

STONE CARVING

To a sculptor, in the true sense of the word (*sculpere*, to carve), a knowledge of the nature of marble is essential, for in marble he visualizes his finished work. However, it often happens that he is ignorant through lack of previous training of the very corner stone of his education as a sculptor, and has to entrust the execution of his work to men, who, though skilled in the art of carving, may not possess the artistic fire of the creator. There is a distinction in the words sculptor and carver. Michelangelo was a sculptor, because he wrested his creations from the stone with his own hands; the artisan, who copies in stone from the model given him by the artist, is a carver, who, often. may not have any knowledge of art, and works to the best of his mechanical ability, upon the work entrusted to his skill.

Marble, because of its texture and consistency, as well as its workable qualities, is the stone best suited to the needs of the sculptor, and for the sake of his art he should be taught early the nature of it, and the way of using it. It is as essential as the academic studies of geometry. perspective, anatomy and form (for Nature herself created it for her glory).

How to Begin a Statue. — In preparation of the finished masterpiece a model of the work on a small scale is essential, either in wax or in plaster. From excavations, years ago, it seems that even the ancient Egyptians made models in plaster, for when a room was unearthed, which seemed to be the studio of an Egyptian sculptor, many sketches in plaster were found in a good state of preservation, as well as casts from life of faces, etc., and all the necessary instruments for the pursuit of his art.

The Etruscans, too, knew and made models in plaster, as well as the Greeks, and certainly, the Tuscan artists of a later day. The model itself, however, is nothing but a sketch. an idea, which must later complete itself under the chisel, upon the marble.

After a little familiarity with the subject it is possible. by means of a few points and measurements, to give form to a marble statue; with the help of a small sketch a life size statue may be executed, or one even larger than life, by beginning with the gradual indication of the lines and principal reliefs For this indication it will be necessary to use pointed tools Then with the aid of compasses, measurements are made between the small model and the marble block, to make sure that the finished work will be done in accurate proportion The statue to be executed is then blocked out in form, always with the help of the pointed tool, taking care to make the indications parsimoniously, though fearlessly. When the pointing is satisfactory, with just regard for reliefs and accurate values, a dented chisel is used. care being taken that the work is done always with due regard for the whole, and avoiding isolating the more fragile details when they are not closely linked with the principal form. This first work on the stone must be maintained at only one value, and care must be taken that no deep cavities are made, which might prevent the making of possible slight changes When the statue has reached this state, the main plan of the finished work being clearly mapped out, it is placed upon a turning table that is at once manageable and very solidly constructed, so that the blows of the hammer will not cause any oscillations. Approaching the block with greater precision, the sculptor next begins the main work, starting with the head of the statue Unlike modelling in clay, wherein from the small one proceeds to the larger and main object, in sculpture one starts with the whole and gradually arrives at the achieved statue as the artist had planned it. For this reason it is necessary upon beginning to work on the model with hammer and dented chisel, to approach with caution and precision toward the release of the final forms. Geometrical working, upon the principles of right angles and squares, has ever been the method of the great masters.

When the head of the statue presents a just value with the whole, and is well allied with the neck, the sculptor proceeds upon the torso and arms, without losing sight of the general plan and construction. Indeed, the whole is ever borne in mind, and no given part is ever dwelt upon at the expense of another. Thus an equal tone is maintained, and harmony achieved in every form and value.

This method seems to have been the one adopted by Michelangelo, Donatello, Jacopo della Quercia, and the brothers Pisano before them, who have left sound traces of their labour.

The Greeks.—Nothing definite has come down to us of the system employed by the Greeks, but all their works show beyond a doubt that they were primarily master carvers on stone. Of course, even they had to make use of sketches in plaster to embody the original form of their creations, but Parian and Pentelic marble. of which the most famous museums are full, was. the medium of their divine art, and never was the medium better employed and immortalized. The work of the Greeks was the product of the *bottega*. Every artist's studio was a school; academies with definite programmes did not exist. At a tender age the future sculptor exercised himself in working upon stone and marble, and this was the first step in his art. Then he drew and modelled under the supervision of the master, who, with paternal love guided the hand of the student and developed his intelligence. From the simple plane to the minutest decorations the students advanced. Often they worked hand in hand with the master upon his statue, and thus they developed into artists—carvers and sculptors.

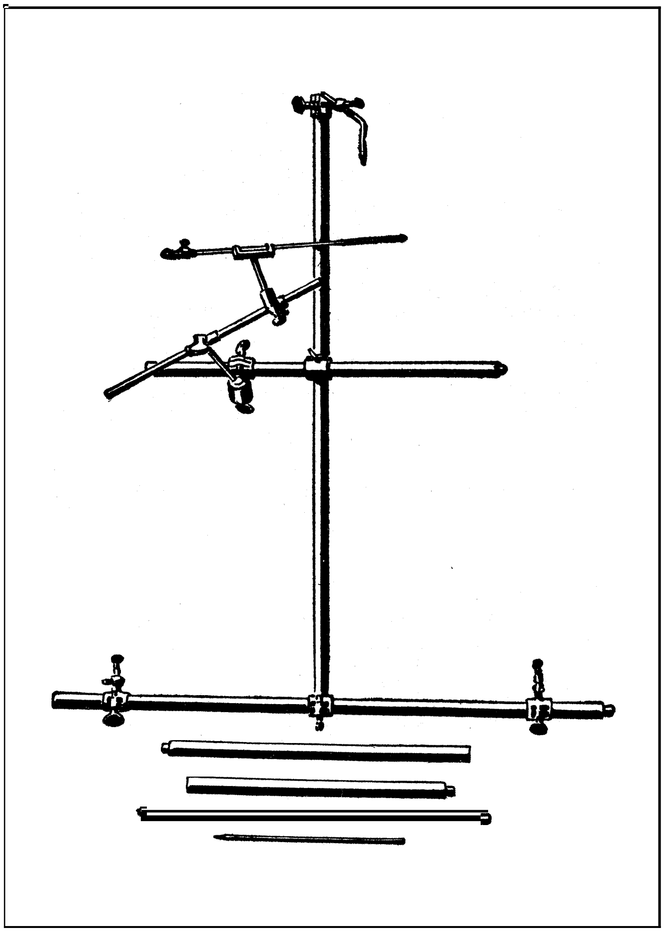
In this fashion. were created the masterworks of the past. The Parthenon, in which sculpture and architecture are united in one glorious harmony, is the expression of the highest art. Pheidias, the sculptor, worked hand in hand with Ictinus, the architect, and under them a legion of master carvers wrought on the Parian marble reliefs, statues and groups that are a glory to this day. Take, for example, the great relief that. covered the wall of the inner portico; it was the chisel of the carver that glorified it. The artist, indeed, contributed in the conception of the work with sketches and designs in charcoal upon the marble; but, working on relief and background, it was the carver that left his impress upon it. A study of the friezes in the Parthenon shows, by its unequal quality, that the carving was executed by various hands: some groups present all the perfection of the Pheidian hand; others, though still of a high order and holding their own with dignity, are lacking, however, in the precision noted elsewhere. Nevertheless, a small fragment of any Parthenon frieze would be enough to build the reputation of an artist.

Michelangelo.—It is well known how Michelangelo created his David. Already the immense block of marble that he used for his statue had suffered sacrilege by the tools of another sculptor. To Michelangelo was granted to create therefrom a miracle of sculpture. The marble was placed upon a pedestal, a house was erected about it, and the artist gave himself up to his task. A sketch was made, smaller by one-tenth, finished in all the minutest anatomical details. From this, with the help of scans and measurements, with carving and reliefs, Michelangelo wrested out of the stone his immortal work, made possible only by the daring of his youth and the supreme mastery he had over his material.

Upon observing the works of Michelangelo it often seems as though the rough and varying form of the raw block of marble as it came from the quarry gave to him the conception of the figure and group. This is more apparent in the four statues of the *Slaves* which were brought to light not many years ago. In two of them in particular are still to be seen the planes and cavities as they were wrought by nature in the marble quarry.

There is also the Madonna *de'Medici,* created in Michelangelo's maturity and which seems to have attained the apex of an artist's and carver's potentiality, both in the largeness of conception and the compactness of form, insuring solidity. No particular of the work is isolated; harmony is maintained throughout. Yet even in this group is to be found the suggestion of the mountain. The principal line has still the imprint of the natural plane, and religiously Michelangelo seems to have maintained it, even though he made it serve the purposes of his group: it is the line that descends from the right shoulder of the Madonna to the sole. It is also to be observed how well allied he kept the foot of the Child in its firmness and strength, making every detail serve toward the ultimate harmony of the finished statue. Only through thorough cognizance of his substance and a mastery of his tools was it possible to the artist to achieve his perfection.

Modern Methods of Carving.—With new times and new civilization have come other methods and ideas in all things, as well as in the method of carving. Under present conditions any young sculptor could become a proficient carver if he devoted a little of his daily time to this art. The problem of his existence would



POINTING MACHINE FOR TRANSFERRING POINTS FROM THE WORKING MODEL TO BLOCK OF STONE

he solved, for if it is too difficult for a young beginner to find in himself statues and monuments to be erected, he can easily manage to gain both experience and a livelihood by learning how to carve marble.

With the help of a pointing machine the present mechanical system of carving is easy to learn and free of responsibility because it is mathematically exact. Let us imagine that a statue is to be carved; the marble block is acquired and brought to the studio, then upon the model is applied a cross with three points, one of which is in the shape of a hook to support the armature of the cross. The three points are of iron or brass, needle-shaped, which will find a place to receive them, also of metal, in the model or plaster mould. Upon the cross there is a movable armature, easy to manipulate, and revolving to the desire of the carver. At the extremity of the instrument there is a needle, the point of which will be approached to the model. At first, that is, for the primary blocking, the needle will not be made to touch the model, but will be limited to approach within an inch of it. The cross will then be placed upon the marble, and the needle will be guided until it touches the point already marked. For the primary roughing out, given a statue six feet in height, a point every six inches should prove sufficient; for the rest, the good sense and accurate eye of the manipulator will be needed. When the statue has thus been dealt with in attaining its first form, the pointing is done anew Even this second time it is advisable not to go to the final points; for the beginner it is better to make an approach of approximately one-third of an inch, leaving the rest for the final pointing. (It is also advisable for beginners not to employ too many points or measures, but rather to content themselves with placing these indications upon the highest reliefs, marking each with the maximum of neatness and assurance, each point being given its own proper plane, before designating with the metal needle the final point.)

The tools used are chisels, plain and dented, and points of various sizes. They must always be clean and sharp; clean, too, must be the statue, in whatever stage of work. The marble must be cut in good, clear light, that the forms may always be well defined. The carver then examines his work from different aspects and by various lights, seeing to it that the surface of the statue is free of little undulations, and that the plane is clean, almost smooth, so that it may attain positiveness.

Later, that the true beauty and colour of the marble may be brought to light, the statue is washed with sand and rubbed with burlap or any cloth of rough texture. If a higher polish is desired, the marble is rubbed with either natural or artificial pumice stone for a long time, clear, clean water always being used. The marble is then washed with oxalic acid which has been reduced to the consistency of table salt, applied with a damp cloth to the surface, and rubbed vigorously. Care must be taken that no quantity of the acid remain upon the statue, for it is injurious to marble.

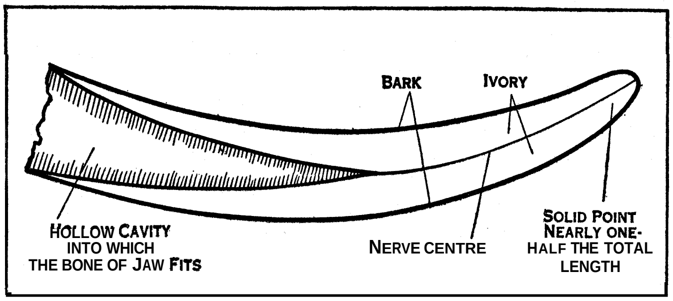
(There is, of course, the danger of refining to a fault, until the stone loses the qualities of its own peculiar nature and seems soft and weak to the eye)

Bernini was among the first to finish his statues with the maximum of precision and care as to detail. Afterwards Canova, taking advantage of all progress and improvements made in the art of sculpture, was assiduous in giving his work such a quality of refinement that his carvers often went to extremes. Under them the qualities of the past masters were not taken into consideration, so that in the meticulous refinement that resulted from their labour the marble often had the semblance of majolica.

That which is best in sculpture never makes one forget the origin or the art, from carving on stone, as the Egyptians carved it, and the Greeks, and the masters of the Renaissance. The most important equipment of a young sculptor should be a knowledge and a love of the mother stone, which immortalizes the artist's greatest dreams. (See also SCULPTURE, and other sections of this article.) (A. P.)

IVORY CARVING

The Material.—In approaching the subject of ivory carving it is necessary first to consider the material in so far as it concerns the carver. Ivory, strictly speaking, is the tusk of the elephant: the tusk being the upper incisor tooth. For practical purposes the term must be allowed to include morse or walrus ivory, hippopotamus ivory and even certain kinds of bone and horn. The best ivory comes from tropical Africa. Asiatic ivory is whiter, more opaque and somewhat softer. The tusk is hollow at the end where it joins on to the jaw-bone; the walls gradually become thicker until, at about half the length, the tusk becomes solid; from here to the tip runs a nerve centre which shows in the cross section as a black spot; the tusk is covered with a rough bark of a hard pithy nature, brown on the outside and greenish white within; the thickness of the bark varies with the size of the tusk from $\frac{1}{16}$ in.–$\frac{1}{8}$ in. or so. The whole of the bark must be removed in carving. Seen in cross section the tusk shows a number of minute intersecting tubes radiating from the centre outwards, giving rather the appearance of engine turning on the back of a



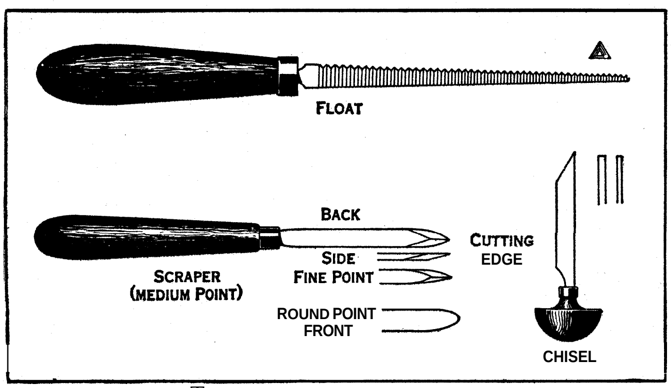
SECTIONAL VIEW OF TUSK; CURVATURE INCREASES WITH LENGTH OF TUSK

watch. The pores of the substance contain a waxy solution, which renders the ivory amenable to the carving tool and also helps to give it its characteristic polish. With age this waxy solution tends to dry out and cracks appear on the surface of the ivory—cracks which in no way detract from its beauty.

But, generally speaking, it does not perish for thousands of years; and, as the surface does not crumble or corrode like stone or bronze, we get in ivory carvings of past ages more nearly the work as it actually left the hands of the artist than is the case with most other materials. Age also gives to ivory a variety of hues—from deepest chestnut to the colour of boxwood. The biggest tusks weigh nearly 200 lb. and measure from 8 ft.–10 ft. These are rare. From such a tusk it may be possible to get a slab 18 in. × 6 in. × $\frac{3}{4}$ in. thick. Owing to the curvature of the tusk through nearly a semi-circle it is difficult to get a larger area and thickness than this. An exceptionally solid point may give a figure in the round of 2 ft. 6 in. in length. These dimensions are not quoted as being absolute limits for size. Chemically, ivory may be placed between bone and horn and is a substance of great elasticity. It has a very pronounced grain running lengthwise. It is carved on the side and not on the end grain.

The Tools.—The tools used in ivory carving are few and simple. Within historic times they do not appear to have varied. They are as follows:—

1. Bow Saw.—This is a narrow saw, say 10 in.–12 in. in length, stretched like a bow string on a wooden frame. With this the



TOOLS USED IN IVORY CARVING

tusk may be sawn into lengths or slabs. [Note: When available a small-toothed circular machine saw is much quicker, more accurate and less wasteful than the bow saw for the preliminary cutting of ivory.]

2. Float.—(See Illustration.) This is a triangular tapering tool in a wooden handle. Two of the three faces are cut across into small ridges throughout their length. By holding the handle in the right hand and forcing one of the ridged faces outwards and obliquely over the surface of the ivory, shreds of the substance

may be pared off.

3. Gouge and *Mallet.*—Small gouges, up to aboat $\frac{1}{2}$ in., tempered as for wood-carving, may be used with a mallet. The carving should always be with the grain and the mallet must not be used with violence. Great care and some experience are necessary as the ivory will break or flake some little distance ahead of the tool.

4. Rasp and File.—Fine rasps and medium files will be found useful at many points of ivory carving.

5. *Chisel.*—(*See* Illustration p 221) After the roughing out has been done, this small tool comes into use. The ball handle is held firmly in the centre of the palm; the blade is held near the point between the thumb and forefinger. Considerable force must be exerted in each cut, pressure being given with the wrist and forearm.

6. Scraper.—(See Illustration p 221.) This is the most distinctive tool used in ivory carving. It resembles a wood-carving chisel ground to a point, fine or round as required, with the front face kept flat and the rear face bevelled off into a cutting edge. It is held like a pen in the right hand: the finger tips being about 1 in.–$\frac{1}{2}$ in. from the point. Gsing the thumb of the left hand to give a steadying pressure at the point, the tool is pushed with a short flicking movement over the surface of the ivory, removing the substance in shavings. Fine pointed scrapers can be used for engraving the most delicate lines. Nearly all ivory carving is finished with the scraper.

Polishing the Carving is most effectively carried out by gently applying fine pumice powder with a soft damp cloth. In small interstices, where the finger cannot reach, a piece of wood, such as a match-stick, may be used with the damp powder. Whiting or a white tooth-powder may also be used for a final polish, if this is required.

Methods of Holding.—When carving in the round, ivory is best held in a wooden vice, or between pieces of wood, cork or thick felt inserted into the jaws of an iron vice. Ivory must never be held directly between the jaws of a metal vice, as this will cause a deep bruise. Larger pieces can often be held conveniently in the left hand at certain stages of the carving Slabs of ivory on which a relief is to be carved should be fixed to a piece of wood of suitable size, 1 in.–$\frac{3}{4}$ in. thick, by means of beeswax. The melted beeswax should be poured on to the centre of the piece of mood, the ivory pressed on to the molten wax. The wax should be in such quantity that a small amount exudes on all sides when the ivory is pressed down. When set, this superfluous wax should be scraped away before the carving is commenced, or it will get on to the hands and tools. When it is necessary to draw upon ivory, as for a relief, an ordinary lead pencil should be used. The pencil lines can be fixed by painting over the whole surface with white spirit varnish. This quickly dries into a hard transparent skin, impervious to moisture, which in no way interferes with the process of the carving. (A. Du.)

TERRA COTTA

Material.—Clay is decomposed felspathic and silicious rock (see CLAY), varying in composition and colour according to its location. Pure clay or Kaolin, as the Chinese named it, is a residual, non-plastic, white-burning clay, not usable in its natural state but essential in the composition of porcelain and china bodies. In contrast, the impure sedimentary clays, of which all earthenware and most terra cotta sculpture are made, are plastic and in their natural state contain all the requisites for modelling (plasticity, porosity, vitrification). If these are lacking, the clay can be modified to obtain these essentials. Buff and red-burning clays in their green (or raw) state are grey, black, tan and red, but when burned these change to a light flesh colour which ranges to a deep chocolate brown, the tones modified according to the proportions of iron carried and also by the temperature reached in the firing.

A good modelling clay must have: (1) plasticity, with the ability of holding its form both while being worked and during the firing; (2) porosity, or sufficient looseness or openness in the clay particles to enable the moisture to escape in drying without shrinking too much or cracking; (3) vitrification, or the proper resistance to heat, so that it does not warp and crack in the firing or shrink excessively. The open, rather sandy clays are the more desirable.

Uses.—Sculptors have worked in terra cotta since the beginning of history, using it for the modelling of small figures, for the making of moulds and for pressing in the moulds, as well as for architectural details, friezes, tiles, roofing and façades. The amount of terra cotta objects produced is naturally governed by the workable material of the country. In Egypt and Italy it was used extensively because of the scarcity of marble and stone.

METHOD

Preparation.—A suitable clay having been located, it must be mined and cleaned of all foreign substances (stone, twigs, etc.) by washing, blunging, sieving, and then separating from the water. In modern efficient equipment the separating is done by means of a compressor which absorbs the water and leaves the clay in compact workable squares, which in turn are placed in a damp box and kept moist for use by the sculptor when needed. In primitive plants one method is to make a trough of hollow tile; into this trough the liquid clay, or slip, is poured and, because of the porous quality of the tile, the water is absorbed and evaporated, leaving the clay which can be rolled up and stored away.

Construction.—Now it is ready for the sculptor. One method of constructing a figure is to build it up on an armature, with either plasticine or clay. If clay is used, it must be kept wet either by spraying water on the figure from time to time as the work advances, or by keeping damp cloths around most of the surface, and by covering it entirely and keeping it in a damp box when not being worked. If the original is not to be cast, but to be fired directly, no armature can remain in the statue because of the twisting and burning of the wire in the fire. Usually small statuettes are made solid; but for larger figures and groups it is best to build them hollow, keeping the thickness of the clay walls as even as possible. In this method the clay requires definite preparation. It must be thoroughly wedged, which means that the clay is cut in two on a taut wire and vigorously thrown down, one piece on top of the other, to expel the air. This is done repeatedly until the clay is even in texture and uniform in moisture. If a clay is too hard, water can be poured on the clay and then the clay cut and beaten again as before. It is wise to start with approximately as much clay as the size of the figure to be constructed, working as long as possible until it begins to sag on account of the moisture. While working up to this point care should be taken when adding new clay to work it thoroughly into the old clay, making sure that no air has been allowed to enter and that the added clay is securely blended to the old. When the sculptor has worked as long as the clay will permit, the statue is allowed to dry and stiffen just enough to hold its shape, and then the sculptor will proceed as before. When the figure is ultimately accomplished, and the fine details are being developed, it is helpful to spray the figure occasionally with a very fine spray of water.

Should a mould be made, the clay is not allowed to dry but is kept in what is known as leather-hard condition, firm and hard but still moist. From this the mould is cast, and if the piece is not too intricate and has no undercuts, the original may be saved. The clay, shrinking slightly as it drys, separates itself from the plaster mould. In order to cast a difficult mould, one with small passages and many pieces, the clay must be poured. Clay in a dry state, powdered and sprinkled into water and then stirred vigorously or blunged, makes what is known as slip (a liquid clay). Slip needs to be fairly thick to prevent too great shrinkage in the drying. The mould should be dry before the pouring, and the slip free from air bubbles Pouring the slip very slowly over the mouth of one pitcher on to the mouth of another will break the bubbles. To make the mould ready for pouring, it. should be tied together securely and wedges placed between the plaster and the cord to tighten the hold. Then the slip is poured in until the mould is full and shaken gently to raise any bubbles. The slip will adhere to the dry mould, the moisture soaking into the plaster, and as the amount soaks donn, more slip is poured in to fill the mould again to the top. This process is repeated until the thickness of the wall can be seen by scraping across the mouth of the mould with a flat knife, and, if sufficient, the mould is then inverted on two or three small blocks or tiles and allowed to drain. When it begins to pull away from the mould, or is firm enough to stand by itself, it is safe to untie and separate the mould. It is stood on a flat level table, and the sculptor then begins to work over the surface, cutting away the seams which always show where the sections of the mould come together, and refinishing and retouching. The statue is then allowed to dry slowly and is ready for the fire.

Another method, which, if possible to use, is quicker, is to saturate the mould and then, after wedging the clay thoroughly, to roll it out with a rolling pin on a flat, dry, unpainted surface until the clay is an even thickness and not hard. The clay is then placed on each half of the mould and with a damp sponge gently patted into all of the irregularities of the mould and the edges are trimmed with a thin pointed knife. Then the two halves of the mould are tied together, and the sculptor works the clay back and forth across the seam inside the mould vigorously, addingsmallbits of clay where it is uneven. This is very important, because if the joining is not sufficient the clay will crack in the firing. The cast can be taken from the mould almost immediately, and the mould is ready to use again. With the heavier clay the shrinkage is less than with the slip. The retouching is the same in both methods.

The colour of the clay can be modified by blending a light clay with a red clay or by completing the objects in one clay and then by giving them a wash, or *engobe*, of slip of the desired colour.

Firing. — Kilns vary in their size, construction, and manipulation and have been built to burn coal, wood, oil or gas. There are updraft, downdraft, and muffle kilns, and round, square, and oblong kilns, made of brick, stone, and sheet iron. The latest development is the electric kiln. In stacking a kiln, the unglazed ware will not stick together and the pieces can consequently be allowed to touch. Figures set in the kiln for firing should be placed on spurs, or small pieces of fire brick, which raise them slightly and allow the heat to circulate all around the figures. When the fire is started it is raised gradually to allow the moisture to escape slowly so as to prevent cracking; for although a piece may have been drying for a year, it still contains from 18 to 20% of moisture.

Terra-cotta can be fired in any type of kiln, different clays demanding different temperatures. To fire heads, sketches, statuettes, animals, etc., the average clay fired to 1,800° F is sufficient. The higher the fire the denser the body, the darker the colour. For unglazed architectural decoration and for garden sculpture, the body needs to be well fired, as it will be exposed to the weather. Science has progressed in registering heat from the sight gauge to the Seger Pyrometric Cones, and finally to the automatic heat-recording pyrometer.

When the kiln has cooled, the ware is unpacked and, if the sculptor is interested in colour by glaze, he weighs out his glaze formula, grinds the glaze and applies it to the statue as a liquid, painting it on and allowing it to dry. Then it is reset in the kiln, great care being taken to prevent the statues from touching, and refired, the temperature being determined by the type of the glaze.

There is a growing interest among modern sculptors to work in clay, some carrying their work to the height of exquisite finish and others dashing off spirited sketches which in this medium express spontaneity as they can in no other material.

Among the American sculptors, Herbert Adams, Paul Manship, Victor Salvatore, Gleb Derujinski, Paul Jennewein, Bessie Potter Vonnoh, Alfio Faggi, John Gregory, Elsa Horn Voss, Janet Scudder, Beniamino Bufana, Carl Walters, and A. A. Weiman are the chief workers. They use various methods of finish., Adams and Manship treat the terra cotta individually with a wax and oil paint finish. Salvatore and Derujinski leave their work in the biscuit, while Jennewein, Gregory, Weiman, and Voss carry their sculpture to a glazed finish. The sculptors show great contrast, Jennewein and Gregory designing strong and decorative architectural details, pediments, friezes, etc., while Voss portrays animals with great charm. Rodin, Despiau, and Maillol are the outstanding figures in modern French terra cotta, and Wackerle in modern German.

The possibilities of glaze sculpture are just being investigated. The Della Robbias used it extensively, but their colour and type of glaze never varied and did not lend itself to very sensitive modelling. The modern sculptor who is interested in colour is working to make a glaze which has quality and yet is thin enough not to hide the details of the modelling. For architectural details, however, the thick brilliant glazes are suitable. (*See* TERRA COTTA, which includes bibliography; also SCULPTURE.) (M. R.)

MODELLING, PRACTICE

Modelling, as treated in this article, is that preliminary stage of a work of sculpture which involves its actual creation in a soft material and its subsequent casting or reproduction in a more permanent material. No consideration is to be given to that attribute of a piece of sculpture which is spoken of in criticism as "good or bad" modelling. The latter attribute is dependent upon those qualities which the sculptor has put into his work, such as the conception of mass, surface, texture and detail. (See following section, MODELLING, THEORY)

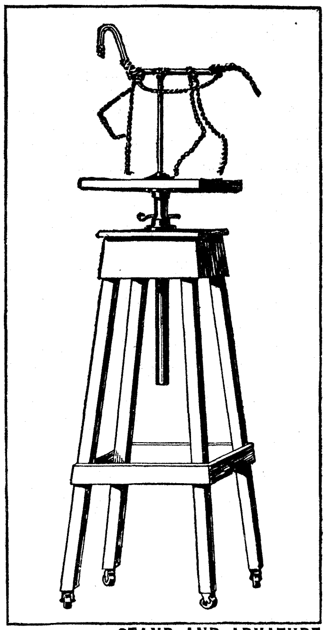
Materials. — Formerly, sculptors often carved their works direct from the stone or wood, but the advantages of being able to take off or add on, to twist and change until such time as the work has assumed the desired form has appealed so strongly to the modern sculptor that modeling is almost universally used and the acceptance of the possibility of these changes help to bring modern sculpture to perfection just as the changes in the manuscript help to bring the writing of a book into better form. Michelangelo and other old masters often carved directly in stone, but only an artist of great vision and much training dare commence work upon a valuable piece of marble, and though work so executed may possibly gain in spontaneity it is sure at all times to lack in that thoughtful consideration which a more tractable material permits.

When the processes in modelling were first practised clay was used, but this material has faults in that it is difficult to keep at just the right degree of moisture, and when too dry it must be frequently sprayed with water or covered with moist rags. Wax, which came into use later, is also difficult to handle and very fragile. Thus a comparatively new substance, which is called plasticine and which is really a clay-like material of an oily composition that dries much more slowly, has come into general use, eliminating many of the sculptor's difficulties.

Conception. — The sculptor often makes a number of preliminary sketches in plasticine of the work of art he is contemplating, and as a rule he makes these sketches small enough to avoid the necessity of supports or armatures. Sometimes these sketches are made over an extended period of time and changed again and again until the general idea has "crystallized" in the artist's mind, and he has established just about what arrangement of his work is going to be best. It is often necessary to make a larger and more detailed sketch, including final corrections so that the whole may be kept in mind as his work proceeds. This preliminary work is necessary because of the fact that sculpture often involves so extended a period of time in its creation that certain considerations are likely to be lost sight of as the work proceeds.

Armatures.—On the basis of the final sketch and upon the sculptor's determination as to the size in which the modelling is to be carried out, a suitable armature or support must be constructed. For instance, assuming that the sculptor intends to model a standing figure 30 inches high, a square, iron rod, with three branches at the bottom for support, and bent at a point about 18 inches' from the base to meet at a right angle the small of the back of the standing figure, is screwed to a board which is used as a base. The fixed centre of the human body is the small of the back, or the centre between the pelvis bone, and it is important that the armature at this point be so arranged that any change in the position of the arms, legs, or torso will not interfere with the fundamental balance of the figure. This bent portion of the iron rod at the small of the back should be, in the example adopted, about 6 inches in length with a 2-inch upward bend at the end. Lead wire, or pipe, of $\frac{3}{8}''$ diameter should be used, one section for each leg, one extended up to the top of the head and two more attached properly for the arms, and these lead extensions are attached to the iron support and bent in accordance with the movement of the sketch from which the sculptor is working.

Sufficient plasticine must next be applied to the armature and the work of modelling should proceed until it arrives at an approximation of the original sketch at which time a living model should be obtained and posed as nearly as possible like the sketch. From the model measurements can be taken and corrections made to bring the work closer to life and actuality. Sculptors sometimes take liberty with modelling and this is the artist's license if any advantage of general effect is obtained, but though it is not entirely essential to follow the anatomy of the model or models exactly, it is certainly very necessary that the sculptor be well versed in this part of his work and equipped with the knowledge which makes it possible for him to change the forms to advantage. It is wise to follow the model closely in the control of mass as a whole, but many of the details may be changed so that the planes and profiles are better related and more pleasing.



MODELLING STAND AND ARMATURE

When the artist feels that he has accomplished to the best of his ability the work before him, he must next consider the process of putting it into plaster, as no casting in bronze or cutting from the stone can be made from the clay model. It is advisable to have a professional moulder do this work, as even the mixing of the plaster is a skilful process and the location and arrangement of the mould sutures takes a great deal of practice. *(See* section, this article, *Plaster Casting.)*

Relief. — The sculptor, if he would be successful in modelling high or low relief, should have a mastery of modelling in the round as he is attempting in relief to give a three-dimensional effect and this involves the same understanding of mass, composition, planes and profiles as in the round The most important question to be considered is that of the relationship of the highest points to the lowest in the background, and this must be carefully thought about and established. The background does not, however, have to be perfectly flat but may follow the general movement of the figures upon it, being deeper in some places than in others, in order to soften certain passages and aid the relief in its various planes.

Enlargement. — For enlarging to life size or greater, the modern sculptor makes use of a so-called enlarging machine of which there are several types, all based, however, upon the principle of the pantograph For the large figure the armature is erected similar in principle to that for the small work, but is usually constructed of mood, lath and plaster so as to bring the bulk of the armature closer to the surface and in this way not necessitate the use of such great masses of clay, and thus avoid the possibility of parts falling off by their own weight and lack of proper support. For some large works plaster may be used as a modelling medium, thus avoiding the extra work and expense of the final casting.

After the figure has been so treated and carefully "pointed up." it must be gone over again carefully by the sculptor to make any minor changes which appear to be necessary when the figure is perceived in larger scale and which were not so obvious in the smaller model. Thus the modern sculptor not only makes use of all the above mediums for the betterment of his work, but also keeps the result carefully under his supervision so that it is in perfect keeping with his personality and the spontaneity of his conception. *(See* discussion of other related subjects in this article.) (L. LEN.)

MODELLING, THEORY

As sculpture is the art of form, modelling is that part of the art of sculpture concerned with the treatment and manipulation of the surface of form; also, in a secondary meaning of the word, the building up and shaping of a work of sculpture in a plastic material preparatory to casting in plaster of Paris, bronze or terra cotta, or cutting in wood or stone.

With the Greeks one of the tests of a work of sculpture lay in the animation, vibration and life of its surfaces. This is due to the modelling and in this special sense modelling may be called the art of the surface of form.

Modelling as a method of building sculpture dates from the time when men hunted the wild horse, the hairy mammoth, the reindeer and the bison in western Europe. There is proof of this to be seen to-day in the caves of France and Spain in the group of bison and the torso of a woman found there. The originals of the Greek terra cottas were undoubtedly first modelled in clay, followed by a mould from which many copies could be reproduced. The earliest bronzes were either modcllcd solid in wax, as was done in the half life-size figure of Gudea from Sumeria, 13th century, B C., now in the Louvre, and the earliest Egyptian and Greek bronzes, or over a core, composed of materials similar to those used in this for casting in bronze, thereby allowing the metal to be made very thin and the statue hollow.

Modelling, considered as the art of surfaces as distinguished from the building up of a statue or other piece of sculpture, is well illustrated by the works of Michelangelo and Rodin. Michelangelo's bronzes have perished, but his works in marble show almost perfectly this special quality of modelling, as the art of surfaces; they rely, almost wholly, for their effect, power and charm on what has been done with their surfaces. The Greeks, instead of relying primarily on the surfaces, which were only part of their conception of sculpture, paid particular attention to the development of clear profiles and significant silhouettes. As a result of this practice, Greek sculpture always appears to good advantage in the open air, while Michelangelo's, with the possible exception of the "David," is confused when placed out of doors. Basing his theory and practice of sculpture on the development of beautiful surfaces and significant modelling, he paid little attention, comparatively, to the clearness of the silhouettes. As seen from a distance, his silhouettes are rather obscure, his statues more or less shapeless. To get the maximum enjoyment out of Michelangelo's masterpieces, the observer should be near enough to see and feel the projections and depressions—the convex and concave surfaces. *(See* MICHELANGELO.)

In the case of Rodin, these qualities of modelling are developed to excess, with the consequent neglect of qualities just as vital. No group of his is as fine as the figures composing it, and no figure is as good as the individual parts. We have only to recall such figures as have been placed in the squares and gardens of Paris to be aware of the difference in the effect of the same figures when seen in a museum, where all the advancing and receding planes, with their projections and depressions, become a source of keen enjoyment and result in a surface of great richness. Thus it was that Rodin instinctively created so many fragments, justifying his use of sensual and highly modelled planes against areas deliberately left rough and unfinished. A Rodin is best when it is small enough to be handled and the surface felt with the fingers, thereby getting the utmost possible enjoyment out of it. This conception of sculpture leads naturally to the "morceau" (the part or detail) and is the result of too much occupation with modelling. It is also one of the causes of the modern cult of the fragment.

In the actual manipulation of the materials used in modelling, many methods are employed, resulting in various textures of the surface. Some sculptors apply the clay, plasticine or wax in small, round pellets, called in French "modelé à la boulette." This method has been very popular since the middle of the 19th century. It allows a gradual building up of the form, producing a surface that is granular and vibrating in the light, and somewhat like the effect of an Impressionistic painting. (See PAINTING; IMPRESSIONISM.) It developed at about the same time as the Impressionist school, and must be looked upon as an outgrowth of ideas current at that time. Other sculptors apply the clay in great hunks and masses, working it slowly into shape by putting on and cutting off until the desired form and surface are achieved. For tools, some sculptors rely almost wholly upon the hands and fingers, especially the thumb, while others use tools of different shapes and of various materials, such as wire, wood, sheets of steel, etc. (see section above, Modelling, Practice). With such a variety of tools, the sculptor is capable of producing surfaces varying from one as smooth as glass to one as rough and corrugated as concrete. As a general rule, sculpture of the earlier periods, and even down to the middle of the 19th century, has a smooth surface, while work done since that time runs the whole gamut from the highest polish to extreme roughness, according to the character of the subject.

From about 1850 many apparently new qualities were introduced into sculpture besides the "modelé à la boulette." Some were qualities derived from the study of ancient works and the effect of time and weather on the materials used in their construction. Other qualities grew out of the general expansion of the fields of science, art and literature. At that time all things seemed possible. There was a spirit of exploration and adventure abroad as well as an interest in the past. Men turned their minds eagerly to the past to discover many forgotten beauties. Greece and the Renaissance were no longer the whole of antiquity. Dissatisfied with the art of the academies and the failure of anything resembling a genuine tradition, men turned hopefully for aid to the whole field of the past, in all times and places, instead of the strictly limited fields they were taught to venerate; they sought for aid and inspiration in the Gothic, the Romanesque, in India, China and Archaic Greece, which, until then, were unknown or forgotten. A general expansion followed. It was realized by some that there were principles and laws underlying the practice and theory of the arts wherever and whenever found. The German sculptor. Adolf von Hildebrand (q v). attempted to formulate and state a number of these fundamental laws in his book The Problem of Form in Painting and *Sculpture*. It has had a great and beneficent effect on the understanding of the arts of painting and of sculpture. Alongside of this attempt to understand and use the principles found in the arts of the past there grew up a desire to imitate. Sculptors and painters strove to work in the spirit and manner of different periods. They tried to give the accidental and picturesque effects of time and weather on bronze, stone, and wood to new work. They attempted to become reconstructors as well as restorers.

Those eager spirits who looked to the future attempted to use the results of science and observation in creating a new art. The outstanding scientific contribution was in the realm of optics; the most fruitful of results was Prof. Rood's book on the colours of the spectrum as applied to the art of Painting. It was this book which determined the course of development of the Impressionistic school led by Claude Monet. In its preoccupation with light it had a great influence on certain sculptors They were no longer content to get effects of colour in their work by the age-old methods, but tried to achieve effects of light and colour by methods more appropriate to painting. The Italian Rossi carried this to extreme, as did Rodin. They tried to obtain colour not only by depressions and projections and the use of ornament, but attempted, by their modelling, to get the effects of light as it not only revealed but obscured the actual form. Hollows were deepened to obtain strong dark effects, and filled up to create surfaces which would reflect the greatest amount of light. Details were accentuated and suppressed for the general effects of luminosity. There are things by Rodin and by Rossi which approach nearer to the paintings of Carrière than to any sculpture of the past.

Sculpture became sketchy and impressionistic for the first time. Such works often had great charm. Effects were attempted in sculpture which had never been thought possible before. But the movement passed; it was an interesting but rather futile experiment. One of the results of the study of the arts of the past has been a renewed interest in the theory and practice of working directly in the material in which the work is to be completed. A cult has grown up of the "taille direct"; it has been elevated into a slogan of almost hieratic import. It has become so important in the minds of some of the practitioners that they would never think of working otherwise. It has become not only necessary that every stroke of the chisel be delivered by the sculptor himself, but has even gone so far that no model can be used except the living model. The block of stone or piece of wood must be attacked direct. Whole figures are cut out of the hardest and most obdurate materials without a preliminary study in plastic form being made. It is insisted that all the great works of the past were so made. Along with this has grown the belief that all work should be cut in place. It is maintained that the unity of the architecture and sculpture in the great monuments was so obtained. Much is to be said for this theory and practice. It results in a much more intimate contact between the artist and his work and, what is of much more importance, in a greater respect for the material in which the work is done. There is less of a tendency toward attempting to do in stone or wood those things which are perfectly possible and proper in bronze. Generally, a greater sense of mass is achieved, or perhaps, not so much achieved as retained. There is more of the feeling of the block in the finished work. With the Egyptians, their practice of cutting their work out of the hardest of stones (granite, basalt and diorite) with primitive tools undoubtedly determined the style of their sculpture. If the sculptor has to cut incisions in a material almost as hard as the tools he is working with, he will cut them no deeper than is necessary, and he will cut no more material than is essential to the finished statue. That some pieces were cut directly in the stone without preliminary studies and models is hardly borne out by historic facts. Too many sculptors' models in chalkstone and other easily worked materials have survived from Egypt. We seem to have no authentic plastic models of the archaic or classic age of Greece. On the other hand, consider the pediment figures and the frieze from the Parthenon; it is inconceivable that they were cut "in situ" without very complete preliminary models. The frieze was perhaps worked from a finished drawing, but even that is very doubtful, as a study of the relief indicates. It is interesting to note that the pediment figures were not cut in place but were carved and finished on the ground and then hoisted into position. As proof of this, one need only glance at the backs of the figures which went against the wall of the buildings. It is assumed by some archaeologists that the Greeks followed, generally, the practice. of carving their statues directly out of the stone block; the reason given was that they knew so well their "canon" and what was to be done that they just went ahead. In the case of men doing "school pieces," this was undoubtedly so; but the creation of an original work was a totally different matter and it is just as likely that the architects of the Parthenon, Ictinus and Callicrates, went ahead without plans for their great building, as to think that Phidias carved the frieze without knowing beforehand what he was doing. The frieze, by the way, shows distinctly the carving of a number of different workmen.

During the Romanesque and Gothic periods, it seems, with the information we have on this subject, that a similar procedure was practised. Minor works are left to the master stone-carvers, but the large groups and statues are too complete, too "right in place," to have been left to the whim of the stone-carver.

During the Renaissance, where we find so many masterpieces, with complete harmony between architecture and sculpture (notably in the tombs by Mino da Fiesole, Desiderio da Settignano, Donatello and the Della Robbias), the work was generally in the hands of a sculptor. In Michelangelo we have the individualist who had difficulty in working with assistants; he found it easier to do the wdrk himself than to put up with the slowness and irritation of helpers. He carved his figures himself directly in the marble, and we see with what results. No statue of his, not even the "David," is completely finished. The top of the "David's" head is not finished. This lack of completeness grew out of a number of different causes, namely, his impetuosity, his impatience, and his practice of attacking the block of marble without sufficient preparation.

Re is recorded to have said that one should make a full-sized model first, but his own temperament forbade it in his own case. As a compensation for the fragmentary and incomplete state of his works in sculpture, we have the most wonderful and expressive marble-carving in the world.

Nowhere is there such surging life, nowhere is the actual stone so transformed.

His chisel cuts the marble with the creative power of a brush stroke of Rembrandt. Under his hand marble becomes truly living stone.

The modern cult of the "taille direct" shows none of this transforming power. Only too often it is used as a questionable, merit to cover up incompetence, the thought being, "I cut it directly in this hard stone; therefore it must be good." The differences in modelling between carved and modelled surfaces is not as great as is generally assumed. Of course, stone should remain stone, granite should remain granite, and wood should remain wood.

Certain things perfectly feasible in bronze when translated into stone or marble become objectionable because of the nature of the materials.

Such things as the statues of Siva, found so often in Hindu art, with the encircling halo of flame, become atrocities when carved in stone. This grows out of the very nature of the materials themselves.

Bronze, being a very tough material with great tensile strength, may be pierced full of holes provided the unity is maintained in the design; stone, having a low tensile strength, demands a treatment more in the mass.

The surfaces of stone, marble and granite, as well as wood, may be treated to show the mark of the cutting chisel or carried to the highest degree of polish.

The polished surface makes a very different appeal to the eye and also to the sense of touch. Marbles, granites, and the hardiest stones, such as basalt and diorite, change colour as well when polished.

The degree of smoothness or polish should always be determined by the effect desired.

It will be well to remember that bronze is always a cast material and though it has very special qualities of its own, of hardness, colour and reflecting powers, it has always been cast molten and fluid into a mould from a model, The better the casting the less work necessary on the finished statue.

Details are often chased on the bronze but generally they exist in the original model and are only sharpened in the bronze.

(M. Y.)

THEORY

So widely separated have become those, in this modern generation uho write on art, from the artists themselves, that criticism is generally completely ignored by the latter save when they receive gratifying though really unimportant praise, and it is almost an unheard-of thing for an artist to change his style because of critical suggestion.

Therefore it has been thought advisable, in the *Encyclopedia Britannica,* to resort to the artists themselves for the articles covering the practice of every art and to supplement this firs't-hand information by a few brief treatises which help to bind it together and unify its deductions.

This article, therefore, like those on DRAWING (TECHNIQUES OF) and DESIGN, is written primarily for the purpose of correlating the artist's theories.

It will be of use to the student, as well as for the purpose of establishing a type of criticism making possible judgment not only of the results of an artist's labours but also of his various plans and methods of arriving at them.

The metaphysical and historical aspects of the problem are represented by the articles on **FINE ARTS** and on **AESTHETICS.**

A study of the various articles written by artists in every field of the graphic and plastic arts of both fine and applied classifications stresses a contrasting view: that the artist is an analytical and reasoning being like the scientist, and that the main concern in his work is what we describe by the general term "technique."

He is inspired at times just as in truth is the scientist, but, like the scientist, he must also apply himself to analytical thinking and hard labour. It is with these aspects that the present article is concerned.

Material. — One of the most important interests to the artist is that of the materials or substances with which he works and the methods whereby they can be most effectively treated. Their relative strengths are spoken of in the preceding sections on SCULPTURE TECHNIQUE: *Modelling.*

From many different viewpoints it is the sculptor's concern that he be well-equipped with an experimental knowledge of textures and qualities, physical as well as aesthetic, qualities which cannot often be described in words, they are so delicate and intangible, but can only be shown in actual work; characteristics which are as true and yet as difficult to describe as the shading of a curve.

If he is working in stone he must know whether it is granular, stratified, or crystalline; he must know the properties in the same manner of wood, ivory and other substances, and there is no possible way for him to find these out other than by trying them, experimenting with them, discovering their properties, just as might a scientist in his laboratory, but properties of course quite different from those which interest the scientist.

Not only must the texture and grain be kept in mind: in the modelling of a head the sculptor finds that the outstanding features such as the nose and ears cannot be left so thin, if the figure is to be cut in marble, as they would be if it were to be cast in bronze, or they will appear too translucent, for marble is not so opaque as bronze.

Finish.—The finish of the surface is a matter of great importance; it should be appropriate to the material, and at the same time to the subject portrayed.

It must, moreover, be such that it creates a surface not harmful to the modelling.

Many Renaissance bronzes lose all quality of their modelling because of the confusing highlights caused by their too-highly polished finish.

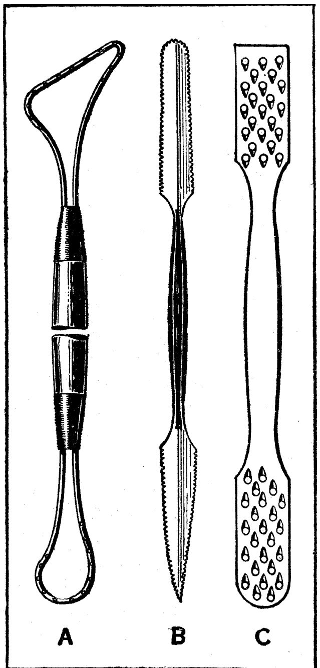
It is offensive to see a beautiful piece of marble capable of sustaining a fine polish, upon which have been left careless chisel marks. This indicates that the artist was either too lazy or too hurried, or perhaps too interested in creating a style of his own.

On the other hand an over-polished finish upon a material which is too rough and crude to sustain it is also lacking in good taste. How is the artist to know just how deeply his carving should go; just what degree of detail to use; and what texture of surface is best suited to his work? Only through a long study of the works of others both contemporary and ancient and through many experiments of his own; and the critic judging a piece of sculpture should always think of this element as well as that of the material and judge as to whether or not the sculptor has been successful in this work.

Detail and Design — The addition of decorative detail to a figure is a question which has been much discussed and it is well enough for the purist to point to the Greeks and Michelangelo and say: "There stands a beautiful form needing no decoration," but he certainly can never disprove the beauty, largely due to the ornamental treatment of drapery, hair, and other details existing in the best of the Gothic, Chinese and East Indian sculpture. It is true that form must grow from within, but form is only seen on the surface. A surface decoration may be quite separate and distinct in detail from the underlying form; its design and texture may have little to do with that other more powerful element, but it must never conceal the life within. Think of the beauty of the swell, only faintly suggested, of a rounded breast, or of a firmly curved thigh as revealed under the draperies of surface decoration of many Greek and Chinese figures. Are they not more enchanting in a way than the more obvious beauties of the nude?

But the sculptor must not approach his problem thinking only of design, whether it be the design of surface or of structure, for his work will then lack life as did some of the Gothic, and may appear self-conscious and strained. It is better to "find" design in one's natural surroundings than to attempt to "construct" it. The observant artist often thrills with a sense of surprise and discovery at the sight of a quite accidentally occurring design which nature weaves into the tapestry of her days and nights. It may come when least expected and from the most unlikely source. It is not inspiration but the lucky chance of a certain combination of light and action and mood which must be grasped and noted at once before it is lost forever. By being always on the alert, the artist can keep himself ready instantly to take note of it. Through the accumulation of his notes he can always be equipped with a stock of designs which may be brought into his work. Korin, that great Japanese screen painter, executed in a perfectly naturalistic and direct way each fragment of nature which impressed him with its expressive design, and so the sculptor may see in the grace of a poised head, the crouch of a cat, or the shrug of a greyhound, a design which needs no enhancement; in the ruffs of fur, the ripples of muscle, the rhythm of ribs, the curling of hair, or the wrinkles of age, he can find a thousand sincere decorations infinitely better than anything he can imagine. He may find them in the folds of clothing, and even a short pleated skirt is a motive in surface decoration which the Egyptians would have employed in making a beautifully successful design.

Expression of Tool.—In sculpture the actual mark of the tool is not so beautiful in itself, nor so sensitive a reflection of the mood and character of the artist as it is in painting. This is undoubtedly because the medium of the sculptor is a more difficult one to handle, but nevertheless the sculptor must consider this question and he must be very careful, if, for instance, he is working in clay or plasticine, that his final bronze does not express the soft plastic appearance which he has imparted to the original substance, upon which he has left the casual marks of his tools or even his fingers.



MODELLING TOOLS: (A) WIRE TOOL FOR MODELLING AND CUTTING CLAY: (B & C) TOOLS FOR PLASTER WORK

One cannot leave a deep thumb impression on bronze, and there is no excuse for leaving it on the clay image from which the bronze is to be cast, for this gives a false impression of the qualities of the final material in which the work of art is to be seen.

Some sculptors not only show great skill in the proper expression of their tools and the impression they make on the medium, but form a personal technique suitable to the subjects they are portraying. Thus Mestrović has developed a technique peculiarly personal and peculiarly suitable to the wood in which he often works; and Rodin not only employed a personal, appropriate and vital method of treating the smoother surfaces of his figures but also, as a gesture effective in its qualities of contrast, left rough tool marks on the surrounding stone.

The sculptor must, however, be very careful that this personal use of tools does not become an affectation. It should be natural, human and appropriate to the medium and should be chosen only because it is suitable to what the sculptor wishes to express.

Modern critics would do well to point out the frequent insincere use of what might be termed personal textures of tool marks which are employed by some sculptors as a trade-mark.

Modelling. — Structural and rhythmical modelling that is true in its portrayal of the artist's theme and which conveys some of the original emotional thrill of beauty which gave to the artist the creative urge is attained only after the artist mastered and balanced his whole array of technical forces. This is well shown by Arthur Lee's figure, "Rhythm."

It is this perfect conception upheld by a perfect technique which puts the breath of life into his work and even the master cannot be always sure of grasping it. But one thing is certain and that is that this life must be drawn from the great tumult of life with which nature surrounds us. Perhaps one model will not suffice for the sculptor; he may have to resort to two or three and perhaps even they are not sufficient, so that he will find himself forced to create details which he remembers from still other models, but it is certain that in the expression of this quality of vital force the artist is but the translator of an epic inscribed by the master of all master craftsmen.

The "modernistic" rhythms which emanate from the finite mind of a single artist are trite and dead as compared with those which millions of years have developed in the evolution of animal and man.

Choice of Subject. — It seems strange that in these days of keen athletic youth, great action and intense living, many sculptors are still content with the portrayal of well-rounded and rather phlegmatic female figures usually reminiscent of days long past. in form, in position and in name.

This is probably due to the sculptor's training in the classics and to the attitude fostered by the adoption of the term "fine arts:" but on every hand slender, beautifully athletic forms are walking, running, skating, skiing, swimming and dancing — doing a thousand things with a clean-cut action and beauty never attained even in the days of Greece, and closer to the modern sculptor and his public.

Some sculptors have adopted this viewpoint and the alert living figures of boxers by Mahonri Young are an example showing the tremendous possibilities, for these two figures are bound together by that intangible, though very real cord of antagonism in a primitive contest, in a way which has hardly been better portrayed. Even though the sculptor may not adopt the facts of modern existence in his work it is still possible for him to portray the spirit of this, even though the name of his subject be hundreds of years old. Edward McCartan has grasped this spirit in his figure, the "Diana with the Greyhound," and it is not difficult to imagine this girl buoyantly walking down some familiar road and shortening the leash on her dog as she crosses at the street corner. In such manner did Michelangelo and Cellini express the spirit of the Renaissance.

Even better did the Greeks record all that was beautiful in their daily lives.

But a sculptor must be careful to choose a subject which he understands and loves. His is perhaps the most enduring craft and many are the miscreations that live too long. Often without more than a few hours of thought he will start a work which will take him years to complete and which may exist for centuries. Thus sculpture must have a fundamental meaning and the artist should think of it as existing not only for his contemporaries but for generations to come.

For this reason he must deal with those qualities which all men comprehend.

By this it is not suggested that a meaning which is involved or literary can be employed. Such meanings are not sufficiently universal, and the contemplation which is necessary before the sculptor begins work should consist of preliminary observation, the assembling of notes made at previous times, and those trial sketches recording things which he may forget in the heat of his actual work.

It is said that famous painters of the Far East often merge themselves in contemplation of the silk upon which they are going to develop a work of srt, and that they do not permit themselves to make even the lightest line suggestive of the composition, for the reason that the first touch of brush to silk to a certain degree commits them, and masses, rhythms and lines can be more easily moved in the imagination before this first lightest touch has begun the crystallization of what they wish to do.

Many great sculptors have weakened their work by not devoting an amount of time in consideration proportionate to that expended in the actual labour. This was especially true of Michelangelo, who in the great vigour of his mind sometimes created beings that seemed to wish to reach outside the block of stone. (*See* SCULPTURE TECHNIQUE: *Modelling,* Tlzeory.)

Characterization. — After having selected the subject and model it is necessary to choose certain characteristics and to eliminate those extraneous details which do not form an inherent and component part of its being. This is the artist's privilege; it is almost the heart of his work, and selection must be thought out carefully.

Many modern artists are carrying this privilege so far that their work eliminates all possibility for those blending chords of characteristics that develop in a fine portrait sculpture as rightly as in organ music.

The work of the true portrait sculptor shows all the complications of the characters portrayed, but reduces them to a meaningful whole.

It is difficult to understand why in these days of diversity of interest and complications of existence some artists should choose to show less in their work than did many of the more primitive peoples.

Association with Surroundings. — Sculptors have found it necessary to specialize in certain fields, because they have found it necessary to study not only the problems of their work in itself but those which are involved in adapting it to its intended surroundings.

In the foregoing articles certain broad truths have been pointed out, but the reader must realize that these are only samples of the problems which must be solved, for not only must the sculptor who is making portraits be a student of craniology, physiognomy and anthropometry, but he who is working for the enhancement of the beauty of a building must be properly equipped with a knowledge of periods of architecture and decorative styles, their reason for being and their influences. Each division in this field of art has its problems of application, whether it be portrait, architectural, garden, monumental or any other branch of sculpture, and whether it be large or small, bronze or stone, designed to be shown indoors or out-of-doors, on an eminence or level with the eyes.

Psychological Balance. — Sculptors, of all artists, feel the necessity for a proper balance, because of the enduring quality of their art, while painters are often the first to take up the enthusiasms of the day and to drop them. In recent years there has been a great wave of interest in the subjective; man searches his inner being with interest in an endeavour to find that which he has not been able to find outside himself. Perhaps this tendency is due to the declining power of religion and it has been suggested that men are no longer moved as were those of the middle ages in the worship of a god and now search for a god within themselves.

In art there has been a revolt against the strongly objective viewpoint of the academist, for realism was carried in the 19th century to its ultiinate climax. The impressionists were not concerned with reality but were interested only in their impression of things, in catching the fleeting moment, and thus their work grew swifter and swifter in the hope that they could catch quickly passing glimpses of light and colour. Sculptors only distantly followed this movement.

However, after the impressionists, various groups of distortionists who were sculptors as well as painters, carved and twisted reality until all semblance of meaning was lost and no one could guess with what model the artist had begun his work. In defense of all this, artists said that they were "expressing themselves," an argument which though not complimentary to their reason was nevertheless unanswerable, for who could tell what another saw or did not see?

This reaction against the too objective viewpoint of the 19th century is a healthy one and was necessary in the development of the evolution of art, but there is nowadays among artists a growing understanding that a readjustment will be necessary and of all artists the sculptors appreciate best the necessity of balance between the objective and the subjective, the factual and the imaginative. that which can be observed in the artist's world and that which the inner being of the artist imposes upon it.

The primitive artist first makes as good a copy as he can of the object he is attempting to portray and then feeling a lack in its static quality resorts to various devices to indicate its movement. In doing so he combines what he actually sees, the objective, with what he feels, the subjective; and every artist does the same, for nothing in nature is quite good enough to satisfy the artist; he must improve on it a little. Nothing in nature exactly fits with the spirit of his mood and thought, and therefore he must mould it the better to suit his expression. It is this subjective quality which, along with his technique, creates what we call the artist's style, for in it we see something of the man himself; we see the object which he is portraying through his eyes, coloured by his emotions, illuminated by his dreams and enriched by his knowledge. But this style should never be consciously imposed upon the theme in such a way as to obscure it, for the artist's true endeavour is to make it possible for his fellowmen to see more clearly and with more feeling than they could without him. In order to accomplish his purpose he may make a round breast rounder to point out its roundness, or in like manner accent or suppress any quality of light or shade, strength or weakness, vigour or impassivity, any emotion, any association or any other reaction which he may choose to employ, if the power of his work upon his fellowmen can thereby be increased, so that it enlightens and instructs them in the experience of the beautiful and broadens their understanding. The grotesque of the Renaissance may be as great art as the placid figures of an Amida Buddha, for art, like science, is not concerned with right and wrong, good and bad. Its urge is to broaden and explain, to impart feelings which could never be expressed in words and which may never have been felt or expressed in just that individual way before. Thus, it makes us understand almost as though we ourselves had experienced all that the artist has.

The sculptor who would express heroism in a monument or pathos in a tomb, the delighted glee of a child or the tenderness of a mother, or a blending of all these things and thousands of others must take the soul of his work from the observations of these actual elements in the faces and bodily movements of those about him. If he wishes to make his work understandable and moving he cannot impose upon it so much of his own secret personal language that it can be understood only if he himself stands by explaining to all men who observe, down through the ages.

People mistrust emotions they do not readily understand and many of our serious plastic artists, because of this personal clouding of the observations which they have made, are actually burlesquing the very emotions, an understanding of which they are so earnestly pleading for. In the tense moment of a great drama an actor can become reasonably extravagant in his gestures, for his audience, having been carried through all of the facts which the dramatist has provided, is with him. They know why he feels as he does and their sympathy leads them to be moved by acting which, if not explained, mould seem ridiculous. All that another actor need do to rouse the laughter of the audience and to burlesque this tense moment is to walk on the stage and to go through the *identical actions* with no preliminary explanations. So it is with sculpture, and this may explain in part why sculptors are so loathe to take up new forms. Everyone knows who Diana is and though the work itself may not be good enough to bring to their minds at once the character of the chaste huntress it may be good enough to pass with the proper label. But, if the sculptor has the perception and insight, if he is sufficiently skilled in his technique and if he does not cloud the subject with his own too self-centred subjectiveness it is possible to find a thousand models in the world about him capable of being understood by all men through the ages, and at a glance. (W. E. Cx.)

CASTING AND FINISHING

The discovery of copper alloys is lost in the prehistoric ages. Their name was Chalcos with the Greeks and Aes with the Latins. Aes Brundusinum was the name of the alloy used in manufacturing famous Roman mirrors, and possibly the origin of the word "bronze" came from Brindisi (Brundusium), a city on the Adriatic coast of Italy where bronze was manufactured on a large scale. The origin of art bronzes or sculpture in bronze had its birth in the most remote days of human history, but after the invasion of the Roman Empire by the Barbarians. there was a long period of obscurity. It was in Italy during the Renaissance period that the regeneration of the bronzes of art took place, especially by the efforts of Benvenuto Cellini.

Bronzes of art are cast by two different methods: (1) the sand process, (2) the *cire perdue*, or lost wax process. Judging from the early specimens of bronze castings, undoubtedly the cire perdue method, or something like it, was used long before sand casting.

Sand Process.—The original model of the sculptor is moulded in an iron flask, with the use of very fine French sand (a composition of clay, silica and alumina). The iron flasks are strongly built frames made in two halves of such a perfect mechanical construction as to fit very closely with the aid of clamps and bolts.

The moulder gently hammers the damp sand against the plaster pattern, taking care of the undercuts of the model or deep recesses, by making as many as necessary small pieces of sand in such a way as to be able to release them from the original model by taking them apart without injury either to them or to the model.

After the model is released, the packed sand mould, which bears the impression of the most minute details of the original model, is recomposed and a proper sand core is built inside of it. This core is so cut that it leaves a space between itself and the piece moulds above described.

After this operation the dampness of the sand mould must be carefully eliminated by enclosing it in an oven properly built. When the mould is completely dried, the liquid bronze at about 1,900 degrees Fahrenheit is poured into the iron flasks previously recomposed and clamped together, and it will run through channels skilfully cut in the sand, going to fill the empty spaces mentioned above.

The sand is then removed, and after the bronze is cleaned with nitric acid, it will be finished and chiselled by skilful artisans.

Cire Perdue, or Lost **Wax** Process.—The first stage of this process, after receiving the model from the artist, consists in preparing a negative made of plaster or gelatine. This is merely a coating of the outside of the model. In this negative, which shows all the details of the model in the reverse, a wax coating is applied in a molten state with a brush until it has acquired sufficient thickness, depending on the size of the figure.

At this stage, we will have a perfect replica of the sculpture in wax, and sufficiently hard to permit handling. The artist can work on it as much as he pleases, obtaining rare results of details, which makes this process of casting invaluable. Gates and vents in the shape of wax rods are then properly attached to the wax figure.

Finally, the mould for the metal is formed by blowing or pouring inside and around the wax a semi-liquid composition, which hardens in a few minutes. This composition of silica, plaster and other chemicals can resist high temperature, and, of course, all the wax inside of it will melt away, leaving a hollow space. This operation is accomplished in large ovens, by baking the moulds over a slow fire. As soon as all the wax is surely melted away, the mould is removed from the oven and packed in foundry earth in a pit provided in the floor. The bronze is then poured from crucibles, and the molten metal will run through the gates (melted away) and fill the space left empty by the wax figure also melted away (lost wax). The figure in bronze is then removed from the silica mould and dipped in acid for a proper cleaning.

With this process, the cast bronzes require very little finishing or chiselling, and the results are far above the sand process.

The so-called "patina" (*see* below) of the finished bronzes is an art in itself, and the different effects of colour are obtained by a large use of different chemicals.

Bronze is an alloy of from 8; to 90% of copper, and from 10 to 15% of tin, zinc and other non-ferrous metals. The alloy called United States Standard Bronze is composed of 90% copper, 7% tin and 3% zinc. This formula is not by any means officially approved by the United States Government, and this name was given by some bronze foundrymen only a few years ago for their own advantage, and strange to say it became an official word. Almost every specification generally written for contracts of art bronzes mentions the United States Standard Bronze as stipulated.

There are hundreds of other formulas of bronze, many of which contain other metals, such as lead, silver, aluminum, etc., which should not be left apart from the specifications of art bronze.

Some formulas of famous art bronzes will show the relative compositions:

Some Greek bronzes have: copper 62%, tin 32%, lead 6%.

Others have: copper 72%, tin 24%, lead 4·6%, zinc 2%.

The famous column Vendôme in Paris has: copper 89%, tin 10% (with traces of lead, tin and silver).

The statue of Louis XIV. in Paris has: copper 91%, tin 2%, zinc 6%, lead 1%.

Statue of Molière also in Paris has: copper 90%, tin 6%, zinc 2·5%, lead 1·5%.

The statue of Frederick the Great in Berlin has: copper 90%, zinc 10%.

There should not be any cause of alarm in judging the bronzes of art from the point of view of durability, as there are millions of specimens all over the world in an admirable condition of preservation composed of every conceivable proportion of alloy.

Not long ago some bronzes were discovered belonging to an age precedent to the Incas, with an alloy of 94% copper and 6% tin. (R. Be.)

PLASTER CASTING

In plaster casting there are at least three methods of procedure, each of which is determined by the kind of mould used: (1) the gelatine mould, (2) the piece mould, (3) the so-called waste mould. The gelatine, or glue, mould is generally employed when more than one plaster cast of the same model is desired, and this we shall consider first.

Glue Moulding.—After covering the clay or plasticine model, which is to be cast, with paper, a layer of clay about three-quarters of an inch is placed over it. Next to this is made the outer shell of piaster which will hold the glue. This shell is made in sections, when the model is in the round, so that it may be removed without disturbing the model. These sections must also be carefully keyed, both to the base and to each other, so that they may be placed in their original position, leaving an even space between the model and this ourer shell This space is filled with the melted casting glue or gelatine, which is poured in through a hole made in the top. Other holes are also made in the shell to allow the air to escape as the melted glue rises in the space, and are closed with clay when the glue reaches that level. When the gelatine, or glue, is sufficiently cooled, the shell is opened and the clay, or plastilene, is cleaned from the gelatine mould. It is then properly greased with a mixture of stearine and kerosene and the mould, with the shell to hold it, is placed together again and plaster, mixed to a normal consistency, is poured into it. Care should be taken to reopen the mould at the proper time so that the heat of the plaster, while in the process of setting, may not melt the gelatine and in this way alter the mould so that the freshness of the original surface of the model is lost in the cast. In re-casting the mould should again be cleaned and greased lightly as before.

Piece Moulding.—This method is employed for the same purpose as the gelatine moulding. It gives a sharper, more accurate reproduction but requires greater skill and time, as the mould is made in many pieces of plaster, so placed and fitted that they may be freed from what is termed undercuts in the cast. In gelatine moulding, on account of the pliability of the mould, this difficulty with undercuts is avoided. Each part of the piece mould must be made separately. The soft plaster, placed on the section of the model that can be cast in one piece, is allowed to set, after which it is smoothed and trimmed with a chisel, and the surface against which the next piece will lie, is oiled so that the fresh plaster will not adhere to it. When the model is covered, the tops of the pieces are oiled and plaster placed over them, which, when set, forms a shell to hold them in place while they are being filled with the plaster of the cast. Before casting, however, the mould must be taken apart and the clay washed from each piece. It is then soaped and oiled and put together ready for casting. After each casting the pieces should be cleaned and oiled to prevent them sticking to the cast.

Waste Moulding.—This process is used either when only one reproduction in plaster is desired or in very large work. Proper divisions are first made in the most salient points of the model by small pieces of brass, so that when the mould is finished it may be opened and all the clay removed. The model is now covered with a coating of coloured plaster which is made by colouring the water, with which the plaster is mixed, with blueing or dry colour. In the process of chipping the plaster mould from the cast, this coating warns the moulder that he is near the cast and must chip carefully to prevent cutting into it.

After the first coating of coloured plaster, about three-eighths of an inch thick, a thicker coating of white plaster is applied. When the cast is large, or when there are parts of it that might break easily, it may be reinforced with iron pipes which are fastened to it with strips of burlap dipped in plaster.

The brass has made a natural cut in the plaster mould, thus dividing it into sections. These are removed from the model, washed with water, soaped with green soap, melted in hot water and allowed to cool. Then with a dry brush all soap is carefully removed from the mould and a slight coating of olive oil is given it to insure the proper separation of the mould from the cast. The sections are now put together and held in place by burlap dipped in plaster, or tied with wire, and the mould is ready for filling. In order to remove this mould it must be chipped from the cast, because the undercutting of the cast does not allow the sections to be lifted off as in the piece-mould.

Casting.—The cast of a bust or other simple work can be made in one piece. The sections of the mould are united, and the plaster at a proper consistency poured into it. By continually turning the mould the plaster may be evenly distributed. A thickness of three-quarters of an inch is sufficient to make a strong cast, especially when it is reinforced inside with burlap dipped in plaster, or with iron pipes. Where the model is small it may be entirely filled, thus forming a solid cast

In the case of large works, in which there is no way of moving the mould around, the cast is made in sections. When set, the sections are joined together and properly strengthened on the inside, great care being taken that all joints are clear of plaster so that they may fit perfectly.

Chipping.—Sufficient time should be allowed for the. plaster to set properly, then, with a mallet and chisel the outside iron pipes are removed and next the natural coloured plaster, leaving the thin coloured coating. This should be removed with care to insure a plaster cast without a blemish. The plaster cast can be re-touched with plaster mixed to a thinner consistency than the casting plaster and care should be taken to wet the model before applying

Tinting Plaster Casts.—Plaster is made of equal parts of plaster and water, the plaster being slowly poured into the water and given sufficient time for absorption, after which it should be stirred gently. There are various ways of tinting plaster casts so that they may resemble bronze, terra-cotta, etc. One of the most common is the oil paint method. One coat of shellac should be given as a prime After this has dried thoroughly a coat of oil paint of brown with a little dryer is applied and allowed to dry. If a greenish blue tint is desired a very thin mixture of light green oil paint is applied to the brown coat. When this is almost dry it is wiped off with a rag, allowing the green colour to remain in the deep parts; for a metallic effect, a little gold or bronze powder mixed with dryer may be applied to the high parts. When thoroughly dry it is rubbed with ordinary prepared furniture wax. This will subdue any unpleasant shiny effect and bring the whole thing together. Similar procedure may be used with any other colour desired.

(See other sections of SCULPTURE TECHNIQUE preceding this article, such as *Casting and Finishing; Modelling.)*

(L. LEN.)

PATINA

Patina, strictly defined, is an artistic product of the corrosion of copper or copper-rich alloys, notably the bronzes. It is an "incrustation which forms on bronze after a certain amouet of exposure to the weather, or after burial beneath the ground. When perfectly developed it is of a dark green colour and has nearly the composition of the mineral malachite, a hydrated carbonate of copper." In the broader interpretation of the term, patina includes mineral or mineral-like coatings or deposits on metal objects of art of a large variety of shades—greens, blues, reds, greys, blacks, etc.—the deposits having been produced by either natural or artificial means.

In this article we are primarily concerned with the patina formed on bronzes, the *verde anticho* or verdigris, the usual constituent being the basic carbonates of copper, malachite and azurite. At times the patina will be distinctly red (cuprous oxide); at other times we will find it to be greyish green and frequently, as is the case with many Chinese and Japanese bronzes, it is almost black, resembling polished ebony.

A good patina of the proper composition and texture serves a double purpose. It enhances the beauty of the bronze object and secondly it protects and preserves the bronze from destruction by the very agents, such as carbonic acid, so necessary to form the patina. The second purpose of the patina, therefore, is like that of a permanent coat of protective paint.

Artistic Qualities.—Most patinas are green or greenish blue. The grey patinas are usually due to a predominance of tin oxide or lead carbonate in the crust. The black patinas are usually found on bronzes containing appreciable quantities of lead. However, there are many different intermediate shades of patina; likewise there are many different textures. The main factors that influence the shade and texture of the patina are (1) the chemical composition of the bronze; (2) the metallographic structure of the bronze, whether fine or coarse grained, presence or absence of intercrystalline impurities, etc.; (3) the location in which the bronze has remained before its discovery; and (4) the time or duration the bronze has remained in the particular location~Thus, for example, some of the finest greens are found on bronzes of pure tin-copper alloys and on objects that were fashioned of native copper. The addition of zinc and lead to the bronze darkens the shades very appreciably. A fine grained crystalline structure of the bronze favours a uniform fine textured patina. As regards location, absence of moisture and salts usually results in the characteristic bronze brown. Presence of sulphur compounds in the air to which the bronze is exposed, as for example in the path of the winds passing over active volcanoes, gives rise to very dark almost black shades of patina. Slow oxidation in alkaline soils but in the absence of carbonic acid will produce the comparatively rare red (cuprous oxide) patina. A short time in a moist salty location will produce a heavier or thicker patina than a comparatively long exposure in an almost dry location.

Durability.—Apart from the artistic quality, a patina must be durable. The major constituent of the bronzes is copper and it is primarily upon the permanency or lasting qualities of the copper compounds entering into the composition of the patina, that the formation and life of the patina depend The permanency of the various copper compounds that come under consideration can best be judged by ascertaining the behaviour of these compounds in the crust and on the surface of the earth where they have been exposed to various corroding or disintegrating influences for millions of years as a rule, Native or metallic copper occurs in Michigan, Australia and elsewhere and has been thus preserved through the ages due to. the absence of corroding influences such as acidulated waters. By far the greater proportion of copper found in the crust of the earth occurs as the sulphide either alone, as chalcocite and covellite, or, more commonly, in association with other sulphides, as chalcopyrite, bornite and others. These sulphides are, however, only permanent "at depth," in the lower strata, away from corroding influences. In the upper strata where the minerals have come into contact with rain water or with moist air containing carbonic acid, the sulphides have been transformed into the more stable malachite. The very large copper deposits of the Belgian Congo are a good example of such occurrence of sulphides in the lower layers and carbonate or malachite in the upper.

Other minerals of copper that are met with in patinas are the basic chloride, atacamite, the basic sulphates, such as brochantite, the blue carbonate, azurite, and cuprite, the red cuprous oxide. All of these minerals when exposed to moist atmosphere decompose and turn into malachite. Among the valuable bronze collections, we do meet with examples of patina composed wholly or in part of one or more of these unstable compounds, *i.e.*, unstable in climates such as those of London, New York or Paris. Thus, there are a large number of instances on record where a natural blue patina (azurite) has been preserved for years by taking proper precautions. On the other hand, collectors have often lamented that a patina originally of a very attractive blue was gradually changing into a green (malachite) patina. The red copper oxide patina is highly prized The large bronze cat, of Egyptian origin, on exhibit at the Metropolitan Museum of Art (New York) has large irregular patches of this beautiful red patina. By suitable protective measures the transition into the carbonate, malachite, can be very much retarded.

Particular attention should be paid to the basic chloride of copper, atacamite, of frequent occurrence in Egyptian bronze patinas, This chloride is perfectly stable in an absolutely dry atmosphere such as is met with in the sealed tombs of Egypt. However, as soon as this chloride-bearing patina is brought into contact with moist air not only is the transformation into malachite very rapid—very often within but a few weeks—but the chloride in presence of moisture and carbonic acid rapidly corrodes the entire bronze. A chloride, such as copper chloride, sodium chloride or ammonium chloride, is a very dangerous constituent of the patina and is one of the most active agents giving rise to the dreaded bronze "disease."

The presence of chlorides in the soil in which a bronze object lies buried will greatly hasten the formation of a patina. However, the rapid growth of *a* patina brings about a poor, loose structure of little or no permanence, The characteristics of the best or "noble" patina are a very slow formation, compact, solid texture, gradual transition from metal through oxide to carbonate, the malachite of fine crystalline structure, the hair line fissures of the bronze directly under the patina tightly packed with oxide or carbonate, and a smooth almost enamel-like surface free from warts and nodules.

Artificial Patinas.—The production of artificial patinas has been practised since time immemorial. Unfortunately, however, nearly every one of the hundreds of formulas prescribed involves the use of sal ammoniac or some other chloride—one of the most destructive compounds to introduce into a patina. Chlorides are very treacherous and should never be resorted to in spite of their "convenient and rapid action." Years of experimentation and testing have led us to condemn all procedures involving the use of chlorides or other strong salts. It is to be borne in mind that the ultimate compound of lasting quality which is sought after is the green basic carbonate compound of copper. The final patina produced must be free of all mineral acids such as muriatic, sulphuric or nitric since these acids will cause a rapid destruction of the entire body of the bronze.

Eliminating the mineral acids and substituting the organic acids, such as acetic, oxalic, citric and carbonic, we can produce coatings of great permanence. The artistic effects brought about are dependent primarily upon the method and means of procedure. Applying a solution of any one of these organic acids to the surface of the bronze with a brush seldom brings about a pleasing or attractive patina. Usually streaky deposits result. The point to bear in mind is to imitate the natural formation of the patina as closely as possible. The following procedure is recommended.

The bronze, whose surface has been carefully cleaned so as to expose the virgin metal or only a thin film of oxide, is placed in a gassing chamber. This chamber must be large enough so as to prevent the bronze from coming into contact with the walls. The chamber is closed on all sides, preferably hermetically sealed. The "gas" is derived from a dish of strong acetic acid situated at the bottom of the chamber. Moistening the surface of the bronze before introducing it into the chamber will hasten the formation of the copper acetate on the surface. The time of exposure is usually three to four days at room temperature. Then follows a gassing in ammonia fumes, using the same chamber and substituting a dish of aqua ammonia, concentrated, for the acetic acid. Then the third gassing is with carbonic acid taken from a cylinder. The procedure is repeated in the same rotation if a comparatively thick patina is desired. Irregular patches of blues and greens and bluish greens are produced, strikingly similar to those met with in nature.

The bronze is then carefully and very slowly dried in an oven which is gradually heated up to 232° F. allowing 12 to 24 hours to attain this temperature, depending upon the thickness of the patina; the thicker the patina the slower the heating.

Finally. the bronze is sprayed with a dilute solution of beeswax in benzol and after 10 to 15 hours' drying in the air is carefully rubbed with a soft dry cloth. Lacquers are not as desirable as the beeswax as most are not durable and fail to bring out the desired artistic effects characteristic of beeswax. Since beeswax is at times bleached with chlorine, the unbleached wax is to be specified.

To produce the red patina (cuprous oxide) gassing alternately in ammonia and iodine vapours may be used. However, the action is comparatively slow and quicker results are obtained by submerging the entire bronze in a suspension of precipitated chalk in water to which has been added 2% to 3% of iodine as tincture of iodine. The bronze remains submerged for a period of three to eight days. depending upon the depth of colour desired. It is then dried and finished as above. The slower the patinating the more artistic the results is a good general rule to follow. (C. G. F.)

SCUNTHORPE, a market town and municipal borough (1936) in the Brigg parliamentary division of the Parts of Lindsey, Lincolnshire. Eng., 28 mi. N.W. of Lincoln by road. Pop. (1961) 67,257. Area 12.3 sq.mi. Parts of the parish church date back to the middle ages. notably the 12th-century pillars and the 13th-century porch. In 1871 the population was only 616, but with the discovery of ironstone in the area toward the end of the 19th century, the foundations of the iron and steel industry were laid. Subsidiary industries are the road-making and building materials industry, tar and benzole distillation. light engineering and the manufacture of clothing and footwear.

SCURVY (*Scorbutus*), a "deficiency" disease, characterized by debility, blood changes, spongy gums and haemorrhages in the tissues of the body. In former times this disease was common and very fatal among sailors. Scurvy has also frequently broken out among soldiers on campaign, in beleaguered cities, among communities in times of scarcity, and in prisons, workhouses and other public institutions. It was early recognized that scurvy and diet were connected. It is now known that the cause is deficiency of vitamin C in the food (*see* VITAMINS). This explains the occurrence of scurvy when fresh vegetables or fruit are unobtainable and its disappearance when they are administered, for these substances are rich in vitamin C.

The symptoms come on gradually with failure of strength, most manifest on making effort, and a corresponding mental depression. Then follow sallow complexion, sunken eyes, tender gums and muscular pains. This may continue for weeks, gradually getting worse, teeth fall out arid haemorrhages, often of large size, penetrate muscles and other tissues. Peculiar disorders of vision have been noticed, particularly night-blindness (nyctalopia), but they are not invariably present, nor specially characteristic of the disease. The further progress of the malady is marked by profound exhaustion, with a tendency to syncope and various complications, such as diarrhoea and pulmonary or kidney troubles, any of which may bring about death. On the other hand, even in desperate cases. recovery may be hopefully anticipated when the deficient vitamin is supplied. No disease is more amenable to treatment both as regards prevention and cure than scurvy, the single remedy of fresh vegetables or some equivalent securing both these ends. Potatoes, cabbages, onions, carrots, turnips, etc., and most fresh fruits, will be found of the greatest service for this purpose. Lime juice and lemon juice are recognized as equally efficacious. The regulated administration of lime juice in the British navy, which was begun in 1795, had the effect of virtually extinguishing scurvy in the service, while similar regulations introduced by the British Board of Trade in 1865 had a like beneficial result as regards the mercantile marine. It is only when these regulations have not been fully carried out, or when the supply of lime juice has become exhausted, that scurvy among sailors has been noticed in recent times.

Infantile Scurvy (Scurvy Rickets, *Barlow's* disease), a disease of childhood due to a morbid condition of the blood and tissues from defects of diet, was first observed in England in 1876 by Sir T. Smith, and later fully investigated by Sir Thomas Barlow. The chief symptoms are great and progressive anaemia, mental apathy, spongy gums, haemorrhages into various structures, particularly under the periosteum and muscles, with suggestive thickenings round the shafts of the long bones, producing a state of pseudo-paralysis.

SCUTAGE or **ESCUAGE,** the pecuniary commutation, under the feudal system, of the military service due from the holder of a knight's fee. The name is derived from his shield (scutum). The term is sometimes loosely applied to other pecuniary levies on the basis of the knight's fee. It used to be supposed that scutage was first introduced in 1156 or on the occasion of Henry II.'s expedition against Toulouse in 1159; but it is now recognized that the institution existed under Henry I., when it occurs as *scutagium,* scuagium or escuagium. Its introduction was probably hastened by the creation of fractions of knights' fees, the holders of which could only discharge their obligation in this fashion. The increasing use of mercenaries in the 12th century would alsc make a money payment of greater use to the crown. Levies of scutage were distinguished by the names of the campaigns for which they were raised, as "the scutage of Toulouse" (or "great scutage"), "the scutage of Ireland" and so forth. The amount demanded from the fee was a marc (13s.4d.), a pound, or two rnarcs, but anything above a pound was deemed abnormal till John's reign, when levies of two rnarcs were made without even the excuse of a war. The irritation caused by these exactions reached a climax in 1214, when three rnarcs were demanded, and this was prominent among the causes that led the barons to insist on the Great Charter (1215). By its provisions the crown was prohibited from levying any scutage save by "the common counsel of our realm." In the reissue of the Charter in 1217 it was provided, instead of this, that scutages should be levied as they had been under Henry II. In practice, however, under Henry III., scutages were usually of three marcs; but the assent of the barons was deemed requisite, and they were only levied on adequate occasions.

Meanwhile, a practice had arisen, as early as Richard I.'s reign, of accepting from great barons special "fines" for permission not to serve in a campaign. This practice appears to have been based on the crown's right to decide whether personal service should be exacted or scutage accepted in lieu of it. A system of special composition thus arose which largely replaced the old one of scutage. As between the tenants-in-chief, however, and their under-tenants, the payment of scutage continued and was often stereotyped by the terms of charters of subinfeudation, which specified the quota of scutage due rather than the proportion of a knight's fee granted. For the purpose of recouping themselves by levying from their under-tenants, the tenants-in-chief received from the crown writs de scutagzo habendo. Under Edward I. the new system was so completely developed that the six levies of the reign, each as high as two pounds on the fee, applied only in practice to the under-tenants, their lords compounding with the crown by the payment of large sums, though their nominal assessment, somewhat mysteriously, became much lower (see KNIGHT-SERVICE). Scutage was rapidly becoming obsolescent as a source of revenue, Edward II. and Edward III. only imposing one levy each and relying on other modes of taxation, more uniform and direct Its rapid decay was also hastened by the lengths to which subinfeudation had been carried, which led to constant dispute and litigation as to which of the holders in the descending chain of tenure was liable for the payment. Apart from its financial aspect it had possessed a legal importance as the test, according to Bracton, of tenure by knight service, its payment, on however small a scale, proving the tenure to be "military" with all the consequences involved.

BIBLIOGRAPHY.—The best monograph on the subject (though not wholly free from error) is J. F. Baldwin's *The Scutage and Knight Service in England* (1897). The view now held was first set forth by J. H. Round in *Feudal England* (1895). In 1896 appeared the *Red Book of the Exchequer* (Rolls series), which, with the *Testa de Nevill* (Record Commission, re-edited as *Book of Fees,* Stationery Office 1920, 1923) and the Pipe Rolls (Record Commission and Pipe Roll Society), is the chief record authority on the subject; but many of the scutages are wrongly dated by the editor, whose conclusions were severely criticized by J. H. Round in his *Studies on the Red Book of the Exchequer* (privately issued) and his *Commune of London and other Studies* (1899). Pollock and Maitland's *History of English Law* (1895) should be consulted. McKechnie's *Magna Carta* (1905) is of value; and Scargill Bird's "Scutage and Marshal's Rolls" in *Genealogist* (1884), vol. i., is important for the later records. (J. H. R.)

SCUTARI (Albanian, SHKODËR), a town of Albania. Pop. (1930) was 29,209, of whom 54% were Roman Catholics, 38% Muslims, and 8% Orthodox. Scutari lies in a plain surrounded by lofty mountains, except where it adjoins the lake. Malaria is prevalent in summer as the town is very liable to flooding, especially since the close of the 19th century, when the Drin was deflected at its junction with the Boyana. The mosques and the bazaar, lately much damaged by fire, give the town an oriental appearance, but the finest buildings are Italian, viz., the Roman Catholic cathedral, and an old Venetian citadel on a high crag. The fortress was recently almost destroyed in a storm, the pasha having fixed a brass spike to the tower containing the powder magazine. Scutari is the seat of a Roman Catholic archbishop and has a Jesuit college and seminary. Trade tends to decline and to be diverted to Salonika and other ports connected with the main European railways. A light railway was built by the Austrians from Scutari to the Voyusa during World War I and the roads were much improved during the occupation by the Great Powers after the Balkan Wars (1912–13). Grain, wool, hides, skins, tobacco, sumach, and draught horses are exported, and also large quantities of a kind of sardine called scoranza (Albanian, *seraga*) caught in the Boyana. Cotton stuffs are manufactured, and Scutari is the centre of the inlaid metal work for weapons. There are copper mines, and a small saltpetre factory. Textiles, metals, provisions and hardware are imported. The Imperial Ottoman bank was closed in 1915.

The Boyana is navigable for small vessels for 12 mi. from its mouth, and cargoes for Scutari are then transshipped into light river boats. In the flood season goods are taken in small steamers up the Drin from the port of San Giovanni di Medua (Albanian, *Shengiin*), or landed at Alessio (Albanian, Lesh), the market and port of the Mirdite country, and conveyed thence in small vessels to Scutari. Steamers ply on Lake Scutari to and from Rijeka in Montenegro, but when the water is low, it is necessary to row out to them.

Livy relates that Skodra was chosen as his capital by the Illyrian king Gentius, who was besieged here and carried captive to Rome in 168 B.C In the 7th century the town fell into the hands of the Serbians, but after the death of Stephen Dushan in 1355, the Balsha family, of Norman extraction, held part of Albania, with Scutari as their capital until 1394, when they sold the town to Venice. In the 15th century it became a stronghold of Skanderbeg's (*q.v.*), but on his death in 1467 reverted to the Venetians, who were, however, driven out by the Turks in 1479. In 1760 Mahomet of Bushat, pasha of Scutari, made himself an independent prince in all but name, and secured the hereditary pashalik for his family, the last of whom, Mustafa, was deposed by the Sultan in 1831. Scutari was wrested from the Turks by the Montenegrins in the Balkan Wars (1912–13) but was surrendered to an international force in the latter year and incorporated into the kingdom of Albania. Italy occupied it in 1939.

Lake Scutari, lying 20 ft. above sea level, and 135 sq.mi. in extent is almost bisected by the line of the Montenegrin frontier.

It occupies one of the depressions known as *polyes,* which are common throughout the Illyrian Karst region, and though its average depth is only 23 ft., there are a series of holes near the south-west extremity, one of which is 144 ft. deep. The Moratcha enters the lake near the Montenegrin port of Plavnitza, while the Boyana issues from its south-west extremity and flows into the Adriatic. The, lake abounds in aquatic birds and fish; its brilliantly clear green waters, and its setting of rugged, many-hued mountains. render it one of the most beautiful lakes in Europe.

SCUTARI (skōō'tāh-rĭ) (anc. Chrysopolis), a town of Turkey in Asia, on the east shore of the Bosporus, opposite Istanbul of which it forms the 9th Cercle Municipale. Its painted wooden houses and white minarets on the slopes of the shore and backed by the cypresses of the great cemetery farther inland present a very picturesque appearance from the sea. The town contains eight mosques. one of them, the Valideh Jami, built in 1547, of considerable beauty. Other remarkable buildings are the vast barracks of Selim III. and a hospital used during the Crimean War. (See NIGHTINGALE, FLORENCE.) The chief industry of Scutari is the manufacture of silk, muslin and cotton stuffs. Pop. (1960) 111,654. The most striking feature of Scutari is its immense cemetery, the largest and most beautiful of all the cemeteries in and around Istanbul; it extends over more than 3 mi. of undulating plain behind the town. Between Scutari and Haidar Pasha the British army lay encamped during the Crimean War, and in a cemetery on the Bosporus are buried the 8,000 British who died in hospital. At Haidar Pasha is the terminus of the Anatolian railway. Chrysopolis ("Golden City"), the ancient name of Scutari, most probably has reference to the fact that there the Persian tribute was collected, as at a later date the Athenians levied there a tenth on the ships passing from the Euxine. Scutari was formerly the post station for Asiatic couriers (*Uskudar* = courier). and also, until the introduction of steam, the terminus of the caravan routes from Syria and Asia. It is known also as Uskiidar.

SCUTTLE, a term formerly applied to a broad flat dish or platter; it represents the 0. Eng. scutel, cognate with Ger. *Schüssel,* dish, derived from Lat. *scutella,* a square salver or tray, dim. of scutra, a platter, probably allied to scutum, the large oblong shield, as distinguished from the *clypeus,* the small round shield. The name survives in the coal-scuttle, styled "purdonium" in English auctioneers' catalogues, which now assumes various forms. "Scuttle" in this sense must be distinguished from the word meaning a small opening in the deck or side of a ship, either forming a hatchway or cut through the covering of the hatchway; from which to "scuttle" a ship means to cut a hole in the bottom so that she sinks. This word is an adaptation of O. Fr. escoutille, mod. *écoutille,* from Span. escotilla, dim. of escoti, a sloping cut in a garment about the neck. The Spanish word is cognate with Du. schoot, Ger. Schoss, lap, bosom, properly the flap or projecting edge of a garment about the neck, O. Eng. sceat, whence "sheet."

SCYLAX OF CARYANDA (in Caria), Greek historian, lived in the time of Darius Hystaspis (521–485 B.C.), who commissioned him to explore the course of the Indus. He started from Caspatyrus (Caspapyrus In Hecataeus; the site cannot be identified: see V. A. Smith, Early *Hist.* oj India, 2nd ed., 1908, 34 note), and is said by Herodotus (iv. 44) to have reached the sea, whence he sailed west through the Indian Ocean to the Red Sea. Scylax wrote an account of his explorations, referred to by Aristotle (Politics, vii. 14), and probably also a history of the Carian hero Heracleides, prince of Mylasae, who distinguished himself in the revolt against Darius (Herodotus v. 121). This work is the earliest known Greek history which centred round the achievements of a single individual. Suïdas, who mentions the second work, confounds the older Scylax with a much later author, who wrote a refutation of the history of Polybius, and is presumably identical with Scylax of Halicarnassus, a statesman and astrologer, the friend of Panaetius spoken of by Cicero (De div. ii. 42). Neither of these, however. can be the author of the *Periplus* of the Mediterranean, which has come down to us under the name of Scylax of Caryanda. This work is little more than a sailor's handbook of places and distances all round the coast of the Mediterranean and its branches, and then along the outer Libyan coast as far as the Carthaginians traded. Internal evidence shows that it must have been written long after the time of Herodotus, about 350 B.C.

Editions by B. Fabricius (1878) and C. Müller in Geograpkici *Graeci* minores, i., where the subject is fully discussed; see also G. F. Unger, Philologus, xxxiii. (1874); B. G. Niebuhr, Kleine *Schriften*, i. (1828); and E. H. Bunbury, History of Ancient Geography, i.

SCYLITZA, JOANNES: see JOANNES SCYLITZA.

SCYLLA AND CHARYBDIS. In the Odyssey Scylla is a dreadful sea monster, daughter of Crataeis, with 6 heads, 12 feet and a voice like the yelp of a puppy. In later authors and in art she is a mermaid, with dogs' heads springing from her loins. She dwelt in a cave in a high rock. out of which she stuck her heads, fishing for marine creatures and snatching the seamen out of passing ships. Within a bowshot was another rock under which dwelt Charybdis, who thrice a day sucked in and thrice spouted out the sea water. Between these rocks Odysseus sailed, and Scylla patched six men out of his ship. In later classical times Scylla and Charybdis, whose position is not defined by Homer, were localized by Strabo in the Straits of Messina — Scylla on the Italian, Charybdis on the Sicilian side. The well-known line, *Incidis* in Scyllam *cupiens vitare* Charybdim, occurs in the *Alexandreis* of Gautier de Lille, a poet of the 12th century, but the metaphor is at least as old as St. Augustine. In Ovid (Metamorphoses) Scylla appears as a beautiful maiden beloved by the sea god Glaucus and other deities, and changed by the jealous Circe (or other rival) into a sea monster. The legend was variously rationalized. Another Scylla. sometimes identified with the sea monster, was a daughter of Nisus (*q.v.*) king of Megara.

SCYLLIS: see DIPOENUS AND SCYLLIS.

SCYMNUS of Chios, the name assigned to a Greek geographer of uncertain date, commonly taken to be the author of a fragmentary anonymous *Paraphrasis* in verse describing the northern coasts of the Mediterranean and the shores of the Black Sea, a work which in the first edition (Augsburg, 1600) was ascribed to Marcianus of Heraclea. Meineke showed that this piece cannot be by Scymnus. It is dedicated to a king Nicomedes, probably Nicomedes III. of Bithynia (91–76 B.C.), and so would date from the beginning of the 1st century B.C. Its most valuable portions relate to the Euxine regions and to the Hellenic colonies of those shores as well as of the coasts of Spain, Gaul and Italy.

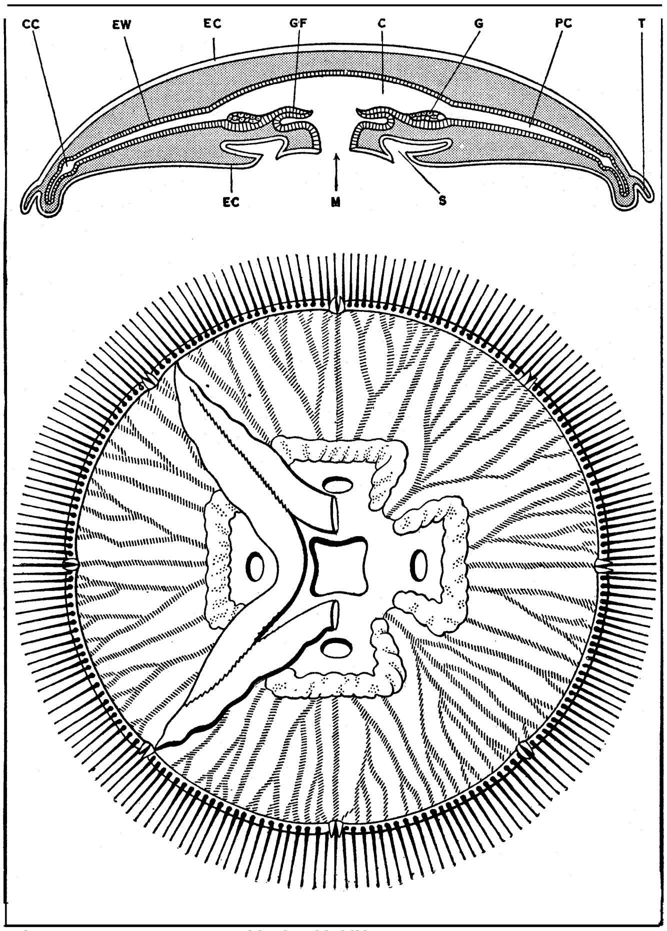
See Meineke's edition (Berlin, 1846); C. Müller, Ceographi *Graeci* minores, vol. i., where the poem is edited with sufficient prolegomena (pp. lxxiv.–lxxvii.); E. H. Bunbury, Ancient Geography, i. 99, 100, 102, 128, 183; ii. 26, 69–74.

SCYPHOMEDUSAE, a technical name for a class of jellyfish more usually known as Scyphozoa. Jellyfish do not all belong to the Scyphozoa, others being included in the groups known as Hydrozoa (q *v*) and Ctenophora. See also COELENTERATA; COMB JELLY; SCYPHOZOA.

SCYPHOZOA, a group of jellyfish belonging to that series of animals known as the Coelenterata (q *v*) whose general characteristics are described in a separate article. other groups of jellyfish being dealt with in the articles HYDROZOA and COMB JELLY. The scyphozoan jellyfish differ from all others in their anatomical characters and, speaking generally, they are larger and more substantial than hydrozoan medusae. Some of them attain extremely large size, measuring as much as 7ft. across the bell; these are the largest known coelenterates.

From the point of view of the general study of the Coelenterata the main interest of the Scyphozos lies in their life-history. The egg sometimes develops directly into a medusa, but in other cases there is a complicated life-history, which may be exemplified by the case of the *Aurelia* (figs. 1 and 2). *Aurelia* is one of the jellyfish most commonly stranded on British shores, and is a transparent medusa usually from 3 to 6in. across in these waters. It has a rather shallow bell tinged with mauve, becoming a darker colour at the sex-glands, which show through from the inside.

It swims by a rhythmic series of contractions of the bell. The fertilized egg of Aurelia develops, not into a miniature medusa, but into a polyp of distinctive structure known as a *scyphistoma* —a small trumpet-shaped creature with long marginal tentacles,



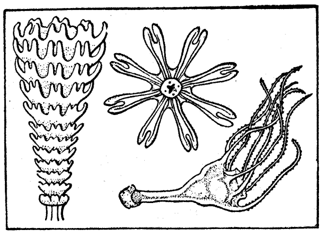
FROM PARKER & HASWELL, "TEXTBOOK OF ZOOLOGY" (MACMILLAN)

FIG. 1.—DIAGRAM OF A JELLYFISH (AURELIA)

Above, vertical section; below, view from below, showing oral arms, radial canals, marginal tentacles, and positions of sense-organs, sex-organs, and of the four pouches of the coelenteron; (C) coelenteron, (CC) circular canal, (EC) ectoderm, (EW) endoderm, (G) gonad, (GF) endodermal tentacle, (M) mouth, (PC) radial oanal, (S) sub-genital pit, (T) marginal tentacle

which attaches itself by its aboral end to a foreign support (*see* COELENTERATA and HYDROZOA).

This polyp can produce rootlets (stolons), from which new polyps are budded, and can also give rise to new polyps in other ways. The scyphistoma is a perennial organism, and at a given time of year may undergo a remarkable change, which varies according to whether the supply of food has recently been scarce or plentiful. In the former case it differentiates from its upper end a disc-like section of its tissues which in time becomes free and swims away. If the food has been plentiful, however, a whole succession of such sections will be formed, one above the other like a pile of saucers, so that most of the substance of the polyp becomes converted into such. The segments separate from the parent (which in its dividing condition is known as strobila) successively when sufficiently developed. Each of them is found on examination to constitute a small flattened medusa with eight long arms, and is termed an ephyra. It is quite unlike the adult *Aurelia* in shape even now, but assumes the fully developed condition by degrees from this point onwards. Occasionally a segment of a strobila becomes a polyp instead of a medusa.



FROM KUKENTHAL, "HANDBUCH DER ZOOLOGIE" (DE GRUYTER)

FIG. 2.— LIFE-HISTORY OF SCYPHOZOAN JELLY-FISH

Left, scyphistoma in the act of strobilisation; centre, an ephyra; right, scyphistoma (all enlarged)

Such a life-history provides an interesting example of that type of polymorphism known as alternation of generations. (See COELENTERATA and HYDROZOA.) The permanent polyp-generation alternates regularly with a relatively transient medusa-generation, and the medusae alone are sexual and produce ova and spermatozoa. The method by which the medusae are formed from the polyp, however, is a specialty of the Scyphozoa, and is quite unlike that adopted by the Hydrozoa.

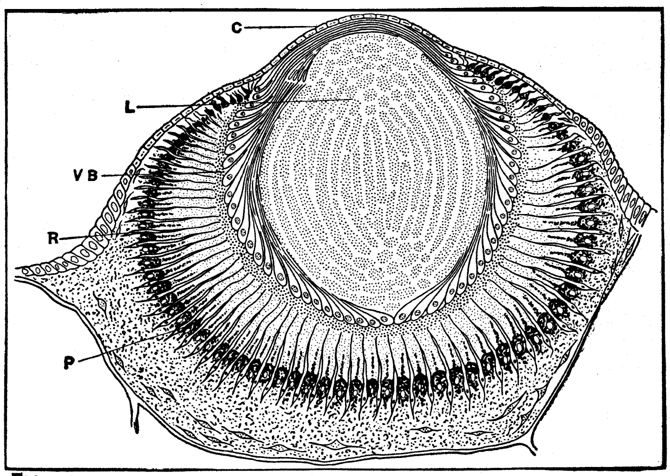


FIG. 3.—VERTICAL SECTION OF A MEDIAN DISTAL OCELLUS OF CHARYBDAEA (ENLARGED): (C) CORNEA, (L) LENS, (R) RETINA. (VB) VITREOUS BODY, (P) PIGMENT

The Scyphozoa constitute a large group of medusae of extremely varied and sometimes very elaborate structure. They possess in common, however, a number of features which distinguish them from the hydrozoan medusae, such as the absence of a velum (see HYDROZOA), and the presence, inside the coelenteron, of peculiar tentacles clothed by endoderm. The Scyphozoa are cruciform in their symmetry, that is to say, all their organs are symmetrically arranged with relation to four main radii placed at right angles to one another. Their sex-organs are endodermal. They possess well-developed sense-organs, these including not only hollow tentaculocysts of a distinctive nature (see also COELENTERATA and HYDROZOA), which occur in definite positions round the margin of the bell, but also ocelli or eye-spots, which attain, in the case of Charybdaea, an astonishingly high grade of development, possessing cornea, lens, retina, and vitreous mass, and recalling in outline the structure of a vertebrate eye (fig. 3). In certain jellyfish (Rhizostomae) a curious condition of the mouth has arisen. By basal fusion of the four long arms which depend in so many of these jellyfish from the corners of the mouth (fig. 1), the mouth itself is obliterated, and food is taken in through a multitude of pores in the surfaces of the arms, which open into canals leading to the stomach. Finally, in certain Scyphozoa (*e.g.*, *Haliclystus*, fig. 4) the animal is not a swimmer, but has a stalk by means of which it attaches itself to weed and other objects; and here the anatomy is distinctive and is rather intermediate between that of a polyp and that of a medusa.

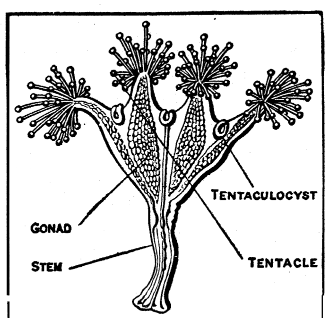


FIG. 4.—HALICLYSTUS AURICULA, A JELLY-FISH WITH A STEM AND 8 TUFTS OF KNOBBED TENTACLES

For general accounts see COELENTERATA bibl., and for lists of literature, W. Kükenthal, Handbuch der *Zoologie* (1923–25).

(T. A. S.)

SCYROS, a small rocky barren island in the Aegean Sea, aff the coast of Thessaly. The earlier inhabitants of Scyros were Dolopes (Thuc. I. 98); Pelasgians, or Carians. There was a sanctuary of Achilles on the island, and numerous traditions connect Scyros with him. Disguised there as a woman, in the palace of Lycomedes, to keep him back from the Trojan War, he was discovered by Odysseus, and accompanied him to Troy. Another legend deals with the conquest of Scyros by Achilles. It was taken by Philip II and was under Macedonian rule until 196 B.C., when the Romans restored it to Athens. It was sacked by Goths, Heruli and Peucini, in A.D. 269. The ancient city was on a rocky peak, on the northeastern coast, where is the modern town of St. George. A temple of Athena was on the shore near the town.

SCYTHIA, originally (*e.g.,* in Herodotus iv, 1–142) the country of the Scythae or the country over which the nomad Scythae were lords; that is, the steppe from the Carpathians to the Don. With the disappearance of the Scythae as an ethnic and political entity, the name of Scythia gives place in its original seat to that of Sarmatia, and is artificially applied by geographers, on the one hand, to the Dobrogea, the lesser Scythia of Strabo, where it remained in official use until Byzantine times; on the other, to the unknown regions of northern Asia, the eastern Scythia of Strabo, the "Scythia intra et extra Imaum" of Ptolemy; but throughout classical literature Scythia generally meant all regions to the north and northeast of the Black sea, and a Scythian (*Skuthēs*) any barbarian coming from those parts. Herodotus (q v.) to whom. with Hippocrates, we owe our earliest knonledge of the land and its inhabitants, tries to confine the word Scyth to a certain race and its subjects, but even he seems to slip back into the wider use. Hence there is much doubt as to his exact meaning.

Geography. — Herodotus' account of Scythia falls into two irreconcilable parts: one (iv, 99 et seq.), in connection with the tale of the invasion of Darius, makes of Scythia a kind of chess-board 4.000 stades square on which the combatants can make their moves quite unhindered by the great rivers; the other (16–zo), founded on what he learned from Greeks of Olbia, and supplemented by the tales of the 7th-century traveller, Aristeas of Proconnesus, tallies more or less with the lay of the land. In accordance with this we can give the relative positions of the various tribes, and an excursus on the rivers (47–57) lets us define their actual seats. In western Scythia, starting from Olbia and going northnards, we have Callipidae on the lower Hypanis (Bug), Alazones (Ἀλαζῶνες) nhere the Tyras (Dniester) and Hypanis come near each other in their middle courses, and Arotēres ("Plowmen") above them. These tribes raised wheat, presumably in the river valleys, and sold it for export; in the eastern half from west to east were Geōrgi (perhaps the same as Arotēres or perhaps garden cultivators not using the plow) between the Ingul and the Borysthenes (Dnieper), nomad Scyths and royal Scyths between the Borysthenes and the Tanais (Don). Behind all these stretched a row of non-Scythian tribes from west to east: on the Maris (Maros) in Transylvania the Agathyrsi: Neuri in Podolia and Kiev; Androphagi and Rlelanchlaeni in Poltava. Ryazan and Tambov. On the lower Don and Volga we have the Sauromatae, and on the middle course of the Volga the Budini with the great wooden town of Gelonus and its semi-Greek inhabitants.

From this region started an important trade route eastward by the Thyssagetae (q v.) among the southern Urals. the Iyrcae on the Tobol and Irtysh to the Kirgiz steppe, where dwelt other Scyths. regarded as colonists of those in Europe: then the traveller passed by the Argippaei in the Altai and the Issedones in the Tarim basin. to the one-eyed Arimaspi (*q.v.*) on the borders of China aho stole their gold from the watchful griffins. and who marched with goat-footed men and Hyperboreans reaching to the sea: but this is all guesswork. To the south of Scythia the Crimean mountains were inhabited by a non-Scythic race, the Tauri (*q v*) The Sauromatae have generally been thought the same as the Sarmatae later found in their place, but Rostovtsev has raised serious difficulties.

Ethnology. — Herodotus divides the Scythians into the agriculturists (Callipidae, Alazones, Arotēres and Geōrgi) in the western part of the country, and the nomads with the royal Scyths to the east. The latter claimed dominion over all the rest. It is clear that we have to do with a mixed population called by foreigners after the ruling tribe. The evidence suggests that this tribe was itself of mixed blood. In the 2nd century A.D., when the steppes were dominated by the Sarmatae (q v.), the majority of the barbarian names in the inscriptions of Olbia, Tanais and Panticapaeum were Iranian. We can infer that the Sarmatae spoke an Iranian language. Pliny speaks of their descent from the Medes. Now the Sauromatae are represented as half-caste Scyths speaking a corrupt variety of Scythian. Presumably, therefore, the Scyths also spoke an Iranian dialect. But of the Scyth words preserved by Herodotus some are Iranian; others, especially the names of deities, rather suggest a Ugrian origin. The Scyths may be regarded as a horde which came down from upper Asia and conquered Iranian-speaking people, perhaps in time adopting the speech of their subjects The settled Scythians might be, in part, the remains of this Iranian population, or the different tribes of them may have been connected with their neighbours beyond Scythian dominion — Thracian Getae and Agathyrsi, Slavonic Neuri, Finnish Androphagi and such like. The Cimmerians (q v.) who preceded the Scythians used Iranian proper names, and possibly represented this Iranian element in greater purity. Herodotus gives three legends of the origin of the Scyths (iv, 5–12); these. though they contradict each other, can be reconciled with the view stated 'above. The first two purport to describe the origin of a people termed Scoloti, who are said to be autochthonous and have Iranian names. Surely this is the national legend of the agricultural Scythians about Olbia, and the name Scoloti. by which modern writers have designated the royal Scyths. is the true designation of one subject race. The royal line of these is quite distinct from the true royal Scyths, who, like most nomad conquerors. allowed their subjects to preserve their own organizations.

According to the third account (which Herodotus prefers), the Scyths dwelt in Asia. and were forced by the Massagetae over the Araxes (Volga?) into the land of the Cimmerians. Aristeas says that the first impulse came from the Arimaspi, who displaced the Issedones, who in turn fell upon the Scyths. The Cimmerian~appear to have given way in tno directions, toward the southwest, where the tombs of their kings were shown on the Tyras (Dniester), and one body joined nith the Treres of Thrace in invading Asia Minor by the Hellespont, and toward the southeast where another body threatened the Assyrians, who called them Gimirrai (Hebrew Gomer; Gen. xi). They were followed by the Scyths (Xshguzai, Heb. *Ashkenaz*), whom the Assyrians welcomed as allies and used against the Cimmerians, against the Medes and even against Egypt. Hence the references to the Scyths in the Hebrew prophets (Jer. iv, 3, vi, 7) This is all put in the latter half of the 7th century B.C. Herodotus says that the Scyths ruled Media for 28 years, and were then massacred or expelled. The Assyrian evidence is in the main a confirmation of Herodotus.

Hippocrates says that the Scqths are quite unlike any other race of men, and very like each other. The main point seems to be a tendency to slackness, fatness and excess of humour. The men are in appearance very like eunuchs, and both sexes have a tendency to sexual indifference amounting in the men to impotence. When a man finds himself in this condition he assumes the woman's dress and habits. Herodotus (iv, 6;) mentions the existence of this class, called Enarees (Ἐνάρεες), and says that they suffer from a sacred disease owing to the wrath of the goddess of Ascalon. whose shrine they had plundered. The whole account suggests a Tatar clan in the last stage of degeneracy.

The burial customs and some other institutions of the royal Scyths are certainly strongly reminiscent of those of the nomads of upper Asia. Distinctive weapons, such as a short sword that the Greeks termed ἀκινάκης, as opposed to the axes current in pre-Scythian times, are likenise oriental. Scythian art, however, may be related to a style best represented in northeastern Europe. Yet even this art province may have extended very much farther east than it has yet been traced The skulls dug up in Scythic graves throw no light on the question. some being round and some long. The representations of nomads an objects of Greek art show people with full beards and shaggy hair such as can not be reconciled with Hippocrates; but the only reliefs which seem to be accurate belong to a late date when the blood of the ruling clan was probably much mixed.

Customs.—Herodotus gives a good survey of the customs of the Scyths; it seems mostly to apply to the ruling race. They lived upon the produce of their herds of cattle and horses, their main food being the flesh of the latter, either cooked in a cauldron or made into a kind of haggis, and the milk of mares from which they made cheese and kumys (a fermented drink resembling buttermilk). They constantly moved in search of fresh pasture, spending the spring and autumn upon the open steppe, the winter and summer by the rivers for moisture and shelter. The men journeyed on horseback, the women in wagons with felt tilts. These were drawn by their cattle, and were the homes of each family. Hence the Greek epithets ἄβιοι (perhaps "of primitive life"), Ἱππημολγοί ("mare-milkers") and Ἁμαξόβιοι ("living in wagons"). The women were kept in subjection, unlike those of the Sauromatae (*see* SARMATAE). Polygamy was practised, the son inheriting his father's wives. Both men and women avoided washing, but there was something of the nature of a vapour bath, with which Herodotus has confused a custom of using the smoke of hemp as a narcotic. The women daubed themselves with a kind of cosmetic paste. The dress of the men is well shown upon the Kul Oba and Chertomlyk vases, and upon other Greek works of art made for Scythic use. It must not be confused with the fanciful barbarian costumes that are so common upon the Attic pots. They wore coats confined by belts, trousers tucked into soft boots, and hoods or tall, pointed caps. The women had flowing robes, tall, pointed caps, and veils descending over most of the figure. Both sexes wore many stamped gold plates sewn upon their clothes in lines or semés. Their horses had severe bits, and were adorned with nose pieces, cheek pieces and saddle cloths. True stirrups were unknown. In war the nation was divided into three sub-kingdoms, and these into companies, each with its commander. The companies had yearly feasts, at which the commander honoured warriors who had slain one or more of the enemy. As evidence of such prowess, and as a token of his right to a share of any spoil, the warrior was accustomed to scalp his enemy and adorn his bridle with the trophy. In the case of a special enemy or an adversary overcome in a private dispute before the king, he would make a cup of the skull, mounting it in bull's hide or in gold. The tactics in war were the traditional nomad tactics of harassing the enemy on the march, constantly retreating before him and avoiding a general engagement. Their weapons were bows and arrows, short swords, spears and axes. The government was a despotism, but a king who aroused the extreme dissatisfaction of his subjects was liable to be murdered.

Religion.—The religion of the Scyths was nature worship. Herodotus (iv. 59) gives a list of their gods, with the Greek deities corresponding, but we cannot tell what aspect of the Greek deity is in question. He says they chiefly reverence *Tabiti* (Hestia), next *Papaios* and his wife *Api* (Zeus and Ge), then *Oitosuros* or *Goitosuros* (Apollo), and *Argimpasa* (Aphrodite Urania). These are common to all the Scythians, but Thamimasadas, or Thagimasadas (Poseidon) is peculiar to the royal Scyths[1]. They set up no images or altars or temples save to Ares only. To Ares they make a heap of faggots three stades square, with three sides steep and one inclined, and bring to it 150 fresh loads of faggots every year. Upon the top is set up a sword which is the image of Ares; to this they sacrifice captives, pouring their blood over it. The account of the cult of Ares, for whom no Scythian name is given, appears to be an addition, and the mention of such masses of faggots suggests the wooded district of the agricultural Scythians, not the treeless steppe of the royal tribe. The Scythian pantheon is not distinctive. The Scyths had a method of divination with sticks, and the Enarees, who claimed to be soothsayers by grant of the goddess who had afflicted them, used another method by splitting bast fibres. They intervened in case of the king's falling sick, when it was assumed that some man had sworn by the king's hearth and broken his oath. If a man accused of this denied it, other diviners were called, and if these concurred, he was beheaded and his sons slain, and his goods given to the diviners. But if a majority of diviners decided against the accusers, the latter were set upon a wagon-load of brushwood and burned to death. The burial rites are the most fully described. Private persons were merely carried about among their friends, who held wakes in their honour, and then buried 40 days after. But the funerals of the kings were much more elaborate. They surrounded the dead man with everything in which he found pleasure during his life. The tombs of the kings were in the land of Gerrhus near the great bend of the Dnieper where the chief tumuli have been excavated. The body was embalmed and filled with aromatic herbs, and then brought to this region, passing through the lands of various tribes. The royal Scyths who followed the body were accustomed to cut about their faces and arms, and each tribe that the cortège met upon its way had to join it and conform to this expression of grief. Arrived at the place of burial, the body was set in a square pit with spears marking out its sides and a roof of matting. Then one of the king's concubines and his cupbearer, cook, groom, messenger and horses were strangled and laid by him, and round about offerings of all his goods and cups of gold—no silver or bronze. After this they raised a great mound, striving to make it as high as possible. A year later they strangled 50 youths of the dead man's servants (all Scyths born) and 50 of the best horses, stuffed them, and mounted them in a circle about the tomb.

[1]The names are read in various ways; it is impossible to establish the correct forms.

Tombs.—The description is generally borne out by the evidence of the tombs opened in the Scythic area. None agrees on every point, but almost every detail finds a close parallel in some tomb or other. The chief divergence is in the presence of silver and copper objects, but making allowance for repeated robberies, the quantity of gold is stupendous and implies that the kings of Scythia controlled the inexhaustible stores of the Altai. To say that there was nothing but gold seems merely an exaggeration. Tombs to which the name Scythic is generally applied form a well-defined class. They are preceded over the whole area by a much simpler form of burial marked by the practice of staining the bones with red ochre. The grave-goods were just a few rough pots, implements of flint, stone or copper and rude ornaments of bone or copper. Yet that some were tombs of great chiefs is shown by the great size of the barrows heaped over them and the often elaborate burial chamber many contain. They have been referred to the Cimmerians, but this attribution is uncertain. The Scythic tombs can be roughly dated by the objects of Greek art that they contain. They seem to begin about the 7th century B.C., and to continue till the 2nd century. A different style of tomb, referred to the Sarmatians, begins in the East in the 5th century and gradually spreads westward. The finest of the Scythic class were opened about the bend of the Dnieper, where we should put the land Gerrhus. Others are found to the south-west of the central area, and in the governments of Kiev and Poltava we have many tombs with Scythic characteristics, but differences (*e* g., the fewness of the horses) which make us think of the settled tribes under Scythic domination. Others occur in the flat northern half of the Crimea, and even close to Kerch, where the famous Kul Oba seems to have held a Scythic chieftain who had adopted a veneer of Greek tastes but remained a barbarian at heart. East of the Maeotis, especially along the river Kuban, are many groups of barrows showing the same culture as those of Gerrhus but in a purer form. Very few of these barrows have come down to us unplundered, and we cannot find one complete example and take it as a type. Soon after they were heaped up, before the beams supporting the central chamber had rotted, thieves made a practice of driving a mine into the mound straight to where the valuables were deposited. It is perhaps by the collapse of such a mine and the crushing of the robber after he had thrown everything into confusion that the treasures of the Chertomlyk barrow, on the whole the most typical, were preserved to us. This was 60ft. high and 1,100ft. round; about it was a stone plinth, and it was approached by a kind of stone alley; a central shaft descended 35ft. 6in. below the surface of the earth, and from each corner of it at the bottom opened out side chambers; beyond the northwest chamber was a large irregular chamber. In the central pit all was in confusion, but here the king seems to have lain on a bier. His belongings. found piled up near the mine, includetl a gorytos (combined bow-case and quiver) and a sword sheath, each covered with plates of gold of Greek work. three swords with gold hilts. a hone with gold mounting. a whip, many other gold plates and a heap of arrow-heads. In the north-west chamber was a woman's skeleton, and she had her jewels, mostly of Greek work. She was attended by a man, and three other men were buried in the other chambers. They were supplied with simpler weapons and adornments, but even so their clothes had hundreds of stamped gold plates and strips of various shapes sewn on to them. By every skeleton were drinking vessels. A store of wine was contained in six amphorae, and in two bronze cauldrons were mutton-bones. The most wonderful object of all was a great two-handled vase standing gft. high and made to hold kumys. The greater part of its body is covered by a pattern of acanthus leaves, but on the shoulder is a frieze showing nomads breaking in wild mares, our chief authority for Scythian costume. To the west of the main shaft were three square pits with horses and their harness, and by them two pits with men's skeletons. In the heap itself was found an immense quantity of pieces of harness and what may be remains of a funeral car. The Greek work would seem to date the burial to the 3rd century B C.

At Alexandropol and Solokha in the same district were equally elaborate tombs, the latter specially rich Another tomb in this region, Melgunov's barrow, found in 1760, contained a dagger-sheath and pommel of Assyrian work and Greek things of the 6th century. In the Kul Oba tomb, mentioned above, the chamber was of stone and the contents, with one or two exceptions, of purely Greek workmanship, but the ideas underlying are the same — the king has his wife. his servant and his horse, his amphorae with wine, his cauldron with mutton-bones, his drinking vessels and his weapons, the latter being almost the only objects of barbarian style. One of the cups has a frieze with reliefs of natives supplementing that on the Chertomlyk vase.

East of the Maeotis on the Kuban we have many barrows; the most interesting are the groups called the Seven Brothers, and those of Karagodeuashkh. Kostromskaya, Ul and Kelermes. the latter remarkable for objects of Assyrian style, the others for the enormous slaughter of horses; on the Ul were 400 in one grave.

Art. — Certain of the objects which occur in these Scythic graves are of special forms typical for the Scythic area. Most interesting of these is the dagger or sword (*akinakēs*), always very short, save in the latest graves. and distinguished by a heart-shaped guard marking the juncture of hilt and blade; its sheath is also characteristic, having a triangular projection on one side and usually a separate tip; these peculiar forms were necessitated by a special way of hanging the dagger from two straps that it might not interfere with a rider's movements. Just the same form of short sword was used in Persia and is shown on the sculptures at Persepolis; the type is no doubt oriental in origin. Another special type is the bow-case (gorytos). made to take a short curved bow and to accommodate arrows as well. Further. there is the peculiar cauldron on one conical foot, round which the fire was built, the cylindrical hone pierced for suspension and the cup with a rounded bottom Assyrian and afterwards Greek craftsmen working for Scythic employers were compelled to decorate these outlandish forms, which they did according to their own' fashion; but there was also a vigorous native style that, more than anything else, expresses the distinctive individuality of the Scyths. The essence of Scythian art is the employment of animal figures— particularly elks. deer, bears. *felidae* and birds' heads — for the decorations of weapons, mirrors. pole-tops and horse-trappings. In every case the representation is severely subordinated to the decorative function it is to serve, and the figures are accommodated to the shape of the object to he adorned. Moreover. several motives are often blended together in a most fantastic way. Yet despite rigid stylization the effect of this "animal style." as it is called, is to give an extraordinarily lifelike impression.

Though it uses oriental and even Greek motives. the roots of this queer compost of naturalism an1 stylization go right back to the carvings of palaeolithic hunters. Its immediate ancestry is to be sought in the naturalistic glyptic of the forest hunters of the so-called Arctic stone age who ranged along the border of tundra and forest from Norway eastward for an unknown distance into Siberia. In the latter region there sprang a parallel branch from the same trunk that, at the beginning of the iron age, is still very similar to the early Scythian.

In south Russia the animal style wilted under the influence of Greek culture, and, with the expansion of Sarmatians, became choked with Iranian monsters and overburdened with polychrome enamels. Yet through this medium it was transmitted to the Teutons at the time of their great migrations, and so to mediaeval Europe. On the other hand the reaction of Scytho-Siberian art can be traced to the borders of China at the beginning of our era, and some carpets of that date, brought back by Kozlov from Mongolia. illustrate its application to textile decoration.

History. — The oldest inhabitants of Scythia were the Cimmerii; some of them were nomads, while others tilled some land in the river valleys and in the Crimea. where they left their name to ferries, earthworks and the Cimmerian Bosporus, (See BOSPORUS. KINGDOM OF THE.) They were, perhaps, of Iranian race. though others regard them as Thracian. In the 7th century B.C. these Cirnmerians were attacked and partly driven out by a horde of newcomers from upper Asia called Scythae. About the same time similar peoples harassed the northern frontier of Iran. where they were called Saka (Sacae), and in later times Saka (*q.v.*) and Scyths were regarded as synonymous.

About 512 B.C. Darius Hystaspis undertook an invasion of Scythia which, according to Herodotus, he traversed as far as the Oarus (probably the Volga). He burned the town of Gelonus and returned to the Ister (Danube) in 60 days. In this march he was much harassed by the nomad tribes. with whom he could not come to close quarters. After losing many men, he found on his return that the Ionian Greeks were still guarding the bridge over the Ister in spite of the attempts of the Scyths to make them desert, and thus he safely re-entered his dominions. Ctesias, the Persian historian, says that the whole campaign only took 15 days and that Darius did not get beyond the Tyras (Dniester). This is also the view of Strabo. Ctesias admits. however, that the great king suffered heavy losses. The whole of Herodotus' account bristles with difficulties. A full discussion of these will be iound in G. B. Grundy, *The Great Persian War* (1901) pp. 48–76. Grundy represents the expedition as a necessary strategical preliminary to the subjugation of European Greece, undertaken with the object of making sure that no large Greek communities should be leit upon Darius' flank (*see* GRAECO-PERSIAN WARS). We may conclude that Darius made an attempt to secure the Danube frontier, suffered reverses and retired.

The Greeks had been trading with the Scyths ever since their coming and at Olbia there were many tales oi their history. We can make a list of Scythian kings — Spargapeithes, Lycus, Gnurus, Saulius (whose brother, the famous Xnacharsis [*q.v.*], traveled over all the world in search of wisdom, was reckoned a sage among the Greeks and was slain among his own people because they did not like his ioreign ways), and Idanthyrsus, the high king at the time of Darius, probably the iather of Xriapeithes. This latter had three wives—a Greek woman irom Istrus, Opoea, a Scythian, and a Thracian, daughter to the great chiei Teres. Scyles, his son by the Greek mother, affected Greek ways, had a house in Olbia, and even took part in Bacchic rites. When this came to the knowledge of his subjects he was murdered, and Octamasadas, his son by the third wife. reigned in his stead. Herodotus adduces this to show how much the Scyths hated ioreign customs, hut with the things found in the graves it rather proves how strong was the attraction exercised upon the nomads by the higher culture of their neighbours. Octamasadas died shortly before the time oi Herodotus. We cannot place Xriantas, who made a kind of census of the nation by exacting an arrowhead irom each warrior and cast a great cauldron out of the bronze. nor Taxacis and Scopasis. the under kings in the time of Idanthyrsus. Aiter the retreat of Darius the Scythians made a raid as iar as Abydos, and even sent envoys to King Cleomenes I of Sparta to arrange that they should attack the Persian empire irom the Phasis while the Spartans marched up irom Ephesus. Henceforward the Scyths appear as a declining power: by the middle oi the 4th century their eastern neighbours, the Sarmatae, have crossed the Tanais (Don) and the pressure of the Scyths is felt on the Danube. Here Philip II of Macedon defeated and slew their king Ateas in 339 B.C., and irom this time on the representatives oi the old Scythic power are petty chieftains in the western part of the country about Olbia. where they could still be dangerous and about Tomi. Toward the second half oi the 2nd century B.C. this kingdom seems to have become the nucleus of a great state under Scilurus, nhose name appears on coins ot Olbia, and who at the same time threatined Chersonesus in the Crimea Here however, he was opposed by the might of Mithridates VI of Pontus and his power was broken, but some Scyths survived until the migration period Meanwhile most ot Scythia had become the land ot the Sarmatae ($q\ v$) These were definitely Iranian; like the Scyths they were pressed ton aid the west bv vet nener swarms, and nith the coming of the Huns Scythia enters upon a new cycle, though still keeping its old name in the Byzantine historians (X , V G C)

SCYTHOPOLIS: see BEISAN.

SEA ANEMONE. Sea anemones are sedentary and usually solitary marine animals nhose flowerlike appearance is striking; their name anemone is taken from the Greek word for windflowers They are polyplike coelenterates belonging to the class Anthozoa ($q\ v$) The radial arrangement o? the usually colourful tentacles around the disc which bears the mouth a: its centre is reminiscent of the petals of a flower.

Anemones vary in size from polyps only a fraction of an inch in both length and diameter to giants measuring about three feet in diameter These carnivorous animals are common along all of the sea shores of the norld are abundant in bays and estuaries and occur even in the greatest depths of the oceans; they are never found in fresh waters Most anemones adhere tenaciously by their bases to hard substrates such as rocks, other animals. pilings, wharves and ship bottoms. They seldom move, although a slow creeping motion is possible. Some anemones do not possess a base but have instead a specialized aboral region, the physa, which makes it possible for them to burrow into soft muddy or sandy bottoms. where they will be iound nith just their tentacles and oral area exposed. A few anemones with a base. such as *Stomphia* and *Boloceroides,* can release their grip upon the substrate and by movements of the column or tentacles can swim short distances. *Minyas* has a base which secretes a porous, chitinous mass which serves as a float in carrying the anemone about at the suriace of the water. Anemones are devoid of a skeleton but they may secrete a horny cuticular covering or, by using various adhesive structures on the body wall, cover themselves with sand grains, bits of shell or other foreign objects.

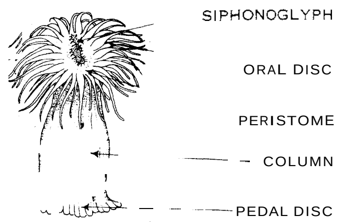


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FIG 1.—GENERAL FEATURES OF A SEA ANEMONE

Many sea anemones possess unicellar algae living in their tissues; these algae, while not serving directly as food are a source of organic material which leaks from their cells and contributes to the nutrition of the host anemone. Anemones possess nematocysts on their tentacles, which makes it possible ior them to capture other animals. Symbiotic relations exist between anemones and other animals. Certain crabs carry sea anemones about in their claws, and some hermit crabs bear sea anemones upon their borrowed shells. The anemones, with their stinging nematocysts, presumably serve as protection for their mates in these associations.

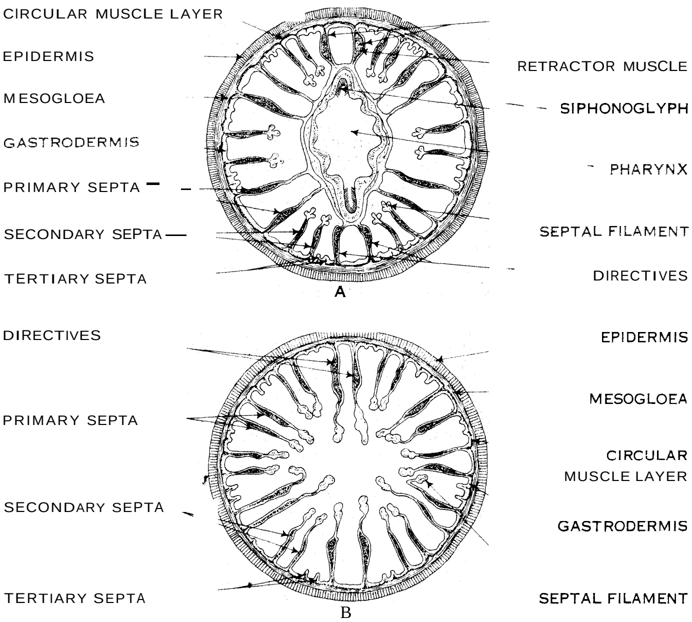

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FIG —CROSS SECTIONS OF A SEA ANEMONE (A) THROUGH THE PHARYNX AND (B) BELOW IT

Technically sea anemones may be classified into several groups: (1) *Actiniaria,* or true sea anernones are the solitary burrowing. attached or free floating animals; (2) *Ptychodactiaria,* or deep water anemones, are found in the arctic and antarctic; **(3)** *Corallimorpharia* are solitary or tropical forms which are intermediate between corals (Madreporaria) and sea anemones (Actiniaria); (4) *Zoanthidea* are solitary or colonial anemones, many species of which occur epizoically on the stalks of sponges, sea fans and sea feathers; (5) *Ceriantharia* are solitary types which live in tubes formed of mucous and extruded nematocysts. These animals usually occur in soft bottoms in subtidal locations.

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(C. HA.)

SEABEES, the popular name for the U.S. naval construction battalions (C.Bs.) in World War II, symbolized by a buzzing bee. Composed of skilled American workmen, mostly 30 years of age or older, and officered by experienced engineers whose abilities and attainments commanded the respect of their men, these units were given basic combat training so that their members could drop their tools and pick up rifles when necessity required. The Seabees built naval bases, airfields and harbour facilities; they manned and operated repair facilities of all kinds. Their work was especially effective in the operation of floating dry docks in forward areas; these facilities saved many naval vessels of all sizes which would otherwise have been lost. The basic idea for the Seabees was tried within the United States with one small unit in 1917–18, and studied later. Adm. Ben Moreell recommended. on Dec. 28, 1941, the immediate organization of Seabees as military units, for service outside the continental United States. His proposals were adopted, and the first unit sailed on Jan. 27. 1942, for Bora Bora. in the Pacific; it demonstrated its value and versatility in such a way as to ensure further use.

See *Building the Navy's Rases in World War II, History of the Bureau of Yards and Docks and of the Civil Engineer Corps, U S Navy, 1940–46,* 2 vol (1947)

(J B. HN)

SEABORG, GLENN THEODORE (1912–), U.S. physical chemist and co-winner nith Edwin M McMillan of the 1951 Nobel prize in chemistry, is known principally for his work on the synthetic transuranium elements He was born in Ishpeming, Mich , on April 19, 1912. and was educated at the University of California (A B Los Angeles, 1934; Ph.D. Berkeley, 1937) He mas successively research associate, instructor and assistant professor (1937–45), becoming profeisor of chemistry and associate director of the Radiation laboratory in 1945. He served as chancellor, 1958–61.

With his co-workers, he added (1940–55) eight new elements encompassing atomic numbers 94–101, of which plutonium (94) is the best known because of its use as a nuclear explosive and for nuclear power During World War II, which he spent as a section chief at The University of Chicago metallurgical laboratory, the first industrial production of plutonium was undertaken in the newly devised uranium reactors, and Seahorg had the primary responsibility for isolating the plutonium from the reaction products The other new elements were: americium (95), curium (96), berkelium (97), californium (98), einsteinium (99), fermium (100), mendelevium (101) Following the tentative identification of nobelium (102) in Sweden in 1957, he predicted, at the Geneva conference on atomic energy (1958) the possible discovery of six more synthetic elements. In Jan. 1961 President Kennedy named him chairman of the Atomic Energy commission. (I. P)

SEABURY, SAMUEL (1729–1796), American clergyman. first bishop of the Protestant Episcopal Church in the United States, was born in Groton. Conn., on Nov. 31, 1729. After graduating from Tale in 1748, he served for four years as catechist in Huntington. N.Y. In 1752 he went to Great Britain and, after studying medicine for a year at Edinburgh, was ordained deacon and priest successively on Dec. 21 and 23, 1753. Returning to America. he served as rector in New Brunswick, N.J. (1754–56); Jamaica. N.Y. (1757–66); and Westchester. N.T. (1766–75). He took a loyalist stand in the Revolution and wrote some pamphlets on that side under the pseudonym of A. W[estchester] Farmer. These led to his being arrested by the revolutionary party and held prisoner in Connecticut for several weeks. After his release, he returned to Westchester for a while but later sought refuge with the British forces in New York, where he served for a time as chaplain of a loyalist regiment. He was there at the end of the war when the clergy of Connecticut, meeting in Woodbury on March 25, 1783, made him their second choice for bishop. As Jeremiah Leeming, the first choice, declined, Seabury was sent to England to seek consecration. A special act of parliament was required to permit the consecration of American bishops, and various circumstances connected with Seabury's election made the archbishops hesitate to seek the power in his case. He then went to Scotland. where he secured consecration on Nov. 14. 1784, from bishops of the nonjuring Episcopal Church in that country. In the meantime, Episcopalians in the middle and southern states had begun a movement that led to the adoption of a constitution for the church in 1786 and the consecration of two bishops in England in 1787. Between that event and the next meeting of the General convention in 1789, the leaders of the church were concerned with the problem of uniting the two episcopal lines. The difficulties arose from Seabury's political viens and from uncertainty as to the canonical status of the Episcopal Church in Scotland. A conciliatory spirit finally prevailed on both sides, and the whole Protestant Episcopal Church was united in the second session of the General convention of 1789. A third bishop was consecrated in England, and all four bishops joined in the consecration of Thomas John Claggett as bishop of Maryland on Sept. 17. 1792, the first consecration on American soil. Though disappointed in some features of the church's constitution and of the Book of Common Prayer as revised in 1789, Seabury secured their acceptance in Connecticut, where he continued to serve as bishop and as rector of the church in New London until his death on Feb. 25, 1796. See also PROTESTANT EPISCOPAL CHURCH.

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SEA COW, a name used for any member of the mammalian order Sirenia (*q.v.*) but in a restricted sense referring to Steller's sea cow (*Hydrodamalis stelleri*). This was a gigantic relative of the manatee and dugong (*qq.v.*) which formerly inhabited Bering and Copper Islands in the Bering strait near Kamchatka. It was discovered in 1741 and described by Georg W Steller, who accompanied Vitus Bering in his voyage of exploration. It was killed in large numbers by the Russian sealers and fur hunters, who found the animals easy to hunt, and by 1768. less than 30 years after its discovery, the sea cow was exterminated.

The sea cow reached a length of about 24 ft., with a relatively small head and broad. horizontal, forked tail fluke. The thin skin was dark brown in colour, sometimes streaked or spotted with white. The jans were toothless but provided nith ridged horny plates. The flippers were short and blunt, lacking the terminal joints of the digits. When discovered, these sirenians were numerous in the bays where they browsed upon the abundant seaweed. Bones of the sea cow are still found there from time to time. See also UNGULATA. (J. E HL)

SEA CUCUMBER, popular name, after their shape, for warty-skinned marine animals of the class Holothurioidea, the most aberrant and diversified class of the Echinodermata (*q* v.). The body is usually elongate, often sausage-shaped, with a spacious body cavity, or coelom, and well-developed muscles which enable the holothurians to move in wormlike fashion. In size sea cucumbers range from about an inch (order Elasipoda) to several feet (order Apoda) in length. They are usually dull in colour, being shades of gray, drab. brown and black; however, some are brightly coloured. The skeleton is usually reduced to minute spicules. important for classification; rarely. larger plates are present, and a few forms presumably have lost all spicules. The water vascular system, characteristic of all echinoderms, is well developed in some orders and almost nonexistent in others Food is collected by means of tentacles, modified tube feet. which surround the mouth. In the bizarre primitive deepwater forms, the Elasipoda, the tentacles are hardly more than enlarged tube feet by means of which the animals scoop up the ooze of the sea bottom. In more advanced groups the tentacles may become shovel-like organs, as in the many reef forms of the tropics, or they become richly branched and are used as a net in which plankton particles are strained and afterward transferred to the mouth where the tentacle is licked clean. In the streamlined members of the order Molpadonia. which tunnel their way through mud, the tentacles are small and used as digging tools, while at the same time food is taken in. The wormlike Apoda, which burrow, use their tentacles in the same manner. while forms which live on reefs have large feathery or plumose tentacles which sweep up food particles. The Holothurioidea comprise about 500 species, ranging from extreme shallow water to the greatest depths of the ocean. A few are utilized as food (see BÊCHE-DE-MER).

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SEA DAHLIA (Coreopsis maritima), a North American plant of the family Compositae, native to the coast of California and Mexico and cultivated for its showy flowers. It is a stout fleshy perennial, about two feet high, bearing much divided leaves and a large solitary flower head, about three inches across, having bright yellow rays.

SEADIAH (or SAADIA; in Arabic Sa'id) BEN JOSEPH: see SAADIA BEN JOSEPH.

SEAFORD, an urban district and seaside resort in the Lewes parliamentary division of East Sussex, Eng., 4 mi. S.E. from Newhaven by road. Pop. (1951) 9,001. Area 6 7 sq mi. The town is sheltered by the South downs behind and the high chalk cliff of Seaford head to the east. In former days the Ouse entered the English channel there, and the natural harbour so formed accounts for the origin of Seaford, probably in Roman times though it is not mentioned in Domesday. It became a corporate limb of the Cinque Port of Hastings. and was doubtless of considerable importance until about the end of the 14th century when its rapid decline began as a result of the silting up of the harbour and the increase in the size of ships. In the 16th century the tonn was finally deserted by the Ouse. which now runs into the sea at Newhaven, and no revival of its prosperity occurred until the early 19th century. when it began to be frequented as a seaside town Seaford is noted for the number of schools established there. The beach is shingle though there are sands at low tide

SEAHAM, a seaport and urban district in the Houghton-le-Spring parliamentary division of Durham, Eng., 5 mi. S S.E. of Sunderland by road. Pop. (1951) 26.142. Area 3 9 sq mi. Seaham is mentioned in a document of 930, but modern Seaham dates only from 1828, when the 3rd marquess of Londonderry built a harbour for the export of coal from the Rainton pits. Later the three Seaham pits were sunk.

The district was first known as Seaham Harbour and comprised Seaham and Dawdon, but in 1937 New Seaham was incorporated and the name changed to Seaham.

SEA HORSE (*Hippocampus*), the name for small marine fishes, in which, as in others of the pipefish family (Syngnathidae), the body is enclosed in bony rings, the small mouth is placed at the end of a tubiform snout and the gills are lobate. Sea horses, of which about 50 species, from an inch or two to a foot long, are known from tropical and warm temperate seas, are distinguished by having the head, which somewhat resembles that of a horse, set at an angle to the body and freely movable, and by the tapering tail, without caudal fin, which is prehensile and can be curled round the stem of seaweeds, etc. They live in a more or less vertical position, swimming by rapid undulations of the small dorsal and pectoral fins. The eggs are carried by the male in a pouch on the underside of the tail, in which they are hatched. Their coloration. the tubercles and spines on the head and body and the skinny flaps tend to conceal these fishes among the weeds; the flaps are most developed in an allied genus (*Phyllopteryx*) from Australia.

BY COURTESY OF THE N.Y. ZOOLOGICAL SOCIETY

SEA HORSE (HIPPOCAMPUS)

SEA KALE, *Crambe maritima,* is a hardy perennial member of the family Cruciferae, which includes mustard, turnip, cabbage, etc. It grows wild along the western coasts of Europe and along the coasts of the Baltic and Black seas. The cultivated form is grown in Great Britain and Europe as a vegetable for its young blanched shoots, somewhat as asparagus is grown. It is little grown in the United States. The perennial planting is set about 3 x 3 ft. with year-old seedlings grown in a seedbed, or with root cuttings 4 to 5 in. long from old plants. Two years after cuttings, or three years after seed, the crown is covered with soil or a lightproof device to blanch the shoots. The large thick glaucous-blue leaves are allowed to grow part of the season, like asparagus tops. Because of its low growth and small white flowers. it may also serve as an effective border plant in gardens. A well-tended planting remains productive eight to ten years. (V. R. B.)

BEN DARBY

SEA KALE (CRAMBE MARITIMA), A SUCCULENT POTHERB

SEAL, the name applied to members of the family Phocidae of the suborder Pinnipedia of the Carnivora (*q.v.*) and sometimes even to all the Pinnipedia except the walrus. Seals are all marine and swim and dive with ease. They feed on fish, crustacea, mollusks and even sea birds and form the main food of the Eskimo, the killer whale and the polar bear. They are fond of basking in the sun on sandy beaches, rocks or ice floes and resort to the land or ice for breeding purposes, often in immense numbers. One young one is usually produced annually and many species are polygamous but do not form true "harems" except in the eared seals and sea elephants; the males fight fiercely for possession of the females. The young are taught to swim by their parents. When on land, the hind dimbs take no part in the seal's progression. Seals are very inquisitive animals. The sense of smell is acute and the voice varies from a harsh bark to a plaintive bleat. The common seal (*Phoca vitulina*) is found on the coasts of the North Atlantic and North Pacific. In the female, the teeth are smaller than in the male. The gray seal (*Halichoerus grypus*) is larger, reaching a length of 8 ft. It is confined to the North Atlantic and is rare on the American side, where it has never been seen south of Nova Scotia. It is the only seal which has its young late in autumn.

See FUR-SEALS: SEAL FISHERIES; SEA-LEOPARD; SEA LION; see also Index references under "Seal" in the Index volume.

SEA LAWS: *see* MARITIME LAW.

SEA-LEOPARD or **LEOPARD-SEAL** (*Hydrurga leptonyx*), a large seal inhabiting Antarctic regions and often reaching a length of 12 ft. Its behaviour and its spotted fur have given it its name. During the summer, the leopard-seal feeds largely on penguins (q v) It is an especial foe of the Adélie penguin; in the stomach of one killed by Levick *(Antarctic Penguins)* the remains of no fewer than 17 nere found.

SEAL FISHERIES. The animals taken by sealers are members of several genera. but are alike in being gregarious in habit, and in producing their young on shore, at well defined seasons, at places which are revisited year after year. Their meat, hides. fur and blubber are of the greatest value to primitive peoples for food, canoe making. light and heat—even the sinews are utilized as thread—and, except in the Antarctic, have made them a quarry from time immemorial; but when sealing on a large scale became important as a commercial undertaking, their habits both dictated the chief methods employed and rendered them in the highest degree vulnerable One species, the sea cow (*Hydrodamalis stelleri*) indeed became extinct only some 20 years after its discovery, and in some regions the depletion of others led to a cessation of sealing The first and usual method employed by sealers nas to attack the herds both on the ice or, particularly, on the breeding grounds or "rookeries." In the pursuit of the fur seals of the Pacific (Otariidae) hunting in the open sea, or "pelagic" sealing, was developed, and proved most wastefully destructive, owing to the frequency with which the dead seals sank before they could be taken into the boats; pelagic sealing, however, was first restricted by various regulations and ultimately prohibited.

Early Seal Fishing.—Seals, and particularly walruses or "morses" (*Odobenus rosmarus*), were taken in the north Atlantic, in the borders of the Arctic region, by whalers from the beginning of the northern whaling at the dawn of the 17th century, for their skins. blubber and tusks, the latter being a somewhat inferior ivory, and their teeth were bought also from natives. In the most prosperous days of northern whaling the whalers neglected seals, but in the latter part of the 19th century the whalers again were glad to include them in their catch. Meanwhile. sealing as a separate occupation had developed during the previous century. The skins were at that time of more value than at any later time. The chief species taken were the Greenland seal (*Phoca groenlandica*), hooded seal *(Cystophoia cristata)* and bearded seal (*Erignathus barbatus*).

The gray seal (*Halichoerus grypus*), and the common seal *(Phoca vitulina)*, are not at present the subject of commercial exploitation. though the latter is killed by fishermen under the conviction. not at present too well founded, that it causes great depredations among the food species.

Atlantic Sealing.—Atlantic sealing occurs in the spring, from Novaya Zemlya to Newfoundland. For the eastern grounds sealers sail chiefly from Norwegian ports, for the western from those of Canada. They are not usually large vessels. The western sealers have been aided materially by the location of the herds by aircraft The young Greenland seals are born along the eastern grounds about the first half of March, and on the western grounds in the latter half of the same month. Some other seals keep somewhat the same season. The regulations made by most nations engaged in Atlantic-Arctic sealing are based on these facts.

The Fur Seal.—The fur seals (Otariidae) differ from those mentioned above in possessing a permanent under coating of short, soft fur, the "seal skin" of the costumier. They were opened to exploitation by the voyage of Bering in the Pacific-Arctic zone in 1741. Their migrations cover great areas, from the latitude of southern Japan on the west and from southern California in the east. to the great rookeries on Commander and Pribilof islands respectively; late in the 19th century the latter held some $2\frac{1}{2}$ million seals, and the former over a million Another rookery, on Robben island, in the Sea of Okhotsk, was of very minor importance. All these herds were greatly reduced, and by 1897 did not exceed 600,000 individuals in all.

The typical adult male or bull (*sikatch*) of the second group attains maturity about the seventh year, and weighs from 400 to 500 lb. It is 6 ft. in length, with a girth of 4½ feet. The fur is blackish or dark brown, with long yellowish-white hairs, especially long and firm on the back of the neck, forming the so-called "wig" or mane. The animal stands erect and runs or "lollops" along the ground when on land. The adult female, or cow (*matka*), is much smaller, averaging about 80 lb. in weight, with length and girth in proportion. The fur is of varying shades of brown; she bears her first young at the age of three years. The breeding-grounds are boulder-strewn beaches or rocky hill slopes near the shore. On these the she-bears congregate in close-set masses called "rookeries." The unit of rookery life is the family group, or "harem," each bull collecting as many females as he can control. The number ranges from one to 100 or more, averaging about 30. The bulls reach the islands early in May and take up their places. The cows begin to arrive the first week in June. The number on the rookeries from day to day grows steadily to a climax about the middle of July, when about one-half are present, the number actually on the ground diminishing to about one-fourth at and after the close of the breeding season with the end of July. The single young, or pup (kotik), weighing 10 to 12 lb. and jet black in colour, is born within six to 48 hours after the arrival of the cow. Within a week the latter is served by the bull, and by the end of another week she goes to sea to feed, returning at gradually lengthening intervals through the summer to nourish her young, left in the meantime to care for itself on the rookeries. The bulls, having fasted since their arrival in May, go away in August to feed. The pups learn to swim at the age of a month or six weeks: and in No\-ember. with the approach of winter, swim away with their mothers to the south. The migration of the seals is said to keep fairly well to the 100 fathom line.

Pelagic Sealing.——At first the catch averaged 75.000 per annum, but after about 1863 it increased rapidly, and from 1879 sailing vessels carrying numerous canoes were employed to attack the migrating seals. which were thus deprived of their natural closed season; these vessels at one time exceeded 100 in number; some of them carried as many as 2j canoe crews. It has been estimated that by 1902 a million seals had been taken at sea, and, unfortunately, the breeding females were killed with the rest. to the great detriment of the recuperative powers of the stock. In the Bering sea pelagic sealing indeed well over half the catch was of this class. The greatest catch, however, was always on shore.' From the Pribilof and Commander herds nearly 2½ million were taken on land between 1868 and 1897.

Land Sealing.— Fortunatel? the conduct of the seals on land permits of the catch being made with the least possible attendant depletion of stock. The young males, or bachelors, "haul out" to rest and sleep on beaches adjacent to. but distinct from, the breeding-grounds. Here they are surrounded at night by the sealing gangs, rounded up in droves of from 1,000 to 3,000, and driven inland to the killing-grounds. The large droves are broken up into successive "pods," or groups. of from 20 to 50, of which the "killable" seals (animals of three years of age or approximating to such in size) are knocked down with clubs, those too large or too small being allowed to escape. The skins are removed, salted in kenches and, when cured, are exported.

Apart from this degree of economy, however, a long series of enactments have been made for the protection of the seals (and of sealing). A treaty between the British empire, the Cnited States, Russia, and Japan, which not only regulates land sealing in the North Pacific but prohibits pelagic sealing, became effective in 1911.

The fur seal (*Arctocephalus* australis) of the south was once taken at the Galapagos islands, Tierra del Fuego, Lobos islands, and this or other species at South Africa. Australia, New Zealand and many points about the Antarctic circle. In South Georgia and other dependencies of the Falkland islands it was abundant at one time, and was takrn heiore 1793. Sealing and exploration were mutually helpful. much geographical discovery being due to whalers and sealers. while sealing. like whaling, followed exploration in other cases. Great numbers of sea leopards (*Hydrurga leptonyx*), sea elephants (*Mirounga leonina*), Weddel's seals (*Leptonychotes weddelli*) and other species were seen by early voyagers, but at first the skins of the fur seals alone seem to have been taken. One of the earliest recorded landings was that of the Argentine ship, "Juan Nepomucena," which brought in 13,000 skins in 1820. In this and the two following years over yo vessels, roughly equally divided between Great Britain and the United States. worked the southern grounds. In the first season, catches of 18,000 were not unusual, and five British ships took 95,000 seals in all. By 1892 sealing vessels sailed from South American ports homeward with mixed cargoes; and though in the early '90s a Scottish whaling expedition to the Ross sea took 20.-000 skins with four ships, by the end of the 19th century the fur seal had almost completely disappeared from the Falkland island dependencies at least. Other seals. sea elephants in particular, had very greatly diminished in number. From 1881 sealing in these territories has been regulated; close seasons were introduced, and sealing is now only permitted under licences, which may determine both the kind and number of seals taken. The capture of fur seals is prohibited.

The Elephant Seal.—The chief modern sealing of this region, and one which has responded in a satisfactory may to the regulations which govern it, is that for the elephant seal. This seal is taken by whalers. but pups may not be taken, nor, as far as practicable, female seals. There is also a close season and closed areas along certain stretches of coast. The absence of segregation of young males on the rookeries is a hindrance to the observance of the regulations. Pairing takes place immediately after the young are born, early in October, and the young, which are born singly, are usually weaned in November; these circumstances have determined the closed periods enforced. During February and March the large males haul out on the beaches, and are there for some time in good condition.

SEALING WAX was once widely used to seal letters and attach impressions of seals to official documents. In medieval times it consisted first of a mixture of beeswax, Venice turpentine and colouring matter, usually vermilion, but when lac from the East Indies was introduced into Europe by the Venetians it displaced the beeswax. Sealing wax was prepared by melting the rosin in a copper or earthenware pot and adding the colouring matter slowly while stirring. The molten mixture was poured into stick-shaped molds. In later times, sealing waxes containing admixtures of chalk (calcium carbonate), magnesium carbonate and barite white (barium sulfate) and employing mineral pigments were developed. In very inferior waxes, ordinary rosin was substituted for lac.

Since the advent of the gummed envelope and various methods of affixing official seals, sealing wax has had only a few applications as a sealing material. It has been used with some success in decorative handwork. (E. L. Y.)

SEA LION, the name for larger species of the eared seals (Otariidae), lacking the underfur that makes the skins of fur seals valuable. In the northern or Steller's sea lion (*Eumetopias*) of the north Pacific and Eering sea the males reach a length of 13 ft. (females are only half of this). The southern sea lion (*Otaria*) lives on the shores of South America. Males have a pug nose and a mane and are about 9 ft. long. The California sea lion (*Zalophus*) is smaller, it is commonly kept in captivity and is the trained seal of circuses. The Australian sea lion (*Neophoca*) is about the size of *Zalophus*. Males have a yellowish wig. Hooker's sea lion (*Phocarctos*) is known only in the Auckland Islands in the South Pacific. (See CARNIVORA.) (J. E. HL.)

SEALS. The word "seal" (Lat. *sigillum*, O.Fr. *scel*) is employed as a term to describe both the implement for making the impression. and the impression itself; this article will be confined to the latter usage. except when the seal is referred to as the matrix. In the east the age-old custom of using the seal as a stamp of authentication of a document is parallel to the western habit of inscribing a signature. The seal is sometimes used in Europe and America for the same purpose, especially in the case of sovereigns, courts, officials, bishops, states. corporations. etc. See under Seal of the *U.S.A.*, *European*, and *Japanese and Chinese*.

SEAL OF THE UNITED STATES

The practice of authenticating important state documents by affixing to them a seal emblematic of the governing power, dates from remote antiquity; and this practice prevailed among the governments of civilized nations at the time the United States came into existence. Accordingly, on July 4, 1776, within a few hours after agreeing to the Declaration of Independence, the Continental Congress recognized the need of a seal for the new nation by naming a committee of three, Benjamin Franklin, John Adams and Thomas Jefferson, "to bring in a device for a seal for the United States of America." This committee called into consultation Pierre Eugène du Simitière, an artist of Philadelphia; each of the four men proposed a design; du Simitière's, with slight modifications, was preferred for the obverse; and Franklin's was accepted for the reverse. On August 20, 1776, the committee reported its design to Congress; but the report was tabled, and for three years and a half no further action was taken. Although this proposal was thus deemed unsatisfactory, certain of its elements were carried over into the seal finally adopted, namely, the use of a shield, the motto "E Pluribus Unum," the "Eye of Providence in a radiant Triangle" and the date "MDCCLXXVI."

On March 25, 1780, the report of the first committee was referred to a new committee, then appointed, consisting of James Lovell, of Massachusetts, John Morin Scott, of New York and William Churchill Houston, of New Jersey. This committee, which received artistic assistance from Francis Hopkinson, Treasurer of Loans under the Continental Congress, reported a new design on May 10 (or 11), 1780; on the following May 17 Congress considered the report and, after debate, ordered it recommitted; and nothing further was accomplished for nearly two years. While this proposal thus suffered the same fate as the preceding one, certain of its elements were likewise carried over into the final seal, namely, 13 alternate stripes on the shield, the olive branch and the crest comprised a "radiant constellation of 13 Stars."

In the spring of 1782 a third committee, consisting of Arthur Middleton and John Rutledge, of South Carolina, and Elias Boudinot, of New Jersey, was appointed to design a seal This committee called to its assistance William Barton, A.M., of Philadelphia, who possessed some knowledge of heraldry and drawing. Barton prepared two complicated designs, the second of which was accepted by the committee and reported to Congress on May 9, 1782. In this design the eagle displayed on the obverse and the pyramid on the reverse made their appearance; and, except for the mottoes and the date, the reverse here reached approximately its final form. Still unsatisfied, however, Congress on the following June 13 referred this and the previous reports to Charles Thomson, Secretary of Congress. With the reports of the three committees before him, Thomson now prepared his own design. Adopting the eagle as a central figure, he specified that it be an American eagle and "rising" instead of "displayed." In the sinister talon he placed a bundle of arrows; in the dexter, an olive branch, which had figured in the design of the second committee; for the crest he used the constellation of 13 stars, also from the design of the second committee; on the shield he rearranged in the form of chevrons the red and white stripes which the second committee had made diagonal and the third had made horizontal; and from the report of the first committee he adopted the motto "E Pluribus Unum," which he placed on a scroll in the eagle's beak. For the reverse he accepted the design reported by the third committee, except for the mottoes, which he changed; the date "MDCCLXXVI," which had figured in the reports of the first and second committees and which he reintroduced. and the "Eye, surrounded with a Glory," which he made "an Eye in a triangle surrounded with a glory," as in the report of the first committee. This device, with a rough sketch of the obverse, Thomson submitted to Barton. Under date of June 19, 1782. Barton rearote the description of the obverse. He changed the shield of Thomson's design by substituting vertical stripe. of alternating white and red, with a blue chief, in place of the chevrons; he restored the "displayed" eagle of the third committee's report; and he specified that the sheaf of arrons contain 13. Thomson immediately wrote his report to Congress, basing it on Barton's description of June 19, with slight modifications, and including his own previous description of the reverse. On June 20, 1782, he submitted his report to Congress; it was accepted the same day; and the question of a device for "the great seal" was thus finally settled. The description or blazon then adopted, which reads as follows, remains part of the law of the land today (for Thomson's "Remarks and explanation" regarding the symbolism of the device, see *Journals of the Continental Congress*, XXII, 339–340):

ARMS. Paleways of thirteen pieces, argent and gules; a chief, azure; the escutcheon on the breast of the American eagle displayed proper, holding in his dexter talon an olive branch, and in his sinister a bundle of thirteen arrows, all proper, and in his beak a scroll, inscribed with the motto, *"E Pluribus Unum."*

For the CREST. Over the head of the eagle, which appears above the escutcheon, a glory, or, breaking through a cloud, proper, and surrounding thirteen stars, forming a constellation, argent, on an azure field.

REVERSE. A pyramid unfinished. In the zenith, an eye in a triangle, surrounded with a glory proper. Over the eye these words, *"Annuit Cœptis."* On the base of the pyramid the numerical letters MDCCLXXVI. And underneath the following motto, *"Novus Ordo Seclorum."*

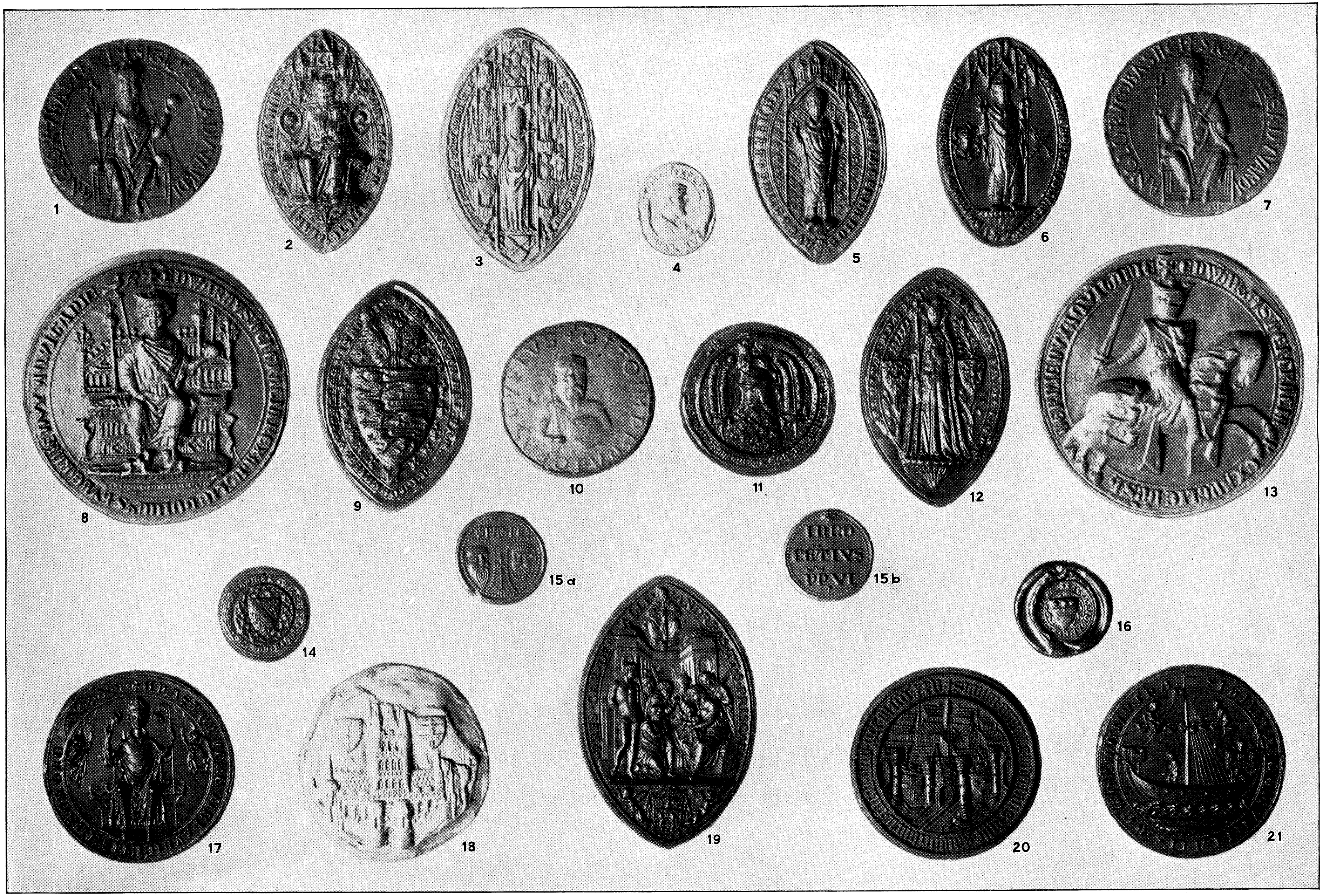
Soon after the action of Congress the obverse of the seal was cut in brass. It was used as early as Sept. 16, 1782, on a full power issued to General Washington to arrange with the British for exchange of prisoners of war. The seal was in the custody of Charles Thomson, as Secretary of Congress, until he delivered it on July 23, 1789, to President Washington, who entrusted it temporarily to the charge of Roger Alden, former Deputy Secretary of Congress. By the act of Congress of Sept. 15, 1789, which changed the Department of Foreign Affairs to the Department of State, the seal of 1782 was declared to be the seal of the United States and the Secretary of State was made its custodian. Sections 3 and 4 of that act (incorporated in U.S. Code, title 4, sections 4–5) read as follows:

SEC. 3. *And be it further enacted,* That the seal heretofore used by the United States in Congress assembled, shall be, and hereby is declared to be, the seal of the United States.

SEC. 4. *And be it further enacted,* That the said Secretary shall keep the said seal, and shall make out and record, and shall affix the said seal to all civil commissions, to officers of the United States, to be appointed by the President by and with the advice and consent of the Senate, or by the President alone. *Provided,* That the said seal shall not be affixed to any commission, before the same shall have been signed by the President of the United States, nor to any other instrument or act, without the special warrant of the President therefor.

In the course of its history six (or possibly seven) dies of the seal of the United States have been cut and used officially. The first, executed in brass by an unknown engraver, was employed as early as Sept. 16, 1782, and as late as April 24, 1841. This seal measures about 2¼in. in diameter. Of quaintly archaic style. its distinguishing characteristics are a border resembling a chain of flowers, six-pointed stars and the arrows touching the border. Intended for impression on wax, it had but one face, cut in intaglio. Almost invariably it was impressed on a circular paper wafer, a thin layer of red wax being introduced between the wafer and the document for the double purpose of attaching the wafer and bringing out the device in relief. To the instrument of ratification of the Treaty of Ghent (1814) and of other treaties of the decade following, this seal was affixed pendantly somewhat in the manner described below.

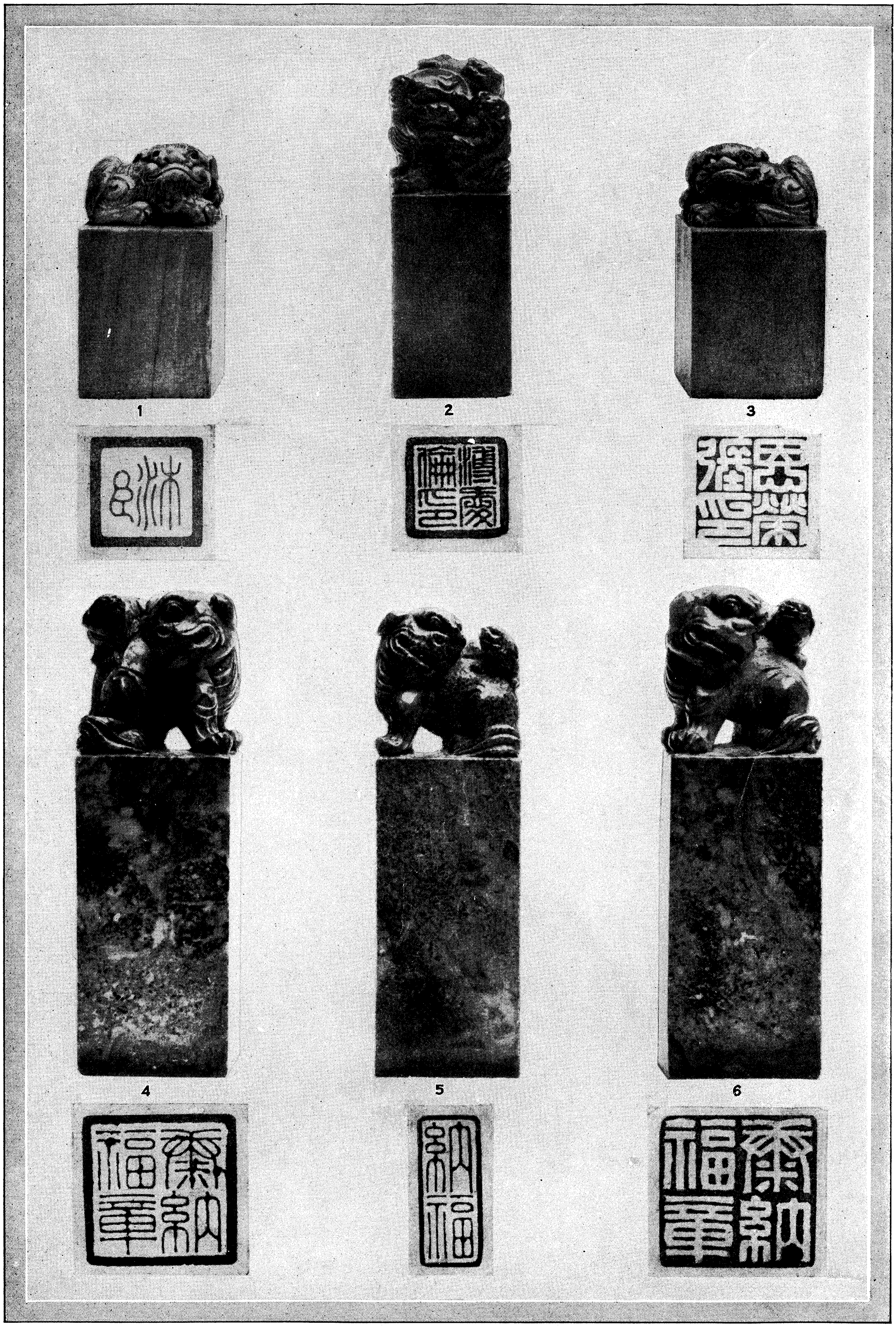
The second die was cut in 1825. It was furnished, it seems, by Seraphim Masi, jeweller and silversmith of Washington, to whom on May 4, 1825, the Department of State paid $406 "for Treaty Boxes & a great Seal." About 4½in. in diameter. it depicts the eagle realistically rather than heraldically. This die did not supersede the first, but was employed concurrently with it, being reserved for preparing pendant seals. Its manner of use was as follows: In the die was cast a red wax disk a quarter of an inch thick; the disk was pressed on melted wax to produce a cake nearly an inch thick, through the diameter of which ran the heavy, tasselled cords that bound the engrossed pages of the document to their blue-velvet cover; and the wax, for protection, was enclosed in a metal case or skippet about five inches in diameter and an inch and a half thick. The skippets were usually of silver; some were "of silver richly gilt"; a few were of gold; and the skippet top or cover bore a representation of the seal device cast



BY COURTESY OF THE SOCIETY OF ANTIQUARIES

EARLY EUROPEAN SEALS, REDUCED NEARLY ONE HALF

1. First great seal of Edward the Confessor, 1043–66, the initial double pendant seal in Europe. 2. Seal of Merton Priory, Surrey, 1241. 3. Seal of Alexander Neville, Archbishop of York, 1374–88, composed of canopy with saints and angels. 4. Seal of Charlemagne as emperor, 800–814, gem in an inscribed mounting. 5. Reverse of fig. 2. 6. Seal of John Stratford, Archbishop of Canterbury, 1333–48, with simple canopy and emblems in the field. 7. Reverse of fig. 1. 8. Great seal of Edward I., 1272–1307. 9. Reverse of seal of Margaret, 2nd wife of Edward I., 1299; shield of arms hanging from a tree. 10. Seal of Otto I., as emperor, 962–973; the beginning of the normal type. 11. Seal of Thomas, Duke of Clarence, 1412; arms between ostrich plumes. 12. Margaret's seal (fig. 9), showing standing figure of a lady in heraldic dress. 13. Reverse of fig. 8. 14. Seal of William de Bohun, 1st Earl of Northampton, 1337, showing shield of arms. 15-a. Bulla of Pope Innocent VI., 1352–62; archaic style. 15-b. Reverse of 15-a. 16. Seal of John Camoys, 1300. 17. Seal of Yarmouth, England, showing patron saint. 18. Seal of Ypres, Belgium; the Cloth Hall within the town wall. 19. Renaissance seal of Cardinal Andreas de Valle, died 1553; pictorial art influence. 20. Seal of Shrewsbury, England, dated 1425. 21. Reverse of fig. 17



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CHINESE SEALS

1. Ivory seal with lion handle, probably late 19th century. Inscription, **Mu-Ch'en,** evidently an intimate name of Chang **En. Jung.** 2. Contemporary soapstone seal with lion handle. Inscription, P'u Ai-Lun. 3. Late 19th century ivory seal, lion handle. Inscription, Chang **En-Jung.** 4, 5, 6. Set of three seals made of soapstone with lion handles. 4 and 6 give the full name of original owner, T'ai Na-Fu. 5 gives only the given name, which probably in this case was used as the **tzu** or intimate name. The name appears to be Manchu

in relief. While ordinarily the pendant seal was used only on instruments of ratification of treaties destined for exchange with foreign governments, it was affixed in some rare instances to full powers and ceremonial letters. The full power and the letter of credence carried by Commodore Matthew C. Perry on his mission to Japan in 1853–54 both bore the pendant seal enclosed in skippets of solid gold; and the instrument of ratification of Perry's treaty of March 31, 1854, was similarly sealed, with a gold skippet for which the Department of State paid $700.

From 1857 the device of the skippet covers was cast in a die cut by Samuel Lewis, a Washington jeweller. This die was of the same size as the second die, described above, and its engraving was closely copied therefrom, distinguishing features being its greater depth and the stronger brow and shaggier feathering of the eagle. Some wax disks similar to those of the second seal were also cast in this die, and possibly a few were used in sealing documents, although no actual example of such use is known. Examination of United States instruments of ratification in certain foreign archives reveals that the seal of 1825 was employed at least as late as 1869. Pursuant to an order of Secretary of State Hamilton Fish of Feb. 4, 1871, use of the pendant seal was abandoned in favour of the wafer seal for all purposes.

The third die, which superseded the first, was used from April 1841 until November 1877. It was cut in cast steel by John V. N. Throop, engraver and copper-plate printer of Washington, at a cost of $60. Of approximately the same size as the seal of 1782, it differs therefrom in the style of its execution. The device has the appearance of being crowded toward the top; the stars, which for the first time are five-pointed. are minute; and the sheaf of arrows departs from the law in that it includes not thirteen, but six. During the first twenty years or more of its service, this die, like that of 1782, was impressed on a wafer over wax; thereafter glue or paste replaced the wax for attaching the wafer to the document, and there are indications that a crude counter-die may have been provided. The die that superseded the third was used from November 1877 until April 1885. It was cut by Herman Baumgarten. seal engraver of Washington, at a cost of $105.50, including press, case and locks. Measuring about 2¼in. in diameter, it was executed in close imitation of the seal of 1841; and like that seal it departs from the law in having but six arrows in the sinister talon. It is readily distinguished from the earlier seal by the larger size of its stars; and it was provided with a counter-die.

Criticism of the faulty design of the seal then in use led to an act of Congress of July 7, 1884, appropriating $1,000 to "enable the Secretary of State to obtain dies of the obverse and reverse of the seal of the United States, and the appliances necessary for making impressions from and for the preservation of the same." Theodore F. Dwight, Chief of the Bureau of Rolls and Library of the Department of State, who supervised the designing of the new die, called into consultation prominent historians and authorities on heraldry and engraving. The design of the obverse was determined upon with great care. It was an enlargement of the seal of 1782 with modifications aimed at artistic improvement and stricter adherence to the original resolution creating the seal. Although the act of 1884 provided also for cutting the reverse, it was decided to leave this provision unexecuted; and the reverse of the seal, "spiritless, prosaic, heavy, and inappropriate," has remained uncut and unused to this day. The obverse provided for by the act of 1884 was cut by Tiffany & Company, of New York, and served from April 1885 to Jan. 1904. Its diameter of three inches distinguishes it from all previous dies. Provided with a counter-die, it was usually impressed over a paper wafer pasted to the document; but there are examples of its impression directly upon a document, a practice authorized by act of Congress of May 31, 1854. About 1888 the present style of wafer, with invected edge, replaced the serrated form previously used.

After 17 years of use the die of 1885 was deemed to have become too much worn for further service. Accordingly an act of Congress of July 1, 1902, appropriated $1,250 to "enable the Secretary of State to have the Great Seal of the United States recut." After some discussion in the Department of State, it was decided that the new die should follow exactly the design of the seal of 1885. The appropriation, having lapsed before the die had been cut, was renewed by act of March 3, 1903, which specified that the seal should be "recut from the original model," thus precluding any departure from the design of 1885. The die, engraved in hardened steel by Bailey, Banks & Biddle, of Philadelphia, was first used on Jan. 27, 1904, and continues in current service. Measuring 3 inches in diameter, it may be distinguished from the seal of 1885 by its greater depth and by minute differences in the rays of the "glory." In the 1885 seal all the rays are solid lines; in the 1904 seal every other ray is a dotted line. Like the earlier seal, it is provided with a counter-die; and it is usually impressed over a paper wafer pasted to the document, although examples are to be found without the wafer. The present dies and press are in the Recruiting and Selection Section of the Division of Personnel Supervision and Management of the Department of State, where they are carefully kept under lock and key when not actually in use.

Legally, the seal has two designations, "the great seal" and "the seal of the United States," both of which appear in acts of Congress and in a decision of the Supreme Court and both of which are in general use. In the resolution of Congress creating it, the seal is referred to as "the great seal," and during the early years of the Department of State that designation served to distinguish it from the seal of the Department, then termed the "seal of office" or "privy seal." The act of 1789, however, declaring the seal of 1782 to be "the seal of the United States," mentions it in those words; in documents to which it is affixed there is long-standing precedent for the same wording; and a publication of the Department of State of 1939 is so entitled.

The seal has a limited use which is strictly guarded by law. With the expanding functions of the Government, the extent of its use has been curtailed from time to time by act of Congress or Executive order. For instance. where formerly the seal was affixed to all civil (not military or naval) commissions signed by the President, now persons appointed by the President to serve under Cabinet officers other than the Secretary of State are commissioned under the seals of the respective departments. At present the great seal is affixed to presidential proclamations; instruments of ratification of treaties; full powers; exequaturs; presidential warrants for the extradition of fugitives from the justice of the United States; commissions of Cabinet officers; commissions of Ambassadors, Ministers and other Foreign Service officers; and commissions of all other civil officers appointed by the President which are not by law required to issue under another seal. Also, the seal is placed on the outside of the envelope containing a letter of credence or other ceremonial communication from the President to the head of a foreign government. To commissions that issue under the great seal, the Secretary of State is required by law to cause the seal to be affixed after signature by the President; for "any other instrument or act" the Secretary must have a special warrant from the President directing him to do so. Except for some proclamations and the commissions of some civil officers, the seal is now used only in connection with international affairs.

Apart from the seal, and as the emblem or coat of arms of the nation, the device of the obverse is employed officially in innumerable ways, and sometimes in more or less modified form, for purposes of decoration or identification. It appears on medals, on stationery, on publications, on currency, on flags, in paintings, and as architectural adornments; it forms part of the seal of the Department of State and, with differences, part of the seal of the President; and it is displayed in colour over the entrance. of Embassies, Legations, Consulates General, Consulates, Vice Consulates and Consular Agencies.

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EUROPEAN

The practice of sealing is of great antiquity; gems and cylinder seals were used in the ancient world. But the custom died out in the West on the fall of the western Roman Empire, and except that bullae were used by the popes from the middle of the 7th century, and very debased examples by the Merovingian kings, it was not revived until the Carolingians under Pippin (d. 768). The seals then employed were either antique gems or copies, generally set in a mount on which the legend was engraved. This use of gems continued throughout the middle ages. Under the Saxon emperors the seal began to approximate the normal later type, consisting of a figure or half-figure surrounded by the legend. Apart from papal bullae, Edward the Confessor seems to have originated the pendent double seal, which was not used in France until the beginning of the 12th century.

Kinds of Seals.—At one time or another almost everyone had a seal, and while the private individual was generally content with one, sovereigns had a great seal, privy seal and signet, as well as seals for their courts and officials, and for customs and staples. Bishops and corporations had a great seal, and sometimes a seal ad *causas* for ordinary business. Bishops and other dignitaries also frequently had a secret or private seal and a signet.

The Matrix.— The matrix was usually of latten or silver, but occasionally of gold, ivory, lead or other material. To ensure the impressions being correctly centred, double seals usually had two or more pierced lugs through nhich pins were passed and frequently a cross or nick engraved on the rim of each half. Occasionally double seals were hinged together. Single seals were fitted with a handle, the most common being a six-sided cone terminating in a trefoil. A few matrices had the centre made to screw out about $\frac{1}{8}$ inch, enabling the device to be used without the legend. The great majority of seals are circular, but bishops generally used a vesica form, not from any religious significance but because a standing figure could thus be more artistically accommodated. For the same reason standing figures of ladies are placed on a vesica seal. Oval seals became common in the 16th century, and square, lozenge- and shield-shaped matrices are also found.

The Engravers.— The names of several engravers are known. Roman in his *Manuel* gives a list of French engravers and in England may be mentioned Luke, who about 1180 made the seal of Exeter and by analogy that of Taunton, Walter de Ripa, the engraver of the first great seal of Henry III., Derrick Anthony, the engraver of the second great seal of Elizabeth, the design for which nas by Nicholas Hilliard the miniaturist, and, greatest of all, Thomas Simon who made the seals of Cromwell and Charles II.

Material.— The impressions themselves are generally of wax, but leaden bullae were used by the popes and in parts of southern Europe. Golden bullae were occasionally employed by the popes and western emperors, while Edmund Crouchback used one as titular king of Sicily, and Henry VIII. and Francis I. for sealing the treaty of 1527.

Methods of Attachment.— Seals were attached to the deed either by impression on its face or by suspension. The former was the earlier system with the exception of bullae, and although in England suspended seals came in in the 11th century, in France impression on the deed continued till the beginning of the 12th and intermittently until its close, to be revived before the end of the 13th. For suspending seals, either a piece of the deed was cut along one edge and the seal impressed on the tag thus made, or the deed was pierced and a piece of parchment or a cord of twisted silk passed through, doubled back and joined together by the seal. Towards the end of the middle ages sealing direct on the document came into general use again.

The Counter-seal.— To make it difficult to detach a seal from its tag, it was usual to furnish at least the larger seals with a counter, that is an impression on the back. In double seals the reverse die served this purpose, but in others, the secret, signet or seal ad *causas* was generally used, and there are instances, especially among the Cistercians, of a special seal, called in the legend *contra-sigillum,* being employed. In double seals there are a few examples of an additional legend in the position occupied by the milling of a coin, and this would make detachment practically impossible.

The Legend.— The legend usually sets forth the name and style of the owner, although on small private seals it is often a motto or pious ejaculation. The simplest form is *Sigillum* followed by the name in the genitive case, but sovereigns and occasionally bishops used the nominative without the word *sigillum.* Abbreviations and contractions are usual. Occasionally the date of the matrix is included in the legend and frequently a sovereign used his predecessor's seal, the name being altered where necessary.

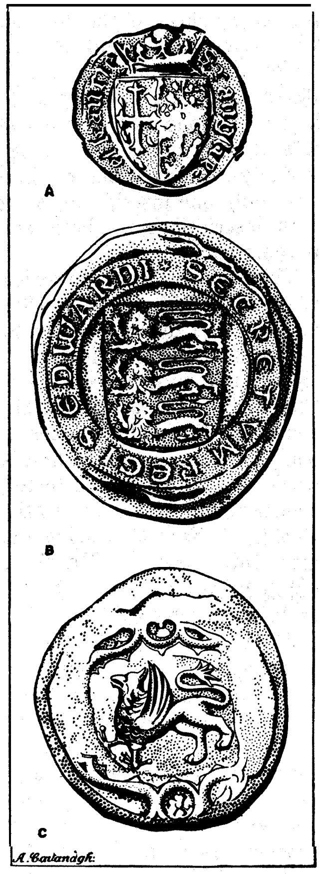
Roman capitals were first used. but from at least the last half of the 11th century they are mixed with Lombardic which slowly displaced them Black letter was first used in England in 134j. and became general for a century after 1375. But Lombardic capitals were usual for initial letters during the whole of that period. When capital letters alone again became usual, it was a modified form of Lombardic that was employed, and this was only slonly ousted by the Roman, which however became the regular type after about the middle of the 16th century.

The Great Seal of England.— The first royal seal of England which ranks as a "great seal" is that of Edward the Confessor, impressions of which are extant. This seal was furnished with a counterseal, the design being nearly identical with that of the obverse. William the Conqueror, as duke of Normandy, used an equestrian seal, representing him mounted and armed for battle. After the conquest of England, he added a seal of majesty, copied from the seal of Henry I. of France, as a counterseal. In subsequent reigns the order of the two seals was reversed, the seal of majesty becoming the obverse, and the reverse being the equestrian seal, a pattern which has been followed almost uniformly down to the present day. (H S. K.)

The Small Seals supplemented the great seal. They were not duplicates of it, nor, although in an emergency they could be used in its stead, were they intended to be substitutes. They were introduced for certain private business of the sovereign, but as the daily task of government grew in volume and complexity they widened their scope. Except in England, they were invariably controlled by chancery, as for example in the papacy and in France The English small seals' freedom from such discretion allowed them to evolve autonomous offices which gave rise to some of the chief ministries of State

The first small seal to appear in England was the privy seal, *priuatum sigillum,* discernible in the reign of John. It was kept by the clerks of the king's chamber (q v), and was used principally for matters connected with that office. Besides witnessing certain of the king's letters, it ordered the issue of great seal writs and instructed the exchequer (q v.) to make payments. To begin with, chancery enrolled privy seal letters but they were soon recorded in rolls of their own. The seal was transferred to the custody of wardrobe clerks in the reign of Henry III., when the king's wardrobe began to relieve the chamber of housekeeping cares *(see* WARDROBES). During the reign of Edward I the controller of the wardrobe assumed sole responsibility for it. In 1312 an independent keeper was appointed, and two clerks were detailed to help him. By 1318 two more clerks had joined them. Although they all remained within the wardrobe, receiving from its keeper their wages. robes and expenses, they formed a self-contained subsection. Before Edward II 's deposition the keeper was a foremost servant of the Crown, and as early as 1330 it was promotion to resign the keepership of the wardrobe for that of the privy seal. Yet until after 1340 the keeper of the privy seal was a member of the household, though he was by then third minister of State How far the privy seal had travelled can be measured by the Walton ordinances of 1338, which laid down that privy seal warrants were to be compulsory on exchequer and chancery for all business outside routine The keepership gained further authority and prestige as a result of the great seal being entrusted to the keepers who went abroad with Edward III. Nicholas Carew (1371–77) excluded, the keepers were clerks until the 16th century, in the course of uhich lay nobles began to be appointed

After 1350, unhampered by wardrobe interference, for from that year the exchequer paid practically all costs and salaries, the office rapidly constituted itself into a public department, with headquarters at Westminster by 1360. It was *extra curiam* (out of court) before the 14th century closed, the process being hastened since, once the privy seal began to walk in the footsteps. of the great seal, the king preferred another small seal for his personal service. This was the secret seal, *secretum sigillum.* As in the 13th and 14th centuries the privy seal was alternatively desciibed as *secretum sigillum,* a habit which lingered on into Tudor times in the legend on the seal, some confusion is unavoidable. But earlv in Edward II.'s reign there was a secret seal distinct from the privy seal. It authenticated the king's private correspondence, authorized the issue of privy seal writs, and soon was commonly used interchangeably with the privy seal as warranty for letters under the great seal. It was consigned to the care of chamber clerks, of whom the receiver was its recognized custodian under Edward III. Before the 15th century dawned, the renamed signet was in charge of a clerk of the chamber who made his own the once less specialized title of king's secretary, *secretarius regis.* The secret seal aped its forerunner still more closely by preparing to become in its turn a public instrument. The term signet was applied to the secret seal as early as 1337, yet in the fourth decade of the century it also denoted a different seal. In 1354 this, and a mysterious seal called *signum* (sign) in use between 1338 and 1344, gave way to the *nouel signet* (new signet), the old secret seal in another guise. In the last 14 years of Richard II. there began to develop a signet office, staffed in Edward IV.'s time by four clerks.



BY COURTESY OF THE PUBLIC RECORD OFFICE

SEALS OF THREE ENGLISH KINGS
A. Signet seal of Richard II, one-faced: B. Privy seal of Edward I, one-faced; C. Griffin seal of Edward III, one-faced

The rise of the signet restricted the privy seal and in practice the signet was the originating force in administration. From 1540 there were two secretaries, each having two signets. The Tudors advanced the signet to the position of a prerogative instrument, and the attitude to it of the 16th century opposition to the king was not unlike that of the baronial opposition to the privy seal of Edward II. The secretaries, with their seals, gradually drifted away from the signet office, which was not, however, abolished until 1851, long after it had ceased to be of value. Each modern secretary of State, of whom there are now seven, has two or three signets for different types of transactions. These even yet show something of their personal origin, for their custodians still receive the seals from the hands of the king on appointment, and are the means of communication between sovereign and people. The privy seal, and its office, were abolished in 1884, but the lord keeper, whose duties diminished as his dignity increased, was retained and is to-day a member of the cabinet (*q.v.*). Another secret seal, the king's secret seal called the griffin, *secretum sigillum vocatum grifoun,* was used between 1335 and 1354 for business connected with chamber lands (*see* CHAMBER. THE KING'S). It was kept by a clerk of the chamber and naturally disappeared when the estate was given up. Yet another secret seal made an appearance in 1367, but it was little used

See F. H. O. Morel, *La grande chancellerie royale, 1328–1400* (1900); C. V. Langlois, *St. Louis-Philippe le Bel, Les derniers capetains directs 1226–1328* (1901); W. R. Anson, *Law and Custom of the Constitution* (1907–09); E. Deprez, *Etudes de diplomatique anglaise, 1272–1485* (1908); L. Perrichet, *La grande chancellarie de France des origines à 1328* (1912); T. F. Tout, *Chapters in the Administrative History of Mediaeval England* (vols. I.–II., 1920, III.–IV., 1928, V. Land last] in preparation; bibl.); F. M. G. Evans, *The Principal Secretary of State* (1923); Sir H. C. Maxwell-Lyte, *The Great Seal of England* (1926). (D. M. B.)

Other Devices.—Amongst the seals of officers of state may be noted those of the admirals, who used for device a ship, generally with their personal arms on the sail. A bishop was represented on his seal of dignity in mass vestments. Later his figure was placed under a canopy, which at first simple, gradually grew in splendour, eventually becoming the principal element in the design. On seals *ad causas* and secrets saints take the chief place, the bishop being shown kneeling below. After the Reformation the design naturally changed, scenes from the Old Testament being common, and by the middle of the 17th century a shield of arms had generally become the only device.

On the seals of cathedrals and religious houses there is often a conventional view of the church sometimes with the patron saint, or the patron saint alone. The universities show the chancellor and masters in convocation, while the colleges have patron saints and founders, a religious emblem or a shield of arms. In foreign universities the faculties and nations generally had seals, a common design being a doctor or master lecturing. On seals of towns a representation of the town itself, sometimes with the patron saint, is frequent; or the patron saint alone or some prominent building might be used, while in France it is not uncommon to find the heads of the civic dignitanes.

At first the shield appears alone, but delicate tracery panels are later introduced to contain it. Wyverns or other animals are often placed round the shield, badges were frequently added, while the shield was sometimes shown hanging from a tree or held by an angel or eagle. In addition to an heraldic seal the noble, like his sovereign, often had an equestnan seal, on which he is occasionally shown in civil costume. Standing figures of ladies, often holding shields or a hawk, and in heraldic dress, are common down to the middle of the 14th century. Persons not entitled to bear arms had usually to be content with such objects as stars, flowers, beasts and birds, while a common device for the lesser clergy was the Agnus Dei, Virgin and Child or other saints.

Papal bullae in design are *sui generis.* On the obverse are the heads of SS. Peter and Paul, and on the reverse the pope's name. Archaic from the beginning, they have so continued, in spite of attempts by Paul II. to alter and by Julius II. to improve the design.

Evolution of the Art.—At first crude and ill designed, an improvement rapidly set in and by the middle of the 13th century the art reached its highest point, the seal of Merton priory, Surrey, made in 1241, being probably the finest ever cut. At this level the art remained for upwards of a century. By the beginning of the 14th century the whole surface had become covered with ornament, and elaborate canopies crowded with tabernacle work are a common feature, so much so that the figure became subordinate. This over-elaboration, which imples no failure in technique but the contrary, finally led to the dechne of the art.

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(1912); O. Posse, *Die Siegel der deutschen Kaiser und Könige von 751 bis 1806* (Dresden, 5 vols., 1909–13), *Die Siegel des Adels der Wettiner Lande bis zum Jahre 1500* (Dresden, 4 vols., 1903–11); M. Tosi, *Bullaria e Bullatores della Cancellaria pontificia,* in *Gli Archivi Italiani,* 1917; F. de Sagarra, *Sigillografia catalana.*

The greater part of the literature on this subject is to be found in the transactions of learned societies. The above is a selection of some of the more general books and articles. (H. S. K.)

JAPANESE AND CHINESE

The use of seals for the purposes of identification and ornament has existed in China since earliest times and was emulated in Korea and in Japan from the inception of her imitation of Chinese usages and manners. The word seal may be applied with equal propriety to the stamped impression and the object with which the impression is made. These impressions appear in an infinite variety of shapes and sizes, the more common shapes being square, oblong, elliptical, round and gourd-shaped. In size they run from the huge imperial seals (sometimes as large as $4\frac{7}{8}''$ by $6\frac{5}{8}''$) to miniature seals which are often as small as $\frac{1}{8}$ in. square or in diameter. The ink used is usually a vermilion red, but black and purple are also employed.

Seals have two general uses: one is for identification, the equivalent of a personal signature or guarantee; the other, while it often identifies, is almost purely ornamental and has no legal significance whatever. The identification seal must bear the *hsing* (姓) or family name of its owner, and the *ming* (名), which is the equivalent of our Christian name. It must be understood that the Chinese use several varieties of individual names, so that when we translate the *hao* (號) or intimate name as nickname, we are incorrect, nickname being properly the translation of what the Chinese call *wai-hao* (外號),which is very rarely if ever used on seals. The *hao* is an intimate name often selected by the bearer himself or given to him by his friends as being appropriate to his pursuits or character. The Chinese also use another intimate name, the tzu (?) (sometimes absurdly and meaninglessly translated as "style") which is created in much the same manner as the *hao,* except that it properly carries some direct literary allusion to the *ming,* and is in its use somewhat more elegant and formal than the *hao.* On ornamental seals the *hao* or *tzŭ* may be used with or without the *hsing,* but in practice usually without. The *ming* may be employed on ornamental seals without the *hsing.* A painter is much more likely to sign his *hao* or *tzu* and stamp his ornamental seal or seals underneath his signature than he is to use his full legal name and seals.

It is very difficult to generalize about Chinese seals because of the frequent departures that Chinese writers and artists indulge in, especially with their ornamental seals. An artist may have as many as, say, 50 to 100 seals, bearing his *ming,* tzu, *hao* or *wai-hao,* the name of his studio, the name of his native district with his family name, etc. These different names, with such characters as *yin* (印), *chang* (章), *chih yin* (之印, seal of), etc., present an almost inexhaustible possibility for variations. Sometimes the identical inscriptions are duplicated or triplicated in different styles of writing Saito Ken's *Signatures and Seals of Chinese Artists* (支那畫家落欵印譜, *Shina Kwaka Rakkwan Infu,* Tokyo, 1906), gives reproductions of 38 seals used by Tung Ch'i-ch'ang (董其昌), an artist of the Ming dynasty, and these do not purport to be exhaustive. As well as personal and official seals, there are countless seals bearing the names of temples, public offices, palace halls, personal libraries, manufactories, shops, family seals, and even, on occasion, small houses.

The materials of which seals are made are as varied as the seals themselves. Practically any hard, fine-grained stone may be used, with the semi-precious stones preferred. Metals are used also, most commonly bronze but, on occasion, gold and silver, either solid or plated. The cheapest and most common materials in general business and private use are wood and soapstone, the latter often as beautifully carved as the rarest jade.

The type of character most used is the *chuan* (篆), which we translate as "seal character," but there is great latitude in the arrangement and period of the characters employed, archaic and historic forms being very popular. Flourishes, embellishments and variations are often indulged in (in spite of the fact that the practice is frowned upon by writers on the subject), making it exceedingly difficult to read or decipher the inscriptions. *See* Hsüeh Ku Pien (學古編), *Studies in Antiquities,* a work on seals written by Wu Chi-ch'eng of the Yuan dynasty, quoted in the *Ku Chin T'u Shu Chi Ch'êng* (古今圖書集成), the K'ang Hsi Encyclopaedia. The lines of the characters may be raised or depressed, giving, in the first instance, vermilion lines against a white background, and in the second, white lines against a vermilion background. The first are variously known as *yang wên* (陽文) or "male" writing, and *chu wên* (朱文) or vermilion writing; the second as *yin wên* (陰文) or "female" writing, and *pai wên* (白文) or white writing. In describing seals, writers invariably mention which of these two styles is used. Seals usually have only one inscription, but early seals, usually made of brass, with inscriptions on both ends or on all six sides, were not uncommon.

There are references to seals in the Four Books (四書) and Five Classics (五經). The *Chi Chia Chou Shu* (汲冢周書) (history of the Chou dynasty unearthed in the 4th century A.D. at Chi, quoted in the K'ang Hsi Encyclopaedia) tells us that when T'ang (湯), the founder of the Shang dynasty (1765–1122 B.c.) deposed Chieh (桀), the last of the Hsia (2205–1765 B.c.) emperors, and convened the feudal princes, he placed the imperial seal at the seat of the emperor. The first report of the use of seals in what we would call authenticated history is in the *Tso Chuan* (左傳, the commentaries of Tso-ch'iu Ming, 左丘明, on *Spring and Autumn Annals,* 春秋 of Confucius, quoted in the K'ang Hsi Encyclopaedia) which tells us: "In the 29th year of Duke Hsiang of Lu (魯襄公, 544 B.C.) the Duke was at Ch'u (楚) for the funeral of Prince K'ang (康王). When he was at Fang Ch'eng (方城) Chi Wu Tzŭ (季武子 the minister of Lu) took possession of Pien (汴) and sent Kung Yeh (公冶) with a sealed document (*hsi shu,* 璽書) to report the matter to Duke Hsiang." We must not infer, however, that this was the beginning of the use of seals, for if it was, the philosopher Chuang Chou (莊周, 4th to 3rd century B.c.) would not have attacked its vogue, declaring that men would return to simplicity and virtue if "tallies were burned and seals destroyed." In fact, it is safe to assume from this pronouncement of Chuang Chou that seals were in general use centuries before his time, probably throughout the Chou dynasty (1122–249 B.c.).

From then on the use and classification of seals became exceedingly complicated. In general seals may be classified as *yin* (印) and *hsi* (璽). The latter character has come to be applied to the seals of the emperor and other important members of the imperial family, such as the empress, the crown prince and ex-emperors; and the former to seals of officials and private individuals, though in ancient times, as late as the Han dynasty, the two characters were used synonymously. It must be observed, however, that during the Han dynasty the distinction began to apply.

In the *Han Chiu I* (漢舊儀, a work on the organization of the governmental machinery by Wei Hung [衛宏] of the Han dynasty) the following regulations were provided for the use of seals: (1) Seals of feudal princes, *chu hou wang* (諸侯王), are to be known as *hsi* (璽), to be made of yellow gold with camel knob or handle. (2) Seals of nobles, *lieh hou* (列侯), are to be known as *yin* (印) and are to be made of yellow gold with tortoise knobs. (3) Seals of ministers or generals are to be known as *chang* (@),to be made of gold with tortoise knobs. (4) Seals of officials with a pension of 2,000 piculs of grain or more are to be known as *chang,* to be made of silver with tortoise knobs. (5) Seals of officials with pensions from 400 to 1,000 piculs of grain are to be known as *yin,* to be made of brass with nose (*pi,* 鼻) knobs.

At the present day such regulations if they exist at all are completely disregarded by the average Chinese, who uses any form he chooses on his personal seals even to representations of landscape. The broadest classification is perhaps the one followed by the *Chi Ku Yin P'u* (集古印譜, *Collection of Ancient Seals* by Wang Chang 王常, 1575) which divides all seals into two main categories: (1) *Kuan Yin* (官印), official or public seals, or, in other words, seals that indicate rank or office. (2) *Ssu Yin* (私印), private seals, used by individuals. Under each main classification the material and the type of knob are mentioned. Private seals may be further classified, as in the *Clzieh Tzŭ Yuan Shu Hua Cltuan* (芥子園書畫傳, *The Mustard Seed Garden Cyclopaedia of Painting and Calligraphy,* by Li Li-weng, 李笠翁, 1679) which gives six classifications with suggestions as to how each class is to be made: *(a) Ming yin* or name seal (名印) used as means of identification. Only such words as *yin,* seal (印), *hsin* (信, faith), *yin chang* (印章, seal), *chih yin* (之印) and *chih chang* (之章), seal of; *ssŭ yin,* private seal (私印) should be used after the *hsing* (surname) and *ming* (given name) without other embellishments. (b) *Tzŭ yin* or intimate name seal (字印), originated during the T'ang and Sung dynasties, should be used only for ornamentation and not for identification. It should not contain such words as *yin* and *hsin.* The character *shilz* (氏), family, alone should be used. (c) *Ciz'en yin* or subject seal (臣印). All under heaven are the subjects (@) of the emperor. Therefore anyone can prefix the character *ch'en* to his name, omitting the surname. It was extensively used during the Han dynasty. (d) *Hao yin* (號印), another intimate name seal may include *wai hao.* Such terms as *tao jen* (道人), Taoist person, *chü shih* (居士), resident, *i shih,* retired scholar (逸士), *chu jen* (主人), master, may be used with one's *hao* or the name of one's "retreat." *(e) Chien shu yin* (箋書印), or letter seal. During the Ch'in and Han dynasties only the name seal was used after one's signature but lately seals bearing inscriptions such as "so-and-so discourses affairs," "so-and-so announces affairs," etc., are beginning to be used. (f) *Shou ts'ang yin* (收藏印) or collector's seal. This class of seals also had their origin in the T'ang and Sung dynasties. Either the name, the *tzŭ* or the *hao* may be used followed by such expressions as *chien shang chang* (鑒賞章, seal of critical examination and enjoyment), *chên ts'ang* (珍藏, treasured and guarded), etc.

The first seal to have much historical backing was the imperial seal made by Chin Shih Huang Ti with a piece of Lan T'ien (藍田) jade of rare quality, with a *li* (螭, one-horned dragon) knob and the following inscription. *Shou t'ien chih ming huang ti shou ch'ang* (受天之命皇帝壽昌, by the command of heaven. long-lived and glorious the emperor). This seal was handed down to the Hans. Since then it has come to be known as the *ch'uan kuo hsi* (傳國璽, seal of succession of the empire) and looked upon as the essential symbol of imperial authority. Six additional imperial seals were made, according to the *Han Chiu I.* The first was used for creating princes, etc., the second for letters and documents to the feudal princes, the third for orders for mobilization, etc., and the fourth for treaties, etc., with tributary States. In succeeding dynasties various forms of imperial seals were made, but it is beyond the confines of this article to enumerate them. We might observe, however, that Empress Wu Tse T'ien (武則天) of the T'ang dynasty changed the character *hsi* to *pao* (%, treasure) and that this character has since prevailed as the name of the imperial seal with the exception of the two T'ang emperors immediately following the empress. During the reign of these two emperors the imperial seal was again known as *hsi.* We might observe further that the *ch'uan kuo hsi* of Ch'in Shih Huang Ti survived', through many vicissitudes, to the reign of Emperor Fei Ti (廢帝 AD. 934–936) of the Posterior T'ang dynasty (後唐) who perished with the seal in the flames rather than surrender to the Posterior Chin dynasty (後晉).

In 1098 a seal purporting to be the genuine *ch'uan kuo hsi* was discovered and offered to Emperor Che Tsung (哲宗) but this was later discredited as was a still later seal discovered (AD. 1295) in the Yuan dynasty.

See also essays, monographs, memorials, etc., by writers of the Sung Yüan and Ming dynasties reprinted in the K'ang Hsi Encyclopaedia

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SEA LUNGWORT (*Mertensia maritima),* a smooth, fleshy, perennial of the borage family (Boraginaceae), called also sea bugloss, sea gromwell and oyster plant. It is a characteristic maritime herb, found on rocks and sand along the northern coasts of North America, from Massachusetts to Greenland and from Oregon to Alaska, and also of Europe and Asia. The plant has pale green herbage; spreading or prostrate branches, sometimes 15 in long; and small white, rose-pink or blue flowers that bloom throughout the summer. *See* MERTENSIA

SEAMANSHIP, the art of handling a ship or boat under any and all conditions of weather, tide, current or other influence affecting its movement or safety. The term is also applied to the skill attributed to a good seaman, It should not be confused with navigation, which is the art of determining the correct course of a ship from one place to another when out of sight of land, nor with pilotage, which is the art of determining the correct course of a ship when working along a coast or up a buoyed channel. Nevertheless, it is a companion art, for without good seamanship in the actual maneuvering of the ship, good practical results cannot be achieved by the navigator or pilot.

In elementary form, seamanship is involved in the handling of even the smallest floating craft. In sailing ships, seamanship is largely concerned with rigging (*q.v.*), the making and shortening of sail (*q.v.*) and the correct manipulation of sails and rudder (*q.v.*) for maneuvering the ship. In power-driven ships, ability to maneuver the vessel by means of screw propeller and rudder replaces skill in handling sails. However, in the handling of all vessels it is necessary for the seaman to know the effect on the ship of wind, tide and current; the behaviour of a vessel in a seaway; the various methods of anchoring in a harbour or mooring to a dock; the safety precautions required aboard ship; and the nautical rules of the road *(see* RULES OF THE ROAD AT SEA).

Seamanship also involves a multitude of other services incidental to maritime work such as the proper loading of cargoes; shifting of weights; making the ship snug for heavy weather; handling the ship's boats; care of passengers; attention to the ship's fittings, and knotting and care of ropes.

Good seamanship is acquired by practice and natural aptitude. It cannot be taught by precept or the study of books alone.

(M. H. I.)

SEAMI MOTOKIYO: see ZEAMI (SEAMI) MOTOKIYO.

SEAPLANE, an airplane capable of taking off from and alighting on water; depending upon its design, it is also sometimes referred to as a flying boat, float plane or hydroplane. The first successful seaplanes were built and flown in the United States by Glenn H. Curtiss in 1911 and 1912. For the next 30 years they played an important role in the development of aviation.

The Curtiss inventions led swiftly to the famous British F-boats of World War I, which originated such naval missions as over-ocean reconnaissance and patrol. aerial antisubmarine warfare and mine laying, and air–sea rescue. After the war, commercial versions of the same seaplanes set the range and endurance records of the time, and inaugurated the first international airlines from the U.S. to Cuba and Canada. In 1919, the U.S. navy's water-based NC-4 conquered the Korth Atlantic. In 1924 four single-engine landplanes of the U.S. army were converted to water operation and made the first flight around the world.

In the 1930s, the largest and fastest aircraft in the world were seaplanes. Their utility and versatility were dramatized by a Russian flight from Moscow to New York via Siberia, by Gen. Italo Balbo's mass flights from Rome to Rio de Janeiro and Chicago. Ill., by Col. Charles A. Lindbergh's flights over the Pacific. and by Adm. Richard E. Byrd's extensive mapping of Antarctica—all with marine aircraft. Seaplanes were used by the German airline, Deutsche Lufthansa, for transcontinental and ship-to-shore airmail service, and by the U.S. Pan-American Airways to initiate regular transpacific and transatlantic service. The "China clipper" became one of the most famous types flown across the Pacific ocean. Racing seaplanes held the absolute speed record from 1931 to 1939, and many of their advanced features were later incorporated in the famous British fighter planes of the early 1940s.

After the outbreak of World War II, the military and commercial significance of seaplanes gradually diminished, partly because of the construction of land bases and aircraft carriers. Following World War II, the development of water-based aircraft continued on a small scale in Great Britain and the U.S., but major advances in aeronautics of this era were made with land-based equipment.

Characteristics and Types.—A seaplane must have sufficient buoyancy to float on water and must also have some means for supporting its weight while moving along the water surface at speeds up to flying speeds. It must be able to take off and land with a margin of stability and control on the part of the pilot; its structure must be strong enough to withstand the shock of landing; and its water resistance must be low enough to permit reasonably short take-off runs.

Ways of meeting these requirements were provided by Curtiss in the form of float seaplanes which are essentially landplanes with buoyant floats or pontoons substituted for the landing wheels, and flying boats in which the main floats and fuselage are combined in a single boatlike body. Single float seaplanes and single hull flying boats require side floats or wing tip floats to keep them upright. Twin float seaplanes do not require the auxiliary floats, nor do twin hull flying boats and single hull boats with stub wings or sponsons located at the water line.

The addition of a retractable wheel landing gear to a float seaplane or flying boat, also first accomplished by Curtiss, creates the amphibian aircraft capable of operating from land runways or water. A post-World War II development was the pantobase or all base airplane incorporating devices for operating from water or from a variety of unprepared surfaces such as snow, ice, mud and sod.

Performance.— When buoyant floats are added to an airplane in place of landing wheels, the plane's weight and aerodynamic drag are generally increased and its flight performance is impaired. These penalties also exist to a degree in smaller propeller driven flying boats since the hull must be larger than a landplane fuselage to provide water clearance for propellers, wings and tail surfaces; but in larger sizes the apparent weight penalty may disappear because of a disproportionate increase in the weight and complexity of the landplane gear. The amphibian and pantobase airplanes naturally have additional weight penalties arising from their many different functions.

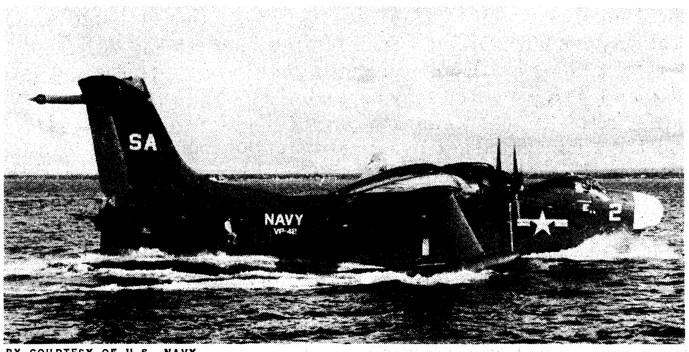
Jet propulsion promises the seaplane exemption from the size required for propeller clearance. It offers for the first time true size and performance parities with landplanes having similar wings and power plants. Nevertheless, flight performance penalties are crucial items in seaplane technology; traditionally they have been the subject of much scientific investigation on the part of aircraft manufacturers and aeronautical research laboratories.

Seaplane Research and Development.— With continual advances in power and flight speeds: aeronautics has been favoured by a concentration of scientific research effort never before known in the history of transport. In this effort, all known mathematical tools have been brought to bear, and the use of scale models for systematic experiments on the problems of flight has become a sophisticated art. The seaplane, along with other aircraft, has benefited from this scientific climate, and its particular drawbacks have been the subject of considerable aerodynamic and hydrodynamic research, notably by such government laboratories as those of the National Advisory Committee for Aeronautics (N.A.C.A.) in the U.S., the Royal Aeronautical Establishment (R.A.E.) in Great Britain, the Deutsche Versuchsanstalt für Luftfahrt (D.V.L.) in Germany, and the Guidonia aeronautical centre in Italy. These laboratories have provided staffs. wind tunnels and seaplane towing tank facilities for theoretical treatments of the fundamental phenomena involved, experimental verifications of the theories and evaluations of their applications to practical aircraft.

Model investigations of seaplane components and configurations were originally carried out in ship model testing establishments. In the 1920s and 1930s specialized towing tanks were built by D.V.L., N.A.C.A., R.A.E. and Guidonia with higher testing speeds for simulating seaplane operating conditions up to the minimum flight speeds of aircraft. These tanks were later augmented in the western world by high-speed facilities at the experimental towing tank of the Stevens Institute of Technology in the U.S., and by several private facilities operated by seaplane manufacturers in the U.S. and Great Britain.

As a result of hydrodynamic research of the post-World War II era, particularly in the U.S., where the department of the navy offered encouragement, important scientific progress was made in theories of planing surfaces, water impact loads and submerged lifting elements (hydrofoils). Better design methods were devised for achieving optimum proportions and shapes of flying boat hulls, improved take-off and landing qualities. and extended rough water capabilities in the face of increasingly severe military performance requirements. Because of limited actual procurement and operation of seaplanes, however, methods for water handling and beaching seaplanes at their terminals and at austere forward bases remained in a relatively primitive stage of development.

Hydro-skis.— Jet propulsion brought with it an improved design concept for water-based aircraft wherein the buoyant float system or oversized flying boat hull is dispensed with and fully retractable planing elements are provided for taking off and landing in much the same manner as with retractable wheels. With this concept,



BY COURTESY OF U.S. NAVY

U.S. NAVY MARTIN P5M

the seaplane floats at rest on the optimum fuselage for flight. The planing elements or hydro-skis are extended for water operation and retracted flush with the fuselage while in the air. Hydro-skis have proved to be compatible with advanced transonic and supersonic airframe and power plant arrangements. Because of their relatively small size and high loadings; they markedly reduce the loads and motions induced by wave impacts.

Land–Water Operations.— As a further extension of the hydro-ski principle, small landplanes have been operated off beaches and ramps on hydro-skis with no attempt to provide flotation at all. In this method of operation, pioneered by Canadian bush pilots with snow skis, the aircraft accelerates on land to the relatively low minimum planing speed of the skis; it then enters the water to complete its take-off run. On landing, the procedure is reversed and the airplane comes to rest conveniently out of the water. This novel means of operation requires runways or cleared areas only a few hundred feet long instead of the thousands of feet needed for conventional landplane operation.

Vertical Take-Off and Landing.— With aircraft designed to rise from and return to the earth vertically: the usual hydrodynamic requirements of water basing virtually disappear. Helicopters have been successfully converted to water operation simply by installing inflated rubber float systems for buoyancy and stability while afloat or by making the fuselage watertight and adding side floats for stability. A further development has been a helicopter fuselage shaped somewhat like a rudimentary flying boat hull for improved water taxiing characteristics.

Notable Seaplanes.— The largest seaplane built was the U.S. "Hughes Hercules" cargo transport flying boat, completed in the latter stages of World War II. This aircraft had a wing span of 310 ft., a gross weight of 400,000 lb. and was powered by eight 3,000-h.p. engines. Because of temporary wartime restrictions on aluminum. it was constructed entirely of molded plywood. The war ended before the plane actually went into service, but it demonstrated that seaplanes are not bound by the same size limitations as landplanes.

Another notable seaplane was the "Mars" flying boat built by the Glenn L. Martin Co. In one short flight in 1949 a "Mars" carried more than 300 persons. A 4-engine military transport, it had a wing span of 200 ft. and made regular flights from California to Hawaii.

The British continued the production of large propeller driven flying boats in the post-World War II era. Their development culminated in the Saunders-Roe SR/45 "Princess" transport for luxury passenger service between London and New York. This aircraft had a pressurized hull for high-altitude operation, a gross weight of 300,000 lb. and was powered by ten turboprop engines of 3,000 h.p. each. It had a pay load capacity approaching 50,000 lb., a range of more than 4,000 nautical miles and a cruising speed of 300 knots at an average altitude of 30,000 ft. It was test flown in 1952, but was not placed in service because of withdrawal of government support. U.S. procurement in the same time period was entirely of naval seaplanes; there was no parallel commercial activity. The U.S navy continued production of replacements for the World War II Martin PBM "Mariners" until 1949 and in the 1950s built more than 200 Martin "Marlins", all-weather flying boats for service with the fleet. The "Marlins" were 72,000-lb. aircraft, driven by two 3,400-h.p. reciprocating engines and carried a large pay load of electronic submarine detection equipment.

The first turboprop seaplanes in the United States were the Convair P5Y and R3Y "Tradewind" flying boats intended for naval patrol and logistic transport missions. The latter had a maximum gross weight of more than 170,000 lb. and a cruising speed exceeding 300 knots at an altitude of 25,000 ft. One version incorporated a bow-loading arrangement for movement of troops and equipment on and off beaches; another multiple in-flight refueling equipment for carrier-based fighters.

The first turbojet seaplane was the British Saunders-Roe Sr/1A experimental water-based fighter, built and flown in 1947. It employed a conventional straight-wing flying boat arrangement with a single jet intake in the nose of the hull. The U.S. navy unveiled the XF2Y-1 "Sea Dart" developed by Convair in the early 1950s. The "Sea Dart" had a delta-wing transonic configuration with air intakes located above and behind the pilot's canopy. It represented the first literal application of the retractable hydro-ski principle. It was operated successfully with a twin ski system mounted on shock absorbing struts, and with a smaller single ski system mounted on fixed struts.

The most advanced seaplane of the 1950s was the U.S. navy's Martin P6M Sea Master, designed for photographic reconnaisance, mine laying and flying attack missions from forward bases, it was capable of sea level speeds of 600 knots. Two prototypes of this transonic flying boat were flown in 1955, but production models of the P6M-2 did not fly until 1959. They were driven by four turbojet engines mounted in nacelles atop a swept wing. The plane had a gross weight of more than 160,000 lb., its wing span was 100 ft. and its length 134 ft.

Conclusion.—Airplanes having thrust–weight ratios of less than one and capable of utilizing natural waterways as their runways have in the past been an effective answer to man's desire to move quickly at will about the earth. Many of their intrinsic advantages—superior economy, safety, flexibility of operation—unfortunately have been lost sight of ,by commercial and military interests. In the second half of the 20th century, they continue to offer to airline planners a practical means of alleviating growing problems of airport cost, congestion, noise and safety. Proponents of the seaplane contend that, for military use, they can provide invulnerable bases, dispersal of weapons systems, relief from undependable land-base arrangements with grasping or unstable governments and the safest test beds for gaining experience with nuclear propulsion away from inhabited areas.

Whether or not such obvious qualities ever are fully exploited, aeronautics owes a great debt to the pioneer Curtiss and his hardy followers for their contribution of a highly useful type of aircraft.

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SEA POWER. Although the basic meaning of the term "sea power" underwent changes following World War II and the Korean war, it has traditionally referred chiefly to the ability to influence sea-borne transportation during wartime, through possession of the appropriate military forces. It is aimed at assisting and protecting friendly shipping from enemy attack, and at destroying or hindering the enemy's shipping—or, in the classic phrases, at using the sea for oneself and denying its use to the enemy.

For the belligerent who dominates at sea, this influence may approximate control. Such control has been traditionally known as "command of the sea," and establishment of command in the areas of chief importance has usually been the first aim of the naval offensive. The inferior opponent uses his sea power to dispute the command of the ascendant navy in the general area, and, if possible, to retain under his own control limited areas or zones near his coast. In other words, "command" is a relative term and may mean merely a marked ascendancy in the contest for general control.

The control of transportation or communications over the seas during wartime involves fulfillment of the following functions, any combination of which constitutes the proper role of sea power:

1 It protects the transfer over water of all military forces and their supplies to those areas where they may be used effectively against enemy forces. This may mean bringing an army to a hostile coast (sea-borne invasion) or to a friendly shore for operations in near-by territories

2. It protects also the transfer of commodities of ordinary sea-borne trade, including industrial goods and raw materials.

3 It prevents the enemy from using the sea to transport his own armies on a large scale. This means, among other things, that it may constitute the primary means of defending one's homeland or overseas territories against enemy invasion.

4. It exerts military-economic pressure on the enemy by preventing him from importing overseas commodities which are scarce or lacking in the region under his control. It prevents him from exporting products, the proceeds of which might be used to pay for commodities received from contiguous neutrals or for various services abroad. It has been used to exert a none-too-subtle pressure directly upon neutrals, to prevent them from trading unduly with the enemy A navy also adds to the strain upon the enemy's system of internal transportation by stopping coastwise or other shipping which normally relieves the burden on the internal transport.

Another important use of a navy is as a mobile heavy artillery (or aircraft base) in direct assault on land objectives, either in covering a landing, in co-operating with armies already ashore but operating near the coast, or merely in the independent bombardment of enemy installations within the range either of the guns or aircraft of the fleet. In a total war in the atomic age, this use would become far the most important.

When World War II began in Europe in 1939, naval bombardment of hostile shores was supposed by many to be. because of the airplane, an obsolete form of war. But World War II, in fact, saw bombardments from the sea in both the European and Pacific theatres in much greater number and on a far heavier scale than in any previous war in history. From Kwajalein onward in the Pacific the most intense and concentrated bombardments known up to that time on land or sea became almost commonplace, arid in the Normandy campaign of June–July 1944, Allied naval vessels continued for peeks to give close and invaluable support to the troops whose landings they had helped make possible. In this connection it is important to note that the guns of a fleet are in general much larger than the mobile guns of land warfare, and a strong fleet will therefore represent a concentration of uncommon, powerful as well as mobile artillery.

The Instruments of Sea Power.—While sea power has generally been regarded as synonymous with naval strength. it has never meant merely warships It has alnays meant the sum total of those weapons, institutions. installations and geographical circumstances which enable a nation to control the seas during wartime. Where the airplane is used in the control of sea-borne transportation, it is functioning as an instrument of sea power. The emphasis should logically be on the objective rather than on the means or instrumentality used. It is clear that while the means of exercising sea power during World War II were vastly different from those used during the Napoleonic wars. the uses and purposes to which sea power was put were almost identical for the two eras.

If the chief purpose of sea power is control of sea-borne transportation, the vehicles of such transportation must be considered not as incidental to sea power but as an essential part of it. Since the warship has meaning chiefly as it affects the movements of cargo carriers, lack of such carriers makes the sea as much a barrier as does a superior hostile fleet. Without sufficient shipping, naval efforts can be only negative; one can keep the enemy from using the sea but cannot use it for oneself.

To the extent. however, that sea power is made up of warships, it is important to observe the specialized character of the various types of vessels which make up the modern navy. The major distinction is between combatant and noncombatant or auxiliary vessels, although the dividing line between the two is irequently indistinct. Ships not used directly in combat but which have great military importance include coastal mine layers, mine sweepers, net layers, tenders of various kinds; repair ships, store ships and oilers. Navies will also maintain fleet tugs. transports, cargo ships and hospital ships. These vessels, especially the various types of supply ships, make up what is known as the fleet train. which in the latter stages of World War II in the Pacific enabled the battle squadrons or task forces to achieve a range and sea-keeping capacity unknown at least since the days of sail. In bulk they accounted for far the greater part of the enormous tonnage operated during that war by the U.S. navy.

It is the combatant ships. however, and the planes which operate from them which comprise, according to popular conception. the essence of sea power. The most sensible modern classification of warships is according to the tools or instruments upon which the ship chiefly relies for fighting. One may thus distinguish between three major categories: (1) ships fighting chiefly with aircraft launched from their decks; (a) those fighting mainly with guns or, more recently. with rocket-propelled missiles; and (3) those fighting mainly with underwater weapons such as mines, torpedoes and depth charges. Among the last, one must differentiate sharply between surface and submarine craft.

The aircraft carrier (*q.v.*), the one really new type of warship produced in the 20th century. won for itself the dominant place in the battle fleet during World War II, taking the position of primacy which the battleships had enjoyed for the previous three centuries. The carrier is a floating airport possessing all the advantages in mobility and sea-keeping power of the large warship. and all the advantages inherent in the use of aircraft. In the latter stages oi World War II. the Cnited States navy was able to concentrate such numbers of carriers in its task forces as to enable them to overwhelm with their aircraft the local air deienses of the various archipelagoes against which they successively moved. Carriers also furnished the major ground-support aviation to the United Nations iorces during the early phases of the Korean war of 1950–53, and continued throughout that war to render invaluable service. The addition of atomic weapons to its magazine enabled the carrier to bid for an important part not only in naval war but also in strategic bombing. though partisans of land-based air power insist that these same weapons have made the carrier much too vulnerable to be worth its huge cost. The naval reply is that in its mobility the aircraft carrier has a kind of protection not available to airfields, and one that would be especially valuable either in the opening stages of a total war or to deter such a war. This mobility. it is argued. will be enhanced in the iuture by the use of atomic power for propulsion. first in the carrier itself. and soon thereafter in its escorting vessels. The several types oi carriers differ mainly according to size, the larger ones usually being also the faster ones. The smaller and slower "jeep" carriers built in large numbers during World War II by the United States were used almost entirely in convoy escort or in "hunter-killer" groups against submarines.

The second category, gun-firing ships, being partly converted to the firing of rockets or guided missiles in the 1950s comprised the battleship and the various types of cruiser. The main common characteristics of these vessels have been their use of large-calibred guns (comprising their "primary armament" for offensive use, as distinguished from their "secondary armament" of smaller guns for defensive use, especially against aircraft); of steel armour for protection against shells and bombs; and of high speed. These several characteristics could be combined only in vessels of medium to very large size.

The battleship (*q.v.*), which is simply the largest of the gun-firing ships, used to represent the hitting power of a navy in its most copious, compact and durable form. It was intended to be able to match the most powerful vessel in an enemy fleet; and despite its large individual cost, it was deemed to be the most economical way of coping with enemy capital ships—more economical and certain. that is, than relying on large numbers of smaller ships. In its last and greatest flowering in the World War II types. it reached a displacement of something like 60,000 tons, much of which was devoted to armour; carried guns of 16-in. calibre (in U.S. types) and even up to 18-in. (in two Japanese vessels); an array of lesser guns which might add up to 150 barrels; and in the case of the "Iowa" class a speed equal to or surpassing that of most cruisers. This prodigious piece of fighting machinery was rendered obsolescent because its guns were tremendously outranged by the bomb- and torpedo-carrying aircraft launched from carriers.

The cruiser (*q.v.*) is simply a lesser battleship, designed to secure economy in individual units so that larger numbers can be sent to sea. In size and armament, it has ranged from a type almost indistinguishable from a battleship' to one very close to a destroyer. The "battle cruiser" of World War I was really a battleship in size and gun-calibre, but sacrificed weight of armour for greater speed. (The "Hood." for example, which was destroyed in combat with the "Bismarck" in May 1941, was designated a battle cruiser but was at the time oi its loss the largest ship in the British fleet.) The battle cruiser was made obsolete by its proved vulnerability (especially in the Battle oi Jutland in 1916) and by the iact that the more heavily armoured battleship was ultimately able. with larger size and better engines, to match it in speed.

The "Alaska" class oi "large cruiser" built for the United States navy in World War II was really a light battleship carrying nine 12-in. guns and displacing some 27.000 tons, making it similar to the "Scharnhorst" and "Gneisenau" in the Germany navy. At the other end of the scale in the United States navy during World War II were cruisers of only 6,000 tons armed with twelve to sixteen 5-in. "dual-purpose" guns, *i.e.*, useful against aircraft as well as surface targets. In other navies even smaller vessels down to 3.000 tons were sometimes designated cruisers.

The well-known distinction between "light" and "heavy" cruisers. employed in the London naval limitation treaty of 1930, refers not to over-all size but to gun calibre. Vessels carrying 6.1-in. or lesser guns in their primary armament mere at that time designated light cruisers, and those carrying larger guns up to 8-in. calibre (the limit set in those treaties), heavy cruisers. Many of the light cruisers, especially in the United States navy, were actually larger in weight (at about 10.000 tons) than heavy cruisers in foreign navies.

In the third category, *i.e.*, those vessels which employ underwater weapons. are the destroyer and the submarine. The modern destroyer (*q.v.*) is a smaller version of the light cruiser, carrying in the United States navy guns of the same calibre (j-in.) as the smaller light cruisers. However. it carries fewer such guns, usually five to an exceptional maximum of eight. and sacrifices armour entirely. Its maximum displacement has been about 2.200 tons, and its speed is comparable to that of the fastest cruisers. In the destroyer type. hon-ever. the gun in the course of the ship's historical development tended to lose its primacy in favor of the torpedo tube and the depth-charge rack. The name of the type is derived from the original "torpedo-boat destroyer." This progenitor of the modern destroyer was originally a speedy vessel designed to destroy with its guns the torpedo-bearing "torpedo boats" first built in the late 19th century as a cheap means of attacking enemy battleships. The destroyer's original role was to defend the battle fleet. Later it acquired the torpedoes, and thus also the function, of those boats it had been designed to destroy. In World War I it became also, with its depth charges, the chief means of fighting submarines. It was supplemented in World War II by the "destroyer escort," which was built in large numbers as a cheaper vessel—more easily constructed and manned—as a means of dealing with submarines. The destroyer escort was smaller than the destroyer, of much lesser speed and with lighter and fewer guns; but it was good enough against the submarine of its day.

The great strategic value of the submarine (*q.v.*) originally derived from the fact that, because of its ability to conceal itself by slipping under the waves, it was the only warship which could operate independently for extended periods in seas otherwise dominated by the enemy. Its torpedoes made it a threat against vessels of all sizes, including the greatest warships, and in World Wars I and II it won striking successes against such naval vessels. Its greatest triumphs, however, have been achieved as a merchant raider.

The tremendous tonnages of Allied shipping sunk by German U-boats in 1917 and again in 1942–43 and the comparable accomplishments of United States submarines in the Pacific during the whole of World War II, indicated the possibilities of a submarine offensive when the opponent lacked the specific means to control it. Its versatility is indicated by the fact that already in World War I it not only fired torpedoes but functioned also as a mine layer and often used deck guns (including some up to 12-in. calibre in the British M-class). In World War II, for example, the French submarine "Castex" carried on its deck two 8-in. guns and even a hangar for a seaplane.

The ultimate and overwhelming defeats suffered by the German U-boats in World Wars I and II reflected the characteristic weaknesses of the undersea craft: their relatively slow submerged speed, vulnerability, absence of or inadequate vision while submerged, and ultimate inability to escape detection by modern instruments. On the other hand, new developments promised not merely to restore the submarine to its former place as a commerce raider, but to make it possibly the most menacing vessel in a fleet. Among these were devices operating on the principle of the "Schnorkel," which permits the submarine to breathe air while submerged, and thus to run on internal combustion engines rather than electric motors. This new power made possible much greater submerged speeds, and also made it unnecessary to surface for charging batteries and replenishing air for crews. The introduction of atomic propulsion gave the submarine almost unlimited range. And the use of atomic weapons launched by missiles or unmanned aircraft could make it a terrible danger to enemy cities, including those 500 miles or more from a coast. Some opinion regarded the submarine as perhaps the most dangerous strategic bombing instrument of the future.

It is not necessary to undertake a discussion of the uses of the airplane in naval warfare in this article. Suffice it to say that its great speed and tridimensional movement combined with its ability to carry and discharge the most powerful of naval missiles—bomb, torpedo, or rocket shell—put it at the forefront of the implements of naval warfare. Its weakness in sea-keeping capacity is offset by using it with carriers, in which case it becomes a weapon quite distinct in character and in purpose from the large bomber which, although capable of operating over the seas, is based on land.

The importance of the naval (and air) base to sea power has been reflected in centuries of diplomatic and strategic history. Britain's ability after the Dutch wars of the 17th century to contain the whole continent of Europe with sea power stemmed not alone from its continuing though sometimes tenuous superiority in ships and seamanship but also from the possession of a particularly advantageous system of bases, most of which were originally acquired through sea power. The first and greatest British base is the United Kingdom itself, with its many fine harbours, splendidly situated for the control of sea lanes from notthern and western Europe to other continents. Bases at Gibraltar, Malta and Alexandria in the Mediterranean enabled the British to seal off the southern exits from Europe.

The entire Pacific side of World War II was in effect a long contest for bases, and it was the acquisition of Okinawa, the Marianas and Iwo Jima which finally enabled the Allied forces to hurl the blows which brought Japan to its knees. These. to be sure, were used mainly as air bases, but their acquisition depended on the prior capture of numerous naval bases for use as stepping stones. On the other hand, the glib assertion that "bases mean ships" may easily be misleading. The relative value of bases and ships is indicated by the fact that while bases can make ships and planes more effective, they cannot produce them, whereas ships and planes (together with armies) can produce bases by capture. A nation which sacrifices mobile naval force in order to maintain an excessive number of oversea bases is likely to lose those bases at the outset of a war and be left with no sea power whatever.

The Role of Sea Power.—The tremendous influence of sea power on the great struggles of history was frequently realized by the leaders of those struggles, both civilian and military. It is hardly conceivable that England should have remained, except for one short interruption, continuously at war with revolutionary France for some 22 years if its leaders had not reposed a deep and abiding confidence in the possibilities afforded by sea power. In general. however. the slowness with which sea pouer exercised its effect and the frequently long periods which remained unpunctuated with naval engagements of any note caused even British historians in their treatment of major wars to concentrate primarily on land campaigns. It remained for Alfred Thayer Mahan, then a captain on active duty in the U.S. navy, to dramatize the role of sea power in the great struggles of modern history with his most famous book, *The Influence of Sea Power upon History, 1660–1783*. This book, published in 1890, won extraordinary attention and gained for its author not only enduring international fame but also the assurance of a large audience for each of the many succeeding volumes which h; published during the next two decades.

An exaggeration of Mahan's views resulted, during the 1920s, in the ascendancy of the doctrine that sea power *determines* the course of history. The use by Mahan himself of the more cautious word "influence" was overlooked. World War I was interpreted by many writers as having been decided by the British naval blockade of Germany, some of these writers going so far as to assert that the gigantic struggle ashore was just so much useless bloodletting. The experience of World War II. however, produced an opposite and equally extreme reaction. Germany's lesser vulnerability to the effects of blockade as compared with the previous war and the startling part played by strategic bombing forces induced many to conclude that sea power represented the declining or obsolescent partner in the new trinity of sea, land and air forces.

World War II was in fact the conflict in which sea power reached the culmination of its influence on history. The greatest of air wars and the one which saw the most titanic battles of all time on land was also the greatest of naval wars. It could hardly have been otherwise in a uar which was truly global. where the pooling of resources of the great Allies depended upon their ability to traverse the highways of the seas and where U.S. men and materials played a decisive part in remote theatres which could be reached or supplied only by ships The maritime union of the three great Allies, Great Britain, the C.S.S.R. and the U.S., was in striking contrast to the isolation of the major axis partners from each other. Even Germany and Italy, though contiguous, were barred from using the communications which in peacetime carried the greatest part of their traffic with each other.

The great efficacy of strategic bombing forces against Germany and the diminished value in itself of the naval blockade obscured the facts first, that blockade represents only one mission of sea power and not necessarily the most important; second, that the blockade in fact contributed to the success of the bombing forces by sealing off the areas whose facilities and supplies were being destroyed (especially by sealing off access to petroleum); and, third and most important, that the United Kingdom would have been untenable as a base either for the air forces or the Allied armies except for the maintenance of the security of the western sea approaches. In other words, sea power made the air campaign possible. A comparable situation obtained in the Pacific war. Rut the excessive discounting of the role of sea power in World War II was perhaps mainly a reaction from the exaggeration of its role in previous wars.

Similarly, the critical role played by United Nations and especially U.S. sea power in the Korean war was not sufficiently emphasized, mostly because the absence of naval opposition—except from Soviet mines laid defensively in large numbers around ports in North Korea, especially Wonsan—precluded the kind of naval battles which win public attention. The plain fact is that overwhelming U.N. naval superiority is again what made the Korean campaign possible. Command of the seas around Korea enabled the U.N. forces to maintain communications to that distant peninsula, giving them in fact a much better and more secure line of communications than was available to the enemy. Carriers in the U.N. forces also provided critically necessary aviation support, and naval task forces made possible several amphibious operations, both landings and evacuation, including the spectacular envelopment from the sea at Inchon.

The atomic bomb necessitated an entire re-evaluation of the role of sea power. Even if we assume that a nation being hit with large nuclear weapons could continue to maintain a navy at sea, which is doubtful, a war in which nuclear weapons are used without restraint in strategic bombing would almost certainly move much too rapidly to permit sea power to exercise its traditional influence on sea-borne commerce. (Such commerce, furthermore, would probably become altogether unimportant.)

In such a war the traditional kind of sea power would play no role, But there might be a tremendous and even decisive role for vessels dispatching nuclear weapons by means of missiles and aircraft against land targets. On the other hand, in various kinds of limited war, sea power might continue to play its traditional and perhaps even dominant role, as it did in Korea.

See also NAVAL AFFAIRS (ARTICLES ON).

BIBLIOGRAPHY.—The basic writings on sea power are to be found first of all in the major works of Alfred T. Mahan. See especially his *The Influence of Sea Power upon History, 1660–1783* (1890), *Influence of Sea Power upon the French Revolution and Empire, 1793–1812,* 2 vol (1892), *The Life of Nelson* (1897), *Sea Power in Its Relations to the War of 1812* (1905) and his *Naval Strategy* (1911). Another writer of almost equal stature was the British civilian naval historian, Julian S. Corbett, whose outstanding contribution was *Some Principles of Maritime Strategy* (1918). A later treatise, encompassing the major experience of World War II, was Bernard Brodie's *Guide to Naval Strategy,* 3rd ed. (1944) and *Sea Power in the Machine Age,* 2nd ed. (1943). The standard work on the development of U.S naval power is *American Sea Power, Since 1775,* ed. by Allan F. Westcott (1947). For an outstanding historical work which places sea power in its proper perspective during the Napoleonic wars see Arthur Bryant's *Years of Endurance, 1793–1802* (1945) and *Years of Victory, 1802–1812* (1945). And for a book on the little-known naval side of the Korean war, see *Sea War in Korea,* by M. W. Cagle and F. A. Manson (1957). (B. BE.)

SEARCH: *see* VISIT AND SEARCH.

SEA SERPENT. Enormous serpents, both terrestrial and marine, are subjects around which have arisen such an array of legends and stories that it is almost impossible to disentangle fiction from fact. So far as terrestrial snakes are concerned it seems fairly safe to assume that there are none in the few remaining unexplored parts of the world that greatly exceed in size those that are already known. In the depths of the sea, possibly, may still be gigantic creatures of which there is no knowledge. Such a creature, however little related to the true serpents, would still qualify very well for the popular idea "sea serpent."

Up to the present no animal has been captured that has not, on examination by competent persons. proved to belong to a previously well-known group. A large number of the well-authenticated stories of monstrous marine creatures seem to be explicable as incorrect observations (because of abnormal visual conditions or ignorance) of animals already quite well known.

Many possible explanations have been put forward to account for sea serpents. A number of porpoises swimming one behind the other and rising regularly to take air might produce the appearance of a very large serpentlike creature progressing by a series of vertical undulations. A flight of seafowl and a brood of ducks have been mistaken for a large snake swimming at the surface of the water. Large masses of seaweed half awash have, on more than one occasion, been believed to be some gigantic animal. Basking sharks *(Cetorhinus maximus),* which have a habit of swimming in pairs one behind the other with the dorsal fin and the upper lobe of the tail just above the surface, produce the effect of a body 60 ft. or more long; even a simple partially decomposed specimen which was cast ashore was reported in all good faith as a sea serpent.

In the same category as basking sharks may be mentioned tunnies *(Thunnus thynnus),* porbeagles *(Lamna cornubica)* and chimaeras *(Chimaera monstrosa),* which at various times have been incorrectly recorded by observers unfamiliar with them. Ribbonfishes or oarfishes *(Regalecus),* which attain a length of 20–30 ft. and are snakelike in shape, have been suggested as the possible explanation of some so-called sea serpents, particularly of those reported from the Mediterranean where these animals are most common. Nemertimes, which may reach a length of 30–45 ft., have also been suggested as a possible explanation of some records. Sea lions when breaking surface for breath might, if seen from an unfamiliar viewpoint or in a fading light, be mistaken for much larger, snakelike animals.

Giant squids *(Architeuthis species)* are undoubtedly the foundation on which many accounts are based; these animals, which may attain a total length of 50 ft., are sufficiently uncommon to be unfamiliar to the majority of persons. They do occasionally frequent those regions from which many accounts of sea serpents have come—Scandinavia, Denmark, the British Isles and the eastern coasts of North America. One of these animals swimming at the surface with the two enormously elongate arms trailing along through the water would produce almost exactly the picture which many of the strangely consistent independent accounts require; a general cylindrical shape with a flattened head (=posterior end of the squid's body), appendages on the head and neck (=lateral fins and edge of mantle), colour dark, lighter beneath, progression steady and uniform, body straight but capable of being bent and spouting water (=water ejected from siphon). Further, sperm whales are known to kill and devour *Architeuthis* and similar cephalopods, and one of the most graphic accounts of the sea serpents speaks of it as in conflict with a whale around which it had thrown two coils and which it ultimately dragged below the surface; actually, it seems quite probable that the whale was eating a giant squid whose tentacles, thrown round the whale in the struggle, were mistaken for the coils of a snake, and that the whale, far from being dragged under, merely sounded with its prey in its mouth. A. C. Oudemans in his *The Great Sea Serpent: an Historical and Critical Treatise* (1893) gives a full account of all these possibilities.

A stranded animal carcass on the coast of Lower California was plausibly reported as a sea serpent. The remains were those of a large beaked whale. The body had been eviscerated (by sharks presumably) and the skin remaining was twisted up so that between the huge head and the large body there appeared to be a long and plesiosaurlike neck.

The discovery of an enormous eel larva in the Pacific, for which no adult is known, suggests that there may be an undiscovered gigantic kind of eel. This would of course perfectly satisfy the popular concept of a sea serpent. (H. W. P.; K. P. S.)

SEASICKNESS: *see* MOTION SICKNESS.

SEASONS, divisions of the year according to consistent changes in character of weather in the course of the annual cycle. The seasons named in European languages are associated with a yearly cycle in the life of plants, particularly of cultivated plants. Winter is the season of dormancy, spring that of sowing (Lat. *satio*[n], whence Fr. *saison,* Engl. *season)* and germination;

summei is the period of growth and maturity and autumn the time of harvest. This fourfold division of the year can seldom he recognized in the annual cycle of weather itself.

Outside the tropics the essential characteristic of this cycle is a pendulation of temperature hetneen a single maximum and a single minimum Other differences among the seasons are subordinate to the cycle of temperature. Thus only the extreme seasons have a distinctive character: if the husbandman's yearly round had not left so profound an impress on European speech. spring and autumn would be considered merely transitional periods, hardly worthy of names co-ordinate in rank with those of summer and winter.

In the tabulation and discussion of climatologic observations made in middle and high latitudes, it is customary to combine the calendar months into seasons as follows:

Northern hemisphere:	*Winter*	*Spring*	*Summer*	*Autumn*
	December	March	June	September
	January	April	July	October
	February	May	August	November
Southern hemisphere:	*Summer*	*Autumn*	*Winter*	*Spring*

This division is only a convenience; in the appropriate northern latitudes March and November may be in fact winter months, May and September summer months. In relation to crops. the year is often divided into two parts, separated by the dates of the earliest and latest killing frosts in autumn and spring respectively.

Solar Radiation. — The seasonal changes of temperature are dependent upon the annual variation in the angle of the sun's rays and in the length of daylight, which determine the amount of solar radiation absorbed daily by the surface of the earth and the atmosphere (*see* CLIMATE AND CLIMATOLOGY: *Climatic Controls; Solar Radiation*). Assuming a cloudless sky and constant transparency of the atmosphere, the amount of solar radiation received at a point on the earth's surface at any moment is approximately proportional to the sine of the angular height of the sun above the horizon (the solar altitude). The amount received during any day evidently increases nith (1) the length of the daily period of sunshine and (2) the sun's altitude at the successive moments of the day. The contrast between summer and ninter is the result of seasonal variation in these two factors. Both have their maxiinum at the summer solstice and their minimum at the winter solstice. They result, in turn, from the changes in exposure of the earth to the solar radiation during its annual revolution about the sun. As the earth moves in its orbit, its axis maintains a nearly constant orientation in space. inclined about 66° 33' to the plane of the orbit. Figure 1, *A*, B and C, show the attitude (position) of the earth's surface with respect to the sun's rays at the solstices and equinoxes. The lines tangent to the meridian at the left of the diagrams represent the plane of the horizon at selected latitudes. The smaller of the two angles made by one of these lines and the shaft of the arrow that represents the solar rays is the sun's altitude at noon on the day and in the latitude indicated.

Diagrams *D*, *E* and F of fig. 1 illustrate the seasonal variation in length of the daily period of sunshine in the northern hemisphere. The great circle that separates the illuminated and shadowed hemispheres swings in an annual period back and forth across the segments of the earth's surface enclosed by the polar circles. In the daily rotation of the earth, any point in the hemisphere (except a segment near the pole at times other than the equinoxes) is carried alternately through sunshine and shadow. The part of the daily cycle during which the sun is above the horizon at any point is represented by the fraction of its parallel of latitude that lies within the illuminated hemisphere, and the part during which the sun is below the horizon by the fraction of its parallel that lies within the shadowed hemisphere.

The graphs of fig. 2 show the annual variation, by weeks, of the average daily amount of radiation from sun and sky actually received on a unit horizontal surface (the average "insolation") at four stations in North America. Outside the tropics, the maximum and minimum of the annual march of insolation usually fall near the solstices. The amount of heat produced by insolation depends on the fraction that is absorbed. Among types of surface common on the earth, a snow cover reflects most and absorbs least of the incident radiation. Hence, the annual march of absorbed radiation on land surfaces that are covered with snow in winter and free of snow in summer has a larger amplitude than is suggested by the total incident radiation plotted in fig. 2, since a larger fraction of the total is absorbed in summer than in winter.

Annual Temperature March in High and Middle Latitudes. — The temperature of the air near the earth's surface, whether land or water, follows closely the temperature of the surface itself. How large a rise in temperature of the surface and the air close to it is produced by the absorption of a given amount oi radiation depends on the disposition of the heat so produced. If heat is removed rapidly from the surface as radiation is absorbed, whether into the air, by radiation into space, or downward into the substratum, the temperature at and near the surface rises less than it does if the heat is removed more slowly. The processes that remove heat most rapidly from an absorbing surface are evaporation of water, the blowing of cool air over the surface and. in nater bodies, the mixing, effected by the nind, of nater at the surface nith deeper nater. All these processes reduce the rate of warming, and prevent the temperature of the surface from rising to as high a maxiinum as is attained by dry surfaces not effectively cooled by nind

A surface of land or water attains its maximum temperature at the time nhen it becomes warm enough to lose heat to the atmosphere and space as rapidly as it is gaining heat by absorption of radiation. This equilibrium cannot be reached until after the maximum of the march of absorbed radiation; that is, in most places, after the summer solstice. It is attained when the curve that represents the rate of absorption of radiation. declining from its maximum, intersects the curve of loss of heat from the surface. The cooler the surface is. in relation to the radiation absorbed, the longer is the time required for the curve of absorbed radiation

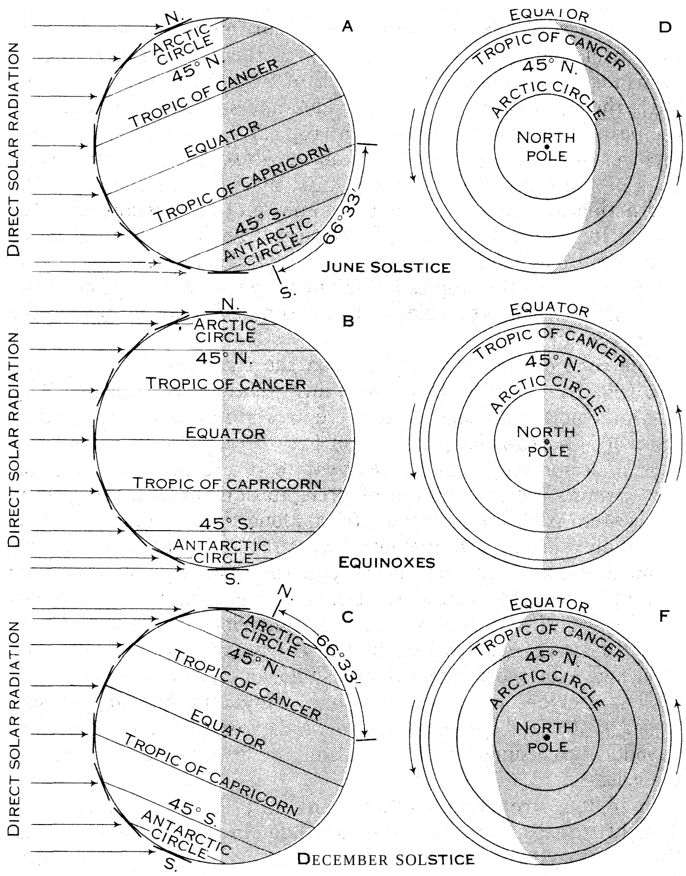


FIG I. — EXPOSURE OF THE EARTH TO THE SUN S RADIATION

A, B and C show the attitude of the midday sun; D, E and F relative length of daily periods of sunshine and aarkness to decline to the level of the curve of loss of heat. With a given march of absorbed radiation. therefore, the maximum of the annual march of temperature occurs later at cooler surfaces than at warmer ones.

A corresponding effect on the minimum of the march of temperature is produced by the return to the surface in winter of the heat transferred downward into the substratum in the preceding summer. With a given annual march of absorbed radiation, the amount of heat accumulated in the oceans and large lakes in summer and returned to their surfaces in winter is many times the turnover of heat belon a land surface. Again with a given annual march of absorbed radiation, the larger the turnover of heat the higher is the temperature of the surface at its annual minimum, and the longer is the minimum delayed after the winter solstice. Thus, the characteristic differences in annual march of air temperature between the oceans and the lands that are embodied in the terms "maritime" and "continental" arise from the difference in annual heat turnover below their respective surfaces. Over the land, the maximum and minimum of the annual march of air temperature occur about one month after the solstices. Over the oceans, they are retarded about two months. As a result of the circulation of the atmosphere, the margins of the continents

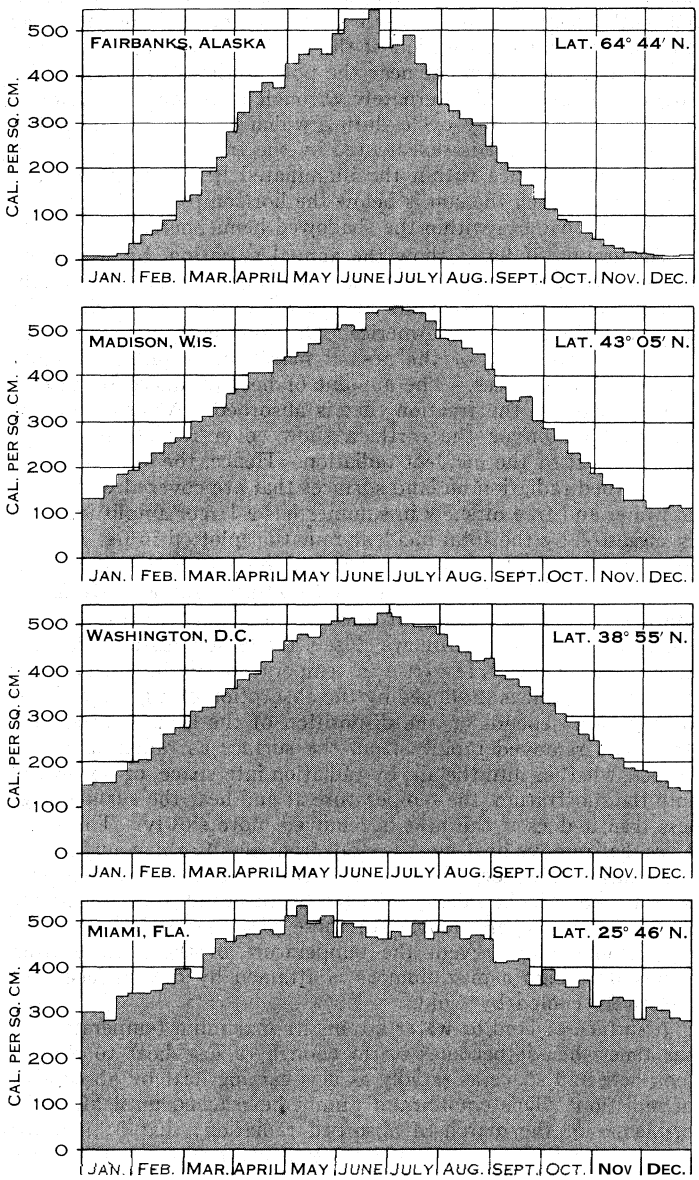
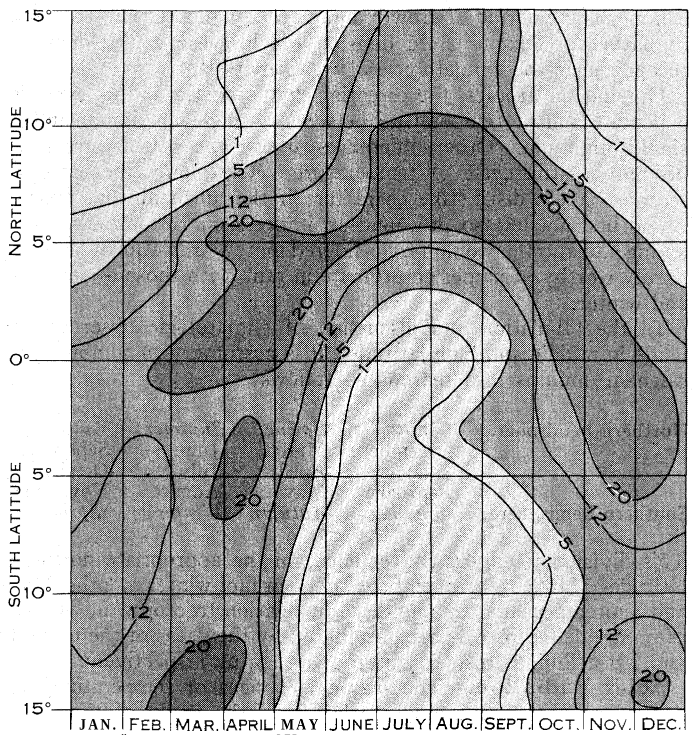


FIG. 2.— RADIATION FROM SUN AND SKY

Weekly means of daily amounts of radiation received on unit horizontal surface at four stations in the United States. Data from U.S. Weather Bureau



ADAPTED FROM KÖPPEN, "DIE KLIMATE DER ERDE: GRUNDRISS DER KLIMAKUNDE"

FIG. 3 — MEAN MONTHLY PRECIPITATION, IN CENTIMETRES. ALONG THE MERIDIAN OF 15° E. LONGITUDE WITHIN 15° OF THE EQUATOR

share the maritime regime of temperature.

Seasons in Low Latitudes.— From middle latitudes toward the equator, the amplitude of the annual march of insolation diminishes. and the annual cycles of insolation and temperature become increasingly susceptible to distortion by seasonal variation in cloudiness and rain. In fig. 2, there is a suggestion of flattening at the peak of the march of insolation at Washington, D.C.. the consequence of summer cloudiness; and at Miami, Fla., the peak is broadly flattened. In tropical latitudes, seasonal differences in weather depend more on the shifting of the great wind belts of the earth than on the annual march of insolation. The alternation of rain and drought becomes more important than the change in temperature through the year. Seasonal alternation of rain and drought itself produces seasonal change in temperature, rainy seasons in the tropics beirig almost without exception cooler than dry seasons, regardless of the time of year in which the seasons occur.

The zone of convergence between the trade winds of the two hemispheres is a rainy belt. and rainy weather accompanies it as it swings northward and southward in its annual cycle. Where the belt is narrow, its pendulation may bring two rainy and two dry (or less rainy) seasons per year to places near the equator. Fig. 3 shows the distribution of precipitation through the year in the western part of equatorial Africa, along the meridian of 15° E. longitude. There the meteorologic processes are more nearly symmetrical with respect to the equator than in any other land area in comparable latitudes. Between the equator and the parallel of ;" N. latitude a fairly symmetrical sequence of two rainy and two dry seasons in the course of the year may be identified. In most tropical areas, however, the alternation of seasons includes no more than one rainy and one dry season. Relief of the land and exposure to winds from different directions introduce exceedingly wide variations in length and intensity of these seasons.

In India a strongly marked seasonal alternation of rainfall and drought extends northward into latitudes in which there are distinct temperature seasons, summer being rainy, winter dry. The result of this superposition of seasons based on temperature and on raininess is a sequence of three seasons of different lengths: a cool season in the months December–February, a hot season from March to mid-June and a rainy season from mid-June to November. The warmest season thus precedes the rainy period, in which cloudiness strongly reduces insolation. A similar superposition of temperature and rainfall seasons is observed, though in less extreme form, in the outer parts of the tropical belt in Africa and South America. In those continents the highest temperatures of the year are sometimes recorded before the rainy season. sometimes after it.

See also METEOROLOGY; WEATHER FORECASTING.

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SEA SQUIRT, the common name for ascidians, one of the three orders of the Tunicata (*q.v*). They are animals with indisputable relationship with the vertebrate kingdom, having at some stage a dorsal tubular nerve cord, a notochord and gill slits; the swimming tadpole metamorphoses into a saclike adult living attached permanently to rocks, etc.; when contracting suddenly, jets of water shoot from the two siphons — from this habit sea squirts get their name.

SEATON VALLEY, an urban district (1935) in the Blyth parliamentary division of Northumberland, Eng., 8 mi. N.N.E. of Newcastle. Pop. (1951) 26.435. Area 19 5 sq.mi. The district lies in the centre of the south Korthumberland coal field and has ten mines employing the greater part of the population. Other Industries produce heat-resisting materials, bricks, fire-lighters and briquettes; agriculture ranks second to coal in importance.

Seaton Valley comprises ten mining villages; the biggest are Cramlington, Shiremoor and Seaton Delaval. The latter, the administrative centre, takes its name from the De la Val (Delaval) family, which dates to Norman times. Delaval hall (1720), just outside the district, is one of Sir John Vanbrugh's great achievements; nearby are the mausoleum (1776) and Sterling castle (a ruin), both built by Delavals. Backworth hall (1780) is a miners' welfare centre.

SEATTLE, the chief city of Washington, U.S., situated on a neck of land between Elliott bay (Puget sound) and Lake Washington (freshwater); a port of entry, headquarters of the Washington customs district; the seat of King county and the largest city of the Pacific northnest. It is 125 nautical miles from the Pacific ocean; 110 mi. S. of the Canadian border. Seattle's population was 557,087 in 1960. The standard metropolitan statistical area includes King county and, from 1959, Snohomish county; the population in 1960 was 1,107,213. The 1960 census showed nine other cities in the metropolitan area with a population over 5,000: Renton, Auburn, Kirkland, Kent and Bellevue in King county, and Everett. Edmonds, Lynnwood and Marysville in Snohomish county. (For comparative population figures see table in WASHINGTON: *Population.)*

Central Seattle is situated on a series of hills, some reaching 500 ft. above the harbour, in surroundings of great natural beauty. Ninety miles to the south in the Cascade range is Mt. Rainier (see MOUNT RAINIER NATIONAL PARK). To the west, beyond Puget sound, rise the jagged Olympic mountains, which shelter the city from the heavy ninter rains and winds of the coast. Beyond Lake Washington to the east are the high Cascades, which protect Seattle from the winter cold of the mid-continent. Prevailing minds (average velocity 8.9 m.p.h.) are from the southwest in minter and the northwest in summer. Average annual precipitation is 33.44 in., two-thirds of it falling between October and March.

The salt-nater harbour measures five miles across from West point on the north to Alki point on the south, and includes the east, nest and Duwamish waterways, extending inland on the south side of the bay; Smith cove, on the north side; and Shilshole bay, the western outlet of the Lake Washington ship canal, north of West point. The canal (8 mi long, minimum depth 30 ft.) connects Puget sound with Lake Washington, passing through Lake Union. The locks near the west end of the canal, which overcome the difference of 26 ft. between water levels, accommodate ships 760 ft. long. Elliott bay, uhere shipping is concentrated, has an entrance width of 2.5 mi. and is very deep and free from natural obstructions. Along the water front the hills have been graded down to give a comparatively level area for the business district. This is built up with several large hotels, public buildings (including the modern public library, 1960), and high business buildings, most of them erected either after World War I or in the post-Korean war building boom. A concrete pontoon bridge across Lake Washington, the floating portion of which is 6,561 ft. long, was completed in 1940.

History. — The first nhite settlement was made at Alki point in Nov. 1851 by a group of middle westerners, most of whom moved around on Elliott bay the following February. The new town was named for a friendly Indian chief. In 1853 a plat was filed and Seattle became the seat of King county, Oregon territory. Later that year the region became part of the newly proclaimed Washington territory. Lumbering was the chief activity, the steam sawmill of Henry Yesler giving Seattle its early importance. By 1855 the population was 300. In Jan. 1856 it was attacked by neighbouring Indians and successfully defended by the U.S. sloop of war "Decatur." The city was incorporated in 1869. Early growth was slow, the 1870 census showing a population of 1.107, which rose to only 3,533 in 1880; in this period the chief exports were lumber, fish and coal (from the mines to the east and south of Lake Washington). After 1880 the rate of growth increased rapidly. In 1883 a spur line connected the city with Tacoma, main terminus of the Northern Pacific, the first transcontinental railroad to reach Puget sound. For some years thereafter (a period of intense rivalry between Seattle and Tacoma) this rail service was unsatisfactory. Not until 1893, when the Great Northern reached the city. did Seattle become a full-fledged rail terminus. In 1889, the year Washington attained statehood, most of the business district of Seattle burned but this did not hamper the city's growth. The population in 1890 was 42,837. The arrival of the first Japanese steamer in 1896 marked the beginning of considerable foreign trade.

Of greater significance was the Yukon mining strike, which touched off the great gold rush beginning in 1897. Almost overnight Seattle became an important commercial centre, the outfitting point for prospectors and the port to which they shipped their gold. Subsequent Alaskan gold strikes, notably at Nome and Fairbanks, gave more impetus to Seattle's growth. Led by City Engineer Reginald H. Thomson, Seattle prepared for the future by grading the downtown hills (a project lasting for decades), by securing an abundant supply of water from Cedar river (in the Cascades, 26 mi. S.E.) and by building the first municipally owned hydroelectric plant in the country (1905). In 1909–10 the Alaska-Yukon-Pacific exposition was held at Seattle. Between 1905 and 1910 ten cities and towns were annexed and the city's population grew to 237,194. By 1910 Seattle had been reached by two other major railroads. The opening of the Panama canal in 1914 gave a new stimulus to the city's commerce, as did the completion of the Lake Washington ship canal two years later. During World War I Seattle built more ships than any other port of the U.S. The average number of wage earners in the city's manufacturing establishments rose in five years (1914–19) from 11,523 to 40,843; the value of the output, from $64,475.000 to $274,431,000. During the same period unions grew rapidly but the labour movement suffered a major setback with the failure of a general strike in 1919 that lasted for five days. The 1920 census showed a population of 315,312. The decade of the 1920s was one of moderate growth; that of the 1930s was one of stagnation and depression. World War II brought a great boom, with shipyards and the aircraft industry playing important roles. The period after World War II was characterized by a resumption of the rapid growth of population. with an increasing diversity of industry.

Government. — The city is governed under a charter amended in 1946 to provide for a park superintendent and an administrative assistant to the mayor. Municipal elections are nonpartisan. The mayor is elected every four years; members of the city council are elected at large for four-year terms also. The city owns its street transit, water supply and hydroelectric generating and distributing systems. Harbour development and administration of public terminal facilities are in the hands of a public corporation called the Port of Seattle, created in 1911 by the people of Seattle and King county and administered by a three-man board of elected commissioners. Also under its jurisdiction is the Seattle-Tacoma International airport.

Commerce, Industry and Transportation.— Seattle is the leading commercial, industrial and financial centre of the Pacific northwest. Its geographical position in relation to the orient and Alaska makes it a natural receiving and distributing point for trans-Pacific and Alaskan traffic and the Panama canal gives access to Atlantic and Gulf markets, while the products of its tributary territory and its own manufactures supply staple articles for outgoing freight. A large part of the mail moving across the Pacific is handled in Seattle. In the early 1960s leading imports were limestone and limerock, lumber, gypsum rock, bananas and newsprint; the chief exports were coal, wheat, barley, tallow and wheat flour. Seattle is the principal outfitting point for the fisheries of the North Pacific and the chief supply point and wholesale market for logging camps and the agricultural northwest. Cheap electric power combined with abundant raw materials of certain kinds and distance from the older industrial centres has stimulated industry. The city has over 1,000 manufacturing establishments.

In addition to highway and railroad transportation facilities. Seattle is served by airlines with flights to Canada, Alaska, Japan and other points in the far east as well as to other points in the U.S. It is a port of call for steamers with sailings to Alaska and California, across the Pacific and through the Panama canal to eastern and European ports. It is the centre of the system of ferries owned by the state.

Education and Cultural Activities.— The public-school system includes elementary, special, junior high and high schools and a technical school. There are also Roman Catholic parochial schools and other denominational and nondenominational private schools. The University of Washington (see WASHINGTON: Education) is in Seattle. Other institutions of higher learning in the city are Seattle university (Roman Catholic, established 1891) and Seattle Pacific college (Free Methodist, chartered 1891). An educational television station broadcasts from the University of Washington. The public library system includes, in addition to the main library, several branches and bookmobiles, a municipal reference library and a library for the blind. Other cultural features of the city include the Seattle Art museum, the Frye Art museum, the Museum of History and Industry and the Seattle Symphony orchestra.

Parks and Recreation.— Seattle's public park system of over 3.500 ac. includes parks, community playfields, neighbourhood playgrounds, golf courses and beaches. The area also offers many opportunities for water sports and hunting and fishing.

See also Index references under "Seattle" in the Index volume.

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SEA URCHIN, popular name for spiny marine animals, members of the Echinoidea, a class of the Echinodermata (*q.v.*). The name Echinus, applied to a common genus, refers to the similarity between some of the Mediterranean urchins and the European hedgehog, called echinos by the ancient Greeks, which when rolled up forms a spiny ball of similar size. The majority of the sea urchins, the Regularia, conform to this type while the remaining, the Irregularia, cake urchins, sand dollars (*q.v.*) and heart urchins, deviate in many respects.

The regular sea urchins have a more or less spherical shell, or test, of closely fitting calcareous plates, arranged in five double rows, the radials, perforated by doubled pores, each pair admitting one tube foot, and five double rows without such pores, called the interradials. On the under side of the test is a large hole covered by skin; the mouth and the elaborate dental apparatus are placed in the centre of the hole. On the opposite pole there is a smaller opening, the vent or anus. (See fig. 1.) The plates of the test carry smooth knobs, each articulating with a calcareous

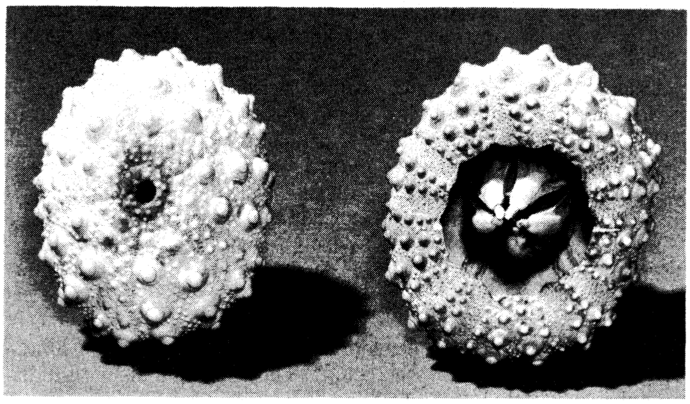

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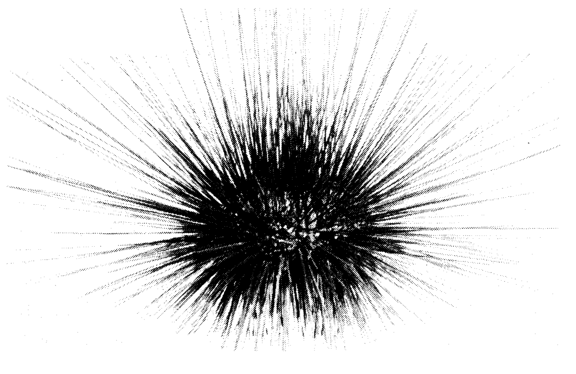
FIG. 1.— TEST OF REPRESENTATIVE SEA URCHIN

Dorsal view (left), with spines removed, and (right) ventral view showing mouth opening and five teeth

spine which can be moved by the action of basally placed muscles. The size, form and number of the spines greatly determine the external appearance. In one primitive form, *Cidaris*, the larger primary spines, few in number and shaped like a policeman's night stick, are surrounded by a circle of smaller secondary spines. In Diadema, well known from most coral reefs, the spines are excessively long and slender and are effective as protective lances. (See fig. 2.) The long, thick spines of the slate pencil urchins (*Hererocentrotus*) were actually used as writing pencils by the early missionaries in the South Sea islands. A close relative has spines shaped like short flat discs, which fit together to form a mosaic of hexagonal plates. From muddy bottom in deep water is known one sea urchin with long slender spines, gently arched and with the tip expanded into a small hoof; by means of these modified spines the sea urchin can move over the soft bottom with little difficulty. A characteristic of most sea urchins is the pedicellariae, minute, three-pronged pincers, often provided with poison glands, borne on slender stalks. They remove dirt, pass food particles along and serve as effective weapons. From the five radial canals of the water vacular system, which characterizes all echinoderms, arise the podia or tube feet, which pass out through the pore pairs of the test and end in a terminal sucking disc.

The sea urchin's masticatory apparatus (the Lantern of Aristotle), is a complex structure consisting of five, ribbon-shaped teeth—rootless, like the incisors of a rodent—each of which is encased in a jaw, a triangular pyramid. Each jaw has the apex directed downward and is united by short muscles to its neighbours. From raised points along the edge of the large opening in the test extend five pairs of bandlike muscles, which attach to the lower part of the jaws. Five similar pairs of muscles, placed between them, attach to the upper ends or bases of the pyramids. By



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

FIG. 2.— SEA URCHIN (DIADEMA ANTILLARUM)

From the West Indies and Florida

contracting or extending these muscles the dental apparatus can be raised, lowered and placed at different angles to facilitate its work of chopping up larger pieces of algae, scraping off the minute algal growth on the rocks, grinding up smaller animals and, in certain species, boring a hole in rock wherein the animal may spend its life. The majority of the regular sea urchins are vegetarians, but some live chiefly on smaller bottom animals and others subsist on the decaying debris of the muddy ocean floor.

Sea urchins are free-living forms, creeping on the sea bottom. They are able to move in all horizontal directions, at right angles to the axis which runs from the mouth to the anus. The Irregularia, however. are burrowers, which have acquired a secondary bilaterality, forcing them to move in one direction only. In these forms the anus has shifted down in one of the interadii and the radius opposite becomes the fore end.

In sea cookies or cake urchins and in sand dollars, which live in shallow water exposed to wave action, the test is thick, flattened and reinforced by internal pillars. The masticatory apparatus is preserved but modified. The mouth opening in the test is small and food is swept in along ciliated grooves and then sifted and ground up by the teeth.

In heart urchins, which live at greater depth on or in mud, the test is fragile and the mouth has moved forward and become a transverse slit; the complex dental apparatus has disappeared. Many of these forms live in burrows lined with mucous secreted by glands on the spines. The food is collected by means of long tube feet which reach up to the surface of the mud through a hole in the burrow and sweep up what organic particles there may be on the muddy surface.

There are about 700 species of sea urchins now in the seas, a fraction of what existed in former times. Because of their easily preserved skeletons. these forms constitute one of the most important groups of fossils used by students of paleontology. See also Index references under "Sea Urchin" in the Index volume.

See L. H. Hyman, *The Invertebrates,* vol. 4, *Echinodermata* (1955); R. T. Jackson, *Phylogeny of the Echini* (1912). (EL. D.)

SEA WRACK, the detached seaweeds thrown up, often in great quantities. by the sea and used for manure, also formerly for making kelp. It consists largely of species of *Fucus*—brown seaweeds with flat branched ribbonlike fronds, characterized in *F. serratus* by a saw-toothed margin and in F. *vesiculosus,* another common species, by bearing air bladders. Also of *Zostera* marina, so-called sea grass, a marine flowering plant with bright green long narrow grasslike leaves. See EELGRASS.

SEBASTIAN, SAINT, a martyr believed to have suffered in Rome during the persecution of the emperor Diocletian. His feast day on Jan. 20 occurs in the early Roman martyrology of the chronographer of A.D. 354. as well as in 5th-century Hieronymian martyrology. According to his legend he was a captain of a Roman cohort who converted many soldiers and was condemned by Diocletian to be shot. to death by archers. When they had left him for dead, a Christian widow, Irene, nursed him in her house. After recovering he presented himself before the emperor who immediately ordered him to be beaten to death. His body, thrown into a sewer, was found by another pious woman, whom the saint told in a dream to bury it near the catacombs. His relics are believed to be in the basilica of S. Sebastiano on the Appian way, which attracted many pilgrims in the middle ages. He is frequently represented in art as a beautiful youth wounded by arrows.

See H. Thurston and D. Attwater (eds.), *Butler's Lives of the Saints,* vol. i, pp. 128–130 (1956). (H. C. G.)

SEBASTIAN (Port., SEBASTIÃO) (1554–1578), king of Portugal, posthumous son of Prince John of Portugal, was born in 1554 and became king in 1557. Sebastian was a mystic and a fanatic, whose sole ambition was to lead a crusade against the Mohammedans in northwest Africa. He entrusted the government to the Jesuits and refused to summon the Cortes or to marry, although the Portuguese crown would otherwise pass to a foreigner. His first expedition to Morocco, in 1574, was little more than a reconnaissance; in a second expedition Sebastian was killed and his army annihilated at Al Kasr al Kebir (Aug. 4, 1578). Although his body was identified, many Portuguese refused to credit his death. "Sebastianism" became a religion. Its votaries believed that the "hidden king" was either absent on a pilgrimage or was awaiting his second advent on some enchanted island.

Four pretenders to the throne successively impersonated Sebastian; the first two, known from their places of birth as the "King of Penamacor" and the "King of Ericeira," were of peasant origin; they were captured in 1584 and 1585 respectively. The third. Gabriel Espinosa, whose adherents included members of the Austrian and Spanish courts and of the Society of Jesus in Portugal, was executed in 1594. The fourth was a Calabrian named Marco Tullio who impersonated the "hidden king" at Venice in 1603 and gained many supporters. but was ultimately captured and executed. The Sebastianists had an important share in the Portuguese insurrection of 1640. and mere again prominent during the Miguelite wars (1828–34).

SÉBASTIANI, HORACE FRANÇOIS BASTIEN, COUNT (1772–1851), French marshal and diplomat. Of Corsican birth. he was banished in his early years from his native island during the civil disturbances, and in 1789 he entered the French army In 1793. as a French lieutenant, he took part in the war in Corsica. serving later in the Army of the Alps. He became *chef de brigade* in 1799. Attached to the future Emperor Napoleon, he took part in the *coup d'état* of 18th Brumaire (Nov. 9, 1799). He was present at Marengo in 1800. Sébastiani next appears in his first diplomatic post, in Turkey and Egypt (1802). Promoted general of brigade in 1803, he served in 1805 in the first of the great campaigns of the Empire. At Austerlitz he was promoted (Dec. 2) general of division. As French ambassador at Constantinople he induced the Porte to declare war on Russia; as a soldier he directed the defense of Constantinople against the British squadron. But the deposition of the Sultan Selim III put an end to French diplomatic success. Sébastiani was recalled in April 1807 and made count of the empire. He commanded a corps in the Peninsular War. In the *grande guerre* of Russia and Germany he did brilliant service. He accepted the Restoration government in 1814, but rejoined Napoleon on his return from Elba. After Waterloo he retired into England for a time. From 1819 he was a prominent member of the chamber of deputies. He became minister of state without portfolio (1832), ambassador at Naples (1833) and ambassador to Great Britain (1835–40). On his retirement he was made marshal of France. He died in Paris on July 21. 1851.

SEBASTIANO DEL PIOMBO (SEBASTIANO LUCIANI) (c. 1485–1547), Italian painter of the Venetian school who became the friend and protégé of Michelangelo, was born in Venice. According to G. Vasari, who knew him. he was 62 when he died in Rome in 1547, and it is therefore assumed that he was born in 1485. The same authority tells us that he learned "the first rudiments from Giovanni Bellini. at that time an old man And afterward, when Giorgione had established in that city (Venice) the methods of the modern manner. with its superior harmony and its brilliancy of colouring, Sebastiano left Giovanni and placed himself under Giorgione. with whom he stayed so long that in great measure he acquired his manner." The truth of this statement Can be seen in such works as the "Madonna and Child nith SS. Catherine and John the Baptist" (Accademia, Venice), the organ doors of S. Bartolomeo a Rialto. Venice, and the altarpiece of S. Giovanni Crisostomo. Venice, recorded by Vasari as having been confused with the work of Giorgione himself. After Giorgione's death in 1510 Sebastiano is said to have finished some of his pictures. and there is a group of paintings whose authorship is still undetermined between them, including such works as the "Adulteress" (Glasgow) and the "Judgment of Solomon" (Bankes collection. Kingston Lacy. Dorset). The "Salome" in the National gallery. London. is dated 1510 and is therefore a key work of this period; Vasari himself once attributed it to Giorgione before realizing his mistake.

Sebastiano perhaps might now have inherited Giorgione's reputation and commissions, but in the spring of 1511 he was invited to Rome by the Sienese banker Agostino Chigi, who had just built the Villa Farnesina by the Tiber and was having it decorated. Sebastiano left Venice and returned only once (1528/29), spending the rest of his life in Rome. His decorations in the Farnesina met with success and he came into contact with Raphael and his pupils, who were also working there, and became his admirer. Later, perhaps quite soon after 1511. Sebastiano transferred his allegiance to Michelangelo and it seems that Michelangelo saw that if he were to correct Sebastiano's draftsmanship. Sebastiano's gifts as a painter were hardly to be equalled in Rome. The first result of this form of collaboration mas the "Pietà" (Museo, Viterbo), for which Vasari says Michelangelo supplied "the invention and cartoon," the actual execution being by Sebastiano. The same thing happened with the "Flagellation" painted in oil on the wall of S. Pietro in Montorio, Rome. Michelangelo supplied a drawing for this as early as 1516, although the painting was executed only in 1520–24.

A direct rivalry between two groups came to a head when Cardinal Giulio de' Medici commissioned the "Transfiguration" from Raphael and the "Raising of Lazarus" from Sebastiano. The "Lazarus" (now in the National gallery) was commissioned in 1516 and finished in 1519; Raphael's "Transfiguration" was still unfinished at his death on April 6, 1520. For the next 11 years Sebastiano was reckoned the best painter in Rome, particularly of portraits, which he produced with less delay than was usual with his other works.

In 1531 Cardinal de' Medici, now Pope Clement VII, gave him the well-paid office of the "piombo" (the supervision of the lead seals attached to papal bulls) and Fra Sebastiano, as he now became, worked less and less. One of his late works (1j31 or later) is the "Lady as St. Agatha" in the National gallery. He also invented a method of painting on stone and a technique for painting in oil on plaster walls. and he tried to persuade the pope to make Michelangelo use oil instead of fresco for the "Last Judgment" in the Sistine chapel. This led to a coolness between them which lasted almost to Sebastiano's death, which was on June 21. 1547.

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SEBORRHEA. Seborrhea is a medical term applied to accumulation on the skin of fatty material from the sebaceous glands and of yellowish oily scales. The condition is usually most marked where sebaceous glands are most numerous, on the scalp. face, centre of the chest and the genital region. Cradle cap, dandruff, acne and seborrheic dermatitis are common skin diseases in which there is increased or disturbed function of the sebaceous glands. Increased sebaceous activity may be produced by the administration of male sex hormones. and is commonly noted at puberty. It is seen after prolonged administration of steroids such as cortisone and ACTH. The relation of seborrhea to the male type of baldness is not clearly defined, but experimental work in animals indicates that components of sebum may interfere with the formation of hair. (D. M. P.)

SECCHI, (PIETRO) ANGELO (1818–1878), Italian Jesuit and astrophysicist, noted for his pioneer investigations in solar phenomena and in stellar spectroscopy and spectral classification, was born at Reggio Emilia, Italy, on June 18, 1818. He entered the Society of Jesus in 1833, and became lecturer in physics and mathematics at the Collegio Romano, Rome, in 1839. Driven into exile in 1848 by the proscription of the Jesuits; he went to Stonyhurst college. Eng., and then to Georgetown university, Washington, D.C., where he pursued his mathematical and scientific work, returning to Rome as professor of astronomy and director of the observatory at the Collegio Romano in 1850. Here he erected a new observatory, equipped with a Merz refractor, over the church of Sant' Ignazio, where he carried out his researches into stellar spectroscopy, terrestrial magnetism and meteorology. His meteorograph was demonstrated at the Paris exhibition of 1867.

Secchi's main achievement was his division of stellar spectra into four groups: (1) stars like Sirius. with strong hydrogen lines; (2) stars similar to the sun, with numerous fine lines; (3) stars of the α Herculis type, with nebulous bands degraded toward the red; and (4) carbon stars. with violet-degraded bands. These divisions were subsequently developed into the Harvard classification, based on a simple temperature sequence, that forms the basis of modern systems. Secchi was also active in solar observation; he proved that prominences are appendages of the sun and discovered many features of their behaviour; he also photographed the corona at the eclipse of 1860. He was, in addition, an active observer of double stars. He died at Rome on Feb. 26, 1878.

Secchi wrote *Sulla mesura della base trigonometrica eseguita sulla Via Appia nel 1854–5* (1855); *Catalogo delle stelle di cui si ē determinato lo spettro luminoso* (1867); *Sugli spettri prismatici delle stelle fisse* (1868); *Le Soleil* (1870); *Le stelle* (1877).

See Agnes M. Clerke, *A Popular History of Astronomy during the Nineteenth Century* (1902). (B. E. J. P.)

SECESSION, a term used in political science to signify the withdrawal of a state from a confederacy or composite state, of which it had previously been a part; and the resumption of all powers formerly delegated by it to the federal government, and of its status as an independent state. To secede is a sovereign right; secession, therefore, is based on the theory that the sovereignty of the individual states forming a confederacy or federal union has not been absorbed into a single new sovereignty. Secession is a right claimed or exercised by weaker states of a union whose rights are threatened by the stronger States, which seldom acknowledge such a principle. War generally follows the secession of a member of a union, and the seceding state, being weaker, is usually conquered and the union more firmly consolidated.

Secession in theory and practice is best exhibited in the history of the United States. Most of the original states, and many of the later ones, at some period when rights were in jeopardy proclaimed that their sovereignty might be exercised in secession. The right to secede was based, the secessionists claimed, upon the fact that each state was sovereign, becoming so by successful revolution against England; there had been no political connection between the colonies; the treaty of 1783 recognized them "as free, sovereign and independent states"; this sovereignty was recognized in the articles of confederation, and not surrendered, they asserted, under the constitution; the union of 1787 was really formed by a secession from the union of 1776–87. New states claimed all the rights of the old ones, having been admitted to equal standing. Assertions of the right and necessity of secession were frequent from the beginning; various leaders in New England made threats of secession in 1803 on account of the purchase of Louisiana, in 1811 because of the proposed admission of Louisiana as a state and during the troubles ending in the War of 1812. In 1832–33 the Union party of South Carolina was composed of those who rejected nullification, holding to secession as the only remedy; and from 1830 to 1860 radical abolitionists advocated a division of the union. As the North grew stronger and the South in comparison grew weaker, slavery came to be the dominant political issue. As the South made demands concerning that "peculiar institution" to which the North was unwilling to accede, less was heard of secession in the North and more in the South. Between 1845 and 1860 secession came to be generally accepted by the South as the only means of preserving its institutions from interference of the North. The first general movement toward secession was in 1850. In 1860–61, when the federal government passed into the control of the stronger section, the southern states, individually, seceded and then formed the Confederate States.

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SECONDARY EDUCATION, a stage in education beyond the elementary (U.S.) or primary (British) level, usually beginning at age 11 or 12 and generally constituting either terminal education or preparation for college—in the United States, high school education. Secondary education constitutes a serious and difficult problem in virtually every country of the world. The difficulties arise from a number of causes: changing demands of modern culture; economic transformation in process everywhere; the ideal of equality of educational opportunity for all; and recruitment and training of young persons of talent to meet the needs and the higher intellectual standards of modern societies. To find a solution for these difficulties involves not only a reorganization of the educational systems of most countries but the abandonment of the monopoly of the traditional concept of secondary education.

This article discusses the background of these difficulties and the emergence and development of systems based on the U.S. common school or single-track plan and the British and European specialized school or multitrack plan, and analyses efforts to provide equality of educational opportunity for all.

For the history of secondary education in various countries see EDUCATION, HISTORY OF. For discussion of the organization of secondary education in various national systems of education see SCHOOL ADMINISTRATION. See also School and *Curriculum* and Education sections of articles on individual countries.

BACKGROUND OF THE PROBLEM

Classical Curriculum.—This concept can be traced to the grammar and rhetoric schools of Greece and Rome with emphasis on literary training. Expanded into the seven liberal arts the concept was directed to a different aim in the middle ages. The rediscovery of Greek and Latin authors established the predominance of the classical studies in European countries and then in the American colonies (see CLASSICAL EDUCATION). As commercial relations and travel expanded, demands for a type of secondary education to meet new needs were met by the establishment of schools in the 17th and 18th centuries. These schools, however, did not enjoy the prestige of the grammar schools, particularly because they were refused recognition by the universities. Justification for the retention of classical studies, which became meaningless because more attention was paid to form than to content, was that even if they were useless, they trained the mind and the mind so trained could without difficulty attack new situations and problems. The classical curriculum enjoyed a monopoly as the only type of secondary education to the middle of the 19th century. Criticisms were met by an internal reform (neo-humanism) giving more attention to content and meaning, which originated in Germany in the 18th century.

From the early years of the 19th century the traditional classical schools began to enjoy special prestige not only because their graduates were admitted to the universities, but also because they were granted special privileges (*Berechtigungen* in Germany and sanctions in France), and in England, after the reforms of Thomas Arnold at Rugby, social recognition as character training institutions. Changing economic and cultural conditions, however, stimulated protests against the monopoly of the classical schools and a demand either for the introduction of modern subjects (foreign languages, sciences, mathematics) or for new types of secondary schools for the teaching of these subjects. By the end of the 19th century different types of curricula (classical, semiclassical and modern) in separate or in the same schools, received equal recognition and privileges. In England, however, publicly maintained secondary schools were not established until after 1902, and the private endowed schools, the best of which were known as "public schools," continued to provide an education which was mainly classical with other subjects grudgingly admitted. The older English universities made Latin and Greek compulsory requirements for admission well into the 20th century. In none of the countries was secondary education for girls provided at public expense until the 19th century, and it was late in that century that opportunities for their admission to universities were provided.

Secondary education constituted a separate type distinct from the elementary schools in all countries except the United States. An insignificant number of pupils passed on from the elementary to the secondary schools, preparation for which was given in different schools (*Vorschulen* in Germany, classes *préparatoires* in France and preparatory schools in England). These schools were fee paying and since their curricula were designed to prepare pupils directly for admission to the secondary schools, the pupils had an advantage over those who wished to transfer from the elementary to the secondary schools. Further, the secondary schools, since they charged tuition, were selective and drew their pupils from the wealthy classes, who could afford to pay the fees and the cost of maintaining their children while at school. Poor pupils of ability might obtain scholarships in competitive examinations, but their attendance usually required some financial sacrifice on the part of parents.

U.S. Common School.—The United States was the first country to provide equality of educational opportunity and to depart from the traditional dual type of organization by adopting the common school system in which elementary and secondary education were articulated. Some doubt still persisted whether the high school grades, in which other than elementary school subjects could be taught came under the provisions for the establishment of common schools. In 1874, in a court decision on the Kalamazoo (Mich.) case, the provision of secondary education at public expense was declared to be constitutional. Another feature of the U.S. high school was the gradual expansion of the curriculum which included the subjects of the colonial Latin grammar school and the practical subjects of the private academies which emerged during the period of the American Revolution. A new type was the English Classical school established in Boston in 1821. The core of the high school curriculum consisted of subjects required for entrance to college whether by examination or by accreditation, first adopted by the University of Michigan in 1871. The proper content of a secondary education was just as much debated in the United States as in other countries and was defined at the end of the 19th century by the reports of the Committee of Ten (1893) and of the Committee on College Entrance Requirements (1899). It was generally considered that what was good for college entrance was also good for a liberal education.

Expansion of secondary education coincided with increasing urbanization and industrial expansion. Both factors made the provision of high schools possible and higher family incomes enabled parents to keep their children in schools beyond the elementary grades. Two other influences contributed to the spread of opportunities for secondary education for all. The first of these were the investigations conducted early in the 20th century of the doctrine of formal discipline and transfer of training in which it was found that neither developed spontaneously from the study of traditional subjects but could be cultivated under certain conditions. The conclusion was immediately interpreted to justify the provision of any subject that a pupil might request or be interested in. The second influence followed studies of elimination (the number of pupils who left school after a year or two) and of mortality (the number who stayed the course but failed to pass the final examinations). Both investigations resulted in throwing the doors of the high schools wide open for the admission of any subject that pupils, parents or the public demanded. The high school consequently became nonselective and the expansion upward of the universal school was encouraged by leaders who showed a greater interest in keeping pupils in school than in the quality of subjects taught.

The outstanding feature of this system is that pupils pass on normally from the primary to the postprimary school without having to pass entrance examinations or paying tuition. The high school has become the school for all youth, who are not distributed into separate schools but find the courses best adapted to their needs and abilities in the same comprehensive high school with the advice of guidance officials or parents. The weaknesses of the system, which were not recognized until after World War II, are that the high school tended to cater to the average pupils and to ignore those above and below the average; that all subjects were considered to be of equal value educationally under the quantitative system of points and units; and that pupils were not required to stay long enough with any subject to acquire a real mastery. The only requirements that were specifically defined are those necessary for entrance to college.

Dual Plan.—The organization of secondary education in the United States stands out in direct contrast to the educational systems of other countries except the few that adopted the American plan. The characteristic organization outside the United

States has been on the dual plan; elementary and secondary education have been distinct types and only a minority of the elementary school pupils passed on to the secondary schools. generally only if they were bright and could win scholarships through a competitive examination. The secondary schools drew their clientele from private preparatory schools. Further the courses in the secondary schools were definite and were limited to the study of the mother tongue and national literature, foreign languages and literature (ancient or modern), mathematics and science, history and geography, some art, music and physical training. The affiliations of the complete secondary schools were with the universities rather than with the elementary schools; pupils who did not complete the full course generally entered white collar rather than manual or technical occupations.

The development of commerce and industry during the 19th century produced a demand for some form of intermediate education, less academic and more practical than the secondary and not as selective. The demand was met in Germany by the creation of *Mittelschulen,* in France of *écoles primaires supérieures* and in England of higher elementary schools and later in some localities of central schools. The curricula of these schools were somewhat more advanced than those of the elementary schools; pupils remained longer and were prepared for employment in business or industry as white collar workers but generally in a lower grade than pupils who came from secondary schools. Through the educational systems a sort of hierarchy was created and the more advanced secondary education was sought frequently for the status and privileges that it conferred. The cleavage between secondary and elementary or postelementary education was maintained by their administration in separate departments of the central authorities. The certificates conferred by different types of schools also contributed to the cleavage, since those of the secondary schools enjoyed higher social and occupational values.

Reform Movements. — This situation continued into the 20th century and gave rise to the reform movements proposed after World War II. In Germany secondary education for boys was provided in nine-year courses in *Gymnasien* where the chief subjects were Latin and Greek; the *Realgymnasien* with Latin and modern subjects; and *Oberrealschulen* with modern subjects. The final examination (*Abiturientenprüfung*) led to a certificate accepted for entrance to a university. Incomplete six-year courses were offered, with the same emphases as in the corresponding complete courses, in *Progymnasien, Realprogymnasien* and *Realshulen.* Girls received their secondary education in *Lyzeen* and *Oberlyzeen.* Secondary education in France was provided in *lycées* (state-maintained schools) and *collèges* (municipally maintained); classical, semiclassical and modern courses were available in each school, with special courses in the final or seventh year in philosophy or mathematics. The leaving examination, held in two parts at the ends of the sixth and the seventh years, led to the *baccalaurdat,* a prerequisite for university entrance.

Secondary education in England was not provided at public expense until the Education act of 1902 set up local education authorities (L.E.A.s) and permitted them, if of a certain size. to establish and maintain secondary schools. The provision of public secondary education followed Matthew Arnold's plea to "organize your secondary schools" and the report of a commission, with James Bryce as chairman, appointed (1894) to consider "the best methods of establishing a well-organized system of education in England." Undoubtedly the growing competition of Germany exercised some influence in the same direction. Until passage of the act of 1902, secondary education was provided in ancient endowed schools, which included the "great public schools" and many others, day and boarding. which began to be called public schools and a large number of private schools. Many new public schools were established after Thomas Arnold's reform at Rugby. All schools, public and private, charged fees; the majority were boarding schools and their curricula were predominantly classical with instruction in modern languages (including English) and science permitted but not particularly favoured. Their affiliations were with the universities of Oxford and Cambridge, which in the latter part of the 19th century conducted school examinations. Schools were not supervised by any government authority, unless they had endowments to administer. Able pupils from elementary schools could win scholarships in competitive examinations to enter secondary schools at about age 11; normally such schools were day schools since boarding school fees were generally beyond the means of boys coming from elementary schools.

Girls received their secondary education at home or in private schools or schools provided by a voluntary organization such as the Girls' Public Day School trust (1872). Those who completed their secondary education and passed the necessary examination could enter the few women's colleges in Oxford or Cambridge but could not (until the 20th century) proceed to degrees; others continued their education in one of the provincial universities on an equal footing with men.

The secondary schools established under the Education act were organized on the model of the existing secondary schools. Pupils were admitted by entrance examinations and tuition fees were charged until 1907, when the government regulations required the schools to provide "free places" up to 25% of the enrollment for pupils coming from elementary schools; the free places were subsequently replaced by "special places," the percentage of such places could be from 25% to 50%, and a means test was introduced. The curriculum was designed to provide a general or liberal education, and included English language and literature, at least one foreign language, geography, history, mathematics, science, organized games, physical exercises, music and drawing. Until 1917 the charge was made that the secondary school pupils had to take too many external examinations. In 1917 the number of external examining bodies, normally associated with the universities, was reduced to eight, and under the government's regulations pupils could sit for only two examinations — the first or school certificate, usually taken after four years of secondary education, and the higher school certificate at the end of the course. The certificates were accepted for entrance to the universities.

Patterns of Organization. — The four systems of secondary education — the German, French, English and American — have either influenced the organization of secondary schools directly or are found in other countries. Thus the German type exercised an influence on the types of secondary schools in the Scandinavian countries; French *lycées* were reproduced not only in French-speaking countries but in all the east European and middle east countries, where the French ministry of education often conducted examinations for the *baccalauréat.* English type public schools, boarding schools to meet the needs of a sparse population, was reproduced in Australia and New Zealand, until with the rise of urban centres day secondary or high schools were established similar in aim and curriculum to the local authorities' schools in England with an emphasis primarily on an academic curriculum leading to university entrance. In New Zealand secondary education in rural areas is provided in district high schools attached to the primary schools; in urban areas two-year intermediate schools have been established leading to the four-year high school. Multipurpose schools are provided in Australia in sparsely populated areas, but in urban centres there exist academic, commercial, technical and home science schools.

In Canada the organization of secondary education varies from province to province; Quebec has replicas of the French and English systems to meet the needs of the different language and religious groups. In the other provinces the majority of pupils attend the publicly maintained schools, which may offer four, five or six year courses, and may be academic only or-comprehensive as in the United States. In South Africa there is a common pattern in the fact that secondary education is continuous with primary, extends from standard VI to standard X with examinations at the end of standard VIII in two provinces and a final examination at the end of standard X, accepted for university entrance.

None of the patterns mentioned is found in Latin-American school systems. They have, however, solved one of the serious problems in having an end-on system — the pupils pass on to the secondary schools directly from the primary schools. Secondary education, given in *colegios, liceos, ginásras* (Brazil) or *institutes de segunda enseñanza* (Cuba), is five or six years in length. Generally the course is divided into two parts or cycles—the first cycle, usually three years in length, is general and common to all, and the second cycle provides for specialization for two or three years in humanities or sciences, depending on the requirements of the faculty that is to be entered in the university. Success in final examinations leads to the *bachillerato* in humanities or sciences. In Chile, a number of experimental schools have been established with courses divided into three parts—a common course of liberal education for all, an exploratory course to discover the pupils' special abilities and interests and a specialized course in humanities or sciences for entrance to the universities.

SECONDARY EDUCATION FOR ALL

World War I marked the beginning of a turning point in the history of secondary education in many countries outside the United States. The basic aim in the new movement was to establish a common system of education founded on the principle of equality of educational opportunity for all. Under various names (*Einheitsschule* in Germany, *école unique* in France and secondary education for all in England) the movement involved the abolition of the traditional dual system (elementary schools for one class of pupils and secondary for a selected group). It also implied a common foundation in education for all at least up to the age of 11 or 12 years. For the time being the term secondary education was not redefined. In Germany, the first step was to abolish the privileged status of the *Vorschulen* and in France the *classes préparatoires* and the same primary education was to be provided for all irrespective of the school that they attended. To enable pupils who did not transfer from the basic school (*Grundschule)* at the normal age of 10, a new type of secondary school (*Aufbauschule*) was established in Germany. In France fees for secondary education began to be abolished in 1931.

In England, following the report on *The Education of the Adolescent* (1926) of the board of education's consultive committee (Sir Henry Hadow, chairman), it was decided that more educational opportunities should be provided and that all pupils should be given some form of postprimary education from the ages of 11 to 15. The age of transfer from the primary to the postprimary stage was thus established at about 11; pupils who did not pass on to a secondary school received a more advanced education in "senior tops" than was previously available in the last three years of the traditional elementary schools. The senior schools, however, continued to be administered by the same department in the central board of education as the primary schools. The raising of the age of compulsory school attendance, recommended by the Hadow committee, was not actually achieved until 1947.

In the United States the problem of the articulation of primary and secondary education had been attacked earlier and for two reasons. It was thought (1) that the transition from the eighth grade of the elementary school to the first year of the high school was too abrupt and (2) it was considered desirable to introduce pupils to secondary school subjects slowly and to explore their abilities and aptitudes. One solution was to establish junior high schools to which pupils passed at the age of 12; another was to organize the last two grades of the elementary school as an intermediate section to serve as a gradual introduction to the high schools. The educational organization might be on the 8–4, 6–6 or 6–3–3 basis. In the United States, as in other countries, the end of World War I represented a new stage in educational development. Enrollment in the high schools began to rise rapidly and resulted in serious discussions not only of the aims of secondary education but also of the appropriate subjects to be taught. It had long been obvious that the traditional academic subjects were not suited either to the abilities or the interests of many adolescents. The issue was discussed by numerous committees of which the most influential was the Commission on the Reorganization of Secondary Education which in its 1918 report recommended the following objectives: health, command of fundamental processes, worthy home membership, vocation, civic education, worthy use of leisure and ethical character. These "cardinal principles" did not solve the curriculum problem. The practices varied throughout the country; in some schools various courses were offered; in others programs were tailor made for each pupil according to his abilities and interests. The only requirements that remained specific were subjects prescribed for college entrance with some leeway for electives. Entrance to college could be obtained under the widespread system of accreditation or in the case of private colleges by taking the examinations of the college entrance examination board established in 1899. Outside these requirements for pupils headed for college, the greatest flexibility prevailed and the number of "offerings" in the high schools increased until a high school certificate meant only that its possessor had spent a certain number of years in the institution or had accumulated 14 to 16 units of miscellaneous subjects.

U.S. Appraisal.—The increasing enrollment in U.S. high schools, attended by about 70% youth between 14 and 18, brought with them a large number of problems, particularly with reference to the content of secondary education. There was at no time any suggestions that a return should be made to selective practices or to separate schools. Criticisms began to be made of the quality of high school achievement. It was stated (*e.g.,* Harvard report *General Education in a Free Society,* 1945) that "the tendency is always to strike a somewhat colourless mean." The Educational Policies commission of the National Education association, on the other hand, based its report *Education for All American Youth* (1944) on the theory that many pupils were not getting an education suited to their abilities, interests and needs and stressed common learnings and vocational preparation for all. At the same time, another group found that of the pupils enrolled in high schools 20% could profit from an academic course, 20% from a technical course and 60% needed quite a different type of education which came to be known as "life-adjustment training" (see *Vitalizing Secondary Education,* U.S. Office of Education Bulletin, no. 3, 1951).

The quality of education became a matter of public concern during and after World War II. Selective service boards had to reject many draftees for illiteracy and physical defects and the armed forces had the task of training many others to the level of functional literacy. The deficiencies of secondary and higher education were revealed when an adequate number of personnel could not be found to fill positions that required a mastery of mathematics, science and foreign languages. Little attention was paid to these revelations until the successful launching of the first sputnik by the U.S.S.R. in 1957 caused a panic throughout the U.S. because of the apparent superiority of the U.S.S.R. in science and technology. Studies were made of the Soviet educational system and groups of educators went to Russia. The general conclusion was that the Soviet system would not be suitable for U.S. education, which would have to be improved internally. Efforts were made in different parts of the country to insist on higher standards of achievement, to require more homework and to set up higher requirements for high school graduation. One aspect that was neglected was the need of teachers with better mastery of special subjects. With the aid of funds from foundations and government agencies, experiments were initiated to improve the courses in mathematics and physics and to provide additional training in summer schools for teachers of these subjects. The emphasis on more science and mathematics was widespread, while inadequate attention was paid to the humanities and social sciences, necessary for a balanced educational program.

Attention was focused on the issue of quality, standards and curriculum by the publication in 1959 of *The American High School Today* by James B. Conant and *Education and Freedom* by Adm. *H.* Rickover. Conant recommended that all pupils in the comprehensive high schools, irrespective of their special programs, for graduation should be required to study four years of English, three or four years of social studies and at least one year of mathematics and science. For pupils able to profit from an academic course, estimated at 15% to 20% he advocated four years of foreign languages, four of English, four of mathematics, three of science and three of social studies. Since the small high school is normally unable to provide such a full course, he suggested the establishment of a number of central high schools. Rickover's thesis was that "only massive upgrading of the scholastic standards of our schools will guarantee the future prosperity and freedom of the republic." He urged a program similar to that recommended by Conant and the establishment of special high schools to demonstrate the new program.

It has been generally recognized that the changes taking place after the end of World War II demand better trained manpower and leaders in every aspect of national life — political, social, cultural, economic and scientific and technological — and that a general or basic liberal education should be available for all adolescents. The danger that threatened was a certain imbalance arising from the emphasis on science and technology. The most serious difficulty in implementing the desired reconstruction of secondary education lay in the inadequate supply of well-qualified teachers, caused in part by better paying jobs in other occupations. This situation stimulated plans for the wider use of education by television and electronic devices.

Secondary Education in the **U.S.S.R.**—The educational systems in the Union of Soviet Socialist Republics are organized on the principle of the common or unitary plan with four years of primary school (entered at the age of 7) and three years of junior and three years of senior secondary schools. The incomplete systems consist of seven years, the complete of ten years of schooling, but the rural areas generally have only the four-year primary schools. Secondary education is free and generally coeducational. The curriculum was academic and included: Russian or native language and literature, foreign languages, mathematics, sciences, history, geography, constitution of the U.S.S.R., drawing, singing and physical training, with many hours of homework and stiff examinations, especially at the end of the course. In 1958 the system became subject to criticisms of which Premier Nikita Khrushchev was a leading spokesman. He attacked the emphasis on academic education as unrelated to life and production needs of the country, and particularly because it developed in the pupils a contempt for physical labour. Students who could not gain admission to the universities were unprepared to enter industrial or agricultural occupations. He recommended the academic course for pupils of recognized superior ability, especially in mathematics and science, music or fine arts. The majority should, after seven or eight years of schooling. continue their education in factory vocational schools or work during the day and attend evening schools. Education, following the principle stated by Lenin, should be linked to socially useful labour and production. An academic secondary education predisposed too many pupils for white collar jobs, whereas the national economy demanded educated workers.

Reorganization. — England. — The demand for educational reconstruction to provide greater equality of opportunity, raised during World War I, was continued in most of the western European countries and began to be met after World War II. (The postwar changes in the German Federal Republic are given under EDUCATION, HISTORY OF.) The groundwork was laid in England by the White Paper, Educational Reconstruction, issued in 1943 by the board of education; and in France by the report of the Langevin commission (La Rkforme de *l'Enseignement*, 1946). The recommendations of the White Paper and the report of the Spens committee, Secondary Education (1938), were incorporated in the Education act, 1944. Local education authorities were required to provide secondary education for boys and girls above the age of 11, suited to "their different ages, abilities and aptitudes." Three types of schools were proposed — grammar, technical and modern, and combinations of these in multilateral schools. Grammar schools give the traditional academic education; modern schools give a combination of general and practical education, which may include a foreign language; technical secondary schools, still few in number, combine general and technical subjects. Fees have been abolished in publicly maintained schools. Academic or grammar school courses are also provided in direct-grant schools, which receive grants from the government on condition that free places are provided for pupils coming from primary schools, and in independent or private schools, including the public schools. In 1952, the examination system was changed and the general certificate examination was introduced to be taken at about 16 to encourage pupils to stay in school to that age; papers may be taken at ordinary, advanced or scholarship standards. Since the subjects to be taken are not prescribed, modern school pupils began to sit for the examination.

The two chief problems of secondary education in the early 1960s in England centred on (1) the examination by which pupils were allocated to one of the three schools, sometimes referred to as educational types, and (2) on the separation of pupils into different schools. It was argued that 11 plus could be too early an age to discover the abilities and aptitudes of pupils and that the separation of pupils into different schools was socially divisive. The ministry of education permitted the establishment of comprehensive high schools — about 45, most of them in London and Coventry. The Labour party was strongly in favour of the comprehensive schools (see Learning to Live: Labor's Policy for Education, n.d.). The conservative policy was to improve the buildings and equipment of all public secondary schools, to reduce the size of classes and to retain the grammar schools for the ablest children (see Ministry of Education, Secondary Education for All, *A* New Drive, 1958).

France. — The system of education in France is being gradually reorganized by decrees; there had been no legislative enactment for reconstruction. The age of compulsory attendance was raised to 14 in 1936. The majority of pupils continue in elementary schools for eight years, of which the last two are practically oriented. At age 12 pupils may take an entrance examination to some form of secondary education: *cours complementaires,* attached to the primary school and offering a modern or prevocational course; *collèges* modernes (formerly *écoles* primaires *supérieures*), which provide a general and practical course; *collèges* techniques with academic and technical subjects leading after six years to a new *baccalauréat technique* and to more advanced technical education; and the traditional *lycées* or *collèges,* the former state and the latter municipal institutions. Courses of the *lycées* and *collèges* have been increased, particularly in the second cycle (fifth and sixth years), and provide for a number of different combinations of academic subjects; the first part of the *baccalauréat* is taken at the end of the second cycle. 'The seventh or last year is devoted to specialization in philosophy–letters. experimental sciences or philosophy–sciences, mathematics or technical and economic sciences. At the end of this year the second part of the *baccalauréat* is taken. Students are no longer admitted to universities on the *baccalauréat* alone but must spend a preliminary propedeutic or preparatory year in a university and pass another examination before being finally admitted.

Transition. — Secondary education is everywhere passing through a transition stage as a result of 20th-century changes in culture and civilization. The problems that emerge involve a reconsideration of the concept of a liberal education, development of a better understanding of contemporary issues, national and international and training for adaptability to social and economic changes In the 19th century the industrial revolution hastened the movement for universal elementary education to produce, among other ends, literate workers. The 20th-century industrial revolution. based on scientific and technological advances, demands more education and is producing occupational redistribution, with prospects of further changes from automation. Redistribution of wealth and the shift of social classes have made the prolongation of education possible. Intensification of nationalism and the consequent economic competition have stressed the importance of well-trained manpower, so that education is being prolonged both in democratic and in communist states. The keynote everywhere is equality of educational opportunity. which brings the problems of allocation according to abilities and aptitudes and of determining the nature of general education for all and the time to begin specialization. *See* ELEMENTARY EDUCATION; COLLEGE; UNIVERSITIES; WOMEN. EDUCATION OF; ADULT EDUCATION; see also references under "Secondary Education" in the Index volume.

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World Survey of Education (1955) and *Current School Enrolment Statistics* (1958). (I. L. K.)

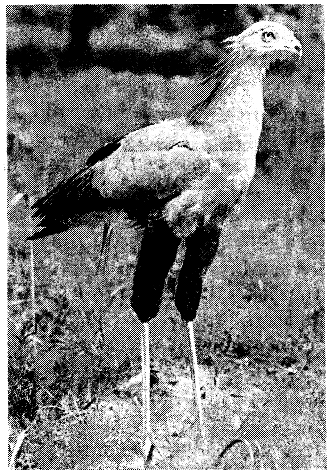
SECONDARY ERA: see MESOZOIC ERA.

SECOND BAKU (VTOROYE BAKU) is the popular name for a group of very rich oil fields of the U.S.S.R., lying between the middle Volga and the Urals. These fields have surpassed the old Baku (*q.v.*) oil field as the major source of petroleum in the Soviet Union. The Second Baku lies in the Tatar and Bashkir autonomous republics and the Kuibyshev, Orenburg and Perm oblasts. The presence of oil there has been known since the 18th century, but only during the first five-year plans were sufficiently deep bores put down. The first well was at Verkhne-Chusovskiye Gorodki near Perm in 1929, followed by Ishimbai (1932) and Syzran (1935). Since then, production has risen very rapidly from about 6,000 tons in 1929 to about 75,000,000 in 1958.

The Second Baku comprises five major groups of oil fields: (1) the Perm area, with Krasnokamsk as the largest centre; (2) on the Volga near Kuibyshev with Syzran as its centre; (3) the Tuimazy area, with its new oil town of Oktyabrski (since 1955 a new and rich field has been developed close by at Shkapovo); (4) Buguruslan in Orenburg *oblast*; (5) the Belaya valley around Ishimbai and Sterlitamak. Oil occurs in rocks of Silurian to Permian age, and in general at considerable depth. At Tuimazy, wells reach 9,600 ft. Natural gas is also found in quantity in the Second Baku, especially in the Buguruslan area. Refining is carried on at a number of centres in each field, notably at Krasnokamsk, Ufa, Sterlitamak and Syzran. (R. A. F.)

SECOND (SOCIALIST) INTERNATIONAL: see INTERNATIONAL, THE.

SECRETARY BIRD (Sagittarius *serpentarius*), an African bird with long legs, standing nearly four feet high. From the back of the head and nape hangs an erectile tuft of long black feathers which reminded early naturalists of a secretary with quill pens in his hair. Around the eyes is orange skin; the head, neck and back are bluish-gray, the lower surface black; tail quills are banded with black and tipped with white; the beak is hooked. There is a second species, also African. The secretary bird feeds on insects and reptiles and can kill the most venomous snakes, striking them repeatedly with its taloned feet. The long legs together with the bird's habit of leaping back after each stroke, preserve it from being bitten. In South Africa it is sometimes tamed and kept around ranches to aid in rodent and snake control. The huge nest is placed in a bush or tree and in it are laid two white eggs, spotted with rust colour. One of the most powerful birds of prey (Falconiformes), it is found locally over most of Africa, south of the Sahara.



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SECRETARY BIRD (SAGITTARIUS SERPENTARIUS)

SECRETARY OF STATE. In the United States the secretary of state is the member of the cabinet who advises the president in the conduct of foreign affairs. In the U.S. system of government the president is solely responsible for the control of foreign relations, but he normally relies upon the secretary of state to initiate and develop policies and to defend them before the senate foreign relations committee and the house committee on foreign affairs. The importance of the role played by the secretary of state is largely determined by the interest in foreign policy or lack of it on the part of the president.

Upon organization of the federal government in 1789, the secretary of state was designated as the "secretary to the department of foreign affairs." However, when in the same year the secretary was legally required to receive from the president the bills, orders and resolutions of congress and have them printed, and was made custodian of the great seal of the United States and given authority to affix it to the commissions of all officers to be appointed by the president, his title was changed to secretary of state; and the department of foreign affairs became the department of state. Other domestic functions were subsequently added to the department, such as issuing letters of patent, carrying out copyright laws, superintending the mint, taking the census and serving as depository for all books published in the United States.

With the gradual establishment of other departments, the state department was relieved of most of these domestic duties, retaining only correspondence with governors of states and territories and with federal officials. As the work of the department increased, particularly after World Wars I and II, the secretary of state was aided by an undersecretary; three deputy undersecretaries; nine assistant secretaries; five geographical bureaus covering all parts of the world; officers charged with administration, legal matters, public affairs, security, research and intelligence; and the foreign service. By the mid-20th century, the secretary of state administered a department with some 5,900 officials in Washington and a foreign service of over 15,000.

In addition to policy making and administration, the secretary of state, as the ranking member of the cabinet, must give consideration to every phase of governmental policy which comes before the president and his advisers. Under the National Security act of 1947 he also serves as a member of the national security council (*q.v.*), which makes recommendations to the president on matters concerning national security.

See Samuel F. Bemis (ed.), *American Secretaries of State and Their Diplomacy*, 10 vol. (1927–29); Graham H. Stuart, *The Department of State* (1949). (G. H. S.)

Great **Britain.**—In the United Kingdom, the term secretary of state applies to each one of seven important members of the ministry: namely, the secretaries of state for foreign affairs! home affairs, commonwealth relations, colonies, war, air and Scotland. These are the only authorized channels through which the royal pleasure is signified to any part of the body politic, and the countersignature of one of them is necessary to give validity to the royal signature (sign manual). The secretaries of state constitute but one office and are co-ordinate in rank and equal in authority. Each in theory is competent to execute any duties of a secretary of state, but in practice the division of duties is carefully prescribed. For example, her majesty's secretary of state for foreign affairs, popularly known as the foreign secretary, as a member of the cabinet is responsible for the initiation of foreign policy which will receive the support of his colleagues. He must defend and explain the government's foreign policy to the house of commons, answering such questions as are put to him. He is administrative head of the foreign office (often referred to by its address, no. 10 Downing street), and he must accept responsibility for all administrative acts which have been carried out by this body. See also GOVERNMENT DEPARTMENTS ; FOREIGN SERVICE.

SECRET LANGUAGES. Quite the reverse of a jargon, pidgin (*q.v.*) or creole (*q.v.*) language, each of which serves to broaden communication between groups, a secret language is used by a special group to preserve its identity and to exclude outsiders. Thus the term refers rather to the social function of a speech form than to any property of its structure. The field as a whole is poorly studied, but there are many isolated cases on record. Occasionally, as with Romany (Gypsy) languages and with the Todas in India, a quite distinct language serves the function of secrecy. An imperfectly remembered language, preserved under unusual conditions, may serve ritualistic purposes, as with the west African Lucumi in Cuba.

Most so-called secret languages are grammatically the same as the language of the surrounding community. but consist in systematic substitutions for individual words. In this case it is difficult to distinguish clearly between secret languages in a strict sense and argot, slang (*q.v.*), which uses ephemeral substitutions, and caste: class and technical occupational dialects. Such lexical substitution is recorded among the Sema Nagas and the Langos and among outlaws, thieves, organized criminals, itinerant peddlers and entertainers and religious groups in many parts of the world. Similar substitutions are used informally by lovers and children. Systematic insertion or substitution of sounds in the normal language of the community is familiar to us as "pig Latin"; analogous practices occur in other western cultures and are elaborately used by Tagalog adolescents in the Philippines.

The principal criterion for application of the term secret language seems to be a concerted effort on the part of the users to exclude others and prevent their acquiring it. By contrast. tabu words are known to a large part of the community, but are by convention not spoken.

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SECRET SERVICE, U.S. A division of the treasury department, the United States secret service is charged by law with the following duties:

1. Protection of the person of the president of the United States and members of his immediate family, the president-elect, and the vice-president at his request.

2. Detection and arrest of any person committing any offense against the lans of the United States relating to coins, obligations and securities of the United States and of foreign governments.

3. Detection and arrest of any person violating certain laws relating to the Federal Deposit Insurance corporation, federal land banks, joint-stock land banks, and national farm loan associations.

4. Detection and arrest of any person violating any laws of the United States directly concerning official matters administered by and under the direct control of the treasury department.

Prior to 1860, con ress had passed several laws with respect to counterfeiting, but had not provided any funds to enforce those laws. Because the paper currency in circulation was privately printed by individual banks in about 3,000 different designs, there was no standard federal paper money. In 1860 an appropriation of $5,000 was made for the suppression of coin counterfeiting, to be paid as rewards to persons who furnished information regarding activities of counterfeiters.

The act of Feb. 25, 1862, authorized the issue of $150,000,000 of "United States notes," not bearing interest and payable to the bearer. They mere legal tender for all debts except duties on imports and interest on the public debt and were popularly referred to as greenbacks.

The act of June 3, 1864, known as the National Bank act, superseding an original act of Feb. 25, 1863, is the basic act for the national banking system, and provided for the organization of national banks and the issuance of circulating notes. These notes were drawn on the various national banks, but were issued under government supervision on the strength of collateral furnished by the banks in the form of United States interest-bearing registered bonds.

National bank notes were issued until Aug. 1, 1935, when the retirement of all such notes began. Many national bank notes, however, continued in circulation.

With the adoption of the federal currency in the form of United States notes and national bank notes, the private bank notes became obsolete and the government necessarily acted to protect the nen money against counterfeiting. In 1864, the sum of $100,000 was made available for the suppression of counterfeit currency and other forms of obligations of the United States.

During the period 1860 to 1865, the money appropriated to suppress counterfeiting had been paid to individuals who furnished information or rendered service which led to the arrest and conviction of counterfeiters. The solicitor of the treasury had supervised the operations of these persons and had approved payments made to them. However, the new federal currency was counterfeited to such an extent that it became necessary to make a definite and centralized effort to suppress these violations and to restore and maintain public confidence in the new money.

Accordingly, in July 1865, Hugh McCulloch. then secretary of the treasury, created the United States secret service and appointed William P. Wood as its first chief.

Although the secret service mas organized in 1865 primarily to suppress counterfeiting, other departments of the federal government soon requested the use of secret service agents to investigate violations of many other laws, and since there was then no other general federal law-enforcement agency it became common practice for the treasury department to loan secret service agents to other government departments for doing important investigative work.

In 1898, during the Spanish-American War, a ring of Spanish spies with its headquarters in Canada directed espionage activities against the United States. Secret service agents organized a counterespionage organization and located the centre of operations of the enemy spies in Montreal, Can. Agents there exposed Lieut. Ramon Carranza, naval attaché of the Spanish legation, as the brains of the spy system. and as a result he was banished from Canadian soil by the dominion government. Agents also arrested other spies in the United States and smashed the espionage organization.

In 1901, Pres. William McKinley was shot and killed at Buffalo. N.Y.. the third president of the United States to meet death at the hands of an assassin. Immediately thereafter, agents of the secret service were assigned to guard Pres. Theodore Roosevelt, and in an appropriation act dated June 30. 1906, congress provided funds for the protection of the person of the president of the United States by the secret service. On June 23, 1913, this protection was extended to the person of the president-elect, and on June 12. 1917, included the members of the immediate family of the president. Authority to protect the vice-president at his request was given the secret service July 16, 1951 (public law 79, 82nd congress).

Agents went to Panamá with Pres. Theodore Roosevelt, the first president to set foot on foreign soil while in office. Agents guarded Pres. Woodrow Wilson during his European visit; they went to Alaska with Pres. Warren G. Harding, and they accompanied Pres. Franklin D. Roosevelt to South America, Casablanca, Mor., Yalta, U.S.S.R., and other foreign places. They safeguarded Pres. Harry S. Truman at the historic Potsdam conference and protected President-elect Dwight D. Eisenhower on his postelection journey to Korea. The secret service makes extensive advance plans for all trips of the president, and agents are near him at all hours of the day.

On May 14, 1930, the White House police force, organized in 1922 to protect the executive mansion and grounds, mas placed under the supervision and control of the chief of the United States secret service.

During visits of rulers of other countries and of foreign missions to the Gnited States. the secret service has been assigned to safeguard many such visitors. frequently in co-operation with special agents of the state department.

During the Civil War, one of the most extensive legal lotteries in the world was organized and held the first drawing of prizes in New Orleans. La. From 1862 to 1895 the Louisiana lottery received in cash about $300,000,000, of which a very small portion was paid out in prizes. The drawing of winning numbers taken from tickets which had never been sold, the manipulation of winning numbers drawn by operators of the lottery and other crooked practices diverted most of the proceeds of the enterprise to the pockets of the lottery owners, many of whom became multimillionaires.

In 1886 the use of the United States mails was denied the lottery, and the charter of the Louisiana Lottery company expired in 1892.

The state of Louisiana then refused to renew the charter, and the drawings were transferred to Puerto Cortez, Hond.; but elaborate offices were maintained in several cities in the United States, a printing plant was built in Tampa. Fla.. and a lottery-owned steamship, "The Breakwater," plied regularly between Tampa. Puerto Cortez and New Orleans, carrying the results of the drawings.

In 1895 congress enacted a lam prohibiting the sending of lottery matter by mail or express. and the lottery owners therefore distributed their tickets in the United States by trusted messengers who carried the tickets in steamer trunks, declaring them as personal baggage.

In 1902, agents of the secret service were assigned to the department of justice to suppress the lottery activities. and from 1902 to 1908 they made numerous arrests and seizures which finally put an end to this enterprise.

By 1905, at the request of the attorney general of the United States, 32 secret service agents were lent to the department of justice to investigate extensive frauds perpetrated upon the government, including those resulting from passage of the Homestead act of 1862, which threw lands open to settlement. Through dummy entrymen, many of the cattle barons in the west obtained rich grazing lands intended for homesteaders, and other unscrupulous landowners obtained lands rich in coal, oil and timber, fraudulently claiming them for agricultural purposes.

In one such investigation near Durango, Colo., on Nov. 3, 1907, secret service agent Joseph A. Walker was shot and killed while investigating the suspected theft of coal from government-onned land. The secret service agents exposed countless land frauds and recovered millions of acres for the government. However, following this exposé, congress, in 190.7, restricted the work of the secret service to its normal treasury department duties and prohibited the loaning of its agents to other government units. Nevertheless, several secret service agents were permanently transferred to the department of justice and other government departments to form the nuclei around which separate investigative units were established.

On May 14, 191j, lifting previous restrictions, Pres. Woodrow Wilson directed the secretary of the treasury, William Gibbs McAdoo. to use the United States secret service to uncover violations of neutrality.

On July 24, 1915, in New York city, secret service agents shadowed George Sylvester Viereck and Heinrich F. Albert, both of whom were active in the German propaganda system in the U.S.

At the 50th-st. station of the Sixth-ave. elevated line Albert proceeded to leave the train and momentarily forgot a brief case he had carried. In the moment the case remained unattended, Frank Burke, the secret service agent watching Albert, seized the bag and left the train. The brief case was delivered to Secretary McAdoo, and an examination of its contents disclosed that Germany was deliberately violating the neutrality of the United States.

The papers showed that German agents had formed elaborate schemes to influence public opinion by buying newspapers and establishing news services, and that a periodical called *The Fatherland,* edited by George Sylvester Viereck, was on the German pay roll for $1,500 a month. There were plans to organize strikes in munitions plants; to corner the supply of liquid chlorine. used for poison gas; to acquire the Wright Aeroplane company and its patents and use them in German interests; to cut off the supply of cotton from England and make it appear that the movement had originated spontaneously among the cotton growers in the south.

The correspondence also showed that Germany, through its secret agents, had actually purchased a large munitions plant at Bridgeport, Conn., the ownership of which was concealed under an assumed name. Orders for shells were taken from the governments of Great Britain and Russia without any intention of ever making deliveries.

The Albert papers were published in the *New York World* by permission of Secretary McAdoo. but the facts surrounding the seizure of the brief case were not made public until 1931, when the true story was told by McAdoo in his autobiography *Crowded* Years.

Numerous other cases involving espionage and counterespionage were successfully completed by the secret service during World War I, and its agents worked in close co-operation with the intelligence services of the United States army and the United States navy.

In 1915 Pres. Woodrow Wilson designated an area in Wyoming, known as Teapot Dome, as a naval oil reserve, embracing about 9,481 ac. of oil land. On April 14, 1922, Sen. John B. Kendrick of Wyoming received a telegram from the Rocky Mountain Oil and Gas Producers association of Casper, Wyo., protesting against the development of Naval Oil Reserve No. 3 and the alleged letting of a private contact to Harry F. Sinclair or other persons without opportunity for competitive bidding.

On April 15, 1922, Senator Kendrick offered a resolution, forthwith passed, requesting that the secretary of the interior and the secretary of the navy be asked to inform the senate whether such negotiations were pending. The assistant secretary of the interior on April 21, 1922, informed the senate that a lease of the entire Teapot Dome reserve had been executed on April 7, 1922, to the Mammoth Oil company.

Irregularities affecting other government oil reserves were also brought to light, and in a joint resolution approved Feb. 8, 1924, congress directed the president of the United States to institute and prosecute suits to cancel leases of oil and incidental contracts and for other purposes, and to appoint special counsel who should have charge and control of the prosecution of such litigation.

Atlee Pomerene, former senator from Ohio, and Owen J. Roberts, an attorney who in 1930 became an associate justice of the supreme court of the United States, were appointed as special counsel by Pres. Calvin Coolidge.

At the suggestion of President Coolidge the special counsel enlisted the co-operation of the United States secret service in the Teapot Dome matter. Secret service agents were assigned to investigation of the oil scandals and worked for about three years before their association with that investigation became generally known.

The intensive efforts of the government resulted in the conviction in 1929 of Albert B. Fall, former secretary of the interior, and Harry F. Sinclair of the Sinclair Oil company, and in the collection by the government of several million dollars in taxes, penalties and interest.

By 1933, losses suffered by victims of passers of counterfeit notes mushroomed into serious proportions. During the four years from 1933 through 1936 such losses averaged about $771,000 per year.

In 1937 it was decided to supplement necessary criminal investigations and prosecutions by preventive methods, and the secret service set out to teach U.S. citizens to know the difference between genuine and counterfeit money, dispelling the ignorance upon which the counterfeiter depended to dispose of his worthless product. For the first time, enlarged pictures of genuine and counterfeit money were published in 1940 in a secret service booklet entitled *Know Your Money.*

For administrative purposes the United States is divided into four regions, each under the direction of an inspector who reports directly to Washington, D.C. Each of the field offices in the four regions is supervised by a special agent in charge who also reports directly to Washington, D.C.

The treasury guard force protects the main treasury building and the treasury annex in Washington, D.C., and each year safeguards many thousands of millions of dollars' worth of money and securities. The guard force operates one of the largest and most efficient burglar alarm systems in the world to protect the treasury vaults.

The badge used by the secret service is a five-pointed silver star in the centre of which appears the monogram "US" encompassed by a small circle from the outer circumference of which radiates an embossed lathework design similar in pattern to the netlike lines observed in the borders of genuine United States paper money.

Surrounding these radiations is another circular pattern which touches the bases of the triangles forming the five points of the star. Within this large circle the word "SECRET" appears in relief above the monogram "US" and the word "SERVICE'! below the monogram. Each point of the star is ornamented by a design similar to the fleur-de-lis, and each point has a rounded tip. Each of the badges is numbered and assigned to its holder accordingly.

In addition to the badge, each agent and special agent in charge carries a commission bearing his photograph. printed name and signature, and the signature of the chief of the secret service. The commission is mounted in a fabricated case on the outer cover of which is an embossed gold reproduction of the secret service badge.

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SECRET SOCIETIES. This term has been loosely used for a medley of associations which have little in common beyond an element of secrecy, which may vary from a mere password to an elaborate ritual of initiation with a private language, peculiar ceremonials and symbols and every circumstance calculated to lend an air of mystery. It may be applied to the Masonic Order or the Ku Klux Klan as well as to similar phenomena in primitive cultures.

From this angle Maciver's definition of an Association as "an organization of social beings . . . for the pursuit of some common interest or interests" applies equally to secret societies with the proviso that it must be re-enforced by secrecy either for the maintenance of the internal solidarity of the society or for its more effectual domination over non-members. Secrecy alone however does not necessarily imply a secret society, and other criteria have to be taken into consideration. Thus many systems of age grades contain rites or doctrines, knowledge of which is prohibited to such members of the tribe as have not yet been affiliated; but age grades cannot properly be termed secret societies. What differentiates age grades from secret societies is the fact that initiation into the former is compulsory to every member of the tribe, but entrance into a secret society is optional. Moreover in all secret societies entrance or promotion from rank to rank is purchasable, whereas in age grades promotion is inevitable and automatic. The Crow Indians combine the two systems by compulsory purchase, the compulsory element of age grades having been added to the idea of purchase inherent in secret societies.

Theories. — The wide correlation of masks with secret societies (and it would appear that even stilts are possibly also involved) suggested to Frobenius that primarily these societies by feigning the death and resurrection of the candidate were the means of bringing the members into closer contact with the spirits of their dead and deified ancestors. To Van Gennep they symbolize a process of rebirth or separation from the world outside and a passage from immaturity to full tribal membership. Webster traces secret societies to initiation ceremonies, and it seems probable that ultimately all such societies are the outgrowths of puberty rites, and what again differentiates secret societies from age grades is the fact that the former have developed away from these rites while the latter retain them as an essential element in the system. For secret societies are always changing, however imperceptibly, as in the change which has transformed the Hu'man Leopard Society from a Mendi war medicine to a definitely cannibalistic institution. Thus, societies which are secret in one area are elsewhere public associations though their functions appear to be identical.

Secret societies, like all other associations, cut across the social units of the family and the clan, though instances do occur which suggest a connection with a totemic clan system. Among the Pueblo Indians the totemic clans on uniting into the tribe still continued to exist as esoteric fraternities, and in certain parts of Melanesia where totemism flourishes fraternities are unknown, but are found where totemism does not exist. This may be due however to other factors. In Africa there is evidently a correlation between secret societies and the political structure of the tribe, and with the evolution of authority from local councils to a tribal autocracy there is a parallel development of secret societies, which though often extra-legal serve to uphold the law and at the same time to act as checks on what would otherwise be complete despotism. The secret societies, or at any rate the higher degrees of the societies, become the ruling aristocracy, and in certain cases, such as the Tenda in French Guinea, it is the secret societies which are the sole means of government.

From the point of view of function secret societies among primitive peoples may be roughly classified as magical, religious and social, and the last must again be subdivided into mutual help societies, like the Nkimba of the lower Congo, certain occupational groups, such as doctors and blacksmiths, feasting clubs, sexual societies, like the Kore of the Mandingo, and governmental or police organizations, the last of which not infrequently degenerate into a system of extortion and tyranny. The Ogboni society of the Yoruba is probably the most conspicuous of these political societies, with the Oro society as their subordinate police. However for all these social functions a religious sanction must be predicated.

Despite contrary examples, such as the Imandwa, a secret society of the Banyaruanda, which is religious rather than social, the secret societies of the North American Indians have in the main religious functions, as contrasted with those of Melanesia and Africa which are primarily social and governmental.

The term secret society obviously implies that there are members of a community outside the society. In the majority of societies membership is generally limited on sex lines, but sometimes as among the Tenda along lines of social status. Some societies like the Poro admit women in exceptional circumstances, others like the Yewe admit them only to certain degrees, and others again like the Ndembo of the Lower Congo are completely bisexual. But the great majority refuse admission to women, with the result that parallel women's societies are instituted, the functions of which are mainly magico-religious and are concerned with fertility and cultivation.

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CHINESE

Most of the Chinese secret societies are merely trade guilds or friendly societies, but the Hung or Triad Society comes in an entirely different category. It has the largest membership of any secret society in the world, and has existed since A.D. 386, in close association with the White Lotus. Contemporary with the ancient mysteries, it is itself a great mystery rite over 1,500 years old.

In A.D. 386 it was founded, or perhaps re-organized, by the Buddhist patriarch Eon or Hwui-Yin at Rozan, to spread the cult of Amitabha Buddha. In A.D. 630 Zendo joined it to gain instruction, and in 1344 it rebelled against the Mongolian or Yüen dynasty. In 1662 it fell under the ban of Khang Hsi, who in his *Sacred* Edict instituted a persecution of the Buddhists and Taoists, and ordered the suppression of five religious societies, among which the White Lotus and the Hung were specifically named. The exact relation between these societies is still obscure, but, if they were not alternative titles for the same organization, they were probably the names of different degrees of one common rite. It is just possible, however, that they were similar, but separate, mystical societies.

Partly as a result of this persecution, the Hung Society became political and anti-dynastic, and has raised numerous insurrections against the Manchus, one of the most famous being the Taiping revolt in 1851. The rituals were peculiarly suitable for conversion from religious to political aims, since the slogan of the brotherhood is "Overthrow Ching and restore Sling."

Ming means light, and especially the perfected spirit in man; while Ching means the vital force, or, as we shculd say, the soul immersed in matter. By slightly changing the way in which the character for Ching is written, it becomes the name of the Manchu dynasty, while the last Chinese dynasty was the Ming. Hence it will be seen that the change from a Buddhist-Taoist mystical initiatory rite to a dangerous political society was easy.

The rituals show a blending of Taoist-Buddhist ideas having curious analogies with the Egyptian Book of *the* Dead, and with certain "Higher Degrees" in western speculative Freemasonry. The ceremony symbolizes the journey of the soul through the Underworld and Paradise to the Holy City of the Gods, here called the City of Willows, and interwoven with this is an allegory of the experiences of the mystic in his quest for union with the Supreme Being. As regards its analogies with Masonry, practically every important incident is found in certain "Higher Degrees" in England and America, while most of the hand signs are known to many Freemasons.

The ceremony falls into four sections. First comes the traditional history, which is given to the candidates in the anteroom before they enter the lodge. It is a moving story, wherein a body of monks who had helped the emperor are requited by him with the foulest treachery, all being murdered, save five who became the founders of the order. There are three villains, and for political purposes one is a Manchu emperor, either Khang Hsi, or, in some versions, his son, but originally the story was allegorical.

After this the candidates are "prepared" in the anteroom. The most notable incidents are (a) ceremonial washing and changing into white robes to symbolize not only mourning but that they themselves are dead; (b) the right arm, shoulder and breast, and also the left knee, are made bare; (c) the substitution of grass slippers for ordinary boots. Meanwhile the master opens and consecrates the lodge and invests his officers.

The third section deals with the actual admission of the candidates, who have to pass through three gates inside the lodge and take the oath of blood brotherhood by mingling their blood with that of all members present in a cup of wine, from which each person present drinks. (Women as well as men are eligible.)

The last section consists of a catechism; the master asks a series of questions, which the conductor answers for the candidates. From these we learn that they have been on a long and mysterious journey, first by land and then by boat, till they reached the City of Willows. Throughout the whole of this part of the ceremony great stress is laid on numbers. which have a definite mystical significance. The triangle also plays an important part in the ritual, hence the name "Triad" Society. The brotherhood has many aliases, the most famous being "The Society of Heaven and Earth." The significance of the ceremony is revealed by the opening questions:

Master: Whence come you?
Vanguard: From the East.
Master: At what time?
Vanguard. At sunrise, uhen the East was light.

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SECULAR, a word with two main branches of meaning: (1) lasting or occurring for a long, indefinite period of time, and (2) nonspiritual, having no concern with religious or spiritual matters. The first sense, which is directly taken from the classical Latin. is chiefly found in scientific applications. of processes or phenomena which are continued through the ages and are not regularly recurrent or periodical. The word is thus used widely of that which is lasting or permanent. In medieval and late Latin, *saecularis* was particularly used of that which belongs to this world, hence nonspiritual or lay.

SECULAR GAMES were celebrated at Rome to mark the commencement of a new saeculum, or generation. It is important to note that there was a *saeculum* civile, the length of which was definitely fixed at 100 years, and a *saeculum naturale*, which. under Greek and Etruscan influence, came to be accepted by the quindecimviri as 110 years. According to tradition the secular games (*Lzcdi Saeculares,* originally Terentini) had their origin in certain sacrificial rites of the gens Valeria, which were performed at the Terentum, a volcanic cleft in the Campus Martius. According to the Roman antiquarians themselves, they were derived from the Etruscans, who. at the end of a mean period of 100 years (as representing the longest human life in a generation). presented to the underworld deities an expiatory offering on behalf of the coming generation. The first definitely attested celebration of the games took place in 249 B.C., on which occasion a vow was made that they should be repeated every 100th year (their name being also changed to Saeculares), a regulation that seems to have been immediately disregarded, for they mere next held in 146 (not 149, although the authorities are not unanimous); in 49 the civil wars prevented any celebration. They would probably have fallen entirely into oblivion had not Augustus revived them in 17 B.C. In explanation of the selection of this year, it is supposed that the quindecimviri invented celebrations for the years 456, 346, 236, 126. the saeculum being taken as lasting 110 years.

In later times various modes of reckoning were adopted. The dates were: A.D. 47 (under Claudius), celebrating the 800th year of the foundation of the city; 88 (under Domitian), an interval of only 10j instead of 110 years; 147 (under Antoninus Pius), the 900th year of the city; 204 (under Septimius Severus), exactly two saecula (220 years) after the Augustan celebration; 248 (under Philip the Arab), the 1,000th year of the city; 262 (under Gallienus), probably a special ceremony in time of calamity. In 304 (which should have been 314) Maximian intended to hold a celebration but does not appear to have done so. From this time nothing more is heard of the secular games until they were revived in the year 1300 as the papal jubilees instituted by Boniface VIII.

At the beginning of the harvest, heralds went around and summoned the people to the festival. The quindecimviri distributed to all free citizens on the Capitol and in the temple of Apollo on the Palatine various means of expiation—torches, sulfur and bitumen. There, and in the temple of Diana on the Aventine, wheat, barley and beans were distributed, to serve as an offering of first fruits.

The festival then began, at which offerings were made to various deities for three days and nights. On the first night the emperor sacrificed three rams to the Parcae at an underground altar on the banks of the Tiber, while the people lighted torches and sang a special hymn. On the same or following nights, a black boar and a black sow were sacrificed to Tellus, and dark victims to Dis (Pluto) and Proserpine. On the first day white bulls and a white cow were offered to Jupiter and Juno on the Capitol, after which scenic games were held in honour of Apollo and Diana.

On the second day noble matrons sang supplicatory hymns to Juno on the Capitol; on the third, white oxen were sacrificed to Apollo, and 27 boys and maidens sang the "secular hymn" in the temple dedicated to him by Augustus on the Palatine.

Originally the gods of the underworld had been the objects of the ceremony. The introduction of Apollo, Diana and Leto was attributable to Augustus, for whom they had become patron deities; hence their imposing position in the rites and in the Carmen Saeculare of Horace. written for the festival of 17 B.C. and still surviving.

BIBLIOGRAPHY.—The above particulars are from Zosimus (vol. ii, pp. 5–6, which contain the Sibylline oracle), who, with Censorinus (*De Die Natali*, 17), Valerius Maximus (vol. ii, p. 4) and Horace, is the chief ancient authority. The inscription commemorating the ludi of 17 B.C., discovered in 1890, relates in fragmentary form the details of the festival and preserve; some of the expiatory prayers. It is printed in the *Ephemeris epigraphica*, vol. viii, with a full commentary by Mommsen. *See* also M. Warde-Fowler, *Roman Essays*, pp. 111–126 (1920); J. Gagé, *Recherches sur les jeux séculaires* (1934); H. Wagenvoort in *Studies in Roman Literature, Culture and Religion,* pp. 193–232 (1956); and the classical dictionaries and encyclopaedias. (T. V. B.)

SECUNDERABAD, until 1945 one of the chief British military stations in India. in the state of Andhra Pradesh, 1.830 ft. above sea level, 6 mi. N.E. of Hyderabad city and at a railway junction. The population of Secunderabad (with Bolarum) was 225,356 in 1951.

It was the headquarters of an infantry brigade. Secunderabad includes Bolarum, the headquarters of a cavalry brigade, covering an area of 17 sq.mi.

SECURITIES REGULATION. Until the close of the 17th century, most industries and businesses were financed by the same persons who managed them. The Industrial Revolution, however. with its complex techniques requiring more capital than could be contributed by few individuals, led to the formation of British and American companies for which necessary funds could be obtained only from the public. To protect investors against sharp practices used by some company promoters, legislation was enacted in both countries. These statutes, while they have not curtailed such practices completely. have considerably reduced them.

United States. — Although various statutory and constitutional provisions affecting sales of securities were enacted by the states beginning about 1850, Kansas, in 1911, adopted the first comprehensive "blue-sky lam," so-called because it was directed at speculative schemes that "had no more basis than so many feet of blue sky." By 1917 the constitutionality of such regulation had been upheld by the U.S. supreme court, and by 1933 every state except Nevada had a blue-sky law.

State regulation is classifiable into three types, with most state systems constituting a combination of all three:

1. *Antifraud statutes*.—These statutes expand the usual definition of "fraud" in ordinary commercial transactions by declaring various unfair securities sales practices actionable by private suit, criminal penalty or injunction. One important expansion of older. judicial definitions of fraud effected by these statutes is to include half-truths, promises without basis, and omissions or concealments of material facts within the definition of fraud in a securities transaction.

2. Broker-dealer registration. — Many states require registration and the filing of periodic reports by all brokers and dealers in securities, who must furnish in an applicatioh for registration evidence of the financial responsibility and good repute of the applicant. Some states require that an independent audit of the registrant be made and reported annually. Most states outlaw "bucket shop" operations, whereby a broker anticipating a price decline mould "bucket" a customer's purchase order instead of executing it and would thereby gamble on making a secret profit after purchasing at a lower price. The common requirement that specific confirmation slips be sent to all customers is aimed at "bucketing." Provisions in many states also require separate registration of each securities salesman.

3. Securities *registration*.—About 40 states have some requirement for registering each individual issuance of securities. Most states permit nonexempt securities — usually those of well-established companies traded on a national exchange or already registered under federal law — to effect registration by mere notification to the state agency. Otherwise, securities must be the subject of a detailed registration statement disclosing the history and business of the issuer; names, addresses and compensation of officers. directors and large shareholders; the underwriting and promotional arrangements; and other information from which the security may be evaluated. Certified financial statements and the principal corporate documents governing legal organization and structure must be furnished with the registration statement. Many states also regulate the character and content of any prospectus or other advertising material used to solicit sales. Among the practices at which these provisions were aimed was the transfer of property, such as mining claims, patents and other undeveloped assets, of speculative, unproved or fictitious value, for securities having a face or market value equal to the inflated value of the assets. Such securities, sometimes called watered stock because not backed by solid asset value, would then be sold to the public without adequate disclosure of the background.

While many state statutes undertake no more than a full disclosure, on the theory that the government interest is limited to protecting investors against purchasing securities which they have no opportunity to evaluate, a few states, notably California, give the securities commissioner or other agencies power to prohibit the sale of securities deemed by the commissioner to be unfair or inequitable. These states usually issue rules indicating what promotional arrangements, in the form of compensation, share options or bonuses, will be deemed so unduly favourable to the promoters and unfair to the public as to preclude sales within the state or require protective orders, such as holding promoters' shares in escrow until the company is successfully established.

Exemptions and exceptions in state statutes normally include small issues. variously defined as issues offered to less than 10 to 25 persons. or in the amount of $25.000, and for private offerings to institutional or other investors.

In 1956 a Uniform Securities act containing all three types of state securities regulation was proposed by the National Conference of Commissioners on Uniform State Laws. It is a disclosure-type proposal and includes provisions whereby state regulations may be more closely co-ordinated with federal registration procedures. At least ten states adopted statutes modeled substantially after the Uniform act in the first four years after its promulgation.

Federal securities regulation first came in the wake of the 1929–32 stock market decline. The Securities act of 1933 required that all nonexempt securities be registered with the government and that the registration statement disclose all material facts about the issuer and the issuance. A prospectus. filed as part of the registration statement, must be furnished to all purchasers prior to sale or upon delivery of the securities. A proposed registration statement prepared by the issuer is reviewed by government lawyers and accountants, who frequently suggest revisions necessary to put it in form to be effective. No sale map be made until the statement is effective. and prospectuses may not be used except in the form approved by the government.

The principal exemptions from the registration process are for government securities, securities of charitable and similar nonprofit organizations. securities sold only intrastate. private offerings. and issuances of less than $300.000, for which a short-form notification procedure is provided. The small business exemption may, honever, be withheld if there is inadequate disclosure of certain facts in the notification procedure.

Under the Securities Exchange act of 1934, which created the Securities and Exchange commission (SEC) to administer federal securities regulation, all securities exchanges must be registered with the SEC. and shares listed for trading on the exchanges must file registration statements with the exchanges and the SEC. The act contains provisions governing a variety of practices, such as short-selling, floor trading, concerted buying and selling for the purpose of artificially manipulating prices, hypothecation of customer's accounts and trading in shares of a corporation by its officers, directors and large shareholders. Brokers and dealers must register with the SEC, and supervision of their activities is carried out by the National Association of Securities Dealers, a private body which must be registered with the SEC and through which disciplinary action of its members is taken in accordance with SEC findings.

The 1934 act also gives the SEC broad rule-making powers, which it has exercised, to penalize fraud, as broadly defined in the statute and rules, in sales effected by mails or in interstate commerce, and to supervise the solicitation of proxies of securities listed on exchanges. Under its antifraud rules the SEC undertakes to curb the activities of "boiler room operators," a term applied to organizations of salesmen undertaking high-pressure securities sales tactics by telephone.

Great Britain. — The regulation of securities in Great Britain began in the 19th century with enactment in 1844 of the British Companies act requiring registration of company prospectuses. By mid-20th century it was largely governed by the Prevention of Frauds (Investment) act, 1958, and the Companies act, 1948. The Investment act permits only members of a recognized stock exchange. dealers licensed by the board of trade or exempted persons (such as banks, insurance companies and issuing houses) to deal in securities. The activities of the former two are tightly regulated by the stock exchanges and the board of trade, respectively. The act also makes it a criminal offense to induce investment by the knowing or reckless use of misleading, false or dishonest statements or the dishonest concealment of material facts. The act further prohibits the circulation of any written invitation to subscribe for, buy or sell any securities, unless it is: (1) made through a permitted dealer; (2) approved by the board of trade; (3) made by a company only to its own shareholders; or (4) accompanied by a prospectus complying with the Companies act.

The Companies act requires every written invitation to the public to subscribe for a purchase shares made by a company, or by an issuing house which markets the issue, to be made in the form of a prospectus containing matters specified in the act. Copies of this prospectus must accompany all application forms sent to prospective investors. The prospectus must reveal full details of the promotion arrangements and the company's history and business, director and promoters, capital structure, financial results for the past five years, certified by its auditors, and all important contracts entered into during the previous two years. Little, however, need be disclosed when the company makes a "rights issue" (in which existing shareholders are offered the opportunity to take up further shares), which is now the usual method used in England by an established company to raise additional equity capital.

An investor induced to subscribe for shares by misrepresentations in the prospectus may repudiate his subscription contract and claim the return of any money paid; or sue the directors for damages for deceit if he can prove fraud; or sue the promoters. directors or the issuing house for compensation for any loss. Certain criminal penalties may also be imposed.

The prospectus must be filed with the registrar of companies, but this official does not check the accuracy of its contents nor does he pass on the merits of the company or of the investment. This absence of surveillance, however, has not resulted in abuses. The realties of corporate financing require, first, that the shares be traded on one of the stock exchanges, usually the London Stock exchange, and, secondly, that they be offered to the public through an issuing house. Compliance with prospectus regulations of the stock exchanges, and the thorough investigation made by the issuing house of all aspects of the company and of the issue, together generally ensure that the public is invited to invest only in reasonably sound ventures. *See* also STOCK EXCHANGE.

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(G. T. FR.)

SECURITY, INTERNATIONAL, the common objective of states co-operating for the maintenance of their respective national security. By national security is meant security of a nation from the danger of subjugation by external power. The organization of grand alliances against aggressors! as against Louis XIV, Napoleon and Hitler, is regarded as one means of assuring the national integrity. Another is collective efforts, embodied in such organizations as the League of Nations and the United Nations, to bring about an association of nations to guarantee the security of each. *See* PEACE, INTERNATIONAL; SANCTIONS AND GUARANTEES.

SEDAINE, MICHEL JEAN (1719–1797), French dramatist, was born at Paris on July 4, 1719. His father, who was an architect, died when Sedaine was quite young, leaving no fortune, and the boy began life as a mason's labourer. He was later taken as pupil by an architect whose kindness he eventually repaid by the help he was able to give to his benefactor's grandson, the painter David. Meanwhile he had done his best to repair his deficiencies of education, and in 1750 he published a *Recueil de pikces fugitives,* which included fables, songs and pastorals.

His especial talent was, however, for light opera. He produced *Le Diable à quatre* (1756), the music being by several composers; *Blaise le Savetier* (1759), for the music of Danican Philidor; *On ne s'avise jamais de tout* (1761) and others with Pierre de Monsigny; *Aucassin et Nicollet* (1780), *Richard Coeur de Lion* (1784) and *Amphitryon* (1788) with André Grétry.

Sedaine's vaudevilles and operettas attracted the attention of Diderot, and two plays of his were accepted and performed at the *Théâtre Français.* The first and longest, the *Philosophe sans le savoir,* was acted in 1765; the second, a lively one-act piece, *La Gageure imprévue,* in 1768. These two at once took their place as stock pieces. Except these two pieces little or nothing of his has kept the stage or the shelves, but Sedaine may be regarded as the literary ancestor of Scribe and Dumas. He had the practical knowledge of the theatre, which enabled him to carry out the ideas of Diderot and gave him claims to be regarded as the real founder of the domestic drama in France. Sedaine, who became a member of the Academy (1786), died at Paris on May 17, 1797. He wrote two historical dramas, *Raymond V. comte de Toulouse,* and *Maillard, ou Paris sauvé.*

His *Oeuvres* (1826) contain a notice of his life by Ducis.

SEDALIA, a city of west-central Missouri, U.S., about midway between Kansas City and Jefferson City; the seat of Pettis county. It was established in 1860 and was chartered in 1889. It became the western terminus of the Missouri Pacific railroad until after the American Civil War and was an important railhead for the Texas cattle drive of 1866. Later the Missouri-Kansas-Texas railroad built through Sedalia and large railroad shops became its most important industry. The city is a thriving agricultural shipping and distributing centre. Industries are diversified, including flour mills, ice and poultry-packing plants, and firms manufacturing glass blocks, trailers and prefabricated houses. Whiteman air force base is nearby. Missouri's state fair is held in Sedalia annually in August. During the Civil War the city was a Union post except for a one-day raid by Sterling Price. Generals Nathaniel Lyon and John C. Frémont outfitted forces there in 1861. For comparative population figures *see* table in MISSOURI: *Population.* (Jo. L. H.)

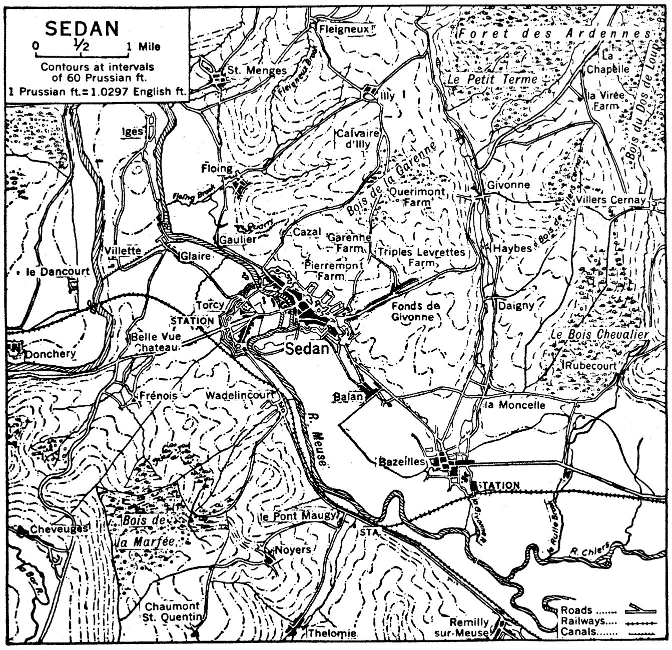
SEDAN, a town of northern France, in the *département* of Ardennes, 12 mi. E.S.E. of Mézières by rail, on the right bank of the Meuse (with the suburb of Torcy on the left bank). It has a municipal school of weaving and factories for woolen goods and machinery. Pop. (1954 census) 16,684.

Sedan in the 14th century was a dependency of the abbey of Mouzon, possession of which was disputed by the bishops of Liège and of Reims. United to the crown of France by Charles V, it was ceded by Charles VI to Guillaume de Braquemont, whose son Louis sold it in 1424 to his brother-in-law the lord of Arenberg, Bvrard II de La Marck (d. 1440). Évrard began the fortification of Sedan, which his son Jean II (d. *c.* 1470) continued. Jean's second son, Robert I, lord of Sedan (d. 1487), became châtelain of Bouillon in 1482. His son Robert II lived until late in 1536, so that Robert III, the famous lord of Fleuranges and a marshal of France (d. Dec. 1536), was lord of Sedan for a few weeks only. Robert IV (d. 1556), also a marshal of France, became duke of Bouillon (1552) and was recognized as sovereign in Sedan. His son Henri Robert (d. 1574), who publicly professed Calvinism (1562), styled himself prince of Sedan. Guillaume Robert died young (1588) and was succeeded by his sister Charlotte, the last La Marck sovereign of Sedan, who in 1591 married Henri de La Tour d'Auvergne, viscount of Turenne (d. 1623). The latter, who kept Sedan and Bouillon on his wife's death (1594), intrigued against Henry IV of France but came to terms when the king captured Sedan in 1606. The next duke of Bouillon, Frédéric Maurice de La Tour d'Auvergne, conspired with the marquis de Cinq-Mars and lost Sedan to the crown of France in 1642. (X.)

Battle of Sedan, 1870.—The battle of Sept. 1, 1870, brought the overthrow of the French Second Empire in the Franco-German War (*q.v.*). During the course of Aug. 31, the retreating French army (1st, 5th, 7th and 12th corps) under Marshal M. E. de MacMahon assembled in and around Sedan, watched throughout the day by the German cavalry but not severely pushed by them. Sedan was a small old-fashioned fortress, lying in a depression between two ridges which converged in the plateau of Illy about $2\frac{1}{2}$ mi. N.E. of the town. From the fine and roomy bridgehead of Torcy the whole French army might have been hurled into the gap between the German 3rd and Meuse armies, had it had a general such as Napoleon I to conceive this plan. But MacMahon seems to have contemplated nothing more than a battle for the honour of the army.

In effect, the French armies were hemmed into a triangle with its base on Sedan and the Meuse and its sides, about four miles in length, almost completely encircled by heights which German artillery proceeded to occupy. By afternoon the guns were firing over Sedan itself, and by evening the leading German infantry were approaching.

During the night the Bavarians threw a pontoon bridge across the Meuse below Rémilly, and in the fog which covered the countryside at daybreak on Sept. 1 they advanced toward Bazeilles. There the marine battalions of J. J. P. de Vassoigne's division put up gallant and stubborn resistance, but the Bavarians captured the village with the aid of artillery fire. During the fight a shell seriously wounded MacMahon. who handed over command to Gen. A. A. Ducrot. Ducrot, appreciating the seriousness of



the encircling movement, ordered a retreat westward to Mézières. But meanwhile Gen. E. F. de Wimpffen, who had arrived only on Aug. 30 but who brought with him a secret commission from the comte de Palikao, minister of war and president of the council, appointing him successor to MacMahon should the marshal be killed or disabled, assumed command and countermanded the order. The result was confusion, in which Wimpffen's efforts to break out eastward toward Montmédy were met with overwhelming artillery fire.

Meanwhile, to the west, Gen. Félix Douay's corps were attacked by two German corps and were in great peril. Troops had to be sent to his assistance across ground swept by gunfire. To relieve the pressure further. five regiments of cavalry under Gen. J. A. Margueritte charged repeatedly, only to suffer immense losses and to be swept back. When Margueritte was killed the marquis de Galliffet took command. The cavalry's magnificent effort was of no avail because the storm of shellfire and the broken ground made all manoeuvre impossible. In the afternoon the Germans mustered all their weight and launched their main attack from the east and west, tightening the ring around the French forces. Lines of men almost two miles long pressed in until they were able to storm the main ridge. Wimpffen ordered a last effort at escape in the direction of Balan and Bazeilles and drove the Bavarians from both villages. But he was checked by the 4th Prussian corps.

The emperor Napoleon III, who earlier in the day had fearlessly courted death, was overcome by exhaustion and extreme physical pain. Seeing the hopelessness of his position, he offered his personal surrender to the king of Prussia and ordered the white flag to be hoisted over Sedan. Grave miscalculation of German might and serious confusion among his generals had led to this trapping of a great army of 100,000 men.

The terms, accepted by Wimpffen on behalf of the army, were unconditional surrender, but the officers nere allowed to retain their swords, h'early 82,000 officers and men surrendered, and there were 17,000 French killed or wounded. German losses were less than 9.000 men.

Combined with the investment of the other major French force at Metz, under Marshal Achille Bazaine, the battle of Sédan meant the collapse of all French military power. It led immediately to the downfall of the Second Empire and, three days later, to the formation of the provisional government of national defense in Paris.

Battle of Sedan, 1940.—The battle of May 13, 1940, inaugurated the German invasion of France in World War II. Between World Wars I and II the French high command built the Maginot line along France's eastern frontier, but it ended near Montmédy. Defensive fortification of the frontier north of that point was slight, consisting mainly of isolated blockhouses and antitank obstacles along the Belgian frontier. The area of Sedan was left particularly undefended because it was believed that the forest of the Ardennes and the river Meuse were natural defenses formidable enough to discourage attack at that point. Yet it was precisely there that the Germans broke through to invade France in 1940, and for the second time in its history the town became the crucial point in France's military collapse.

In 1939 the 1st army group, under Gen. G. H. G. Billotte, consisted of four armies, the 1st, the 2nd. the 7th and the 9th. While the 1st and the 7th armies covered the northern stretches, the and under Gen. Charles Huntziger held the stretch from Longwy to Sedan and represented the hinge between the whole 1st army group and the 2nd army group, in the Maginot defenses. The 9th army, under Gen. André Corap, covered the 6j-mi. front from Mézières to Namur, north of Sedan. The 2nd and the 9th armies were relatively weak forces, roughly half of their strength consisting of reserve divisions, ill-trained and ill-armed. Plan D, prepared by the high command to meet invasion. assumed that the Germans would follow the pattern of the Schlieffen plan, hinging on Sedan and aiming a hammer blow through Belgium at the northern frontier. It arranged for a concentration of French striking-power in that area, ready to move forward into Belgium , and assume a new defensive line from Sedan to Antwerp. The Germans learned of this plan, partly from observing the concentration of forces and partly from the two false alarms given in Nov. 1939 and Jan. 1940. They therefore prepared to do precisely the opposite to what was expected of them, by attacking along the so-mi. front between Dinant and Sedan. Their aim was to strike at three widely separated points, at Houx north of Dinant, at Monthermé and at Sedan, the main blow falling on Sedan. By thus gaining local superiority and complete tactical surprise they hoped to effect a breakthrough across the Meuse which would enable them to outflank both the Maginot line to the southeast and the armies of the 1st army group in the north. From Sedan a direct railway line ran to the coast and excellent roads radiated toward the coast and Paris and behind the Maginot line.

German armies invaded the Low Countries on the morning of May 10. Armoured divisions, under Gen. Paul von Kleist, advanced through Luxembourg toward the Belgian Ardennes. The first French resistance came from Huntziger's cavalry, which fought a pitched battle with heavy losses on May 10. Corap's cavalry, supposed to advance into the Ardennes farther north to protect the flank of Huntziger's, failed to do so until May 11. On that day a fierce battle was waged in the Ardennes between these advanced cavalry forces and German tanks and dive bombers, and the cavalry were driven back. By evening German tanks had approached Bouillon, about 9 mi. N.E. of Sedan. On May 12 Gen. Heinz Guderian's 1st panzer division launched an all-out attack on the little town, in an effort to cross the Semois river. It was held up by French artillery and Allied bombers, but in the course of the day it passed Bouillon and reached the outskirts of Sedan. All resistance in the Ardennes virtually collapsed, and there remained only the second natural obstacle, the Meuse, whose bridges had been blown up. The remarkable speed of the German advance was a major factor in its success.

On May 13 dive bombers began at noon to pound French guns and pillboxes in front of the tonn and kept the attack up for four hours. Cnder cover of this attack artillery and tanks were brought to the river's edge, and hundreds of rafts and rubber boats were launched across the river. The Germans were elite units, the French defenders second-class reservists. Although German losses were very heavy, two crossings were effected, one north and one south of Sedan. Having gained a foothold on the west bank, German engineers erected a pontoon and trestle bridge and two large ferries. They established a bridgehead deep enough to prepare a further advance next day. By evening the breakthrough was complete, and Sedan was a town of desolation and destruction.

Confronted with this position, Huntziger at great cost succeeded in holding a point about 10 mi. S. of Sedan. Guderian turned westward against Corap and was fortunate in finding intact two bridges across the Ardennes canal. He routed Corap's forces and vastly widened his bridgehead. On May 15 Gen. Henri Giraud replaced Corap at the head of the 9th army. But by now the position was irretrievable. The German thrusts at Houx and at Monthermé farther north had also succeeded in effecting crossings of the river, and the lack of Allied air power allowed all three crossings to develop into a three-pronged drive into France, which reinforcements were unable to check. The implementation of the rest of Plan D, involving the advance of the French and British armies into Belgium, then simply placed the Allied forces all the more at the mercy of the German encirclement from the rear. German strategy had proved completely successful. It led to the British withdrawal from Dunkirk and, in June, to the signing of the Franco-German armistice. (D. Tn.)

SEDAN CHAIR, a portable chair or covered vehicle, with side windows, and entrance through a hinged doorway at the front, the roof also opening to allow the occupant to stand, carried on poles by two "chairmen." The sedan chair was a fashionable mode of transport in towns up until the end of the 18th century. Some authorities trace its name to the town of Sedan, in France, where it was supposedly first used. It was introduced into England by Sir S. Duncombe in 1634.

SEDBERGH, a town in the Skipton parliamentary division of the West Riding of Yorkshire, England, 11 mi. E. of Kendal by road. Pop. of rural district (1951) 3,442. It stands in a valley, surrounded by high moors, on the River Rawthey. The church of St. Andrew is principally late Norman. The grammar school was founded in 1525 by Roger Lupton, a provost of Eton. Its chantry was suppressed by Edward VI but the school continued and now ranks among the important public schools.

SEDDON, RICHARD JOHN (1845–1906), New Zealand statesman, was born at Eccleston, Lancashire, England, in 1845, the son of a schoolmaster of Eccleston High school. Brought up to the engineering trade, he went to Australia at 18 and entered the railway workshops at Melbourne. He was caught by the gold fever and spent some time in the diggings at Bendig; but in 1866 he went to New Zealand, starting work as a miner. He entered the New Zealand legislature in 1879. He was a member of John Ballance's ininistry (1891) and on Ballance's death (1893) he became premier, a post he held until his death. Under his leadership much was done to aid the poorer classes. The Industrial Conciliation and Arbitration act, Shops and Offices act, and acts to regulate attachment of wages and to protect workers' homes against mortgage and sale for debt were passed; and the franchise was amended and extended to women (1893). Other measures passed included the Old-Age Pensions act (1898), the Workers' Compensation act and the liberalized Education act, extending the facilities for secondary education and introducing technical education. He introduced state coal mines (1901), state fire insurance (1903), legislation to safeguard maternity and child life (1904) and workingmen's dwellings (1905). He attended the Imperial conference in London in 1897, and thenceforth was regarded as one of the pillars of British imperialism. He died suddenly on June 10, 1906. When Seddon came into New Zealand politics no party that was not Conservative had ever been in power, and liberalism had only recently been enunciated. Under his leadership New Zealand became the social laboratory of the world. (A. T. Cl.)

SEDERUNT, ACT OF, in Scots law, an ordinance for regulating the forms of judicial procedure before the civil courts, passed by the judges of the court of session under authority of a power originally conferred by an act of the Scottish parliament. 1540, c. 93. A quorum of nine judges is required to pass an act of Sederunt. The equivalent ordinance for regulating criminal procedure is an act of adjournal passed by the judges of the high court of justiciary.

SEDGE, the common name for the Cyperaceae (*q.v.*) family, and also for the genus *Cavex* belonging to this family. Carex contains about 1,100 perennial grasslike species of temperate and subarctic zones. frequently growing in damp, boggy, marshy, or riparian habitats and sometimes yielding marsh hay. (J. M. Bl.)

SEDGWICK, ADAM (1785–1873), English geologist, was born on March 22, 1785 at Dent, Yorkshire, son of Richard Sedgwick, vicar of the parish. He was educated at the grammar schools of Dent and Sedbergh, and at Trinity college, Cambridge, where in 1810 he was elected a Fellow. In 1818 he was admitted to priests' orders, and in the same year he succeeded John Hailstone as Woodwardian professor of geology.

In papers read (1820–21) before the Cambridge Philosophical Society (of which he was a founder) on the structure of parts of Devonshire and Cornwall, he made observations of exceptional interest and value. Sedgwick dealt with the geology of the Isle of Wight, and with the strata of the Yorkshire coast (in papers published in the *Annals of Philosophy,* 1822, 1826); and examined the rocks of the north of Scotland with Murchison in 1827. He was elected president of the Geological Society in 1829–30, and in 1831 he commenced field-work in North Wales. Eventually Sedgwick applied the name Cambrian to the oldest group of fossiliferous strata. In 1833 Sedgwick was president of the British Association at the first Cambridge meeting, and in 1834 he was appointed a canon of Norwich. In 1836 with Murchison he made a special study of the culm-measures of Devonshire, and together they demonstrated that the main mass of the strata belonged to the age of the true Coal Measures. Continuing their researches into the bordering strata they were able to 'show in 1839, from the determinations of William Lonsdale, that the fossils of the South Devon limestones and those of Ilfracombe and other parts of North Devon were of an intermediate type between those of the Silurian and Carboniferous systems. They therefore introduced the term Devonian for the great group of slates, grits and limestones, now known under that name in West Somerset, Devon and Cornwall. These results were published in the great memoir by Sedgwick and Murchison, "On the Physical Structure of Devonshire" (*Trans. Geol. Soc.,* 1839). Among other works *A Synopsis of the Classification of the British Palaeozoic Rocks* (1855) may be mentioned. Sedgwick continued to lecture until 1872, and died at Cambridge on Jan. 27, 1873. The Sedgwick Museum built as a memorial to him was opened in 1903.

See the *Life* and *Letters,* by John Willis Clark and Thomas McKenny Hughes (1890).

SEDGWICK, ADAM (1854–1913), English zoologist. best-known for his researches on *Peripatus,* was born at Norwich on Sept. 28, 1854. A grand-nephew of the geologist Adam Sedgwick (*q.v.*), he entered Trinity college. Cambridge, in 1874, there becoming attracted to zoology. He was one of the group of students inspired by Francis Maitland Balfour. leader of scientific research in comparative anatomy and embryology. In 1878 Sedgwick became Balfour's lecturer and in 1882. when Balfour was killed in the Alps, took charge of his young school of morphologists. Sedgwick's greatest researches were concerned with that remarkable animal *Peripatus* (*see* Onychophora), an ancient type standing between the segmented worms and the insects. Later work confirmed Sedgwick's brilliant demonstration that the development of this animal holds the key to the relationships of several major divisions of the animal kingdom. From 1897 to 1909 Sedgwick devoted himself to his outstanding *Text-Book of Zoology,* and its publication marked the close of the great era of evolutionary morphology which began after 1859. In 1907 he succeeded Alfred Newton as professor of zoology at Cambridge, and two years later became professor of zoology in the new Imperial College of Science and Technology at South Kensington, London. He died on Feb. 27, 1913. (C. F. A. P.)

SEDGWICK, JOHN (1813–1864), C.S. general. was born at Cornwall, Conn., on Sept. 13, 1813, and graduated at West Point in 1837. He saw active service against the Seminoles in

Florida, and took part in the Mexican War, winning the brevets of captain and major. In command of a division in the army of the Potomac in the Civil War, he took part in the Seven Days and Maryland campaigns. He was given command of the 6th corps and took an important part in the battle of Chancellorsville. Sedgwick declined the chief command of the army at Hooker's resignation. and retained his command of the 6th corps during the Virginia campaign of 1863. being on several occasions placed by Meade in charge of a wing of the army, and given the command of the whole army in Meade's absence. At the action of Rappahannock station Sedguick by a brilliant night attack destroyed two brigades of Early's division (Nov. 7). When the army of the Potomac was reorganized in three corps. the 6th was one of these, and he thus led his old corps at the battle of the Wilderness At the opening of the battle of Spotsylvania Court House, Sedgwick was killed (May 9, 1864). A monument to his memory. cast from the guns taken in action by the 6th corps, was erected at West Point in 1868.

SEDILIA, in ecclesiastical architecture, the seats on the south side of the chancel. for the use of the officiating priests.

SEDIMENTARY **ROCKS.** Although the term rock is commonly understood to be something durable and unyielding, and is so understood even in engineering circles, in geology it denotes only a body of solid materials forming a significant part of the crust of the earth. Included here are the unconsolidated clays and sands as well as the truly consolidated, or lithified, materials. Unconsolidated sediments. however, are not just soil. Soil is a somewhat ambiguous term and is usually applied to the very thin surficial materials. generally unconsolidated or only weakly indurated. as opposed to the bedrock upon which these materials rest and from which. in many cases, they were derived. Soil may be considered as one variety of sedimentary rock — and indeed has been called the mantle rock (saprolith or saprolite if it was produced by weathering *in situ* of the bedrock).

The sedimentary deposits form an important class of rocks. They are defined as those rocks formed by sedimentation — a process of deposition of mineral matter from (fluid) suspension or from solution at the relatively low temperatures and pressures which prevail at or near the surface of the earth. The systematic study of the properties and origins of these materials is the science of sedimentology.

This article deals with the history of sedimentology and its application> in exploration for gas and oil, the volume. origin and classification of the sedimentary rocks and the process of sedimentation. In addition to the cross references given under the various headings of this article, for explanation of the geological terms and concepts referred to *see* GEOLOGY; MINERALOGY. Modes and locations of occurrences and distinctive characteristics of various accumulations of sedimentary rocks are dealt with in separate articles on geologic systems and epochs, as CAMBRIAN SYSTEM; PLEISTOCENE EPOCH: etc. *See* also *Geology* sections and sections dealing with physiographic regions of articles on countries and states, as CANADA; CONNECTICUT; etc.

SEDIMENTOLOGY

Petrology is science of rocks. It is concerned with the properties; classification and origin of rocks. Sedimentary petrology is that branch of petrology which deals with rocks of sedimentary origin. Some investigators have applied the term sedimentation to the body of knowledge, both observational and theoretical, concerned with the origin of sediments and sedimentary deposits (and their lithified equivalents). As the term, in the strict sense, only applies to a process, other workers have rejected it and used the term sedimentology for the science of sediments. As so used, it is more or less equivalent to the term sedimentary petrology but has tended to replace both sedimentation and sedimentary petrology.

History of Sedimentology.—Primitive man knew and made use of many sedimentary materials: flints for his spears, clay for his pottery. He soon learned where to look for these things and as his technology evolved he made many observations on and applied terms to these materials of sedimentary origin. Many of these terms derived from the common language remain and have been more precisely defined and incorporated into scientific nomenclature. Others have become obsolete and discarded. Such terms as cobble, sand, flint and limestone are among those retained; terms like hornstone or pudding stone are no longer used.

Geology had its real beginnings as a science in the early part of the 19th century. A significant event in its development was the publication in 1815 of the geological map of England by William Smith, a self-taught land surveyor and engineer. Smith's map embodied the first real attempt to portray the distribution and relative ages of the sedimentary strata of a region. Smith's contribution was in the establishment of the stratigraphic order and the discovery of the usefulness of fossils in stratigraphic correlation. The first scientific nork on sedimentary rocks was essentially stratigraphic — namely the distribution of the sedimentary rocks in space and time. Field studies were directed, therefore. toward determining the order of superposition and the gross geometry of the sedimentary bodies — their thickness and lateral extent.

The science of sedimentology thus had its beginning in the science of stratigraphy to which it is closely related *(see* also STRATIFICATION). The central problem in stratigraphy is the establishment of the temporal order of deposition; the central problem in sedimentology is to determine the origin of the deposit. The early stratigraphers. however, made many observations on the character of the sedimentary strata with which they mere concerned. The collective knowledge thus obtained became embodied in many scientific papers and reports. Such works as A. W. Grabau's *Principles of Stratigraphy,* published in 1913, contains an extended summary of such knowledge.

The justly famous "Challenger" expeditions of 1872–76 did much to put the study of the oceans on a scientific basis-—did in fact establish the science of oceanography. The data collected by this expedition which appeared in 1880–95 in the monographic *"Challenger" Reports* by Sir John Murray and A. F. Renard shed much light on marine geology and especially on marine sedimentation. The impetus which this work gave to the study of modern marine sediments has continued. The influence of the *"Challenger" Reports* on speculations concerning the origin of the ancient sediments cannot be overestimated.

The science of sedimentary petrology or sedimentology can be considered to have been established as a separate geologicsl discipline with the publications of tno papers by Henry Clifton Sorby. Sorby's paper on the structure and origin of limestones nhich was delivered as a presidential address before the Geological Society of London in 1879 is a paper of such importance and merit that it can still be read with profit. A second paper "On the Structure and Origin of the Yon-calcareous Stratified Rocks" which appeared in the *Proceedings* of the Geological Society of London the following year is a companion study of equal rank. Sorby can justly be called the father of sedimentary petrology. The last paper published by him. in 1908 at the age of 82. "On the Application of Quantitative Methods to the Study of the Structures and History of Rocks" foreshadowed work which was to come several decades later.

Sorby is best known for his early use, perhaps the first use, of the polarizing or "petrographic" microscope for the study of rocks and minerals in thin sections *(see* PETROLOGY: *Methods of* ***Investigation).*** This method of study, now routine for petrographers, was applied by Sorby to both minerals and rocks, especially the sedimentary rocks. But it remained for Lucien Cayeux (1864–1944), the French petrographer, to carry the microscopic study of the sedimentary rocks forward to maturity. Cayeux's monographs on the sedimentary rocks of France, especially those on the siliceous and the calcareous rocks. have never been excelled. Likewise his earlier studies of the ironstones and phosphates of France are without peers.

The study of sediments and sedimentary rocks entered a new era with the publication, in 1919, of "A Field and Laboratory Study of Cobble Abrasion." by C. K. Wentworth. This study, a master's thesis submitted at the University of Iona, inaugurated an era of quantitative studies and laboratory experimentation. Except perhaps for the early work of Gabriel Xuguste Daubrée (*q.v.*), the great French experimenter, sedimentary geology was largely an observational field science. Even the laboratory studies of Cayeux and others were primarily observational and nonexperimental. Wentworth's contribution was to formulate operational definitions for specific properties of clastic materials (*i.e.*, rocks made up of fragments of pre-existing rocks), such as roundness of cobbles, and devise methods whereby these properties could be measured. It became possible. then, to study the effects of abrasion in laboratory mills or "tumbling barrels" as well as to make a quantitative analysis of the action of streams and waves in the field. Wentworth's original paper was followed by similar quantitative field and laboratory studies by him and others. As a consequence of the collection of numerous measurements, the need for statistical summarization of these data became acute.

Although Wentworth himself attempted to utilize statistical methods. the first generally successful use of statistics in sedimentology seems to have been that of Parker D. Trask who in 1930 devised simple statistical parameters to characterize grain-size distributions in clastic sediments. The making of grain-size analyses of sediments — another quantitative procedure — had been done, however, as early as 1899 by J. A. Udden of Augustana college, Rock Island, Ill.

The study of sediments and sedimentary rocks was greatly accelerated by the establishment of a National Research Council Committee on Sedimentation in 1920. Under the chairmanship of W. H. Twenhofel of the University of Wisconsin, this committee prepared the well-known Treatise on Sedimentation, published in 1926. revised and republished in 1932.

Exploration for Oil and Gas. — Much of the interest in the sedimentary rocks and the accelerated development of sedimentology as a science has arisen because of the close relations betneen sedimentation and the formation of oil and gas. To promote the use of microfossils and heavy minerals in stratigraphy and the exploration for oil and gas (see also FORAMINIFERA: Role in *Petroleum* Geology; PETROLEUM), the Society of Economic Palaeontologists and Mineralogists was established in 1927. This society founded the *Journal of* Sedintentary Petrology in 1931, and this journal has been a popular outlet for researches on sediments and sedimentary petrology since that date.

Although oil and gas are caught in natural traps — mainly structural — it has been shown that their occurrence within a sedimentary basin can be better understood from studies of the distribution, both in space and time, of the various sedimentary lithologies (systems of rockj within the basin. Such studies are promoted by the preparation of lithofacies maps using data obtained both from outcrops and subsurface borings — large numbers of which have been made in exploration for gas and oil. The data so obtained, such as the number of sand beds, net sand thickness, and sand-shale ratio, can be plotted and contoured. Facies mapping of this type had to wait until adequate subsurface data from borings were available; as a result interest in the subject did not develop until after World War 11.

The facies symposium, sponsored by the Geological Society of America, the proceedings of which were published as a *Memoir* of the society in 1949, did much to stimulate interest in the quantitative study of facies.

In 1938 Hans Cloos, of Bonn university, Ger., and his students began mapping of the primary sedimentary structures — cross-bedding, ripple marks, oriented fossils and the like—which record the direction of current flow during the deposition of the Devonian strata of the Rhine valley. Similar studies of cross-bedded sandstones in Arizona and in England were in progress at about the same time. Such paleocurrent studies combined with facies studies have proved not only important in the search for petroleum. but also are an aid to paleogeographic reconstruction — location of axis and trend of the ancient sedimentary basins. location of margins of basins and probable sources of the sedimentary fill, location and trend of the shore lines etc.

The mapping of facies and directional properties of sediments has led to fusion of field and laboratory studies of sedimentary rocks and to a new phase in the development of sedimentology. This development has been furthered greatly by the study of the sedimentary framework—location and orientation of sand bodies—in modern sedimentary basins. most notably the delta of the Mississippi and adjacent gulf coastal areas.

International interest in sedimentology culminated in the calling of the first International Congress of Sedimentology in 1946 in Belgium. With the appearance of the Treatise on *Sedimentation,* various other reference and textbooks (see *Bibliography*), the establishment of a separate journal and a sponsoring society, and an international congress, sedimentology has come of age as a geological subscience.

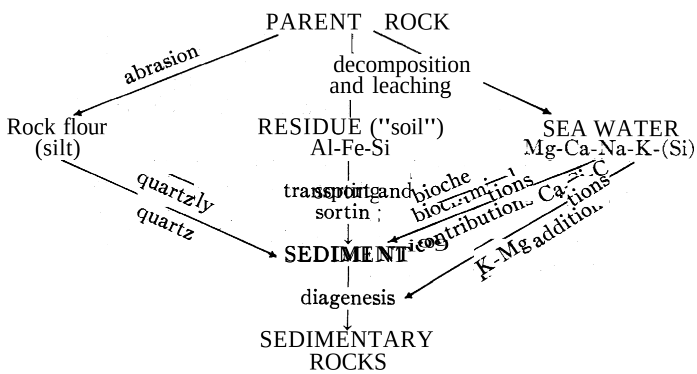
The volume of research. represented by published papers, theses and courses taught in the universities, has grown very rapidly since the early 1930s.

THE SEDIMENTARY ROCKS

Because of the fossils entombed in them, the sedimentary rocks contain the whole of the life-record of the past. And by means of their fossil content they can be arranged in a chronological order. Moreover they also carry the record of past climate and past geography and. therefore, are of the greatest importance in unravelling the geologic and life history of our planet.

In addition. 85% to 90% of the mineral wealth of the world is derived from the sedimentary deposits or rocks. They are the reservoirs for petroleum, natural gas. and ground water. Indeed the oil and gas are as much a product of sedimentary processes as are the rocks in nhich they are found.

Coal is likewise a sedimentary rock and, together with petroleum and natural gas, supplies most of the energy for the industrial machine as well as raw materials for the chemical industries. Even the ores of many metals are of sedimentary origin. The principal ores of iron, aluminum. manganese and magnesium and some copper ores are of such origin. The alluvial deposits are. of course, sedimentary and many ores of tin, gold and platinum as well as gemstones occur as alluvial deposits Most nonmetallic materials, such as building stone. the mineral fertilizers. the raw materials of the ceramic and cement industries. and rock salt. are of sedimentary origin. Clearly an understanding of these deposits, their discovery and their exploitation is basically a problem in sedimentary geology.



FROM F. J. PETTIJOHN, "SEDIMENTARY ROCKS"; REPRODUCED BY PERMISSION OF HARPER & BROS.

Volume. — The total volume of sediments, both ancient and modern is very large. The thickness of sedimentary rocks varies greatly; locally accumulations in excess of 60.000 ft. are known. The average thickness on the continents however is much less and has been estimated to be about 7.000 ft. The thickness of the sediments over the floor of the ocean is highly uncertain and probably quite variable. The total volume of the sedimentary materials has not been measured and can only be estimated from geochemical calculations. If the sodium in the sea is derived from weathering of igneous rocks, at least 50,000,000 cu.mi. of average igneous rocks would be needed to furnish the quantity of sodium now contained in the oceans. But the volume of sediment released during this weathering, owing to porosity and to volume increases due to hydration and oxidation, would be somewhat greater. Inasmuch as not all the sodium released has been stored in the oceans, the total volume of igneous rock neathered (and hence the total volume of sediment produced) has been estimated to be in excess of 85,000,000 cu.mi. Some estimates, based on other considerations, suggest that the volume of sedimentary materials may be even greater. Even so, the sedimentary rocks form only a relatively small part of the outermost ten-mile shell of the earth. Of this shell, commonly called the "crust" of the earth, only 5% is of sedimentary origin.

Although there are many kinds of sedimentary rocks, some 99% can be classed as some type of sandstone, shale or limestone. Estimates based on measurement of exposed sedimentary sequences assign from 4454 to 56% of the total to shale; from 14% to 37% to sandstone and the remaining 19% to 29% to limestone. The proportions of average shale, sandstone and limestone required to make the average igneous rock (from which they are presumed to have been derived by weathering) are computed to be 70%–82% shale, 12%–16% sandstone and 5%–14% limestone. The discrepancies between the observed and computed proportions are believed to be due to loss of the finest materials (which would form shale) to the deep oceanic basins.

Origin and Classifications. — Close examination of many sedimentary rocks shows that they consist of a detrital framework fraction that can only be debris derived from pre-existing rocks. This framework consists of close-packed, worn and rounded detrital elements: pebbles or cobbles of various rocks in the case of the gravels and conglomerates, and sand grains, most commonly single mineral grains of quartz or feldspar, in the case of the sands and sandstones (see CONGLOMERATE; SANDSTONE).

Some such deposits consist exclusively of one kind of detritus; others contain detrital material of diverse kinds. The lithified rocks, such as sandstone and conglomerate, contain a mineral cement which fills or partly fills the voids or interstices in the framework. This cementing mineral matter must be introduced, therefore, after the deposition of the detrital elements and be the cause of the lithification of the rock as a whole. Commonly cementing materials are silica (quartz) and calcium carbonate (calcite). The total volume of cement may be as much as one-third or more of the whole rock.

The sedimentary materials described above are clearly the waste products of the disintegration of earlier rocks. They have been called the clastic (=broken) sedimentary rocks in recognition of the fragmental character of their detrital elements. The origin of these materials is not difficult to surmise. Remove the cement from a sandstone and one obtains a sand identical in all details with that found in streams or on beaches. The stream sands are clearly seen to form by erosion of the weathered residues of various older or pre-existing rocks. They are, however, washed residues markedly sorted and thus enriched in quartz and impoverished in the clay materials.

Other sedimentary rocks are not so formed. Some consist of a more or less cemented accumulation of shell or other skeletal debris and form a veritable fossil "hash." Such rocks must have originated from the accumulation of the skeletal hard parts of invertebrate organisms, either in situ or by current transport without introduction or addition of other mineral matter. Such accumulations can be found today in the coral reef areas and elsewhere. As these materials are mainly calcium carbonate, their accumulation leads to the formation of limestones and related rocks (see LIMESTONE; CHALK). The cliffs of the English channel are cut in thick and extensive deposits of chalk of Cretaceous age. The skeletal materials of which the chalk is composed are mainly of microscopic dimensions similar in character to those forming the calcareous muds found today in some places on the sea floor. Siliceous skeletal debris. though less common, may also form extensive and thick deposits (see DIATOMACEOUS EARTH).

The shales appear to be the finest waste products of weathering and erosion. Under the microscope they are seen to consist of a mixture of silt particles and clay materials. The silt, like sand, is the unaltered residue of weathering or abrasion; the clay is mainly the product of the decomposition of the feldspars of the parent rocks from which the detritus came. Not uncommonly to this silt-clay mixture is added skeletal and other biochemically precipitated carbonate and silica as well as organic materials. The hybrid sediment thus produced, upon compaction, becomes mudstone or shale (*q.v.*).

The sedimentary rocks are. therefore, accumulated sediments. Their constituents are of varied nature and their composition depends on the relative proportions of the materials of the diverse origins (see fig. 1). Those consisting mainly of the products of abrasion ("rock flour") and the washed residues of weathering (sand, silt and clay) are the clastic sediments. Those consisting mainly of the biochemically or chemically precipitated materials (calcium carbonate and silica) are nonclastic sediments. Not uncommonly the sediment has a multiple origin and is in truth a hybrid deposit. Very commonly also the original composition is modified by reaction with materials in solution in the medium from which it was deposited or with those in solution in the ground waters with which it may later come in contact. The postdepositional alterations which result from such reactions nith dissolved materials may lead to cementation of the sediment or drastic modification of its composition (as in the conversion of limestone to dolomite). The postdepositional changes are collectively considered diagenetic changes (see DIAGENESIS). Other products of diagenesis include concretions, stylolites, nodules and petrefactions.

A few rare sediments appear to be precipitated wholly from solutions. Thus formed are the extensive evaporitic sediments—the products of an evaporating brine {see GYPSUM; SALT: Rock Salt). Other sediments appear to be precipitated by reactions in more dilute solutions, as phosphorite (*q.v.*) and chert. In addition to the sediments formed by deposition from suspension or solution, there are accumulations of partly degraded organic matter, as peat and coal, and accumulations of air and water-borne volcanic debris, as tuff and agglomerate (*qq.v.*), which are commonly classed with the sedimentary rocks.

Germane to the study of sedimentary rocks is a study of the structures which they show — most especially their stratification. Indeed the term "stratified rock" is almost synonymous with sedimentary rock. Some volcanic materials, including lava flows and some ash beds. are also stratiform and should be included in the stratified rock group. On the other hand. a few sedimentary rocks, notably coral reef rock, may lack a well-defined stratification. Stratification or bedding is a structure produced by slight changes in the conditions of deposition during the sedimentation process. Changes in current strength result in slight changes in the grain sizes transported and deposited; changes in the chemical or physical environment may result in slight to marked changes in composition in the sediments forming by precipitation. Depending on the relation between the frequency of these changes and the rate of sedimentation, the stratification planes or surfaces of discontinuity may be close together or widely spaced. Sediments accordingly exhibit thin bedding or thick bedding. If the changes responsible for bedding planes are seasonally induced, the strata are then annual layers or varves.

Though there are minor exceptions. the planes of stratification are initially horizontal, or substantially so. The sedimentary rocks in many places, notably in the mountain tracts, are no longer horizontal but are tilted at various angles, or even vertical or overturned (see FOLD). The recognition of these deformed stratified rocks as the ancient equivalents of sediments now being deposited in horizontal position, is one of the major achievements of geology for it leads to the conclusion that vast elevation and deformation of the earth's crust has taken place.

Stratification is not to be confused with rock cleavage which is a structure that commonly transects or cuts the true bedding and is a structure, therefore, that is post-depositional in origin. Another structure, also commonly confused with bedding is colour-banding — a phenomena most characteristic of sandstones — which consists of rhythmically spaced precipitation surfaces of reddish iron oxide. These bands commonly, but not everywhere, transect the bedding.

SEDIMENTATION

Although the term sedimentation has been used as a synonym for sedimentary petrology and sedimentology, it is more properly a process. It is the process of deposition of a solid material from a fluid—usually air or water—from a state of suspension or solution. Broadly defined it would also include deposits from glacial ice and those materials collected by gravity alone—as in talus deposits, or accumulations of rock debris at the base of cliffs.

The physics of the most common sedimentation process—the settling of solid particles from fluid media—has long been known. The settling velocity equation formulated in 1851 by G. G. Stokes, is the classic starting point for any discussion of the sedimentation process. Stokes showed that the terminal settling velocity of spheres in a fluid was directly proportional to the difference in densities of fluid and solid. the radius of the spheres involved. and the force of gravity and inversely proportional to the viscosity of the fluid. Stokes' equation is valid, however, only for spheres of very small size (under 0.04 mm. in diameter) and hence various modifications of Stokes' law have been proposed for nonspherical particles and particles of larger size.

No settling velocity equation, no matter how valid, provides a sufficient explanation of even the basic physical properties of natural sediments. The grain size of the clastic elements and their sorting, the shape and roundness of these elements and their fabric and packing are the results of complex processes related not only to the density and viscosity of the fluid medium but also to the velocity of the forward motion of the depositing fluid and to the turbulence resulting from this motion and the roughness of the beds over which it moves; to various mechanical properties of the solid materials propelled, to the time or duration of the transport action and to other little-understood factors. Present knowledge, most of it empirically obtained, is inadequate to account for the known facts.

Chemical sedimentation is understood in terms of chemical principles and laws. Although the famous physical chemist, J. H. van't Hoff, applied the principles of phase equilibria to the problem of crystallizing brines and the origin of salt deposits as early as 1905, only a little effort was made to apply physical chemistry to the problems of chemical sedimentation. More recently, however, there has been investigation of the role of the redox (mutual reduction and oxidation) potential and pH (acidity/alkalinity) in the precipitation of many chemical sediments, renewed effort to apply known thermodynamic principles to the origin of anhydrite and gypsum deposits, the chemistry of dolomite formation, the problem of the ironstones and related sediments. New developments in isotope chemistry and nuclear physics are reflected in sedimentology in direct age determination of the potash-bearing minerals by the potassium-argon method, notably glauconite, and in paleotemperatures or the determination of temperature of formation of the carbonate skeletal materials of marine invertebrates.

The geochemist also considers the sedimentation process in terms of the chemical end-results. To him sedimentation is like a gigantic chemical analysis in which the primary constituents of the silicate crust of the earth are separated from one another in a manner similar to that achieved in the course of a quantitative analysis of rock material in the laboratory. The results of this chemical fractionation are not always perfect, for nature uses poor methods. but by and large the results are remarkably good. The greatest concentration of many elements found in nature are those of the sedimentary rocks. No igneous or metamorphic process can match the sedimentation process in effective isolation and concentration of these and other elements. Geochemical differentiation or fractionation, which began in Precambrian times, perhaps 3,000,000,000 years ago, has resulted in an enormous accumulation of sodium in the sea, calcium and magnesium in limestone and dolomite. silicon in the bedded cherts and orthoquartzitic sandstones. carbon in the carbonates and carbonaceous deposits, sulfur in the bedded sulfate: iron in the ironstones. etc.

Sedimentation is most generally considered by the geologist in terms of the textures. structures, and fossil-content of the deposits laid down in different geographic and geomorphic environments. Great efforts have been made to differentiate between continental, littoral and marine deposits of the geologic record. The further classification of environments and the criteria for their recognition is still a subject of lively interest.

The analysis of the record of ancient basins of sedimentation has been promoted by the study of present-day basins. Oceanographic and limnologic expeditions have shed much light on the sedimentation in such basins as the Gulf of Mexico, the Black sea, the Baltic sea, various estuaries, lakes and fluvial basins.

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SEDITION, in law, an attempt to disturb the tranquillity of the state. In English law it is a very elastic term, including offenses ranging from libel to treason (*q.v.*). It is rarely used except in its adjectival form; *e.g.*, seditious libel, seditious meeting or seditious conspiracy. Sedition is a common-law indictable misdemeanour, and embraces everything whether by word, deed or writing which is calculated to disturb the tranquillity of the state and lead ignorant persons to endeavour to subvert the government and laws of the empire. The principal enactments now in force dealing with seditious offenses were all passed during the last 25 years of the reign of George III. They are the Unlawful Oaths act, 1797, prohibiting the administering or taking of unlawful oaths (*see* OATH) or the belonging to an unlawful confederacy: the Unlawful Drilling act, 1819, which prohibited unlawful drilling and military exercises; and the acts for the suppression of corresponding societies, the Unlawful Societies act, 1799, and the Seditious Meetings act, 1817. No proceedings can be instituted under these last two acts without the authority of the law officers of the crown. By the Prison act, 1877, any prisoner under sentence for sedition or seditious libel is to be treated as a misdemeanant of the first division.

In the United States, congress has passed sedition acts for the supposed protection of the government. The Alien and Sedition laws passed during the administration of President Adams were partly responsible for the defeat of the Federalist party. During World War I, congress passed, with the approval of President Wilson, sedition measures for the purposes of minimizing domestic opposition to the war.

SEDLEP, SIR CHARLES (1639–1701). English poet, dramatist, wit and courtier, was baptized at St. Clement Danes church, London, on March 5, 1639. He was the second son of a Kentish baronet, Sir John Sedley, and his wife Elizabeth, daughter of Sir Henry Savile, the great Elizabethan scholar. Admitted to Wadham college, Oxford, on March 22, 1656, he left without taking a degree. He inherited the baronetcy on the death of his elder brother in April 1656. After the Restoration he was a prominent member of the group of court wits called "the merry gang." Charles II delighted in his conversation and declared that "Nature had given him a patent to be Apollo's Viceroy." In June 1663 he took part in a wild frolic at the Cock tavern in Bow street, Covent Garden, for which he was fined 2,000 marks by the court of the king's bench. Dryden and Shadwell were among his friends and Dryden introduced him into his *Essay of Dramatic Poesy* under the name of Lisideius. His original comedy *The Mulberry Garden* was staged by the King's company at Drury Lane theatre in May 1668. In March 1677 his rhymed tragedy *Antony and Cleopatra* was produced at the Duke's theatre and in May 1687 his second comedy *Bellamira or the Mistress* was acted with great success by the King's company.

Sedley married Katherine Savage, daughter of Earl Rivers, in 1657. She became insane and was sent to a convent at Ghent probably about 1670. In 1672 he went through a form of marriage with Ann Ayscough, the daughter of a Yorkshire gentleman, and he seems to have lived with her for the rest of his life. Katherine Sedley, his daughter by Katherine Savage, though no beauty, was clever and witty. She became the mistress of James, duke of York (later James II), by whom she was created countess of Dorchester in 1686. Her father was an active supporter of William and Mary at the time of the 1688 revolution, when he is said to have remarked "Well I am even in point of civility with King James, for as he made my daughter a Countess, so I have helped to make his daughter a Queen." By Ann Ayscough he had a son who took the name of Charles Sedley and was knighted by William III. In the latter part of his life Sedley seems to have been transformed from a Restoration wit into an Xugustan gentleman. He sat in all the parliaments of William III as M.P. for New Romney and his speeches were thoughtful and sensible. He died at Hampstead in hug. 1701.

Sedley's best play is undoubtedly *Bellamira,* a racy. amusing rehandling of the theme of the *Eunuchus* of Terence in terms of Restoration life. *The Grumbler,* his adaptation from the French *Le Grondeur* of *D.* A. de Brueys and J. Palaprat, is also a sparkling and lively performance. His literary reputation, however, rests on his lyrics and verse translations. His best lyrics such as the well-known "Phillis is my only Joy" have an exquisite grace and charm. while the poem beginning with the following stanza expresses deep feeling with a success only equalled among contemporary poets by his friend Rochester:

Not *Celia* that I juster am
Or better than the rest,
For I would change each Hour like them
Were not my Heart at rest.

His versions of the eighth ode of Book ii of Horace and the 4th *Georgic* of Virgil have been highly and deservedly praised

A number of Sedley's best lyrics appeared in Hobart Kemp's *A Collection of Poems* (1672). The first collected edition of his works was published in 1702.

See V. de S Pinto, *The Poetical and Dramatic Works of Sir Charles Sedley,* 2 vol (1928) and *Sir Charles Sedley, A Study in the Lire and Literature of the Restoration* (1927), where an account of early editions may also be iound. (V. DE S P.)

SEDUCTION, a term generally used in the special sense of urongfully inducing a woman to consent to sexual intercourse. The action for seduction of an unmarried woman in England stands in a somewhat anomalous position. Because of her consent, the woman seduced has no right of action. The foundation of the action is the relationship of master and servant, and the plaintiff must prove that the woman seduced was in his service at the time of the seduction and that he has lost her services by reason of her subsequent pregnancy. A father may maintain the action in respect of a daughter who is under 21 years of age and living with him. without proof of any actual services rendered. for he has a right to the services of his daughter. so that she is constructively in his service. But if the daughter is over 21 years of age, the father must give evidence of actual services rendered by the daughter. On the other hand, if the girl is not living at home but was in the service of a third person, only that third person can sue Where the girl was at the time of the seduction in the service of the seducer himself no action is maintainable. unless the hiring was merely a pretense and contrivance for the purpose of seduction. The relationship of master and servant must have existed at the time of seduction and also at the time of the confinement that deprives the plaintiff of the girl's services Although the action is nominally for loss of service, the plaintiff can, if a parent, recover in addition to the actual loss sustained damages for distress and anxiety of mind, for the loss of the society of the daughter seduced and for the dishonour which he receives. But where the action is not brought by a parent, the plaintiff can only recover the actual pecuniary loss which he has sustained.

The defendant can. in mitigation of damages. give evidence as to the general loose character of the girl, and also call witnesses to prove that they have had sexual intercourse with the girl previously to the seduction.

As to seduction of a married woman, the old action for criminal conversation was abolished in England, but not in Ireland. by the Divorce act. 1857, which substituted for it a claim for damages against the corespondent in a divorce suit; but if a married woman were living apart from her husband in her father's house, and giving her services to her father in the slightest degree, an action for seduction would lie. Seduction in England is not as a rule a criminal offense. but a conspiracy to seduce a woman is indictable at common law and the Criminal Law Amendment act. 1885 (which extends to the United Kingdom). makes it a felony to seduce a girl under the age of 13 and a misdemeanour to seduce a girl between 13 and 16 (ss. 4, 5). The Children act. 1908, gives a further protection to young people, enacting that if any person having the custody, charge or care of a girl under the age of 16 causes or encourages the seduction of that girl, he shall be guilty of a misdemeanour.

Scotland. — In Scotland the seduced woman may herself maintain an action, but only if some species of fraud or deceit was practised on her; *e.g.,* if her consent to the connection was induced by a promise of marriage or by a profession of honourable love leading her to expect marriage. Indeed. if a man. by an abuse of the confidence resulting from his position as master, and by the exercise of dominating influence, has induced a girl in his service to allow him to have connection with her, or by gradually debauching the mind of the girl and by continued solicitations, has overcome her resistance to the act of intercourse, an action of seduction will lie at her suit. though marriage was not thought of.

United States. — In the United States the common law tort of seduction exists, but by statute the woman. if previously of chaste character, is usually given a right of action in her own name. The element of the offense is the accomplishment of the seduction by deceit or false promises, illicit intercourse by itself being insufficient. Most states also make seduction a criminal offense, some. however, limiting the crime to cases where the seduction is accomplished by false promises of marriage. Previous chaste character is an essential element of the crime. Subsequent marriage of the parties is generally a defense to both civil and criminal actions. The seduction of married women is covered by the maintenance of an action for criminal conversation or. where abolished, for the alienation of affections. Illicit intercourse unaccompanied by false artifices may constitute the statutory crimes of fornication or adultery.

SEDULIUS SCOTTUS, poet and scholar, belonged to a group of Irish savants at Likge, now in Belgium, where he can be traced from *c.* 848 to 860 (or 874?). His poems, mostly in classical Latin metres: include panegyrics on the emperor Lothair II, on Charles the Bald and especially on his protector, Bishop Hartgar of Likge. A master of versification. Sedulius did not lack the human touch. His ingenious elegy on the death of Hartgar's ram blends mock-heroic elements with genuine affection and culminates in the bold comparison of the "martyred" ram with the Lamb of God. Some of his verse foreshadows the goliard songs of later times. More abstract poetry, alternating with prose. is iound in his treatise *De rectoribus Christianis* ("On Christian Rulers"), one of the earliest among medieval "mirrors for princes." His commentary on the Pauline epistles makes use of the commentary by Pelagius. As a scholar Sedulius cultivated grammatical. classical and biblical studies. Connected with his circle are the Leiden and St. Gall copies of Priscian, with Old Irish glosses, and the miscellaneous Codex Bernensis 363. of the late 9th century. which ranks high among early manuscripts of Horace. Sedulius took considerable interest in the Greek text of the Bible. Four Greco-Latin biblical manuscripts are attributed to his circle; one of them was possibly written by his hand.

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SEDUM, a genus of the family Crassulaceae, the stonecrops, containing about 300 species, natives chiefly of the north temperate and frigid regions, and mostly perennial herbs with succulent leaves of varied form, but never compound. The white or yellow, rarely pink or blue, flowers are usually small and grouped in cymes. They have a calyx of five sepals, as many petals. usually ten stamens and five distinct carpels, which have as many glands at their base and ripen into as many dry seed pods. More than 30 species are native to North America, widely distributed across the continent. In addition, the old world S. *telephium* and *S. acre* have become widely naturalized in the eastern states and Canada. Several species are found in Britain, including some with tuberous roots and large leaves (S. *telephium*), and others of smaller size, chiefly found on rocks, walls and dry banks; *S. acre* is the wall pepper or golden moss, well known also in gardens, a variety of which, *aureum,* is in cultivation with golden-yellow tips to the leaves and shoots. Many species are cultivated for the beauty of their foliage or flowers, and many are remarkable for their vitality. They succeed on rockwork, old walls or as border plants; some, e.g., *S. lydium,* a native of Asia Minor, are excellent for carpet bedding. *S. spectabile,* 1 to $1\frac{1}{2}$ ft. in height. with pink flowers in great cymose heads. is fine for borders.

SEE, a seat or throne. particularly the throne of a bishop, the cathedra, the symbol of his office and dignity, the placing of which in a church makes it a cathedral (*q.v.*). The term is thus applied to the place where the bishop's cathedral is situated and from which he properly takes his title, and so is to be distinguished from diocese (*q.v.*), the territorial province over which his jurisdiction extends.

See DIOCESE

SEECKT, HANS VON (1866–1936), German soldier was born in Schleswig April 22, 1866 He entered the Kaiser Alexander Grenadier regiment as ensign (*Fahnenjunker*). In 1897 he was appointed to the general staff. becoming chief of staff of the III Army corps (Berlin) in 1913. in which capacity he went on active service in Aug 1914. with the rank of lieutenant-colonel. On Jan 27, 1915 he was promoted colonel and soon after became chief of staff to Mackensen's army group He had a large shdre in conducting the break-through of the central pou'ers at Gorlice-Tárnow, May 1915. and the subsequent invasion of Serbia After the collapse of the monarchy he became adjutant-general (*Chef des Truppenamtes*) in the *Reichswehrministerium* (Nov 1919). After the Kapp "putsch" of March 1920 he was appointed chief of the German army command In Jan. 1926 he was again promoted to the rank of general by President von Hindenburg.

SEED. The seed is the new generation in the life of a plant. Typically the ripe seed consists of a partially developed young plant (the embryo) provided with an abundant food supply (endosperm) and enclosed in a protective seed coat In size seeds range from the dustlike seeds of begonia and orchid to the large nutlike seeds of the double coconut palm or Coco de Mer (*q.v*). the fruit of which often reaches a foot in length and 40 lb. in weight The mature seed usually is air dry and in a resting condition. In nature the seed is important as a means of carrying plant life over periods unfavourable for growth and as a means for distributing the plant in space and in time In agriculture the seed is important in two ways: (1) the food stored in the seed for the development of the new plant can also serve as an important food source for man and animals (wheat, beans): (2) with most annual crop plants the seed is the start of the new crop each year To a great extent the yield and quality of the crop depend on the quality of the seed planted. The quality of the seed depends on both its genetic background and its ability to germinate and to produce strong plants.

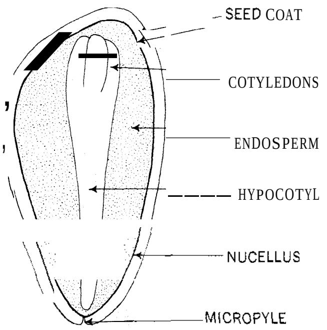

FIG I —LONGITUDINAL SECTION OF SEED OF LOBLOLLY PINE (PINUS TAEDA)

Development.—The seed develops from an ovule in the ovary of the flower (*q v.*). The male germ nucleus from the tube of the germinated pollen grain unites with the egg cell within the ovule This fertilized egg divides and develops into the embryo, which is the beginning of a new plant. The stage of development of the embryo at seed maturity varies from the well-formed plantlet of pea or corn to the slightly developed embryo of an orchid. a small spherical mass of cells in which the beginnings of embryo plant parts, cotyledons, hypocotyl and epicotyl (*see* below). are barely distinguishable As the embryo develops the other parts of the ovule also grow and develop until the seed is mature. In angiosperms (flowering plants) the endosperm develops from the endosperm nuclei of the embryo sac. In gymnosperms (conifers and their allies) the female gametophyte enlarges around the growing embryo and is usually designated as endosperm. The integuments of the ovule, which are a part of the mother plant, develop into one or more layers to form the seed coat, or testa. Details of the development of the seed from the ovule are found in articles on GYMNOSPERMS AND ANGIOSPERMS.

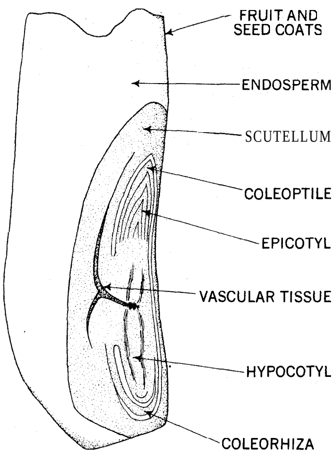

FIG. 2.—LONGITUDINAL SECTION OF GRAIN OF CORN

Structure.— The structure of seeds may be described first in general terms. although the details for different types of plants differ greatly. The embryo has one or more cotyledons (seed leaves) below which is the hypocotyl with the growing point of the root at its tip. and above which is the epicotyl with a growing point for new stem tissue. The embryo is surrounded by the endosperm with its food reserves or occasionally by the perisperm developed from the nucellus of the ovule. In the seeds of some plants, *e.g.,* the pea family, Leguminosae, the food reserves of the endosperm are absorbed to form enlarged cotyledons. The endosperm is enclosed by a seed covering (largely the seed coat). In some seeds thin layers remaining from the nucellus or the endosperm may form an important part of the seed covering. The details of seed structure differ in gymnosperms and in angiosperms. In gymnosperms the embryo with two to many cotyledons is buried in the endosperm. In pine seeds 6 to 15 needlelike whorled cotyledons. the number varying with the species. surround the small epicotyl. The cotyledons and epicotyl are attached at the top of the cylindrical hypocotyl. The endosperm is enclosed by the comparatively thick and tough seed coat.

In angiosperms the embryo may have one cotyledon (monocot) or two (dicot). Corn is fairly typical of many monocot seeds. The well-developed embryo is at one side of the seed. The hypocotyl and root tip are enclosed by a thin sheath (coleorhiza) and the epicotyl with two or three young leaves formed is enclosed in its sheath (coleoptile). The large shield-shaped scutellum almost encloses the axis and one surface is in contact with the starchy endosperm. The scutellum is attached to the axis between the hypocotyl and the epicotyl and is considered by many to be a special development of the single cotyledon. A thin seed coat and the adhering fruit coat surround the embryo and the endosperm. The castor bean is representative of a dicot seed with much food stored in the endosperm. The embryo with two thin. broad cotyledons enclosing the small epicotyl and the short cylindrical hypocotyl are embedded in the endosperm. The whole is covered by the hard brittle seed coat. In the pea, typical of many dicots, a !yell-developed endosperm of the immature seed is gradually absorbed by the enlarging cotyledons until at maturity only a thin membranous layer remains. At maturity the large food-filled cotyledons protect an axis consisting of a cvlindrical hypocotyl and an epicotyl with two or three leaves already evident. This large embryo is enclosed by a comparatively thin covering of combined testa and endosperm.

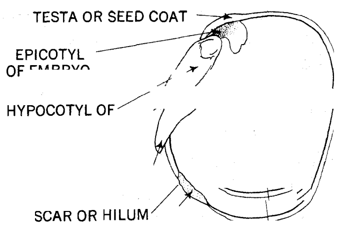

FIG 3 —SEED OF COMMON GARDEN PEA (PISUM SATIVUM), WITH ONE COTYLEDON REMOVED

The developing seed, attached to the placenta of the ovary by the funiculus. receives food through its vascular strand At maturity the seed separates from the funiculus. leaving a scar called the hilum. The shape and position of the hilum often are a distinguishing character useful in the identification of seed kinds. The micropyle is a small porelike opening in the ovule. where the ovule coverings, or integuments, meet and the pollen tube usually enters. In some seeds the micropyle is visible when the seed is mature, but usually it is closed by cuticle or wax. In the bean it can be seen near the hilum. The raphe is seen as a slight ridge along one side of some seeds. The raphe is the result of the fusion of the funiculus to one side of the ovule (bean and pansy). The area at the end of the vascular tissue of the funiculus is known as the chalaza. Sometimes a rough outgrowth called a caruncle develops near the hilum (castor bean). An additional or partial covering outside the seed coat develops on some seeds (water lily) after fertilization. It is called an aril.

The outer surfaces (epidermis) of some kinds of seeds may have characteristic modifications. Cotton fibres are formed as extensions of some of the epidermal cells of the seed coat. In contrast a smooth cuticle forms on the epidermis of the lima bean seed and makes the surface hard and shiny.

The seeds of flax have thickenings of the epidermal cell walls

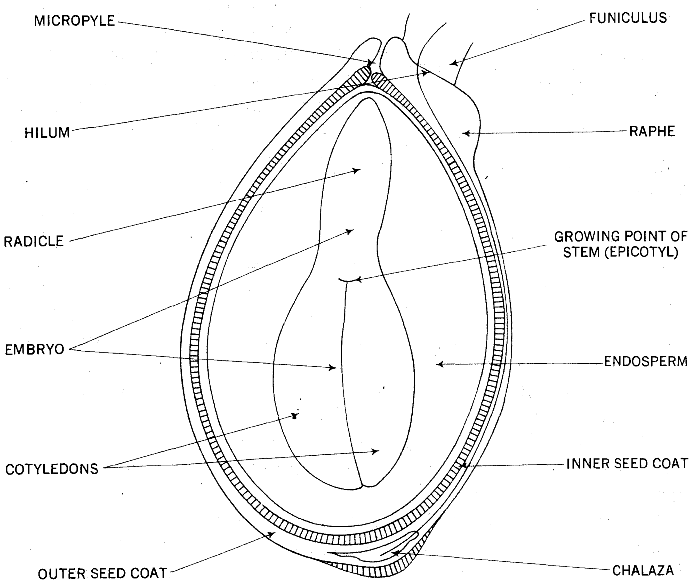

FIG. 4.— SEEDOF PANSY (VIOLA TRICOLOR), CUT VERTICALLY

that swell in water and become gelatinous. In turnip. cabbage and related seeds a network of ridges. formed as a result of differences in heights of epidermal cells, gives the seeds a characteristic pitted appearance.

The general form of different kinds of seeds is in part determined by the orientation of the ovule with respect to the placenta on which it is borne. Four types of orientation have been described The orthotropous, or atropous, ovule is straight and erect with the micropyle in line with the funiculus. The anatropous ovule is completely inverted with the funiculus fused along one side so that the micropyle is close to the hilum. The campylotropous ovule is curved to bring the micropyle near the chalaza The ovule is called hemitropous when it is half inverted but straight and with the hilum on the side of the ovule.

Composition. — Not only the structure and form but also the compositions of different kinds of seeds show great variation. The cotyledons of soybeans and peanut have a high oil content, but in bean the oil is replaced by starch. The seeds of all legumes have a high protein content. In cereals (corn. wheat, etc.) the embryos are high in oil and protein, but the endosperm, which occupies the greater portion of the seed, is high in starch. The oil of the castor bean seed is in the cells of the endosperm. A few seeds, *e.g.,* onion, contain sugar as a reserve food. The immature seeds of sweet corn and garden pea contain much sugar, but most of it changes to dextrin or starch by maturity. Layers of hemicellulose are deposited as thickenings of the cell walls of the endosperm of carrot, date and other seeds, and serve as food reserve.

Adaptations for Distribution. — The seed represents an inactive state in the life history of the plant and thus is itself an adaptation for distribution in space. The seed is relatively insensitive to changes of surroundings and lends itself admirably to transportation from place to place by wind, water and animals. It was for this reason also that the seed made possible the development of agriculture by primitive man—the seed could be kept from one crop season to the next and could be carried from one region to another. As man selected plants for food. the seeds of many crop plants tended to lose their natural ability for survival in the wild and became largely dependent on man for preservation from season to season.

Special forms and structures of seeds and fruits. adapting them for wide distribution, have developed during the evolution of plants. These adaptations vary greatly in nature, as do the means used for distribution.

Wind Distribution. — Wind is an important factor in seed distribution. The very small size of many seeds may be considered as an adaptation that allows them to be borne long distances in the air. Small grass seeds have been collected by airplanes at elevations from 200 to 3.000 ft.

The dandelion bears many one-seeded fruits to which are attached tufts of fine hairs that act as parachutes or sails. The seed of the milkweed when it bursts out of its pod has similar hairs that aid the wind in carrying it abroad. The cattail head has countless closely packed. tiny seedlike fruits, each with fine hairs attached; when the fully ripe head is disturbed, the expansion of the closely packed hairlike attachments pushes the seeds out into the wind to be carried away.

The much heavier seeds or seed-bearing fruits of pine. maple and ash trees have large, flat wings that permit the seeds to glide a moderate distance from the mother tree.

In some plant kinds the adaptation for distribution by wind is found in the form and structure of the entire plant rather than in the form of the seed or fruit. Several species of plants. belonging to different families but all known as tumbleweeds, are bushy and when mature nearly spherical. The main stem at the soil surface is weak and breaks readily. As the wind rolls these detached plants across fields and plains the seeds gradually are loosened and fall to the soil. The Russian thistle and the tumbling mustard are common examples.

Many wild plants shed some of their seeds in winter after snow has fallen, and these may be blown considerable distances on the frozen surface of the snow.

Water Distribution. — Water is another natural agent for the dissemination of seeds and fruits. Aside from resistance to germination with the first absorption of water. the principal adaptation for water distribution is low specific gravity, permitting many seeds and fruits to float for long periods. One of the most noteworthy examples is the fruit of the coconut, which has a fibrous outer coat with many air spaces and a smooth outer surface. Shortly after a new island had been formed in the Pacific ocean by a submarine volcano in the Krakatoa group of islands, many germinating coconuts were found on the volcanic sand of the beach; some had sent down roots and become established plants.

In addition to the coconuts, seedlings of several other tropical plants were found. all having developed from seeds washed up on this barren beach from distant islands. The seeds had floated long distances undamaged by sea water because of their protective coatings.

Animal Distribution. — Animalsand birds are other agents for seed dispersal. After a walk in the fields in autumn, a person may find many seeds and burs attached to his clothing. These burs cling equally well to the fur of passing animals. Different species of plants have evolved various special forms for attachment, but all depend on projections with recurved hooks at the tip or with tiny reversed teeth. The devil's pitchfork. the flattened fruit of a plant of the sunflower family, has two long prongs with many reverse pointing barbs. The stick tight is the pod of a plant of the pea family that has tiny spines with hooked tips; the pods are jointed and easily break apart into one-seeded segments. The cocklebur is a two-seeded bur with comparatively long hooked spines.

Fleshy fruits and berries may be considered as special adaptations of the plant that serve to aid in the distribution of seeds by animals and birds. The seeds of most fleshy fruits have tough coverings that resist digestion. The seeds remain in the excrement. ready to grow when they are deposited in some new location. The fruit of the mistletoe has a sticky covering, so that the seeds stick to the beaks of birds, to be scraped off later on the bark of a tree.

Distribution by Expulsion. — Some fruits have special adaptations that violently expel the seeds to distances of several fret from the mother plant. The pansy and the violet have three-parted pods thatsplit into three boat-shaped segments. As the ripe pod dries, the sides of each segment close together and violently expel the seeds, one at a time. The two halves of the pod of the vetch and of other legumes split apart, and then each half twists and curls'. thus violently throwing the seeds for some distance. The seeds of the touch-me-not or impatience are borne in a pod that develops strong differences of tension. When the fruit is ripe these tensions are so great that the least touch will cause the pod to split apart; the segments curl violently and expel the seeds to a distance of several feet.

Adaptations for Preservation. — Seeds may be adapted not only for distribution in space but also for preservation of their viability over unfavourable conditions, thus providing distribution in time. When mature the seeds of many plants, especially weeds and native species. are dormant and require special conditions before they will germinate. Some seeds, notably those of the pea family, have seed coats impervious to water (hard seeds). This impervious coat must be weakened by bacterial action in the soil or by mechanical scarification (scratching or splitting the seed coat) or other treatment before the seeds can absorb water and germinate.

The seeds of many winter annual weeds (*e.g.*, chickweed, shepherd's purse and upland cress) that ripen in late spring or summer do not germinate while the weather is still warm, b'ut they start to grow with cool fall temperatures. Other seeds germinate only after the moist seeds are exposed to light. As long as they remain buried in the soil the seeds are dormant, but when they are brought to the surface and receive light they germinate. It has been found that this response to light is controlled by a reversible photoreaction that also controls stem elongation, leaf expansion, flowering and other plant responses (see PHOTOPERIODISM). Germination of light-sensitive seeds is promoted by red light and prevented by radiation near the limit of visibility (far red). The seeds of many temperate zone plants have deep-seated and prolonged dormancy. The embryos must undergo chemical and growth changes (afterripening) before germination

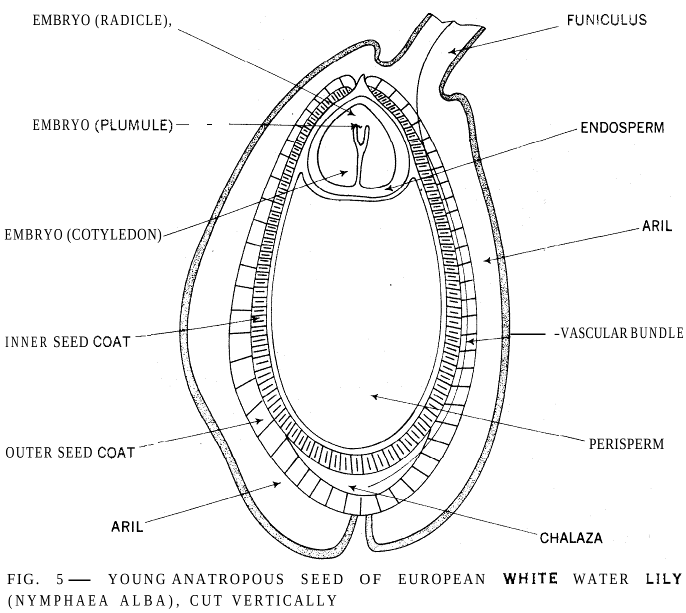

FIG. 5 — YOUNG ANATROPOUS SEED OF EUROPEAN WHITE WATER LILY (NYMPHAEA ALBA), CUT VERTICALLY

is possible. Most such seeds (many trees and shrubs) afterripen when held moist and cool for varying periods. In nature afterripening occurs as the seeds lie in moist ground for one or more winters. It may be accomplished artificially by holding the seeds in moist sand or other media at temperatures a little above freezing for one to several months, the period depending on the species. (See PLANT PROPAGATION.)

Longevity. — The longevity of seeds of different kinds of plants

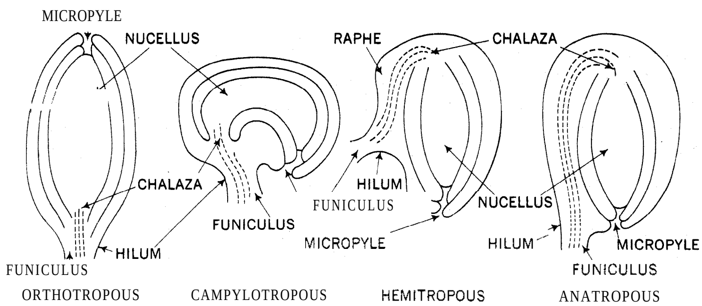

FIG. 6.—TYPES OF OVULES

varies greatly. Hard impervious coats protect the embryos so that they may persist for many years. Seeds of legumes taken from herbarium specimens knonn to be more than 100 years old have germinated. A very striking example of long life is shonn by the seeds of the oriental lotus (*Nelumbo nucifera*); these were recovered from an ancient peat bog in Manchuria and germinated and produced flowering plants. Radiocarbon dating of seeds from the same source indicated an age of approximately 1.000 years. In contrast to this the seeds of willow and poplar remain viable only a few weeks. The seeds of many plants, especially weeds, may remain viable for many years when buried in the soil. In an experiment in which seeds of 107 species were buried in the soil so as to permit recovery, those of 51 kinds grew after 20 years and those of 36 after 39 years. Seeds of both crop plants and weeds were included The longevity of field and garden seeds depends on the moisture content of the seeds and on the temperature at which they are held. Low moisture and low temperature ensure long life. Vegetable seeds are sometimes dried and sealed in moisture-proof containers by seedsmen so that they will retain their viability even in a humid. warm climate. See SEED TESTING; SEED TRADE: HORTICULTURE; FRUIT; NUT. See also references under "Seed" in the Index volume.

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SEED TESTING. The scientific testing of seeds before planting, recognized as an essential aid to agriculture, is performed to determine the value of seeds for planting. Such testing reveals. for example, the proportion of seeds labeled white clover that are actually white clover seeds, the percentage of these that could produce plants, and the presence of seeds of noxious weeds.

Development. — Seed testing developed first in Europe with the rapid expansion of agriculture in the second half of the 19th century. The practical application of botanical knowledge to determine the value of seeds for planting apparently developed more or less simultaneously in several countries. but leadership usually is credited to Frederick Nobbe, who established a laboratory for testing seeds in 1869 at Tharand. Ger. Within a few years seed-testing laboratories were started in Denmark, the Netherlands and Switzerland. E. H. Jenkins. of Connecticut, while studying in Europe. was much impressed with the seed-testing work of Nobbe. Jenkins included in the 1876 report of the Connecticut Agricultural Experiment station a statement of the possible advantages of seed studies to American agriculture. Late in the 19th century botanists and agronomists at various state agricultural experiment stations tested seeds for farmers and determined the quality of those on the market. During this period, W. J. Beal of Michigan and C. E. Bessey of Nebraska were especially active in laying the foundations for seed testing in North America and interesting their students in seed studies. G. H. Hicks, a student of Beal, organized seed-testing work in the United States department of agriculture in 1896.

Governmental Controls. — The early work by several states and by the department of agriculture showed that much of the seed in commerce had low germination capacity, contained seeds of many weeds and often was adulterated with seeds of similar appearance but with low agricultural value. Much seed that had no other use than for the adulteration of other seed was imported. The generally low quality of seeds led, early in the 20th century, to the passage by several states of laws regulating the sale of seeds. These laws all were based on the premise that the farmer should have the details as to the quality of the seeds he bought. They required that all agricultural seeds be labeled as to percentage of pure seeds, inert matter, other crop seeds and weed seeds and as to the percentage of pure seeds capable of germination. Most state laws also designated the weeds especially troublesome in the respective states as "noxious weeds" and required a listing of the seeds of any such noxious weeds and a statement as to their rate of occurrence.

Each state controls the sale of seeds within its borders, just as it does the sale of other materials, but the federal government has power to control importations and interstate shipments. The first federal law concerning seeds, enacted in 1912 and administered by the United States department of agriculture, referred only to the purity and the weed-seed content of a few agricultural seeds. After several successive amendments. a new Federal Seed act, which prohibited the importation of all important agricultural and vegetable seeds unless they met certain minimum standards of purity and germination, was passed by congress in 1939. This act also required the truthful labeling as to purity and germination of agricultural and vegetable seeds entering into interstate commerce. The Federal Seed act is brought up to date by amendments from time to time. The foregoing is only a general outline of the practices of seed control and does not cover all features.

As might be expected. the seed-testing practices used in the United States followed in general those developed in continental Europe. Although the general methods of seed testing are similar, the details of the control of seed sales vary greatly in the different European countries. In Canada a system of seed grades has been developed to replace the labeling for purity, germination, and so forth. These grades represent an attempt to evaluate the different qualities of seed lots. Seed control in Canada is under the dominion government. The laboratory seed-testing procedures used in Canada, like those of the United States, are for the most part similar to those developed in Europe.

Testing Procedures. — The first step in seed testing is to be certain that the sample of seed accurately represents the lot of seed from which it is drawn. If the sample tested is not representative, the results of the test cannot accurately indicate the value of the entire lot of seed. Procedures for adequate sampling of seed lots have been worked out.

Purity. — The separation of four components of a seed lot is known as the "purity test." A representative portion of the seed sample of suitable weight is separated first into seeds and other material called "inert matter" (chaff, stems, fungus bodies, dirt, etc.). The seeds are separated into pure seeds (as labeled), seeds of other plants grown as crops, and seeds of weeds. Each portion is weighed and the percentage of each is calculated. Each kind of seed is identified and listed. Because even very small proportions of noxious weed seeds are important, a much larger sample than is used for the regular purity test is examined for the presence, the identification and the rate of occurrence of each kind of noxious weed seed found. Seeds of many kinds of weeds occur in the different crop seeds, and many of these are superficially similar to the crop seeds or to each other. The seeds of some related crop plants are very much alike and separable only by special study. Identifications are based mainly on the analyst's familiarity with the seeds but may be based on comparison with correctly identified samples or with illustrations. An analyst needs thorough knowledge of plant classification and must be familiar with the appearance of many kinds of seeds.

Seed as it comes from the harvester contains much foreign material and may carry excessive weed seeds. This seed must be processed to make it as clean as possible. Many seed companies have their own analysts who make many special tests at different stages of processing to evaluate the success of the cleaning operations. Also, successive germination tests may be made to learn the effectiveness of attempts to remove immature or injured seeds.

Viability. — The viability of seeds is determined directly by finding whether the seeds will germinate. This measurement of viability is not as simple as it may appear to be. Seeds are young plants whose growth processes have been suspended. In general these growth processes are resumed when the seeds are supplied with moisture and placed at a suitable temperature for germination. Nature, however, has developed various special provisions in certain kinds of seeds to prevent germination under conditions unfavourable for seedling development. Even in the absence of special requirements, seeds of different kinds have different moisture and temperature needs. Living seeds are subject to many hazards during harvesting, processing, storage and shipping. A seed does not lose life all at once, but certain parts may be injured or certain organs may die before others. Because the purpose of seed testing is determination of the value of seeds for planting, a seed cannot be counted as germinated unless it is able to develop into a plant capable of continued growth. A seed may show some signs of life and yet be worthless to the farmer. The evaluation of seedlings (determination of which seedlings can develop into useful plants) is an important part of the germination test and it requires much experience as well as knowledge about plant structure and normal plant development.

In order to handle many samples and to provide standard reproducible conditions, analysts carry out most viability tests under artificial but controlled conditions. They provide a suitable material to supply moisture (the substratum). This may be blotting paper, absorbent paper, moss, sand or suitable sterile soil. The substratum used varies with the kind of seed, the test conditions and the space available. Counted seeds are spaced on a suitable moist substratum and placed in a cabinet maintained at sufficiently high humidity to prevent drying of the substratum and at a temperature optimum for the particular type of seed. Many seeds, including clover and onion, must be kept cool to germinate; others, such as watermelon and cotton, must be kept warm. For good germination, seeds of bluegrass and many other plants must be kept cool at night and warm during the day. At suitable intervals, as the seeds germinate, the normal seedlings, which have all essential parts for a plant, are removed and the number recorded. Standard times for making counts of each kind of seed have been worked out.

Dormancy. — For varying periods after harvest some seeds of some species will not germinate under conditions usually favourable for germination. Such seeds are called "dormant" and must not be confused with dead seeds. The potential value of dormant seeds for planting can be determined by special procedures. For example, freshly harvested wheat will germinate if the temperature is lowered 5° to 10° C. below the usual temperature for germination, or if the seeds on the moist substratum are held at a few degrees above freezing for three to seven days. Freshly harvested bluegrass seeds and the seeds of some varieties of lettuce will germinate only after a suitable exposure to light.

Hard Seeds. — Seeds of some plants of the pea and morning-glory families have impermeable coats (the seeds do not absorb water when put on a moist substratum). These are known as "hard seeds" and are recorded separately and reported separately on the analysis label. Hard seeds usually are viable, and their viability can be checked by scratching the coat in some manner and then placing the seeds under suitable conditions for germination. The proportion of impermeable seeds of some crop plants increases with increased dryness of the surrounding air. The agricultural value of hard seeds varies greatly with the species or variety and the proposed use of the seeds.

Chemical and Other Tests. — Many attempts have been made to estimate the viability of seeds without actually germinating them. These methods depend on measuring by physical or chemical means some one characteristic of a viable or of a dead seed. Because the development of a useful plant depends on many processes in many tissues of the seed, none of these quick methods has been entirely successful. The most nearly successful quick test, developed by Georg Lakon of Germany, depends on soaking the seeds in a weak solution of a salt of tetrazolium. Certain enzymes of the viable embryo reduce the colourless soluble salt to an insoluble red compound. The method has definite value for obtaining the approximate viability of seeds that require a long time to germinate, but it does not. promise to supplant the usual germination test.

Seed tests of other types are often required. With the development of many new varieties with special adaptations it is increasingly important for a grower to know whether a seed lot is of the variety shown on the label. Usually the variety cannot be determined by examination of the seeds. Often it is necessary to plant the seeds and grow mature plants. Sometimes, however. the variety can be identified in the seedling stage, either directly from seedling appearance or from differential responses to special growing conditions such as temperature or length of day. For example, commercial seeds of annual rye grass having awns broken off cannot be separated by appearance from the awnless seeds of perennial rye grass, but they can be distinguished by a chemical property of the seedlings. The roots of young seedlings of annual rye grass growing on filter paper change the paper in contact with the roots so that it shows a blue fluorescence under an ultraviolet lamp in a dark room. Seedlings of perennial rye grass do not cause this change.

The region of origin of a seed lot can often be determined from the presence in the sample of weed seeds, incidental soil or rock particles characteristic of the region. It may be important to know the origin because seeds reproduced for many years in a given region may. by natural selection, have developed qualities that make them of little or of great value for crop production in some other region.

A few seed laboratories in the United States, as well as Canadian and most European laboratories. determine whether seed-borne plant diseases occur in seed samples. The fungi causing the diseases are identified from spores washed from the seeds or developed on young seedlings. Sometimes distinctive symptoms develop on the seedlings.

The moisture content of seeds may be determined in connection with other seed tests. A sample for a moisture test must, of course, be submitted in a moisture-proof container. Interest in seed moisture arises from the knowledge that high moisture content is an important factor in the loss of seed viability in transit and in storage.

Statistics. — The special problems of statistics as applied to seed testing have received much attention. A knowledge of statistics and of normal distribution is important because the tests are made on a small sample of the seed lot. A second small sample will differ in composition from the first, and therefore it is important to know the amount of variation that normally may be expected. "Tolerances" have been applied in seed-law enforcement because of these expected variations of small samples.

Seed-Testing Associations and Rules. — Early in the development of seed testing it became obvious that many definitions and methods of procedure must be established and that these should be uniform in different laboratories. This need led to the organization of seed-testing associations that agreed upon rules and procedures. In 1896 a committee of the Association of American Agricultural Colleges and Experiment Stations described standard seed-testing apparatus and outlined methods of procedure for testing seeds. This information was published in 1897 as Circular 34 of the United States department of agriculture. The formation of the Association of Official Seed Analysts of North America in 1908 assured more formal co-operation. This association. which consists of workers engaged in seed testing in the several states, the United States department of agriculture and the Canadian department of agriculture, continues to be increasingly active. The development of rules for the testing of seeds was one of the main objectives of this association. The first formal rules, adopted in 1917, have repeatedly been revised. brought up to date and published by the association. The United States department of agriculture also publishes rules and regulations as required for the enforcement of the Federal Seed act. These two sets of rules are in very close agreement.

Those doing seed testing for commercial seed companies have formed the Society of Commercial Seed Technologists. This group co-operates closely with the Association of Official Seed Analysts.

An International Congress of Seed Testing was held in Europe in 1905 and at several subsequent times. In 1924 the International Seed Testing association. which has continued to bring about uniformity of seed testing to facilitate international commerce in seeds, was organized. Procedures for testing seeds have been similar in the different countries: but differences in definitions and in interpretations have developed. As a result reports from different countries on tests of the same lots of seed have not always been in agreement. The International Seed Testing association adopted international rules for seed testing at a congress in 1931, but it was not until 1953 that complete agreement was reached and truly uniform international rules were adopted.

Developments in Seed Research. — The improvement of seed testing to make it increasingly useful to agriculture has been based on seed research. Not only those engaged in testing seeds but also botanists interested in the classification of plants and plant physiologists interested in life processes have advanced knowledge about seeds.

Detailed studies of similar-appearing seed types have revealed characteristic differences of form, markings or structure by which the seeds can be distinguished. The results of such studies are the basis of illustrations, descriptions and keys used in the identification of seeds.

Other studies have shown that high seed moisture and high temperature during storage are causes of weakened seeds that eventually die. The weakened seeds produce seedlings of reduced vigour and also abnormal seedlings that cannot grow into useful plants. The difficulties of the interpretation of the results of germination tests are increased by seedlings of borderline value. It has been found that mechanical injuries to seeds during harvesting and processing often result in abnormalities and death.

The research of many workers has shown that the germination of different kinds of seeds is benefited by exposure to light during germination and also that the germination of a few kinds is prevented by exposure to light. It was found that the promotion of germination is caused by a comparatively narrow band of light in the red portion of the spectrum and that seeds promoted by this red light can be prevented from germinating by exposure to far-red light (near the limit of visibility). Whether a seed is promoted or inhibited by white light depends on the relative sensitivity of the particular kind to red or to far-red radiation.

Studies of the germination requirements of seeds of many species that are very difficult to germinate have demonstrated that many of these grow promptly after they are held on a moist substratum at a temperature just above freezing for from one to several months. Rose and apple seeds are typical examples.

Further research may reveal physical or biochemical methods of distinguishing similar-appearing kinds of seeds. The moisture and temperature conditions needed to keep seeds viable are known, but the changes within seeds that lead to weakness and death have had little study. The results of such studies would aid in developing better means of maintaining seeds at high vitality, thus reducing the amount of low-quality seed on the market. Very little is known about the changes within seeds that result in dormancy or about the internal processes that accompany the overcoming of dormancy. Further knowledge about such changes would make it possible to devise more dependable methods of determining seed viability.

See also SEED TRADE: and articles on individual plants, such as CORN; COTTON. etc.

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(E. H. T.)

SEED TRADE. Seeds are the essential beginning of most farm and horticultural crops, and therefore a basic factor in agriculture, which in turn is vital to the life and prosperity of every country. Much responsibility thus rests on the shoulders of those who grow and distribute seeds. Factors affecting the production of satisfactory food crops include seed, soil type, fertilizers, cultural methods, weather and control of insects and diseases. Unless seed true to name and of high quality is sown, the crop may be a commercial failure even though all other factors are at an optimum level. For greatest success not only should the seed be of high quality and true to name, but it should also have high vitality and be free of disease organisms and weed seeds. To ensure that the demand for high-quality seeds is met is the constant concern and duty of the seed trade.

Early Beginnings.—Man has grown and saved seed ever since he began cultivating plants. Seed growing as an industry, however, was hardly recognized as such until the early 18th century. The first commercial production of seed occurred in northern European countries, but this was followed within the same century by similar production in North America. The Shakers in New York state developed a business of growing and distributing to home gardeners over a dozen different kinds of vegetable and herb seeds. In the early 19th century some acreage of garden pea seed was grown in Ontario for the D. Landreth company, a U.S. firm. By 1847 this same company had 250 ac. of pea seed in Pennsylvania. Seed acreages increased steadily after that.

Prior to actual seed production in the United States, a number of seed dealers, of whom David Landreth was the first (in 1784), became established, principally in Philadelphia, but also in New York and Boston. These merchants imported seeds from European producers, and, until World War I, Europe continued to be the chief source of vegetable seed for most of the world. With the advent of that war, and again as a result of the dire need for seed in World War II, commercial seed production in the United States was greatly increased, as was seed production in Australia and New Zealand. In times of peace there is considerable interchange of seed on a commercial scale, not only between seed-producing countries and those that do not grow seed, but between the former countries themselves.

Climate and Seed Production.—During the 20th century climate has become more of a determining factor in the location of areas where seed is grown than earlier in the history of the seed trade. This has been especially true within the United States, where there has been, and still is, a definite movement toward greater seed production in the western states. Low precipitation supplemented by adequate supplies of irrigation water has made it possible to produce vigorous crops free from disease. During the period of seed maturity and harvest dry air and absence of rain facilitate the collection of high-quality seed. In Europe some northern seedsmen arrange for certain crops to be grown in countries to the south, where ideal conditions for seed productiop exist.

Various areas of the world have become associated with the production of certain seed crops. Among the producers of field seeds, Canada is known for the production of alfalfa, various clovers and grasses. Many of these same crops, except alfalfa, are grown in Denmark in sufficient quantity for export. France has long been a big producer of various field seeds; so also has Italy. All the field seeds are grown in large quantities in the United States, and, in spite of the movement in production to the western part of the country, over one third of the principal field seeds were produced in the north central states in the 1950s. Before World War II Czechoslovakia, Rumania and Poland supplied large quantities of these seeds, and Hungary was noted for production of clovers.

Such vegetables as cabbage and related crops, as well as spinach and beets, thrive best under conditions of high humidity in areas adjacent to the sea; hence they are widely cultivated for seed in the northern European countries such as the Netherlands, Denmark and England; as well as around the Puget sound area of the Pacific northwest in the United States. Japan also produces such types of seed extensively. In both Europe and Japan curing of the seed often presents difficulties because of inclement weather. In such regions the moisture content of seed sometimes has to be reduced by artificial drying even after it has been cleaned.

In southern France and Italy, as well as in parts of adjacent countries, such vegetable seeds as lettuce, endive, onion and carrot, which require dry atmospheric conditions prior to and during harvest are widely grown. Similar crops, and in addition peas, beans and sweet corn, are grown in the western United States except in the Pacific northwest. California, with a wide range of climatic conditions, grows a greater variety of such seeds than any other state, but they are also widely cultivated in Idaho and the eastern sections of Oregon and Washington and to varying degrees in other western states. Some seed crops such as tomatoes, peppers, eggplants and watermelons, and to a lesser extent the other vine crops, are often grown for seed in the same regions where they are cultivated for processing and marketing. While tropical countries are not normally considered as a source of seed for temperate climates, there is some evidence that such seed can often be successfully grown if the crop is planted at the correct time at a high elevation where temperate climatic conditions exist.

Many of the flower seeds are grown in the Netherlands, France, England and the United States, particularly California, and to a lesser extent in the Pacific northwest and some eastern states.

Size of Industry.—The seed industry has considerable economic value aside from its importance as a source of seed for other varied businesses. Seedsmen, or at least seed dealers, are located in practically every country of the world. In those countries where seed is grown on a commercial scale there are large capital investments in office buildings, warehouses, seed and many types of farm and specialized machinery necessary for the handling of seed crops, as well as trucks, other vehicles and the innumerable items associated with a highly diverse type of business. Figures on actual acreages and production are not available for the seed industry as a whole. Statistics collected by the agricultural marketing service of the U.S. department of agriculture give an idea, however, of the extent of production in that country. In general total seed acreage remains fairly constant from year to year, although acreage of individual kinds of crops may fluctuate greatly. Field seeds (alfalfa, grasses, clovers, etc.) excluding small grains were harvested from well over 3,000,000 ac. every year during the 1950s. At the same time 170,000 to over 200,000 ac. were devoted annually to the production of vegetable seeds.. Of this latter acreage approximately 95% was occupied by the large-seeded vegetables—beans, peas and sweet corn—and 5% by over

35 small-seeded vegetables. In contrast to the large acreages devoted to farm and vegetable seeds, there are about 6,000 to 7,000 ac. of flower seeds in the United States. Seed acreages in Europe, while differing as regards specific crops and varying from year to year like those in any seed producing area, are in general of the same over-all magnitude.

Types of Activity. — Seed production is a rather complex business enterprise in which the actual growing of seed is only one of many activities. Comparatively few seed companies are involved in seed-growing operations. Most of them as jobbers or retailers handle seed as a commodity rather than as a product which they produce. Many producers are also wholesalers and as such often operate large organizations among whose employees are plant breeders, production supervisors and fieldmen, warehouse men, seed analysts, salesmen and others. Often among warehouse employees are men especially trained to operate the numerous seed cleaning machines. Jobbers aid in the distribution of seed through their buying and selling operations. Retailers are most numerous in the trade. Most of them operate small stores, the business of which is not limited to seed. Some large producers retail their products by mail through seed catalogues. In such catalogues field seeds may be merely listed as to name and price, but the varieties of vegetables and flowers are often illustrated and described in detail. Still other producers market their seed by means of commission packets placed in hardware, grocery and other types of stores. All this activity is part of the seed trade.

Growing the Seed.—The production of seed requires special knowledge and aptitudes and at times the exercise of considerable skill. In general two types of seed are produced and handled by all seed growers — stock seed and market seed. Stock, foundation, or "mother" seed is seed grown and used by seedsmen to produce market seed. Market seed is the product which is sold. Stock seed must be of the highest quality, and in particular it must be absolutely pure as regards variety. It is the seedsmen's most prized possession, for on it much of his reputation as a seedsman rests, and without good stock seed no producer can long stay in business and make a profit.

In growing the seed, and particularly stock seed, the best cultural practices must be employed and care must be'taken to ensure adequate isolation from growing crops of a similar kind in order to prevent cross-pollination with related plants. Plants of the same species found growing along the margin of the field are cut down before they develop flowers and endanger the purity of the seed crop by cross-fertilization. Weeds particularly should be kept to a minimum in seed crops. They not only compete with the crop for moisture and nutrients, but their seeds become mixed with those of the crop and later can be separated only with difficulty. During the growing season, especially when the seed crop is approaching the flowering stage, all plants which show characteristics dissimilar to those of the particular variety under cultivation are carefully removed — a process known as roguing. With root and bulb crops which have to be dug and replanted after the root or the bulb has matured, off-type plants are usually rogued at that time. Severe roguing is more essential in a crop of stock seed than it is in market seed. The latter often needs no roguing if grown from strictly selected stock seed. Harvesting at the proper stage of maturity calls for great care and experience. If the seed is harvested too early, yields and quality may be reduced by immature seed; if harvested too late seed may be lost by shattering or shedding. Methods of harvesting, curing and threshing vary according to the kind of seed produced, as well as the country or section in which it is groun. Machinery is commonly used wherever possible in harvesting and threshing operations. However, some of the flower seeds are grown on such a small scale that even if a machine could be used it would hardly be feasible. Where machines are used, they have to be thoroughly cleaned of seed between each crop. Although production and handling procedures are fundamentally alike for all seeds, those followed nith field seeds do differ in some respects from those required for vegetable and flower seeds.

Field Seeds. — Trade in field seeds flows in general in two directions, particularly within the United States. This comes about largely because in certain regions the production of field seeds was a regular part of the cropping system prior to the period when specialty growers were becoming more common. The farmer producing clover or grass seed commonly sells to a local jobber or elevator man, who is either an agent of some wholesaler or is in touch with the general market. Such lots are shipped to a large dealer by whom the seed is cleaned, graded, bulked and bagged in accordance with quality and designated by the various grade names used by the dealer. Sales are then made to country merchants who, in turn, sell to the farmer. In some seed-producing sections, especially those far removed from terminal markets, large dealers have established plants in which field seeds are cleaned prior to shipment to a central warehouse.

Many field seeds are a world commodity. Price thus often depends on the available supplies in countries offering seed for sale. There is consequently a more or less constant movement back and forth, and a given lot of clover seed, for example, may be exported and later imported, depending on price fluctuation.

Production of Field Seeds. — Although field seeds are grown extensively by general farmers, there is a definite trend toward production by special growers. With the increasing development of new varieties and strains of alfalfa, grasses and clovers specially selected for definite regions, growers having the proper aptitude find it profitable to devote much of their farming operations to seed production. The steadily increased use of certified varieties of field seeds has done much to encourage growers to specialize in seed production. Within the United States crop improvement associations were formed in most of the states, and these organizations established certification services in conjunction with public agencies, such as experiment stations, state extension services or state departments of agriculture. Through a system of inspections and detailed records officials are able to certify that crops grown by properly authorized farmers are true to name, free of varietal and mechanical mixtures, noxious weeds, etc. Similar certification practices have been established in Canada as well as in some European countries. An International Crop Improvement association has been in existence since 1919. Certification procedures for growing seed became necessary with the release of improved varieties from experiment stations and similar agencies. Certification tags on each bag of seed assure the purchaser that he has high quality seed of the variety that he wants.

Verification of Origin. — Before the development of improved varieties it was discovered through experimentation that commercial alfalfa and red clover seed grown in one country or in one section within a country were not always adapted to other areas having different soil and climatic conditions. In 1927 a seed verification service was inaugurated in the United States. This service verifies the origin of much of the domestic uncertified alfalfa, red clover and open-pollinated field corn and sees that the seed is so labeled. Imported alfalfa and red clover seed are artificially coloured to indicate country of origin. Verification of origin will continue to be a necessary service so long as the old common varieties are offered for sale.

Vegetable and Flower Seeds. — The production of vegetable and flower seeds tends to be more specialized than that of the field seeds. and control of the industry is maintained more within the trade itself. Practically all vegetable and flower seedsmen have their own stock seed of each variety that they handle. Such seed is usually grown by the seedsman on his own farm under his direct supervision. In contrast, most market seed, the volume of which normally exceeds by many times that of the stock seed, is grown under contract. Seedsmen make contracts with farmer-growers who grow the market seed from stock seed supplied by the seed company. Such a practice is common in all the large seed-producing areas of the world. Any unused stock seed, together with all the market seed produced, is the property of the seed company. The grower is paid on the basis of a certain price per pound of clean seed produced. Contract growing has come about partly because of the great diversity of vegetable and flower seed crops. and partly because many of these are grown for seed in areas other than those where they are commonly grown as a food or an ornamental. There are over 40 different kinds of vegetables and literally thousands of varieties. The number of kinds of flowers is even greater, and each of these in turn has many varieties. Much of the competition within the vegetable and flower seed industry is the development of new varieties and the maintenance of superior strains of standard ones. Certification of vegetable seeds is extremely limited and that of flower seeds practically unknown.

Many companies, almost by necessity, operate on an international scale. Northern European companies may produce their stock seed in their home country but, through branches or through contract arrangements nith other companies or individuals, grow much of their market seed in a country more suited to such production. A number of U.S. firms have production stations in widely separated sections of the United States, and in addition sometimes make arrangements for market seed to be grown for them in Europe, Japan, Mexico or elsewhere. Likewise European seedsmen have some of their supplies grown in North America.

Breeding and Selection. — With the tremendous increase in knowledge of plant genetics and modern techniques of plant breeding, the specialist in this field has become of increasing importance to progressive seed companies. Not only do such companies often wish to develop new varieties of their own, but they also need to increase new releases from experiment stations and other government agencies. Since such varieties have often been developed for resistance to such factors as diseases, insects. heat, cold and drought, they may also wish to transfer if possible such characteristics to already established varieties. Such programs require skilled plant breeders and often considerable investment on the part of the company. The increasing production of first-generation or F_1 hybrids cf corn (both field and sweet), onions, tomatoes, sorghums, petunias and other crops often necessitates elaborate breeding and production programs. *See* also PLANT-BREEDING.

Processing Seeds. — Preparing seeds for market is a most important function of the wholesale dealer. All seeds as they come from the producer contain a certain proportion of dirt and weed seeds, all of which must be removed. Large dealers are equipped with cleaning mills of various kinds. Although screening and fanning mills are still the basic equipment required for seed processing, many ingenious and specialized machines for handling seeds have been developed. Equipment is available so that seeds can be separated on the basis of specific gravity, friction, adhesion, light and colour (by electric eye), as well as handled by the old standard procedures. Processing includes more than cleaning. With the increasing use of precision planting machines, seeds often need to be bulked on the basis of rather exact sizes, and this some seedsmen are prepared to do. In all plants of any size, seed is processed in line, which means that from beginning to end of the operation, the seed is mechanically transferred from one machine to the next without having to be set aside to await further handling. Such co-ordination of machinery to maintain an even flow requires skillful supervision by trained personnel. Throughout such operations a complete record of the various seeds being processed has to be maintained so that no mixtures occur. As the processing of each is completed, it is labeled as to its lot number, variety, strain, grower, etc., so that the seedsman can, if necessary at a later date, easily trace its history.

Legislation Affecting the Trade. — Many countries and most states within the United States have laws regulating the sale of seed, but these laws vary in detail. In general, such laws require the giving of certain information covering percentage of purity, of germination and of weed seeds present, place of origin, and similar facts. In some states the sale by trade of seed containing more than a specified number per unit of weight of certain noxious weed seeds, such as dodder, is prohibited. Owing to the fact that seed laws are not uniform in the various states, large dealers are compelled to attach various tags to shipments in accordance with the laws of the state to which the seed is consigned. Some weeds are considered noxious in one state or region but not necessarily so in another.

Laws in many countries regulate the importation of seeds and affect the movement of seed in international trade. Import licences are required in some countries. By such means domestic producers are often protected. Domestic prices may be maintained at a higher level than otherwise and domestic production is encouraged. There are regulations in a number of countries to limit the sale of seed to those varieties which have been tested and approved by governmental agencies. A seedsman's problems are therefore by no means disposed of when he has grown and processed a crop of seed. He may still have the task of placing it in trade.

Seed-Testing Laboratories. — Most large wholesale producers have established seed-testing laboratories and employ competent seed analysts. All lots of seed entering the warehouses of such firms are tested for purity and germination. If the seed is held unusually long in storage prior to sale, a further test for germination is often made. Under some laws the date of germination test has to be indicated on the tag. Most countries and states have official government seed-testing laboratories, which check on the purity and germination of seed in commerce and determine whether the information on the tag is correct. Such laboratories are sometimes authorized to test seed for seedsmen and others under some sort of fee system.

Trial Grounds. — Most reputable seedsmen grow samples of all their seed lots, as well as many from their competitors, in what is generally referred to as a trial ground. New varieties from experiment stations, other government agencies and other growers are included. A trial ground may often occupy many acres. Samples are usually grown in comparatively short rows, the actual length depending on the crop and the wishes of the seedsman. The planting, care and note-taking in a trial ground may take a considerable investment in ground, labour and technical personnel, and yet if a company is going to be sure of the performance of its stocks, operating a well-managed trial ground is essential. A good trial ground can also be an advertisement for the company, as customers can see and compare the performance of the different varieties planted in adjacent rows. Flower trials are the most colourful of all. In all trials varieties that are offered under more than one name can frequently be identified.

See also SEED TESTING.

See W. A. Wheeler and D. D. Hill, *Grassland Seeds* (1957); *L.* R. Hawthorn and L. H. Pollard, *Vegetable and Flower Seed Production* (1954). (L. R. H.)

SEELEY, SIR JOHN ROBERT (1834–1895), English essayist and historian, was born in London on Sept. 10, 1834. His father. R. B. Seeley, was a publisher, and author of several religious books and of a life of Edward I. Seeley was educated at the City of London school and at Christ's college. Cambridge, where he was head of the classical tripos and senior chancellor's medalist, was elected fellow and became classical tutor. For a time he was a master at his old school, and in 1863 was appointed professor of Latin at University college, London. His essay *Ecce Homo*, published anonymously in 1865, and afterward owned by him, caused much controversy at the time. His later essay on *Natural Religion* (1882), which, premising that supernaturalism is not essential to religion, maintains that the negations of science tend to purify rather than destroy Christianity, satisfied neither the Christian nor the scientist. In 1869 he was appointed professor of modern history at Cambridge, where he gave stimulating lectures.

His *Life and Times of Stein* (1878) is a lengthy narrative of the anti-Kapoleonic revolt, led by Prussia mainly at Stein's instigation. The famous essay, the *Expansion of England* (1883), shows how and why Great Britain gained its colonies and India, the character of its empire and the light in which it should be regarded: it secured him the title of knight commander of St. Michael and St. George in 1894. His last book, *The Growth of British Policy*, written as an essay and intended to be an introduction to a full account of the expansion of Great Britain, was published posthumously. He died at Cambridge on Jan. 13. 1895.

See G. W. Prothero's article on Seeley in the *Dictionary of National Biography.* (*M. R. D.* F.)

SEGANTINI, GIOVANNI (1858–1899), Italian painter, known as a painter of the Alps and hard peasant life. was born at Arco in the Trentino on June 15, 1858. His mother died when he was four and his father went to Milan, leaving Giovanni in the care of a poor relative. At the age of seven the child ran away to the mountains and was employed by peasants as a herdsman. He spent long hours of solitude in drawing. His fame became known to the local authorities, who sent him to the school of art at Milan. In 1882 he settled in Brianza near Como and four years later sought the Swiss Alps, finally settling in the Engadine among the humble shepherds and farmers. There he gave himself up to the study of mountain life, and became in truth the painter of the Alps.

The "Ave Maria" took a gold medal at the Amsterdam exhibition (1883). The atmosphere of this picture is clear and crystalline. and his figures stand out in sharp relief. "The Drinking Trough" received a gold medal in Paris (1889) and "Ploughing in the Engadine" (Munich Pinakothek) gained a gold medal at Turin (1892). Besides those works in which he studied simple effects of light and Alpine scenery, such as "Midday on the Alps" and "Winter at Savognino," he also painted symbolical subjects: "The Punishment of Luxury" and the "Unnatural Mothers." He died on Sept. 28, 1899, at Maloja, Switz., where a museum contains many of his works, including the great unfinished triptych of "The Alpine World."

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SEGESTA (Gr. Egesta), an ancient city of Sicily. 8 mi. W.S.W. of the modern Alcamo and about 15 mi. E.S.E. of Eryx. It was the chief city of the Elymi, a people for whom a Trojan origin was claimed by Thucydides; they are archaeologically indistinguishable in the Early Iron Age (first half of the 1st millennium B.C.) from their Sicanian neighbours. Segesta became in its material culture almost a Greek city, but generally took the Phoenician side against its Greek neighbours; disputes with Selinus over questions of boundary were frequent from 580 B.C. onward. One of the ostensible objects of the Athenian expedition to Sicily in 41j was to aid Segesta against Selinus in a dispute about questions of boundary and rights of marriage. After the Athenian debacle, the Segestans turned to Carthage; when in 409 B.C. Hannibal. son of Gisgo. established the Carthaginian power in western Sicily, Segesta became a dependent ally. It was besieged by Dionysius in 397 B.C. In 307 Agathocles marched on the city, massacred many of its inhabitants, sold the rest into slavery and changed its name to Dicaeopolis; but it soon recovered its old name and returned to the Carthaginians. Early in the first Punic War, however, the inhabitants massacred the Carthaginian garrison and allied themselves with Rome; they had to stand a severe siege from the Carthaginians (260 B.C.). Segesta was treated with favour by the Romans; it was a free city and perhaps the territory of Eryx was assigned to it. It is little heard of under the Roman empire. The theatre, of the 3rd century B.C., and an unfinished temple of the 5th century B.C. are well preserved, and there are fragmentary remains of houses and the town walls.

See R. van Compernolle, "Ségeste et l'Hellénisme," *Phoibos,* vol. v, pp. 183–228 (1950–51). (T. A.; T. J. DN.)

SEGHERS, CHARLES JEAN (1839–1886), Belgian Roman Catholic priest, missionary, twice bishop of Vancouver Island and archbishop of Oregon City, was born at Ghent on Dec. 26, 1839. Although his parents died while he was a young boy, Charles Seghers received a good education. and his preparation for the North American missions was made at the American Seminary of Louvain. He was ordained on May 31. 1863, and soon embarked for the diocese. of Vancouver Island. His labours in this diocese were interrupted by his attendance at the Vatican council as theologian" to his bishop, Modeste Demers, whom he succeeded in March 1873. The new prelate continued his missionary activity in the northwest and Alaska until his appointment as coadjutor to the archbishop of Oregon City in 1878. His several visitations in his new archdiocese took him to Idaho, Montana, northern California and throughout Oregon. When the archbishop, Francis N. Blanchet, retired, he was succeeded by his coadjutor. who received the pallium at Portland, Ore., on Aug. 15, 1881. Archbishop Seghers' immediate task was the development of the Catholic school system. In 1883 he journeyed to Rome with other U.S. archbishops to prepare the schema for the proposed Baltimore council, which he attended in 1884. While he was in Rome, the see of Vancouver Island became vacant. whereupon Seghers offered to return to his former diocese since a successor was more readily available for Oregon than the more northern diocese. He repossessed the see of Vancouver Island on April 2, 1885. During a visitation to Alaska, he was murdered by a demented companion on Nov. 28, 1886.

See Maurice de Baets, *Apostle of Alaska: Life of Charles John Seghers,* Eng. trans. by Sister Mary Mildred, S.S.A. (1943). (F. G. McM.)

SEGHERS (SEGERS), **HERCULES PIETERSZ** (1589/90–*c.* 1638), Dutch painter and etcher of stark, fantastic landscapes, was born in 1589 or 1590, probably in Haarlem, and became a pupil of Gillis van Coninxloo in Amsterdam. In 1612 Seghers entered the painters' guild in Haarlem but was back in Amsterdam by 1614. In 1631 he resided in Utrecht, and in 1632 or 1633 he moved to The Hague. Early reports indicate that he was lonely and poor, even though several artists, including Rembrandt, gave evidence of their admiration for his work. Seghers' style contrasts strongly with the main aspects of the Dutch output of that period; most of his works would have been difficult to understand prior to their rediscovery in the 20th century.

The majority of Seghers' works represent forbidding mountain scenes with jagged cliffs, desolate valleys, broken tree trunks and scant traces of human habitation. They usually are of an entirely imaginary character. Rembrandt's painted landscapes were deeply indebted to such works. Seghers painted and etched a smaller number of serene panoramas of his native countryside which deeply influenced Dutch painters of the "national" school such as Jan van Goyen, Rembrandt's etchings and Seghers' imitator Jan Ruyscher (called "Young Hercules"). In some of Seghers' works, motifs of both trends are combined. He also executed architectural motifs, still lifes of a morbid type, and a few copies after older masters. Seghers' etchings belong to the most original and impressive experiments in the whole history of print making. He used different-coloured inks and often printed on coloured or dyed paper and even on canvas; the diversity in the appearance of each individual print was increased by his adding accents by hand. The one large collection of original etchings, in Amsterdam, indicates Seghers' colouristic daring and technical skill. Approximately 6j different etchings are known. most of them in few impressions only. One plate was later owned by Rembrandt, who reworked Seghers' figures of Tobias and the Angel into those of a Flight into Egypt.

Seghers' paintings are rare; few are documented, and a large number of forgeries exist. His *Mountain* Landscape in the Uffizi in Florence was formerly attributed to Rembrandt who seems to have altered parts of it.

See Jaro Springer, *Die Radierungen des Herkules Seghers (Graphische Gesellschaft, Veröffentlichungen,* no. xiii, xiv, xvi) (1910–12); Leo C. Collins, *Hercules Seghers,* with many debatable attributions (1953); articles by J. G. van Gelder in *Oud Holland* (1950, 1953); Catalogue, *Hercules Seghers Exhibition,* Museum Boymans, Rotterdam (1954). (W. SIT.)

AL MORTON

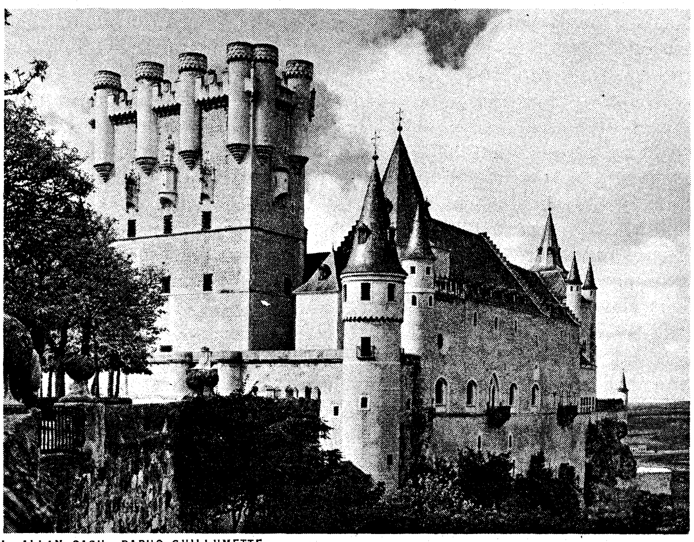
SEGO LILY (CALOCHORTUS NUTTALLII), A SPECIES OF MARIPOSA

SEGO LILY (*Calochortus nuttallii*), a Sorth American plant of the lily family (Liliaceae), native to dry soil from South Dakota to Washington and south to California and Oregon. Its slender stem rises from a coated corm and bears narrow leaves and large, beautiful, somewhat tuliplike, white flowers, variously marked with yellow, purple and lilac. Like manna in the wilderness, the edible roots are said to have been used for food by the early Mormon settlers in the Salt Lake valley. The plant has since been identified with the symbolism of the Mormon Church in Utah, of which state it was formally adopted as the floral emblem or state flower. See

MARIPOSA LILY.

SEGOVIA, a town and province in Old Castile. Spain. Pop. (1960 est. mun.) 34,711. The town lies north of the Cordillera Central (Cordillera Carpetovetónica), 3,297 ft. above sea level and 87 km. (54 mi.) N.W. of Madrid by road. Founded about 700 B.C., it was an important place in Roman times. It was taken at the beginning of the 8th century by the Moors, from whom Alfonso VI recaptured it in 1079. Thereafter Segovia enjoyed prosperity and a position of some importance in medieval Castile. During the reign of the emperor Charles V the revolt of the *comuneros* (common people) caused some destruction. An outbreak of plague at the end of the 16th century ushered in a long period of decadence, but the town's fortunes began to revive with the railway-building era in the 19th century.

There are two well differentiated areas: an upper town encircled by ancient walls situated on a narrow limestone ridge between the Eresma and its tributary the Clamores; and a lower part outside



J. ALLAN CASH—RAPHO GUILLUMETTE

ALCAZAR. A CASTILIAN STRONGHOLD BUILT MAINLY IN THE 14TH AND 15TH CENTURIES AND EXTENSIVELY RESTORED AFTER 1862

the walls. The centre of the old town is the Plaza Mayor (or del Generalísimo Franco) on one side of which stands the cathedral and from which streets lead into the outer suburbs. Crossing the Plaza del Azoguejo, the focal point of the town's communications, is the Roman aqueduct known as El Puente. It is one of the finest and best preserved examples of its kind, built probably in the reign of Trajan, from dark coloured Guaderrama granite without the use of mortar. Still in use, the aqueduct consists of a double tier of arches and carries water from the Rio Frío for about half a mile across the valley outside the old town. At its highest point above the ground it stands 934 ft. high.

The 16th-century Gothic cathedral was designed by Juan and Rodrigo Gil de Hontaiion to replace the church destroyed during the revolt of the *comuneros*. Construction began in 1525 and was virtually finished by 1577. There are also several other fine ecclesiastical buildings including the Romanesque churches of San Esteban (12th–13th century) with a superb tower; San Martin (12th century); la Trinidad (11th–12th century); San Lorenzo (12th centuryj; San Millán (12th century); Vera Cruz (13th century), the former church of the Knights Templar; and San Juan de los Caballeros (11th and 12th centuries), now the Museo Zuloaga of ceramics. Across the Eresma is the Gothic Hieronymite monastery of El Parral and also outside the walls is the Dominican convent of Santa Cruz (15th century) founded by Ferdinand and Isabella and now a welfare centre. In the Carmelite convent (17th century) is the tomb of St. John of the Cross.

The Alcázar, mentioned as early as the 12th century, was the fortified palace of the kings of Castile. Most of the original palace was destroyed by fire in 1862 but has since been extensively restored. There are many houses and palaces built between the 15th and the 17th centuries. Modern buildings include the palace of justice and the offices of the civil government. Segovia has an artillery academy in the former convent of San Francisco, a provincial museum and an archaeological museum.

In the late middle ages Segovia was the centre of a flourishing textile industry, As this declined agriculture took its place. The town now has factories for rubber, pottery, flour, biscuits, artificial fertilizers, cement. chemical products, etc.

Segovia is linked by road and rail with Madrid and also with the north of Spain.

SEGOVIA PROVINCE (area 2,683 sq.mi.; pop. [1960 est.] 213,793), formerly part of Old Castile, is bounded north and northeast by Burgos and Soria, southeast by Guadalajara and Madrid, southwest by Ávila and northwest by Valladolid. It is primarily an agricultural tableland. 2.500 ft. above sea level. producing wheat, rye, barley, hemp, flax and vegetables, and also rearing sheep, cattle, mules and pigs. The sierras in the province are quarried for granite, marble and limestone. The province is traversed by the Madrid-La Coruña railway which passes through its capital, the only city of importance.

Segovia was the scene of heavy fighting during the first months of the Spanish civil war. (M. G. SA.)

SEGRÈ, EMILIO GINO (1905–), U.S. physicist. cowinner of the Nobel prize in physics for 1959 with Owen Chamberlain for the antiproton discovery, was born in Tivoli, Italy, on Feb. 1, 1905. He took his doctor's degree in physics at the University of Rome in 1928. He has been on the staffs of the Universities of Rome and Palermo. After 1946 he was professor of physics at the University of California at Berkeley. After 1948 he was also at the Lawrence Radiation laboratory of the Gniversity of California. Segrè became a U.S. citizen in 1944.

An associate of Enrico Fermi when the epoch-making discovery of slow neutron efiects was made in Rome in 1934, he discovered (1937) the first artificial element, technetium. while at Palermo, using materials irradiated in one of the Berkeley cyclotrons. At Berkeley he made the first chemical separation of nuclear isomers. changed by chemical means the radioactive decay constant of berylllium and took part in the discoverv of the element astatine and of plutonium-239, of which he determined the slow neutron fissionability. He has done extensive researches in high energy physics, including the discovery, with Chamberlain, Clyde E. Wiegand and Thomas Ypsilantis, of the antiproton in 1955. (E. M. Mc.)

SEGREGATION, RACIAL, the practice of restricting people to certain limited areas of residence or to separate institutions (schools, churches) and facilities (parks. playgrounds. restaurants, restrooms) on the basis of race. In the United States such restrictions developed primarily as one aspect of relations between whites and Negroes, especially in the south, although other groups, such as Chinese and Japanese, have at times been affected. But segregation and the establishment of colour bars are not confined to the relations between white and coloured populations; coloured races—Asian Mongols. African Bantus, American Aztecs—have been great conquerors throughout the ages and have practised discrimination including segregation of subject races. The most extreme system of segregation, in which occupation as well as race and religion were equally important elements, prevailed in the caste system of Hindu India (*see* CASTE [INDIAN]). The history of racialist theory and thinking and studies of racial attitudes are dealt with in the article INTERRACIAL RELATIONS. (See also APARTHEID and related material under ANTI-SEMITISM; CLASS, SOCIAL: GHETTO.) For the U.S. supreme court decision in the case of *Brown* v. *Board* of *Education* (1954) declaring racial segregation in public schools to be unconstitutional *see* EDUCATION, HISTORY OF. (*See* also NEGRO, AMERICAN, and *Education* sections of articles on individual states.)

Segregation appears always as a means of maintaining the economic advantages and the superior social status of the politically dominant racial group. This does not lead necessarily to spatial or physical segregation because the social segregation of the subordinate group may be maintained through a system of etiquette and symbols and exclusion from intimate social contacts that would reduce the social distance between the races. In an urban industrial society it becomes more difficult to maintain the physical and spatial segregation of races, and more dependence must be placed upon institutions to maintain it. Consequently, as the result of segregation. the races live in different social worlds and communication between them is restricted no matter how close they may be physically.

Racial segregation as an ecological process should be differentiated from racial segregation which is the result of a conscious or deliberate social policy. As an ecological process racial segregation is in a sense a natural process since it results from a relatively impersonal competition between races for space or land. An example of racial segregation as an ecological process is the concentration of Negroes in the areas of the U.S. south known as the Black Belt. These areas were congenial to development of the plantation system of cotton production (*see* SOUTH, THE: *Biracial Population*). Ecological segregation may also be seen in cities where in the absence of legal enactments or social pressure various racial and cultural groups. because of their economic status. have created Little Sicilies, Jewish ghettos and black belts. It should be noted, however. that racial segregation as an ecological process is not a purely biotic or symbiotic phenomenon as among subhuman living organisms. Among human beings there is always social interaction involving the influence of customs and laws and human sentiments. During the process of ecological segregation human beings seek close association with those who have the same interests or similar traditions and values. Even within the same racial and cultural communities there is ecological segregation on the basis of age. sex, education, occupation and income. Hence, the social process can never be completely separated from the ecological process except for the purpose of analysis.

As far as the economic relations of races are determined solely by competition, a racial division of labour may emerge which results in the "segregation" of racial groups in different occupations. The racial division of labour is rarely due to an impersonal competitive process but more generally reflects the distribution of power in a community. Thus. the system of Negro slavery and the economic organization of life in the U.S. south as well as in the colonial areas in Africa represented a racial division of labour, but in all these cases the relation between that division and the distribution of power is clear.

When, however, members of different races have access to the same education the racial division of labour tends to break down. If competition on an individual as opposed to a racial basis is not permitted racial conflicts arise and the politically dominant race attempts to maintain its superior status by establishing a system of racial segregation.

The distribution of power in a biracial community is not only important in determining the economic relations of races but it is of equal importance in determining their social relations or their status in the social order. In fact, race relations can only be said to exist where, as sociologist Robert E. Park has stated, "racial differences enter into the consciousness of the individuals and groups so distinguished, and by so doing determine in each case the individual's conception of himself as well as his status in the community."

The phenomenon of racial segregation has appeared in all parts of the world where there are biracial communities except where racial amalgamation has occurred on a large scale. as in Hawaii and Brazil. In Brazil, where there has never been a system of racial segregation, the dominant economic and political position of the whites was never challenged by the rise as a group of persons of Negro derivation to economic and political power. In the transformation from a feudal to a middle class society in the 19th century the mulatto was the most mobile element in the military, economic and political sectors of Brazilian society. (*See* BRAZIL: *The People.*) On the other hand, in the southern states of the United States the emancipation of Negroes brought them into economic competition with the white working class, and during Reconstruction following the American Civil War it was the political power of the Negroes that helped to consolidate the power of northern industrial capitalism. Since the proportion of Negroes in the population of the south has decreased and their concentration in the Black Belt has declined there has been some relaxation of segregation in public relations. But the white working class continues to refuse to permit Negro workers to compete, especially in white collar occupations where status is important. and whites of all classes continue to exclude Negroes from participation in political power.

The problem of racial segregation is present in the multiracial communities of central Africa and east Africa but it has been most acute in South Africa. In South Africa the National party has attempted to maintain the dominance of the white minority through the policy of apartheid or racial segregation in the spatial, economic, political and social relations of the races. The white minority had already undertaken to maintain its economic position and social status by a colour bar in industry. The urbanization of the native or Bantu population and the dependence of industry upon native labour tend to nullify the spatial and economic segregation. But the whites have been able through force and the threat of force to exclude the unarmed natives and other coloured peoples — Cape Coloureds (q *v.*) and Asians — from political power, and to maintain a system of racial segregation in all social relations.

Whereas in the United States it appears that racial segregation in the public relations of the races tends gradually to disappear where Negroes offer no threat to the economic and political power of whites. in South Africa racial segregation appears as a desperate attempt on the part of the white minority to maintain its dominance despite the economic and political forces in the situation which are opposed to racial segregation.

See also references under "Segregation, Racial" in the Index volume.

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SÉGUIER, PIERRE (1588–1672), chancellor of France, was born in Paris on May 28. 1588, of a famous Quercy legal family. Pierre was brought up by his uncle. Antoine Séguier, *président à mortier* in the parlement, and became master of requests in 1620. From 1621 to 1624 he was intendant of Guienne, where he became closely allied with the duc d'Épernon. In 1624 he succeeded to his uncle's charge in the parlement, which he filled for nine years. In this capacity he showed great independence with regard to the royal authority; but when in 1633 he became keeper of the seals under Richelieu, he proceeded to bully and humiliate the parlement in his turn.

Séguier became allied with the cardinal's family by the marriage of his daughter Marie with Richelieu's nephew, César du Cambout, marquis de Coislin, and in December 1635 he became chancellor of France. In 1637 Séguier was sent to examine the papers of the queen. Anne of Austria, at Val de Grâce. According to Anquetil, the chancellor saved her by warning her of the projected inquisition

In 1639 Séguier was sent to punish the Normans for the insurrection of the Nu-Pieds. the military chief of the expedition, Gassion. being placed under his orders. He put down pillage with a strong hand. and was sufficiently disinterested to refuse a gift of confiscated Norman lands. He was the submissive tool of Richelieu in the prosecutions of Cinq-Mars and François Auguste de Thou in 1642.

His authority survived the changes following on the successive deaths of Richelieu and Louis XIII., and he was the faithful servant of Anne of Austria and of Mazarin. His resolute attitude towards the parlement of Paris made the chancellor one of the chief objects of the hatred of the Frondeurs. On Aug. 25, 1648, Séguier was sent to the parlement to regulate its proceedings. On the way he was assailed by rioters on the Pont-Neuf, and sought refuge in the house of Louis Charles d'Albert, duc de Luynes. In the course of the concessions made to the Fronde in 1650, Séguier was dismissed from his office of keeper of the seals. He spent part of his retirement at Rosny, with his second daughter Charlotte and her husband, the duke of Sully. He was recalled in April 1651, but six months later, on the king's attaining his majority, Séguier was again disgraced, and the seals were given to President Mathieu Molé, who held them with a short interval till his death in 1656, when they were returned to Séguier. Séguier lived for some time in extreme retirement in Paris, devoting himself to the affairs of the academy. When Paris was occupied by the princes in 1652, he was for a short time a member of their council, but he joined the king at Pontoise in August, and became president of the royal council.

After Mazarin's death in 1661 Séguier retained but a shadow of his former authority. He showed a great violence in his conduct of the case against Fouquet (*q.v.*), voting for the death of the prisoner. In 1666 he was placed at the head of a commission called to simplify the police organization, especially that of Paris; and the consequent ordinances of 1667 and 1670 for the better administration of justice were drawn up by him. He died at St. Germain on Jan. 28, 1672.

Séguier succeeded Richelieu as official "protector" of the Academy, which from that time (1642) until his death held its sessions in his house.

See F. Duchesne, *Hist.* des *chanceliers* de France (fol. 1680); for the affair of Val de Grâce, Catalogue de documents *historiques . . . relatifs au règne* de Louis *XIII.* (Paris, 1847); also R. Kerviler, Le Chancelier P. *Séguier* (Paris, 1874). Great part of his correspondence is preserved in the Bibliothèque Nationale, Paris.

SÉGUR, the name of a French family, the first member of which to attain distinction was FRANÇOIS DE SEGUR, better known as the seigneur de Sainte-Aulaye (d. c. 1605), who professed the reformed religion, and was closely associated with Henry IV., becoming in 1576 president of his council. Jean-Isaac, marquis de Ségur (d. 1707), fought in most of the campaigns of the France of his time, and remained loyal throughout the troubles of the Fronde. His son, HENRI JOSEPH, marquis de Ségur (1661–1737), was lieutenant-general of Champagne and Brie, governor of Foix. In his youth he was the hero of an episode of gallantry with Anne of Beauvilliers, abbess of La Joye, which led to the suggestion that she was none other than the Portuguese nun of the famous Letters. (But see ALCOFORADO, MARIANA.) His son, HENRI FRANÇOIS, comte de Ségur (1689–1751), was colonel at seventeen, when he succeeded to the command of the Ségur regiment, which his father had raised. In 1718 he began a thirty years' tenure of the lieutenant-generalship of Champagne and Brie. He had married in that year Angélique de Froissy, a natural daughter of the regent, Philip of Orleans, but the death of his father-in-law a few years later prevented his reaping special advancement from his marriage, though Mme. de Ségur belonged to the inner circle of Louis XV.'s intimates.

Ségur served in Italy during the war of the Polish Succession under Marshal Villars, and became, in 1736, inspector-general of cavalry. In 1738 he was sent to Nancy as lieutenant-general under Marshal Belle-Isle, and to Bohemia in 1741 with the French troops allied with the Bavarians. But in September 1741 he was compelled by the imperial troops to surrender at Linz. In 1744 he was again sent to Bavaria, and defeated the Austrians at Lichtenau on Jan. 28, 1745. He served throughout the Flemish campaigns of 1746 and 1747, and was commandant of Metz at the time of his death (June 18, 1751).

OCTAVE-HENRI GABRIEL DE SÉGUR (1778–1818), elder son of Louis Philippe de Ségur, served in the later Napoleonic campaigns, and remained in the army under the Restoration. He threw himself into the Seine on Aug. 15, 1818. The domestic unhappiness that led to his suicide is retailed by the comtesse de Boigne in her *Mémoires* (vol. i., 1907). His eldest son, EUGÈNE, comte de Ségur, succeeded his grandfather in the peerage in 1830. He married Sophie Rostopchine (1799–1894), daughter of Count Feodor Rostopchine, governor of Moscow. The countess of Ségur wrote some famous books for children, the most familiar of which are perhaps the *Malheurs* de Sophie and the *Mémoires d'un âne,* and many tales in the *Bibliothèque* rose. Her letters to her daughter and son-in-law, the count and countess de Simard de Petray, were published in 1891, and those to her grandson in 1898.

RAYMOND JOSEPH PAUL, comte de Ségur d'Aguesseau (1803–1889), third son of Octave de Ségur, took his mother's family name in addition to his own. He studied law at Aix and Paris. As *procureur général* of Amiens he gave in March 1830 a decision on the question of the electoral lists which pleased the liberal party, but late in the year, as substitute in the royal court of Paris, he ordered the suppression of certain liberal journals, and in other civil appointments was accused of reactionary administration. He gave his adhesion to Prince Louis Napoleon, and became a member of the consultative commission in 1851, and of the senate in 1852. After the fall of the empire he retired into private life.

PIERRE MARIE MAURICE HENRI, marquis de Ségur (1853–1916), wrote a life in 1895 of the marshal de Ségur, which was crowned by the French Academy. His book on Madame Geoffrin, Le Royaume de la *rue Saint-Honoré* (1897), also received a prize. His principal work is the three volumes devoted to Marshal Luxembourg—La Jeunesse du *maréchal* de Luxembourg, *1628–1668* (1900); Le *Maréchal* de Luxembourg et *le prince d'Orange, 1668–1678* (1902); Le *Tapissier* de *Notre-Dame. Dernières années* du *maréchal* de Luxembourg, *1678–1695* (1904); *Julie* de *Lespinasse* (1905), English Transl., 1907; and Au couchant de la monarchie *Louis* XVI. et Turgot, *1774–1776* (Paris, *1910*). He was elected to the French Academy in 1907.

There is much general information on the family of Ségur in A. de Ségur's Le *Maréchal* de *Ségur, 1724–1801* (Paris, 1895), and in L. P. de Ségur's Recueil de *famille* (1826).

SEGUR, PHILIPPE HENRI, MARQUIS DE (1724–1801), marshal of France, son of Henri François, comte de Ségur, served under his father in command of an infantry regiment in Italy and Bohemia. He lost an arm at Lauffeld in 1747. In 1748 he succeeded his father as lieutenant-general of Champagne and Brie; he also received in 1753 the governorship of the county of Foix. He fought in the Seven Years' War and in 1760 he was taken prisoner at Kloster-campen. As minister of war (1780–87) under Necker he created in 1783 the permanent general staff, and made admirable regulations with regard to barracks and military hospitals. In 1783 he became a marshal of France. During the Terror he was imprisoned in La Force, and after his release was reduced to considerable straits until in 1800 he received a pension from Napoleon.

Ségur died in Paris on Oct. 3, 1801.

See A. de Ségur, Le *Maréchal* de *Ségur, 1724–1801* (1895).

SEGUR, PHILIPPE PAUL, COMTE DE (1780–1873), French general and historian, son of Louis Philippe, comte de Ségur, was born in Paris on Nov. 4, 1780. He served with General Macdonald in the Grisons in 1800–1801, and published an account of the campaign in 1802. By the influence of Colonel Duroc (afterwards duc de Frioul) he was attached to the personal staff of Napoleon. He served through most of the important campaigns of the first empire, and was frequently employed on diplomatic missions. He remained in the army at the Restoration, but, having accepted a command from Napoleon during the Hundred Days, he was retired until 1818, and took no further active part in affairs until the revolution of 1830.

During his retirement Ségur wrote his *Histoire* de *Napoléon* et de *la* grande *armée* pendant *l'année* 1812 (Paris, 2 vols., 1824), which ran through numerous editions, and was translated into several languages. The unfavourable portrait of Napoleon given in this book provoked representations from General Gourgaud, and eventually a duel, in which Ségur was wounded. On the establishment of the July monarchy he received, in 1831, the grade of lieutenant-general and a peerage. In 1830 he was admitted to the French Academy, receiving the grand cross of the Legion of Honour in 1847. After the revolution of 1848 he lived in retirement. He died in Paris on Feb. 25, 1873. His works include: *Histoire* de *Russie* et de Pierre *le Grand* (1829); *Histoire* de

Charles *VIII.* (2 vols., 1834–1842), in continuation of the history of France begun by his father; and the posthumous *Histoire et mémoires* (8 vols., 1873).

See *Un* Aide-de-camp de Napolton *(1800–1812), mémoires* du *général* comte de *Ségur,* new edition by his grandson Louis de Ségur (3 vols., 1894–1895), of which an abridged English version was published in 1895.

SEGUSIO (mod. *Susa*), an ancient town in north Liguria, the capital of the Cottii *(see* COTTII REGNUM). Here the son of King Donnus, Cottius—who held the rank of imperial praefect over the 14 tribes over which his father had ruled as king--erected a triumphal arch in honour of Augustus in 9–8 B.C., which is still standing. Claudius restored the royal titles to the family; but, after the death of its last member, Nero made the district into a province. It was strongly fortified and garrisoned, and remains of its walls, including those of a double-arched gate, exist. Constantine captured the town, which offered some resistance to him. on his march against Maxentius.

SEMESTED, HANNIBAL (1609–1666), Danish statesman, born at Arensborg Castle on Ösel, was'kducated abroad, returned to Denmark in 1632 and was attached to the court of Christian IV. Two or three years later he was sent to Wismar to negotiate a treaty with the Swedish chancellor, Axel Oxenstjerna, and, if possible, bring about a match between Christian's son Frederick and Gustavus Adolphus's daughter Christina. Though failing in both particulars, he retained the favour of the king, who betrothed him to his daughter Christine, then in her tenth year, whom he married in 1642. In May 1640 Sehested became a member of the *Rigsraad.* In 1642 he was appointed viceroy of Norway (April 1642). He sought to develop Norway's material resources, and reorganize her armaments and fiscal system; and he aimed at giving her a more independent position as regards Denmark. During Christian IV.'s second war with Sweden (1643–1645), Sehested, as viceroy of Norway, assisted his father-in-law materially. He invaded Sweden four times; successfully defended Norway from attack; and he won an engagement at Nysaker in 1644. After the war he renewed his reforming efforts, and during the years 1646–1647 he succeeded with the help of Christian IV. in creating a separate defensive fleet for Norway and giving her partial control of her own finances. Sehested's success, and still more his accumulation of money and honours aroused the distrust of the Rigsraad and the envy of his rivals.

Charges of embezzlement and peculation were brought against him. and he surrendered his private property in Norway *to* the Crown. From 1651 to 1660 he lived abroad. In the summer of 1657 he returned to Denmark, but Frederick III refused to receive him, and he hastily quitted Copenhagen. During the crisis of the war of 1658 he was at the headquarters of Charles X of Sweden. In seeking the help and protection of the worst enemy of his country, Sehested approached the very verge of treason, but, as soon as he was assured that the case of Denmark was not hopeless, he began to work in its interests in Sweden. In 1660 Frederick III allowed him to return to Copenhagen, and finally made him plenipotentiary to negotiate with the Swedes. The treaty of Copenhagen, which saved the honour of Denmark, was largely Sehested's work. He was one of the willing abettors of Frederick III at the revolution of 1660, when he re-entered the Danish service as lord treasurer and councilor of state. As a diplomatist he, in some respects, anticipated the views of Griffenfeldt, supporting the policy of friendship with Sweden and a French alliance. He died suddenly on Sept. 23, 1666, at Paris, where he was conducting important negotiations. His "political testament" is perhaps the best testimony to his liberal and statesmanlike views.

See Thyra Sehested, Hannibal Sehested (1886); Julius Albert Fridericia, Aldelsvaeldens sidste Dage (1894).

SEHORE, a town and district in the Bhopal division of Madhya Pradesh, India. The town, headquarters of the district, lies near the confluence of the Siwan and Latia streams, 20 mi. W.S.W. of Bhopal on the Bhopal-Ujjain railway. Pop. (1961) 28,462. It became the headquarters of the British agent of the former princely state of Bhopal in 1818. It is an important trade centre, and an annual fair called Hardaul Lala mela is held in December.

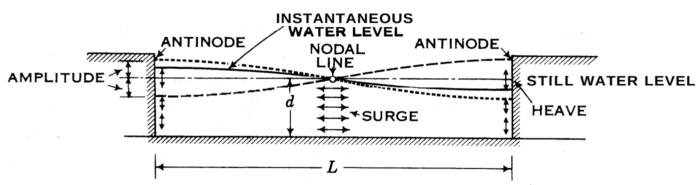
SEHORE DISTRICT (area 3,600 sq.mi.; pop., 1961, 755,017) was formed by the merger of the former Bhopal state with Madhya Pradesh. It extends to the eastern margin of the Malwa *(q.v.)* plateau drained by the Betwa river. The soil is mainly black cotton soil; 44% of the total area is arable and 24% under forests. Wheat, jowar, cotton and linseed are the principal crops. There is a heavy electrical equipment plant at Bhopal *(q.v.)*, the capital of Madhya Pradesh. Other industries include cotton textiles, sugar, paper and straw products. (S. M. A.)

SEICHE, a free oscillation of fluid in an enclosed or semi-enclosed basin. The word originated centuries ago (supposedly from Lat. *siccus,* "dry," hence exposed) to describe the occasional tidelike rise and fall of water at the narrow end of Lake Geneva, Switzerland. Its rhythmic movement was noted first by N. F. de Duillier (1730); that it was common to other lakes and related to atmospheric conditions was observed by Jean Pierre Vaucher (1803). But to F. A. Forel (1869–95) belongs the credit for recognition of its essential character and origin. Forel's classic work incited continuing observational and hydrodynamic studies of lake and sea oscillations of which G. Chrystal's (1904–09) are most noteworthy. Refinements to Chrystal's theory were contributed by A. Defant (1929) and J. Proudman (1952).

Forel recognized that a pure lake seiche is in effect an interaction of two equal long waves, traveling in opposite directions. Their resultant is a standing wave that remains fixed in position while the water surface see-saws about nodal line or lines, at still water level. Between nodes, peaks and troughs are known as antinodes If the distance between antinodes is a multiple or submultiple of the length of the lake (for uniform depth), the standing wave fits exactly into the length (see figure). It is then capable of resonating since repeated reflections contribute additional synchronous standing waves which accumulate amplitude. Only bottom friction and viscous turbulence prevent indefinite amplitude-growth. Such a resonant standing wave system constitutes a seiche. Equal opposing progressive waves, that are not commensurate with the lake length, produce interfering standing waves, on repeated reflection. tending to annul each other. Thus when the water in a basin is disturbed, incommensurable wave motions die out rapidly while commensurable ones develop as persistent seiches.

The fundamental seiche in a closed basin is uninodal, as in the figure. Forel discovered that binodal. trinodal and other multinodal seiches were often coexistent with the fundamental. These several modes of oscillation are higher harmonics of the fundamental seiche, the binodal seiche, for instance, being second harmonic. The periods of harmonics (time intervals between successive antinodal peaks) are usually integral submultiples ($\frac{1}{2}$, $\frac{1}{3}$, . . .) of the period of the fundamental; departure from this is a feature of irregular, variable-depth basins. Periods of seiches depend exclusively on basin-dimensions and mode of oscillation. As examples. the fundamental, second and third harmonic periods of Lake Constance (Switz.) are 55.8, 39.1 and 28.1 min.; of Loch Earn (Scot.) 14.5, 8.0 and 6.0 min. Lake Erie has a fundamental period of 13.1 hours; the Aral Sea 22.8 hours. In general, periods are proportional to basin length L, and inversely proportional to the square root of water depth d.

Unlike lakes. coastal bays and inlets require the node of any seiche to be at the mouth where the basin communicates with a



SCHEMATIC REPRESENTATION OF **A UNINODAL SEICHE** IN **A** BASIN OF UNIFORM DEPTH (see TEXT)

larger body of water. The even harmonics of such basins are normally suppressed and periods thus tend to the harmonic order of 1, $\frac{1}{3}$, $\frac{1}{5}$, ...

An important property of pure seiches is that water-particle movements are all linear synchronous oscillations. At the nodes surge movements are horizontal, and greater in range than the antinodal vertical range by a factor of $L/\pi d$. At the antinodes, heaving movements are entirely vertical. Between these extremes, magnitudes and directions change gradually.

Seiches tend to develop in bodies of water during or after imposition of agitating forces. Forel, Chrystal and others identified forms of excitation as (a) release of pent-up water at a leeward shore through lapse of onshore winds, (b) heavy rain, snow or hail over a portion of a lake, (c) rapid change of air pressure through passage of a squall, (d) flood discharge from rivers at one end of a lake, (e) impacts of wind gusts on the water surface, (f) disturbances from earth tremors *(see* EARTHQUAKE). More gradual energizing sources are (g) variations in wind velocity and pressure and (h) passage of small barometric fluctuations, both synchronizing approximately with seiche periods.

Seiches in certain coastal ports have caused ships to break moorings and sustain damage under action of nodal surge currents. Such seiches are usually of two distinct kinds: those of fairly long period (15 to 60 min.) attributable to (h), and those of much shorter period (0.3 to 15 min.) attributable to ingress of long period waves originating from distant cyclonic storms through causation (g). "Surf beats" afford another mechanism for coastal seiches as result of greater water transport shoreward frorn groups of high waves than from groups of low waves.

Internal seiches at the stratified interface (thermocline) of lake waters were discovered by E. R. Watson and E. M. Wedderburn (1904–12). Amplitudes are larger than surface seiches and periods longer—Lake Baikal, for instance, has an internal seiche period of 38 days. amplitudes up to 75 metres.

See J. Proudman, *Dynamical Oceanography* (1952); Basil W. Wilson, "Origin and *Effects* of Long *Period* Waves in Ports," *Communication 1, Section II, XIXth International Navigation Congress, London, 1957* (1957). (B. W. W.)

SEIGNIORAGE. The due levied by the authority that possesses the right of coining on the metal that it manufactures into coin. The term "brassage" has been used to describe this due. when confined to the mere cost of the process, the wider term "seigniorage" being employed when the charge is so raised as to become a profit to the imposer. The exercise of the right of seigniorage has been the instrument by which most of the debasements of currency have been carried out. Under feudalism, especially in France, the chief nobles had this prerogative. In the modern state it is reserved for the sovereign authority. Most countries adopt a moderate seigniorage charge. Thus the fundamental currency law of France (1803) provides that "only the expense of coining" shall be charged. The limitation on the coinage of silver in practically all countries has made the seigniorage on that metal very heavy. The policy of England in respect to gold has been peculiar. Since 1664 it has been freed from any charge though the delay in returning the coined gold causes a small loss of interest.

The theory of the effects that a seigniorage produces have been discussed at length. The definitive results obtained. briefly stated, are: (I) X seigniorage charge is the same as a debasement, but, its evil effect may be avoided by limiting the amount of coin issued. (2) Seigniorage operates as a tax on the metal subject to it, and this tax tends ultimately to fall on the producers or rather on the rent obtained through the production.

SEIGNOBOS, CHARLES (1854–1942). French historian, was born Sept. 10. 1854, at Lamastre (Ardèche). Educated at the Lycée de Tournon. he passed to the École Normale Supérieure. Entrusted with an independent course of historical instruction in 1879 at Dijon, he was appointed to the Sorbonne, first as unattached professor in 1883 and later as special lecturer in 1890. In 1897 appeared his *Histoire politique de l'Europe contemporaine,* which was crowned by the Académie française. His n-ork is distinguished by a broad-minded and often democratic tone, and a grasp of' social science which place him in the forefront of modern historical writers.

His other published works include: *Histoire de la civilisation* (1886); *Histoire des anciens peuples de l'Orient* (1890); *La méthode historique appliquée aux sciences sociales* (1901); *Le Second Empire* (1921); *Le Déclin de l'Empire et l'Etablissement de la III^e^ République* (1921); *Histoire sincère de la Nation Française* (1933) and *Histoire comparée des peuples de l'Europe* (1938).

SEIGNORY or SEIGNIORY, in English law, the lordship remaining to a grantor after the grant of an estate in fee simple. There is no land in England without its lord: "Nulle terre sans seigneur" is the feudal maxim *(see* FEUDALISM). Where no other lord can be discovered the crown is lord as lord paramount. The principal incidents of a seignory were an oath of fealty; a "quit" or "chief" rent; a "relief" of one year's quit rent, and the right of escheat.

In return for these privileges the lord was liable to forfeit his rights if he neglected to protect and defend the tenant or did anything injurious to the feudal relation.

Every seignory now existing must have been created before the statute of *Quia Emptores* (1290), which forbade the future creation of estates in fee-simple by subinfeudation. The only seignories of any importance at present are the lordships of manors. They are regarded as incorporeal hereditaments, and are either appendant or in gross. A seignory appendant passes with the grant of the manor; a seignory in gross—*i.e.,* a seignory which has been severed from the demesne lands of the manor to which it was originally appendant—must be specially conveyed by deed of grant.

As to seignorial tenures in the Channel Islands *see* W. Burge, *Commentaries on Colonial and Foreign Laws,* vol. iv, pt. 1, p. 1,018; and as to Quebec, *see* p. 1,028 of the same work.

SEINE, the *département* of northern France which has Paris as its chief town, formed in 1790 of part of the province of Ile-de-France. It is entirely surrounded by the *département* of Seine-et-Oise. from which it is separated at certain parts by the Seine, the Marne and the Bièvre. The area of the *département* is only 185 sq.mi., and of this surface about a sixth is occupied by Paris; the suburban towns also are close together and very populous. The population in 1954 was 5,154,834, of which number 2,820,534 were in the city of Paris. Flowing from southeast to northwest through the *département,* the Seine forms three loops: on the right it receives above Paris the Marne, below Paris the Rouillon, and on the left the Bièvre within the city. The left bank, higher than the right, consists of the Villejuif and Chbtillon plateaux separated by the Bièvre; the highest point (560 ft.) is above Chbtillon and the lowest (105) at the exit of the Seine.

Market gardening is the chief agricultural industry, and by means of irrigation and manuring the soil is made to yield from 10 to 11 crops per annum. Below Paris the plain of Gennevilliers, fertilized by sewage water: yields large quantities of vegetables. Milch cows are reared in large numbers. The principal woods (Boulogne and Vincennes) belong to Paris. It is partly because of the number of quarries in the district that Paris owes its origin: Châtillon and Montrouge in the south yield freestone, and Bagneux and Clamart in the south and Montreuil and Romainville in the east possess the richest plaster quarries in France. Within the circuit of Paris are certain old quarries now forming the catacombs. Most of the industrial establishments in the *département* are situated in Paris or at St. Denis (*qq.v.*). The *département* is traversed by all the railway lines which converge in Paris, and also contains the inner circuit railway (Chemin de Fer de Ceinture) and part of the outer circuit. There are many canals. The *département* forms the archiepiscopal diocese of Paris. falls within the jurisdiction of the Paris court of appeal and the *académie* (educational division) of Paris, and is divided among the II, III, IV. V and VI *corps d'armée.* Apart from Paris (*q.v.*) the *département* includes the *arrondissements* of St. Denis and Sceaux with 22 cantons between them. The 20 *arrondissements* of Paris are ranked as cantons for certain purposes. The chief places besides Paris are St. Denis. Xsnieres, Xubervilliers, Boulogne-sur-Seine, Clichy-sur-Seine, Courbevoie, Levallois-Perret, Neuilly-sur-Seine, Pantin, St. Ouen, Colombes. Charenton. Ivry-sur-Seine, Montreuil-sous-Bois. Nanterre. Nogent-sur-Marne, Vincennes and Arcueil.

SEINE-ET-MARNE, a *département* of northern France, formed in 1790 of almost the entire district of Brie (half of which belonged to Champagne and half to Ile-de-France) and a portion of Gbtinais (from Ile-de-France and Orléanais). Pop. (1954) 453.433. Area 2.290 sq.mi. The *département* belongs to the Seine basin, and is drained partly by that river and partly by its tributaries the Yonne and the Loing from the left, and from the right the Voulzie, the Yères and the Marne, with its affluents the Ourcq, the Petit Morin and the Grand Morin, at the last-named of which the German advance in Aug.–Sept. 1914 was stayed.

The oats and wheat of Brie are very good; potatoes, sugar beet, mangel-wurzel and green forage are important crops. and market gardening flourishes. Provins and other places are well-known for their roses. The cider and honey of the department are of good quality. Brie cheeses are well known, and large numbers of calves, sheep and poultry are reared. There are large forests covering a fifth of the surface. Most important is the forest of Fontainebleau. Large areas are devoted to game-preserves. Excellent freestone is quarried in the department, notably at Château-Landon and Nemours, mill-stones at La Fertć-sous-Jouarre; the Fontainebleau sandstone is used for pavements, and the white sand which is found along with it is in great request for the manufacture of glass. Along the Marne are numerous gypsum quarries; lime-kilns occur throughout the department; and peat is found in the valleys of the Ourcq and the Voulzie. Beds of common clay and porcelain clay supply the potteries of Fontainebleau and Xfontereau. Paris is the chief outlet for the industrial and agricultural products of the department.

The Seine, the Yonne, the Marne, and the Grand Morin are navigable: and, with the canals of the Loing and the Ourcq and those of Chalifert, Cornillon and Chelles, which cut off the windings of the Marne, form a total waterway of over 200 mi. Seine-et-hlarne has 3 *arrondissements* (Melun, Meaux and Provins), 29 cantons and 534 communes. It forms the diocese of Meaux (archiepiscopal province of Paris), and part of the region of the V. army corps and of the *académie* (educational division) of Paris. where is its court of appeal. Melun, the capital, Meaux, Fontainebleau, Provins, Nemours (*qq.v.*), Coulommiers and Montereau, are the chief towns. Lagny (pop. [1954] 8,629) has an abbey-church of the 13th century; Brie-Comte Robert has a church of the early 13th century; Ferrières, a 13th century church; Moret-sur-Loing preserves 15th century fortifications including two remarkable gateways; St. Loup-de-Naud a church of the early 12th century; Jouarre a church of the 15th century, built over a 10th century crypt: and Vaux-le-Vicomte has the famous *chateau* built by Fouquet, minister of Louis XIV.

SEINE-ET-OISE, a *département* of France. formed in 1790 of part of the old province of Ile-de-France, and traversed from south-east to north-west by the Seine, which is joined by the Oise. Pop. (1954) 1,708,791. Area. 2.185 sq. miles. It is bounded by the *départements* of Seine-et-Marne on the east. Loiret on the south. Eure-et-Loir on the west, Eure on the north-west and Oise on the north. It encloses the *département* of Seine. and with it forms the centre of the Paris basin. The Epte on the north-west is almost the only natural boundary of the *département*. The streams (all belonging to the basin of the Seine) are: (right) Yères, Marne, Oise and Epte; (left) Essonne (joined by the Juine, which passes Étampes), Orge, Bièvre and Mauldre. Seine-et-Oise belongs in part to the Pliocene tableland of Beauce in the south and to that of Brie in the east. In the centre are the wooded hills of the Hurepoix which make the charm of Versailles, hfarly and St. Germain. In the north-west, in the Vexin, the culminating point (690 ft.) is reached, while the lowest point, where the Seine leaves the *département*, is little more than 40 ft. above the sea.

Seine-et-Oise is a flourishing agricultural and horticultural *département*. Wheat, oats, potatoes and sugar-beet are important crops. Versailles. Rambouillet; Argenteuil are among the many market-gardening and horticultural centres, and wine is grown at Argenteuil and elsewhere. Forests occupy about 190,000 ac.. the largest being that of Rambouillet (about 32.000 acres). There are mineral springs at Enghien and Forges-les-Bains. Important industrial establishments are the national porcelain factory at Sèvres; and the government powder-mills of Sevran and Bouchet.

The railways of all the great companies of France (except the Midi) traverse the *département*. The Seine and the Oise. and the canals of Ourcq and Chelles provide about 120 mi. of waterway. Seine-et-Oise is divided into five *arrondissements* (Versailles, Corbeil-Essonnes, I'ontoise, Mantes-la-Jolie, Rambouillet) with 41 cantons and 691 communes. It forms the diocese of Versailles under the archbishop of Paris, and part of the educational division (*académie*) of Paris and is under the command of the military government of Paris, where is its court of appeal.

The chief towns are Versailles, the capital. Corbeil, Sèvres, Étampes, Mantes-la-Jolie, Pontoise, Rambouillet, Argenteuil, Poissy, St.-Cloud. St.-Germain-en-Laye, Meudon. Montmorency, Rueil-Malmaison. Marly-le-Roi and St. Cyr. Montfort-l'Amaury has a Renaissance church, a 16th century gateway and a ruined château once the seat of the family of Montfort; Montlhéry preserves the keep (13th century) and other ruins of a fortress which commanded the road from Paris to Orléans; Roche-Guyon, seat of the family of that name, has two châteaux, one a feudal stronghold, the other also mediaeval but altered in the 18th century; Vigny has a Gothic 15th century château; Ecouen. a château of the 16th century once the property of the Condé family: Dampierre has a 17th century château once the property of Charles, cardinal of Lorraine; Maisons-Laffitte, a château of the same period once belonging to the family of Longueil. The château of Malmaison (18th century) is famous as the residence of the Empress Joséphine.

Of the many churches the most interesting are those of Jouy-le Moutier (11th and 12th centuries); Beaumont-sur-Oise (13th century); Taverny (12th and 13th centuries); Longpont (remains of an abbey-church dating from the 11th to the 13th centuries). Near Cernay-la-Ville are remains of a Cistercian abbey and near Lévy-St.-Nom those of the abbey of Notre-Dame de la Roche, including a church (13th century) with stalls which are among the oldest in France and the tombs of the Lévis-Mirepoix family.

SEINE-MARITIME, a *département* of the north of France, formed in 1790 of four districts (Vexin normand, Bray, Caux and Roumois) belonging to the province of Normandy. Pop. (1953) 941.684. Area, 2,449 sq.mi. Seine-Maritime is bounded north-west and north by the English channel for a distance of 80 mi., northeast by Somme, from which it is separated by the Bresle, east by Oise, south by Eure and the estuary of the Seine. which separates it from Calvados. The *département* consists of a portion (Pays de Caux) of the chalk plateau of western France, through which the Seine has sawn its way near the southern boundary. From the slopes of the plateau many small streams drain seawards, the most important being the Arques, emerging at Dieppe, and the Bresle at Le Tréport on the north-eastern boundary. In the comparatively regular outline of the coast there are a few breaks. as at Le Tréport, Dieppe. St. Valéry-en-Caux, Fécamp and Le Havre, the Cap de la Hève, which commands this last port, and Cape Antifer, 12 or 13 mi. farther north. Le Tréport, Dieppe. Veules. St. Valéry, Veulettes, Fécamp, Yport, Étretat and Ste. Adresse (to mention only the more important) are fashionable watering-places. Forges-les-Eaux (in the east of the *département*) has cold chalybeate springs.

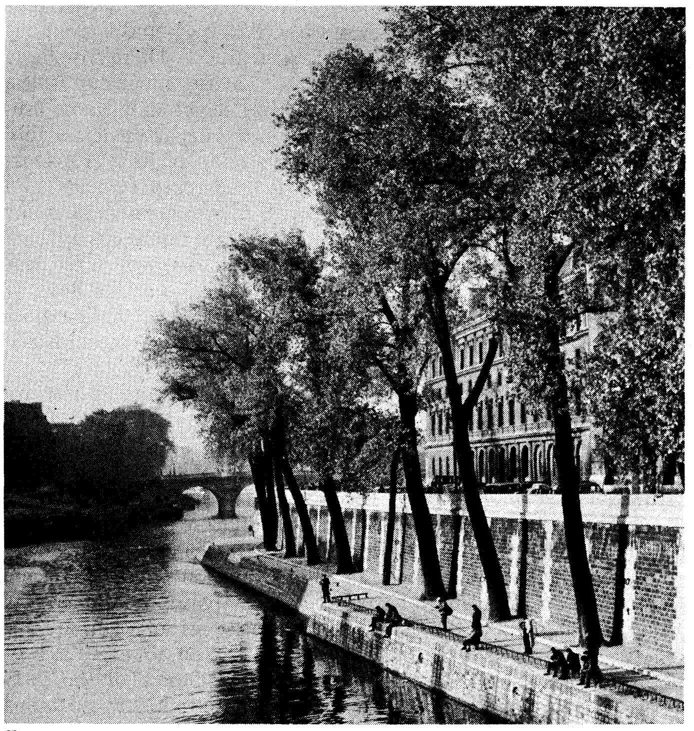
In general the *département* is fertile and well cultivated. Along the Seine fine meadow-land has been reclaimed by dyking; and sandy and barren districts have been planted with trees, mostly oaks and beeches, at their finest in the forest of Arques and along the railway irom Rouen to Dieppe. The forest of Eu covers 36 sq.mi. in the northeast. Wheat and oats are the principal arable crops. rye, flax, colza, sugar beet and potatoes being also important. Milch cows are kept in great numbers especially in the Bray district, and Gournay butter and Gournay and Neufchbtel cheese are in repute. The farms of the Caux plateau are each surrounded by an earthen dyke, on which are planted forest trees. generally beech and oak. Apples and pears are grown. and much cider is produced. A little peat is cut. and there is a number of quarries. Rouen is the chief centre of the cotton trade. which comprises spinning and the weaving of *rouenneries, indiennes* (cotton prints), cretonnes and other cotton goods. Elbeuf is the centre of woollen manufacture. The dyeing and printing of fabrics and other accessory industries also employ many hands. Engineering works, foundries and iron ship-building yards are found at Le Havre and Rouen. Wooden ships are also built at Le Havre, Rouen, Dieppe and Fécamp. Other establishments of importance are the national tobacco-factory at Dieppe, sugar-refineries, distilleries, glass-works, potteries, paper-works, soap-works, chemical-works, flour-mills, oil-factories, leather-works, etc. Fisheries are important. Fécamp, which plays a very important part at the Newfoundland fisheries, sends large quantities of cod, herring, mackerel, etc., into the market; Dieppe supplies Paris with fresh fish; St. Valéry sends boats as far as Iceland. The principal ports for foreign trade are Le Havre, Rouen and Dieppe.

Seine-Maritime is served by the Ouest-Btat railway, but the Northern railway also has several lines there. The Seine and other rivers provide 85 mi. of navigable waterway. The canal of Tancarville from Quilleboeuf to Le Havre is about 15 mi. long, that from Eu to Tréport about 2 mi. The *département* is divided into three *arrondissements* (Rouen. Dieppe and Le Havre), 55 cantons and 759 communes. It forms the diocese of the archbishopric of Rouen and part of the region of the III army corps and of the *académie* (educational division) of Caen. Its court of appeal is at Rouen, the capital.

Rouen, Le Havre and Dieppe and in a lesser degree, Elbeuf, Fécamp, Harfleur, Lillebonne, Yvetot, Eu, Le Tréport, Aumale, Étretat, Bolbec, Barentin and Caudebec-en-Caux are the chief towns. St. Martin-de-Boscherville has remains of an important abbey, with a fine church in the 12th century Romanesque style, and a Gothic chapter-house of the latter half of the 12th century; Valmont has fine ruins (16th century) of the choir of a Cistercian abbey-church; Varengeville is well known for the manor (16th century) of Jacques Ango (see MANOR HOUSE); Graville-Ste. Honorine has a Romanesque church and other remains of an ancient abbey; Montivilliers has a fine abbey-church of the 11th, 12th and 16th centuries; and Arques, Boos, Martainville. Mesnières and Tancarville have old chbteaux of various periods.

SEINE RIVER, the second longest river of France (482 mi.) and economically the most important, rises on the Plateau de Langres 18 mi. N.W. of Dijon. and reaches the English channel in a wide estuary which passes between Le Havre and Honfleur. With its several large tributaries. it represents a relatively mature river system, with gentle gradients throughout. It has a drainage area of more than 30,000 sq mi. and for most of its course flows transverse to the general geological structure of the Paris basin. Since it rises on Jurassic (Oolitic) limestone (at about 1,500 ft.), the uppermost part of its course is not permanent, and in dry summers the valley may be dry as far down as Chbtillon, where it leaves the limestone and crosses a narrow strip of Oxford clay. It then enters a narrow wooded valley through the escarpment of the Corallian limestone; the valley widens temporarily at the succeeding outcrop of Kimmeridge clay, where the Ource river enters from the east. At Bar-sur-Seine. the river cuts through the Portland limestone, beyond which it enters the broad lowlands of Champagne humide (mainly the outcrop of the Gault clay), before encountering the Chalk escarpment at Troyes. The course then follows a broad entrenched valley across the chalk area, Champagne *pouilleuse,* until it is joined by its right-bank tributary, the Aube river (*q.v.*). From there the Seine follows a southwesterly direction at the foot of the Tertiary escarpment to Montereau. where the Yonne river joins it, and then passes into the Tertiary limestone uplands, which rise in steep wooded hillsides 200–300 ft. above the river. From there to the sea, the Seine receives only minor left-bank tributaries, but larger rivers such as the Marne (at Paris) and the Oise on the right. Below Paris, the river begins its series of huge swinging meanders. and gradually re-encounters the Chalk, which appears as cliffs wherever the valley sides are undercut by the river. The meanders add about 120 mi. to the direct distance between Paris and Le Havre. Below Rouen, the valley widens with extensive alluvial flats. In the estuary, which begins near Tancarville (the lowest bridging point), there are strong currents, and a tidal bore associated with exceptionally high tides.

The Seine carries the heaviest tonnage of shipping of all the French rivers; the most important section is Le Havre-Rouen-Paris. The lower-middle course of the river has a regular regime resulting from the large drainage area. Low water occurs in summer, while the maximum discharge is in winter and early spring, aided by snow melt and reduced evaporation losses. The concentration of several large rivers in the Paris district brings the danger of winter flooding. The approximate maximum discharge at Paris is about 100,000 cusecs. The head of navigation is at the Aube confluence, though from there upstream to Troyes a lateral canal



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THE SEINE ALONG QUAYS OF THE ÎLE DE LA CITÉ, PARIS. THE RIVER DIVIDES INTO TWO ARMS AROUND THE ISLAND

provides a minimum depth of 5 ft. Between Paris and the Aube confluence. there are numerous cuts to straighten the river, and 39 locks maintain a minimum depth of 6.5 ft. At Paris, the minimum depth increases to 9.8 ft. Rouen can receive sea-going craft with 25 ft, draft at mean high-water springs. Below Tancarville, river craft tend to use the canal to Le Havre to avoid the strong currents of the estuary. The Seine is linked by canal with the Somme, Scheldt (Escaut), Meuse, Rhine, Sbone, and Loire rivers.

Paris is the third largest French river port (after Rouen and Strasbourg). The river port begins at Nanterre, and wharves and quays extend upstream for more than 25 mi. Within Paris the river is divided by several islands, and the 27 bridges of the city are a serious obstacle to some ships at high water. The main incoming traffic consists of coal, iron and steel, building materials and agricultural produce. Rouen is the outport of Paris, 145 river mi. downstream; oil and coal are the principal imports, the former proceeding to the important Shell refineries there. Le Havre on the north shore of the Seine estuary is capable of handling large ocean-going liners, and possesses shipbuilding and engineering industries. (C. EM.)

SEINING, NETTING AND TRAWLING. From remote antiquity fish have been taken by spear, line, trap and net. At the present day nets are by far the most important fishing implements employed, although certain deep water fish (for instance halibut) are still taken mainly by long lines. Fishing nets, although of innumerable kinds, fall naturally into two main groups, namely, stationary nets and nets used in motion. The former group contains the most primitive nets, though nets of great complexity are now included in it; and the simplest fixed nets, themselves derived probably from dams of rushes or stones so placed as to lead fish in to a "pound" or enclosure, may with some confidence be considered as the ancestors of the great otter trawls now shot and towed daily from powerful steamers on fishing grounds more than a thousand miles from the market they work to supply. The more primitive fixed nets are of far less importance than movable nets (except in the capture of certain particular species), owing to the fact that they are necessarily confined to very shallow water. The main types of movable nets may therefore be treated first.

All nets are constructed in accordance with what is known of the habits of the fish they are designed to capture; and as fishes may be roughly divided into those spending at least the greater part of their lives on or near the sea-bottom and those spending a great portion of their lives near the surface, two lines have been followed in the development of nets, some being designed to work on the bottom, others to work near the surface. The most important nets used in the capture of "demersal" or bottom-living fishes are trawls; the most important pelagic nets are drift nets (gill nets) and purse seines. The word trawling was at one time applied to more than one method of fishing, but has, at all events in Europe, now become restricted to the operation of a flattened conical net or trawl, dragged along the sea-bottom. There are t o trawls in common use, the beam-trawl and the otter-trawl. They differ in the method adopted for extending the mouth of the net. The original form is the beam-trawl.

The beam-trawl may be described as a flattened conical net whose mouth is kept open when in use by a long beam preferably of elm supported at the ends by iron runners, the trawl-heads. Trawl-heads are of various shapes, but usually take the form of a loop, the curve being in front and ending in straight bars which meet at a point behind. One of these bars, the "shoe" lies along the sea-bed when the trawl is in use, and is usually of double thickness, in order to withstand wear. A square socket is bolted to the top of the head, to receive the beam, and ring-bolts are fitted at the front of the curve and in the angle of the "heel" for attaching the towing ropes and the "ground rope" to which the lower lip of the net is lashed.

The Net.—The top lip of the net is lashed along the beam, but the ground rope, being much longer than the beam, when the trawl is towed forms a deep curve between the trawl-heads, the centre or "bosom" thus being considerably behind the beam. Accordingly, when the fish on the sea-bed are disturbed by the travelling ground rope, the roof of the trawl is above them, and the way of escape has already passed and is moving steadily on: a great number of them therefore ultimately pass over the ground rope into the net. The net narrows gradually until the last few feet are reached: this terminal portion is cylindrical and is called the "cod-end." It is closed by a line rove through the terminal meshes, the "cod-line." The fish taken mostly collect in the cod-end, and as their weight increases friction with the bottom, it is protected by pieces of old netting laced across its under side. The fish not taken from the cod-end are found in the "pockets"; the pockets are made by lacing together the upper and under sides of the net. They are wedge shaped, the points lying at the sides of the net, at about the level of the bosom, the broad ends at that of the entrance to the cod-end. At this level the lumen of the net thus is divided into three: a fish enters by the central passage, which is furnished with a valve-like curtain, the "flapper," and then either stays in the cod-end or works back along the sides into the pockets. Some species, particularly soles, are frequently found in the pockets.

Dimensions.—A full-sized beam trawl has a beam from 45 to 50 ft. long, and its own length is nearly twice as great: the heads hold the beam from 34 to 44 ft. from the bottom. There are, however, wide local differences in size and pattern: and the proportions of the various parts of the net and the sizes of the mesh depend also on the species sought. A North Sea trawl has a cod-end of about 12 ft., out of a total length of 75 ft.: its meshes are 3 in. in size in the front part of the net, lessening to $1\frac{1}{2}$ in. in the cod-end. Small pocketless trawls of 1j ft. beam are used for shrimping from open boats. Shank-nets, whose mouths are kept open by wooden rectangles, with the lower lip a few inches from the ground are also used in shrimping.

Working the Net.—The large beam-trawl is towed a little faster than the tide, and in the same direction. It is drawn along by two ropes ("bridles") of 15 fathoms, one attached to each trawl-head and which are shackled to a 6 in. manila rope or warp. The length of warp run out is rather over 3 times the depth of the ground. Successful shooting of the trawl is an art which has to meet and overcome innumerable difficulties caused by the various combinations of wind, tide, ground and weather, and space does not permit of its discussion here. Essentially, it proceeds in the following stages. The beam and heads are put over the side and the net paid out after them: the fore bridle is run out until the beam is at right angles to the ship's side: both bridles and the warp are then run out: a rope ("guy") is however attached to the warp when nearly out and made fast in the bow, in such a manner that if the net "comes fast" on an obstruction the guy takes the strain and brings the ship head to wind, where she can lie until a change of tide enables her to free her gear. The towing generally lasts one tide (6 hours) and the hauling of the nets is now usually effected by a small steam capstan ("steam man"), whose compact engine is housed under a cover on the capstan top. When the trawl-heads are made fast the net is hauled in by hand until the cod-end is reached, when a bight of rope is put round it, passed over a "tackle" (pulley block) and the cod-end heaved in by the capstan, when the cod-line is loosed and the fish fall on deck.

Replacement of Beam- by Otter-trawl.—Although a very old net, the beam-trawl reached its highest importance in the nineteenth century. In that century the sailing trawlers which employed it increased greatly in numbers and tonnage and improved in equipment and efficiency: and they brought the whole North Sea undei the trawl. Its closing decades however witnessed the beginning of the rise of the otter-trawl and of the use of steam in fishing vessels: and saw also the decay of beam-trawling and the decline of sailing trawlers. Thus in England and Wales there were over 2,000 first class sailing trawlers in 1893, over goo in 1900, 817 in 1913 and 272 in 1928: in the same period the average tonnage fell from 57 to **33.** In the first stages of the change the fact that the otter could not be worked with confidence from a sailing vessel no doubt accelerated the adoption of steam power, since the efficiency of the otter rendered its use inevitable; while on the other hand the power of steam favoured the development of larger nets and enabled more distant grounds to be explored and worked, and the otter, having no rigid beam, was capable of manufacture in a large size and of yielding, on an abundantly stocked ground, the large catches necessary to pay the expenses of long voyages. It is probable that the low working expenses of sailing beam trawlers may ensure their continuance on grounds near ports in close touch with good markets, especially when the fish on the ground are of the more valuable kinds ("prime"), although even on these grounds the motor otter trawler is increasing in importance; but in the present phase of fisheries it is clearly the great steam trawler that bears the main burden of the supply of demersal fish. In 1928 steam trawlers landed in England and Wales 415,000 tons of these fish; sailing (beam) trawlers less than 7,000 tons.

The Otter-trawl.—The essential feature of the otter-trawl is that its mouth is kept open not by a rigid structure but by two large boards, the otter-boards or "doors" acting like kites working horizontally instead of vertically. The device was employed by yachts since its invention by Hearder in 1860, and later by Danish plaice seiners, but the boards now used were first patented in 1894 and 1895 by Scott of Granton and Nielsen, a Dane, respectively.

The otter-boards resemble massive wooden doors, liberally strengthened by iron bands: they are about 8 ft. high, 9 ft long and 3 in. thick. The net is fastened to shackles placed at the top and bottom of the after-end of the board. Like the beam-trawl, the otter has many types, the proportions of the parts varying with the species sought. Headlines may be as much as 120 ft.

in length: the fore and aft length of the actual net is rather less than that of the head rope, and as has been said that of the ground rope greater: the cod-end is usually about 14–18 ft. Much research has been devoted to determining the actual spread of the net when towed: and it appears probable that a go ft. headline gives a spread of rather over 50 ft.

Working the Net.—The operation of shooting is carried out fundamentally as in the beam-trawl—*i.e.,* the trawl is brought at right angles to the ship by running out the fore warp sufficiently, before both warps are lowered. The fore warp is then drawn to the quarter of the vessel, where it is shackled with the after warp during towing. Towing takes place at varying speeds, round about 2½ knots, or in herring trawling 3½ knots. Hauls vary in duration with the abundance of the fish: a common duration, seldom exceeded, is 3 hours. When about to haul the fore warp is released from the aft and the ship steered in a curve to bring them both at right angles to the side and so clear of the propellers. The warps are then rapidly wound in, and the net and cod-end brought on board as in the beam-trawl. The trawler carries her fish iced to port.

Seines.—The movable nets most resembling trawls are seines. This net consists essentially of a long strip of netting with a buoyed headline and a weighted ground rope. It is taken out in a boat to some distance from shore, paid out in a curve concave to the beach, and the lines attached to the net being brought ashore, the net is hauled to land. This simple seine is used for the capture of smelts and other small fish, but most seines have developed into more complex forms, usually by changes involving the formation of a bunt, or a true cod-end in the middle of the net: and several forms are worked completely away from shore.

Thus the *Danish* plaice-seine is now worked by a small steamer or motor vessel. It is a net some 180 ft. long, with a 50 ft. codend, and to each wing over a mile of warp is attached. One end of a warp is buoyed, and the ship moves in a great oval, paying out warp, net and second warp, and then returning to the buoy, when both warps and the net are hauled by special winding engines. The net gives excellent results with plaice or, properly modified, with haddock on clean level sand at moderate depths, but has hardly fulfilled expectations for general fishing far from land.

This net is the last development of the Danish seines. A simpler form is the eel drag-seine, which is worked from a boat in shallow water. It is somewhat smaller (140 ft. long) tapering at the wings and with a bag of 30 ft., the wings are attached to spars and drawn on board by warps. The *drift* eel-seine is an interesting development. It is similar but smaller, and drifts with the boat, the ends of the net being kept apart by a floating spar or, latterly, by small·trawl boards. The bag is valved by a funnel of netting.

The Mediterranean *filet de* boeuf may be here included, as a net having affinities with both trawl and seine. It is worked between two boats, and has a very long cod-end.

Pilchard-seines used in Europe are shot about a shoal of these fish by boats guided by the signals of watchers ("huers") on shore. They are shot in a nearly complete circle, which is then closed by a short "stop" net, when lines from the ends of the main net are taken ashore and the whole hauled to the shallows. The fish are then removed by a "tuck net," a small seine through whose lowest meshes a line is rove, so that by hauling this line the net changes from a wall of netting to a shallow basin. The main seine is about zoo fathoms long: as in the trawl, the meshes decrease in size towards the cod-end or purse.

The Purse-seine, much used in the United States and in Japan, is in principle a tuck-net. The mackerel, sardine or other shoal is surrounded by a long wall of netting whose ground-rope bears rings through which is rove the line which on hauling converts the circle into a saucer. The slack of the net is then taken up gradually until the area is small and the fish are reached.

Drift-nets (Gill-nets).—The nets of most importance after the otter-trawl are the drift-nets employed for the capture of herring, mackerel and other fish which pass much of their life near the surface of the sea.

Drift-nets as employed in Great Britain are of fine cotton, the rougher nets being used now only by continental nations. The size of net varies with the locality and the fish to be taken, as does the mesh; but a common length is 30 yds. The mesh, measured in rows of knots to the yard, varies from more than 60 for sprat, 29 to 36 for herring, and from 25 to 36 for mackerel. The nets are shot end to end on the same long uarp, which may extend for as much as 3 miles, all headlines are buoyed by cork, the groundropes ueighted, and in addition the warp is buoyed at intervals by buoys called bowls, the net being attached to the buoy ropes also. Some small nets are used with their headline at the surface, but usually they are sunk, except for mackerel. The warp is sometimes worked above the net, sometimes a fathom or more below it. When riding at nets the strain of the warp is taken by a chain or rope called the "tissot" which joins the warp near the net. The warp is of 39 in. manila.

Stationary Nets.—Stationary nets, except for a few fish, are relatively unimportant and can receive little more than a mention. Stake-nets are gill nets usually set up between tide marks and supported by stakes. Occasionally the net between pairs of stakes is occupied by a simple bag. If the stake-net acts as a "leader" into a circular enclosure the net is a pound- or kettle-net. The bag-net and fly-net for the capture of the salmon are merely elaborated forms of this type. The pound is roofed by netting, in the fly-net, and in the bag-net, which is floated—not staked—floored also. It is wedge shaped. narrowing gradually from the entrance end and divided incompletely by oblique internal walls or valves of netting into side compartments. The stox-net is a pyramidal net, about 200 ft. long, whose nearly square mouth is kept open by 20-ft. "balks" of timber. the bottom one weighted. Four bridles lead from the ends of the balks to the chain by which the vessel employing the net is anchored, always in a tideway. Sprats are carried by the tide into the net, which on the slackening of the tide is hauled after it has been closed by raising the bottom balk against the top one. (J. O. B.; X.)

SEIPEL, IGNAZ (1876–1932), Austrian statesman and Roman Catholic priest, was born in Vienna, July 19, 1876. As professor at Salzburg (1909–12) he saw much of Heinrich Lammasch. with whom he morked until 1917 in the preparation of an edition of the writings of Hugo Grotius on international law.

Seipel mas appointed to Vienna university in 1917 and his work, Nation and State, dealing with the supernational state. such as the Austro-Hungarian monarchy, as a higher type of state compared mith the national state, and thus viewing Austria-Hungary's future optimistically, at the same time favouring a reasonable pacificism. caused the emperor Charles to include him in the circle of those men who aere to prepare the way for peace through unofficial negotiations abroad. At the same time, the German parties in the Austrian parliament summoned him as scientific expert to the consultations on the reform of the constitution now recognized as overdue, and in these Seipel supported moderate federalism on a national basis. But the downfall of the Austro-Hungarian monarchy could not be prevented either by reform of the constitution or by the peace policy of the Lammasch ministry, which took office in Oct. 1918, and included Joseph Redlich and Seipel as peace exponents.

After the collapse, Seipel succeeded in preventing the threatened split of the strongest conservative party in the country, the Christian Socialist. into a monarchist and a republican party. This and the necessity of getting new men into parliament under the new conditions caused his election in 1919 to the national constituent assembly by the electoral division for central Vienna, and later to the national council. During the first coalition government, Seipel morked against too close an alliance of the Christian Socialists with the Social Democrats; in particular he prevented the execution of far-reaching schemes for the socialization of means of production. After the elections of 1920, which returned the Christian Socialists at the head of the poll, Seipel was undisputed leader of his party. Under his influence Austrian policy gradually veered to the right, and after the resignation of J. Schober (*q.v.*), Seipel created a firm anti-Socialist majority by concluding a parliamentary pact with the Pan-Germans. He then took office as chancellor (May 31, 1922). At that time the universal misery had reached its climax as a result of the policy of inflation. Seipel, together with his ministers of finance, August Ségur and Victor Kienbock, put an end to inflation by the creation of a new note bank independent of the government and prepared for his negotiations with the League of Nations in the autumn of 1922 by his political journeys to Prague, Berlin and Verona. by which he obtained the guarantee of a foreign loan by a number of states and eventually the loan itself. Seipel succeeded by hard fighting in carrying through parliament the acceptance of the Geneva protocol and of the foreign controller of Austrian finances appointed by the League of Nations, and led Austrian policy to the re-establishment of almost complete financial equilibrium, and his majority and position were confirmed by the elections of Oct. 1923. In the autumn of 1924, however, when he had hardly recovered from a wound inflicted in an attempt on his life, he resigned office on account of opposition encountered from that wing of his own party which represented local interests in the provinces. Seipel took office again on Oct. 20, 1926, at the head of a Christian-Socialist–Pan-German coalition. which he managed skillfully, discouraging open *Anschluss* propaganda and insisting on the maintenance of treaties. but stressing every opportunity for co-operation with Germany. Proper control of the budget was assured as a safeguard against the repetition of scandals. The elections of April 1927 continued Seipel's mandate; but his term of office witnessed dangerous growth of hostility between the Socialist and anti-Socialist elements.

On May 4, 1929, Seipel retired, and was succeeded as chancellor by Ernst Streerowetz.

SEI SHŌNAGON (966/967–1013?), Japanese diarist and poet, was a nitty and learned member of the court, the daughter of the poet Kiyohara no Motosuke. In 991 she entered the service of the empress Sadako. Her celebrated *Pillow-Book* begins in that year and continues until the year 1000. It consists in part of vividly recounted memoirs of Sei Shōnagon's impressions and experiences, in part of such categories or judgments as "Annoying Things" or "Things Which Distract in Moments of Boredom." Apart from the high value of the book as the vehicle of one of the most original and scintillating Japanese prose styles, it is the best modern source of information on Japanese court life in an unusually brilliant period.

Sei Shōnagon was apparently not a beauty, but managed to hold her place at court by virtue of her ready wit and intelligence. qualities that won her numerous enemies as well, as is nitnessed by a passage from the diary of her contemporary, Murasaki Shikibu. Although capable of great tenderness, Sei Shōnagon was often merciless in the display of her wit, and she showed little sympathy for those unfortunates whose ignorance or poverty rendered them ridiculous in her eyes. Her ability to catch allusions or to compose in an instant a verse exactly suited to a particular occasion also led her to affect, if her detractors can be believed, an air of superiority that others found intolerable. Perhaps by way of poetic justice, legends state that Sei Shōnagon spent her old age in misery and loneliness.

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SEISIN, a term from medieval English land law, of little modern significance, signifying possession of a freehold estate. Seisin was basic in the feudal theory of estates (see LAWS OF REAL PROPERTY AND CONVEYANCING). The old form of conveyance, known as feoffment with livery of seisin, required a symbolic delivery of possession by handing the transferee a clod of earth, a twig or the like.

See FEOFFMENT. (A. DM.)

SEISMOGRAPH, an instrument for recording and measuring vibratory movements of the ground. Its use originally was restricted to movements produced by earthquake waves. Subsequently special types have been devised to record ground movements produced by artificial blasts for location or delineation of subsurface geological structures in prospecting operations for petroleum and other minerals. They have also been used for measuring the thickness of ice sheets covering Greenland and other polar regions.

Earthquake waves are propagated from the source in all directions throughout the earth and are affected or modified by the physical conditions occurring over their paths. Consequently study of their forms and the patterns of their occurrence over the earth as revealed by seismographs has been the principal source of knowledge concerning the nature of the earth's interior. The seismograph's contribution to geophysical and geological knowledge is thus comparable to the contributions of the telescope and microscope to astronomy and biology respectively.

This article deals with the development of modern seismographs and describes their operation. For discussion of their uses in the location and study of earthquakes and in the investigation of the earth's interior see EARTH; EARTHQUAKE. For description of their application in prospecting see GEOPHYSICAL PROSPECTING; MINE PROSPECTING AND DEVELOPMENT.

General Types.—All seismographs fall into one or other of two general forms depending upon their initial responding element or mechanism which is either a pendulum or a device responsive to strain. The pendulum consists of a weight, called an inertia reactor, suspended or attached to the ground in such a way that it is free to oscillate. If displaced from its rest position it is acted upon by a force known as a restoring-force which tends to return it to its rest position and which is proportional to the displacement. The restoring-force may be provided by a spring'or by gravity as in the gravity pendulum. The time for one complete oscillation of the pendulum is called the period of the pendulum. If the pendulum were well constructed and contained only a restoring-force, once set into oscillation it would continue to vibrate indefinitely and would thus be of little use in measuring ground movements.

Accordingly. an additional force is introduced into the system proportional negatively to the velocity of the pendulum and known as a damping force. The damping force is derived almost universally from reaction of electric currents generated in a moving conductor attached to the pendulum and immersed in the field of a magnet fastened to the supporting structure. The damping force is adjusted near or exactly to the critical value which allows the pendulum freely to just return to rest from a displaced position.

When the ground vibrates the inertia of the pendulum prevents it from moving identically with the ground and the difference in motion between the two is the quantity measured and recorded on the recorder, after suitable magnification and other modification. The written record is known as a seismogram.

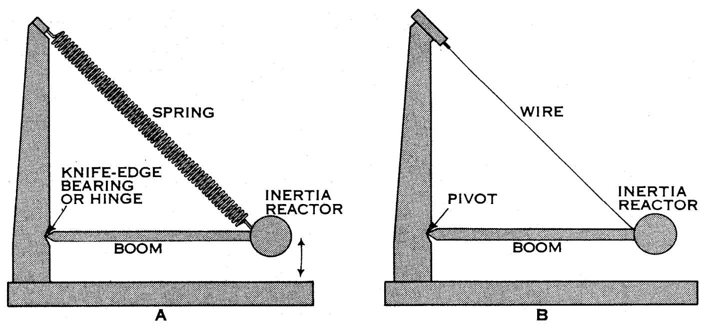

FIG. 1.— SCHEMATIC DIAGRAMS OF PENDULUM SEISMOGRAPHS

(A) LaCoste pendulum used to measure vertical component movement of the ground and (B) pendulum used to measure horizontal ground movement

In order fully to measure the ground movement, three perpendicularly oriented pendulums are required. one for the vertical or up and down component of motion and two for the horizontal components, usually oriented north-south and east-west. The simplest type of vertical component pendulum is represented by a weight suspended by a spring. With suitable transverse restraints, instruments of this type have found extensive use in prospecting seismology as well as in earthquake recording where such pendulums designed with periods of about 1 sec. are particularly well suited to the shorter period components of seismic waves ranging in period from about 0.2 sec. to 10 sec. Pendulums of this type are not constructed with periods much longer than 1 sec. because of the extension of the spring by the weight of the inertia reactor is proportional to the square of the period and so becomes too large for practical use. In order to get around this difficulty Sir J. A. Ewing introduced (1880) a mechanical structure so arranged that a portion of the spring tension produces a negative restoring force; *i.e.,* a force which acts to drive the pendulum away from its rest position rather than towards it. Lucien LaCoste modified the original mechanical structure somewhat and introduced in addition a zero-length helical spring—one which when fully collapsed has a large built-in residual tension so that when extended just sufficiently to separate the coils, tension is exerted equal to that of an ordinary spring extended a distance equal to its own unextended length. The residual tension is due to the twist of the spring wire introduced during winding of the helix. The LaCoste pendulum is shown schematically in fig. 1A. With this form, periods up to 80 sec. have been attained with good stability.

The simplest horizontal component pendulum is perhaps the gravity pendulum such as used in pendulum clocks. Its use in seismographs has been limited, however, by a condition similar to that of the simple vertical component pendulum in that for periods much longer than 2 sec. the dimensions are impracticably large. A form in common use which gets around this difficulty is shown in fig. 1B. Here the inertia reactor consists of a weight attached to one end of a horizontal boom. The other end of the boom is pivoted against the vertical supporting column. The weight is supported by a wire fastened at the top of the column. If the weight is displaced horizontally a small distance, the boom rotates through a small horizontal angle and at the same time the geometry of the structure is such that the boom raises a slight amount. Gravity thus provides a restoring-force which acts to return the boom to its rest position, and with careful design such pendulums can be made with periods extending to one minute or more. Another horizontal component form due to J. A. Anderson is known as the torsion pendulum (fig. 2). In this the inertia reactor is a small cylinder or vane supported excentrically by a thin wire suspension. This type has found extensive use for periods from 0.1 sec. to 1 sec., although it can be constructed with longer periods.

Recording Systems.—In the early seismographs movement of the pendulum was magnified and recorded on a strip of smoked paper using a system of levers ending in a pointed stylus. The useful magnification with these recorders was severely limited by the circumstance that any frictional or other force acting on the stylus tip is reflected back to the inertia reactor by a factor equal to the square of the magnification. To get around this difficulty John Milne and J. J. Shaw introduced a system using optical magnification with photographic recording. A small mirror was arranged to be rotated by a movement of the pendulum so that a beam of light reflected from the mirror produced a magnified replica of the motion of the pendulum on a strip of photographic paper wrapped around a slowly rotating drum. This system was brought to its ultimate efficiency in the torsion seismograph mentioned earlier. In this form the mirror is attached directly to the tiny inertia reactor, less than an eighth of an inch in diameter, so that a small linear movement of the ground produces a relatively large rotation of the inertia reactor and mirror. Magnifications of 3,000 times were attained with this instrument for short pendulum periods. For longer pendulum periods such direct coupled recording systems are severely limited as to useful magnification because of the horizontal pendulum's sensitivity to tilt of ground (varies as the square of the pendulum period) and because of creep and thermal response of the spring in vertical component pendulums.

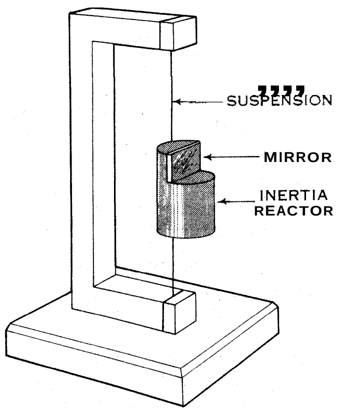

FIG. 2.—SCHEMATIC DIAGRAM OF TORSION PENDULUM

Electromagnetic Seismographs.—To overcome this limitation B. B. Golitsyn developed an electrical system in which recording was accomplished photographically with a D'Arsonval galvanometer actuated by an electromagnetic transducer on the pendulum. The transducer takes the form of a coil of fine wire attached to the inertia reactor and arranged to move in the field of a strong permanent magnet fixed to the instrument. With movement of the pendulum the transducer thus becomes a small generator of electrical power which serves to actuate the recording galvanometer. Since the mirror system of the galvanometer was very small and of light weight in comparison with the pendulum weight of about 50 lb., the available magnification was increased to around 10.000 times. But of greater importance is the fact that the electromagnetic transducer ouptut voltage depends upon the rate of movement of the coil relative to the field rather than the displacement. It thus produces negligible output for the slow movements of the pendulum caused by temperature changes or tilts of the ground and consequently higher magnifications for seismic movements can be used. Golitsyn adjusted his pendulum and galvanometer to the same period, about 12 to 15 sec. Later Frank Press and Maurice Ewing, and then Press, Ewing and Francis Lehner made extensive modifications of the Golitsyn seismograph resulting in greatly improved performance, especially for very long period waves. They changed the vertical component pendulum to the LaCoste type and compensated it for barometric pressure variations which produce movements of the pendulum because of the accompanying changes in the buoyancy of the air on the inertia reactor.

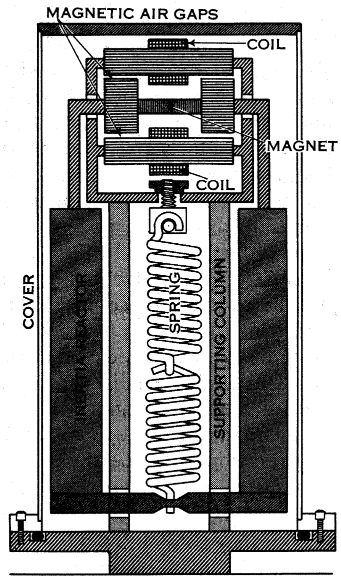

FIG. 3.—SCHEMATIC SECTION OF BENIOFF VERTICAL COMPONENT SEISMOMETER

In addition, they increased the pendulum period to about 30 sec. and the galvanometer period to 90 sec. Their instrument provides a maximum magnification of about 4,000 times in the period range from about 15 to 40 sec.

Another type of electromagnetic seismograph was developed by Hugo Benioff especially for recording the short period components of seismic waves in the range 0.2 to 5 sec. He used a cylinder of 200-lb. weight for the inertia reactor and suspended it directly by a helical spring (fig. 3), to give a free period of 1 sec. For such a large weight and short pendulum period it was impracticable at the time to use the Golitsyn type moving coil transducer because of the great size of the magnet required. He therefore used a variable reluctance magnetic transducer for providing the required electrical output. In this form magnetic flux from a permanent magnet flows across four air gaps formed between laminated iron alloy pole faces in a push-pull arrangement as shown in the drawing. Movement of the pendulum varies the length of one pair of gaps relative to the other with a resulting change in flux in the two circuits. These changes generate voltages in the two sets of coils wound around the laminated iron alloy armatures carrying the flux, and the induced currents operate two galvanometer recorders simultaneously with galvanometer periods of 0.2 sec. and 90 sec. respectively. The large weight of the inertia reactor and the high efficiency of the reluctance transducer allow maximum magnifications of about 1,000,000 times with the 0.2 sec. galvanometer for periods in the vicinity of 0.5 sec. Such high magnification can only be used in the few regions of the earth where the ground unrest is very small. For most regions the amplitudes of the ground unrest limit the useful magnification to 50,000 times or less. With the long period galvanometer the magnification is approximately 2,000 times at 1-sec. periods and gradually falls off to 30 times for periods of 90 sec. Because of a negative restoring-force introduced by the reluctance transducer, the spring and other constraints of this seismograph are much heavier than those of other types for the same pendulum periods. The instrument is thus extremely rugged relative to other seismographs.

Strain Seismograph. — The strain seismograph was developed by Benioff in 1935. Unlike pendulum seismographs which respond to vibration of the ground, the strain seismograph responds to linear strain (stretching or compression) of the ground. Strain is produced by seismic waves since in different parts of the wave the ground is displaced by different amounts or even in opposite directions. Thus during the passage of a seismic wave train past a given observing point, the ground is alternately compressed and stretched in conformity with the undulations of the wave. The strain produced by seismic waves is exceedingly small so that the measuring elements of the strain seismograph must be very sensitive. The principle of the strain seismograph is illustrated in fig. 4. The two piers, usually made of 12-in. steel pipe, are sunk into rock. A length standard in the form of a tube of fused quartz 60 to 100 ft. long is firmly attached to one pier and extends to within a short distance of the other pier. When the ground between the piers is stretched or compressed during passage of a seismic wave, the distance between the piers changes and this in turn alters the separation betn-een the end of the standard tube and the adjacent pier. With a proper transducer and recorder this small change in separation can be magnified and recorded. Benioff uses two types of transducers. One is the variable reluctance electromagnetic type similar to the one described in the preceding paragraphs for his pendulum instrument. With this transducer, recording is accomplished with a galvanometer on photographic paper. The other transducer is a carrier-current resonant capacitance bridge type recording with an ink writing galvanometer on a paper strip. Although the operation of this type of transducer is too highly technical to be described here, it is simple and stable in practice and records not only strains produced by seismic waves but also the strains produced in the solid earth by the tidal forces of the sun and moon. As to be expected, the response characteristics of the strain seismograph differ from those of pendulum instruments in a number of ways including different directional and period characteristics, and absence of response to tilt of the ground.

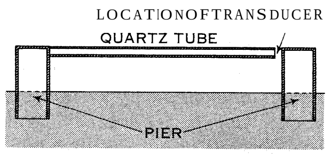

FIG. 4.—SCHEMATIC DIAGRAM OF STRAIN SEISMOGRAPH

BIBLIOGRAPHY.—Hugo Benioff, "Earthquakes and Associated Instruments." *Advances in Geophysics,* vol. ii *(1955)*; Milton Dobrin, *Introduction to Geophysical Prospecting,* 2nd ed. (1960) ; F. W. Sohon, "Introduction to Theoretical Seismology," *Seismometry,* part 2 *(1932).*
(Hʊ. B.)

SEISTAN, the ancient *Sakastane* ("land of the *Sakae"*). an extensive border district between Iran and Afghanistan. Its area, about 100 mi in extreme length and breadth, covers about 7.000 sq.mi., about two-fifths of nhich lies in Iran and three-fifths in Afghanistan.

A physical feature of this region of Asia is that none of the rivers flow to the sea, but discharge into great inland depressions—the Seistan depression being one—of which the general level is about 1.400–1,700 ft. above the sea. Regarded as a whole the Seistan depression. or Saberi into nhich the rivers here discharge themselves, consists of two extensive lagoons, formed respectively by the Harud and the Farah (both coming from the north), and by the Hirmand river and Khash (coming respectively from the south and east). South of these lagoons extends a tract of country covered with reeds called the Naisar. When the rivers are in flood the two lagoons become united and the inundation covers the Naisar also.

A further tract then also becomes overflowed, so that a great lake is formed which, lastly, discharges its redundant waters, through a course called the Shela (or Shelag), into a depression called the Gawd-i-Zarih.

The population consists chiefly of Tajiks. but Baluchis and Qainis, descendants of the ancient rulers of the land, have also established themselves, and Nadir Shah forced some nomad tribes of Shiraz to emigrate to Seistan.

Politically, Seistan is divided between Iran and Afghanistan by a theoretical boundary line fixed by commissions in 1872 and 1903–05. This line runs from the Kuh-i-Malek Siyah mountain, on the Irano-Afghan frontier, roughly northeast to Band-i-Seistan on the Hirmand, then northward to the Naisar reed beds on the Saberi shore, then it turns westward to Siyah-Kuh. The part falling to Iran west of this line is usually known as Seistan Proper and that on the east as Outer Seistan.

The original chief town of Persian Seistan, Sokaneh, has been supplanted by Nasrabad (formerly Nasirabad), founded by the Amir of Qain about 1870 and locally known as Shahr-i-Seistan. Qain (*q.v.*) and Seistan together form a hereditary governorship, which is practically independent of the governor general of Khurasan.

The trade outlets from Seistan proper are: (a) from Nasrabad southward to Zahedan (Duzdab), 135 mi.. and thence by rail to Nushki and Quetta; (b) from Nasrabad to Birjand, where the route joins the Mashhad-Zahedan motor road. Wheat is the special product of the district.

Afghan Seistan comprises the land east of the frontier described above; and includes the Hamun-i-Puza (the more eastern of the two northern lagoons) up to Juwaim in the north: the tract extends southward to the frontier of Iranian Baluchistan, in which country lies the Gawd-i-Zarih lagoon. The capital is Khakansur, a small settlement on the Khash, about 30 mi. northeast of Nasrabad.

History. — The ancient *Drangiana,* or land of the *Drangai,* received the name of Sakastane after the country was conquered by the Sakae (Scythians) about 128 **B.C.** Certain references in the Avesta lead to the supposition that Seistan, in antiquity, was a principal seat of the Zoroastrian religion. In ancient and mediaeval times the name Sakastane denoted a larger area than the name now implies and possibly even included a great area toward the east up to Kandahar. Ardashir, the founder of the Sassanian dynasty, subjugated Sakastane, but during the Sassanian epoch the Sakae appear rather as allies than subjects.

The Arab conquest of Seistan began in 683–4, but the hold of the country by some of the caliphs was precarious and uncertain. The only time Seistan played an important part in mediaeval history was during the reign of the Safavid dynasty — founded by Yaqub b. Layth, himself a Seistani — during which period it was naturally the central land of the dynasty. After the downfall of the Safavids, Seistan belonged successively to the empire of the Samanids and Ghaznawids, but the land had its own *maliks,* or native rulers, under the suzerainty of the greater dynasties.

The early ravages of the Mongols reached the frontiers of Seistan, and after their departure its history becomes confused and several persons strove for the supremacy. In 1300–01 Seistan suffered from an invasion of the Chagatai and then, again, sustained fearful damages from the Mongols at the hands of Timur, who destroyed Zaranj, the capital situated near the Sanarud canal, took prisoner the *malik,* Qutb ud Din Kayam (1383) and destroyed the canal system of the land.

Thenceforward Seistan had its own rulers until Shah Ismail conquered the country in 1508–09. The native princes of Seistan remained vassals of the Persian empire until the Afghan invasion of Mir Mohammed (1722), when the *malik,* Kayani Mohammed, by means of a disloyal treaty with the Afghans, secured for himself the possession of Seistan and Khurasan. He was slain by Nadir Quli Khan, the general of Shah Tahmasp who, afterward, as Nadir Shah, retained Seistan as part of his Persian dominions. After Nadir's death (1736), Seistan came under the suzerainty of Ahmad Shah, the Durrani ruler of Afghanistan but, on his death (1773), the land became a bone of contention not so much between Persians and Afghans as between Herat and Kandahar.

Eventually the internal dissensions of Afghanistan gave Persia her opportunity—the Sarbandi chief, Ali Khan, allied himself with the Persian government, hoisted the Persian flag on the fortress oi Sihkuha, the capital town, and sent his sons as hostages to the shah at Meshed (1853). The shah's army finally took possession of Seistan in 1865, and two years later it was placed under a Persian governor with the title of *Hashmat ul Mulk*. Complications between Persia and Afghanistan during this period led to British arbitration and the delimitation of the border by the Seistan commission of 1872, under the leadership of Sir F. J. Goldsmid. In accordance with the award, the Persian forces evacuated that part of Seistan lying on the right bank of the Hirmand. The work of delimitation was finally completed by the McMahon mission in 1903–05.

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SEITZ, KARL (1869–1950), Austrian politician, was born in Vienna on Sept. 4, 1869, the son of a wood merchant. Joining the Social Democratic party in 1888, he organized the Social Democratic teachers of Vienna, and in the diet of Lower Austria waged a fight against the dominant Christian Socialist party. Elected to the Austrian *reichsrat* in 1901 he was later its vice-president to its dissolution.

After the revolution of 1918 he was president of the German-Austrian national assembly, and subsequently of the national parliament *(nationalrat)* until the elections in Oct. 1920, and acting federal president until Nov. 1920. In Feb. 1934, after the failure of the socialist revolt, Seitz was imprisoned, but was released in December. He was again arrested after the anschluss in March 1938 and was imprisoned (1944–45) by the Nazis. After his liberation he served in the *nationalrat* from Nov. 1945 until his death in Vienna on Feb. 2, 1950.

SEJANUS, LUCIUS AELIUS, favourite and minister of the emperor Tiberius. He was the son of Seïus Strabo, prefect of the praetorians, and was adopted into the Aelian gens.

After his father's departure from Rome to take up the governorship of Egypt, Sejanus was made prefect in his stead. Me gained the confidence of Tiberius and, supported by the praetorians, whom he concentrated in a camp on the Viminal hill, became virtually ruler of Rome. But he aimed still higher and was determined to put all the members of the royal house out of his way. He removed Drusus, the son of Tiberius, by poison. The death of Drusus was followed some years later by those of Agrippina, the wife of Germanicus, and her sons Drusus and Nero, all under suspicious circumstances. He then induced Tiberius to return to Capreae.

Tiberius at last saw through his designs and caused Sejanus to be put to death (A.D. 31).

See Tacitus, *Annals*, iv. 1, 2, 3, 8, 39–59, 74, v. 6–9; Suetonius, *Tiberius*, 62; Dio Cassius, lvii, lviii.; Juvenal, x. 65–86; J. Jülg, *Vita Aelii Sejani* (1882), with notes giving full references to authorities; J. C. Tarver, *Tiberius the Tyrant*, chap. xvii. (1902).

SEKIGAHARA, BATTLE OF. Victory in this battle on Oct. 21, 1600, enabled Tokugawa Ieyasu (1542–1616) to gain control over all Japan as the first of the Tokugawa shoguns. The contending forces were feudal coalitions formed around Ieyasu and Ishida Mitsunari. Both of these men were members of a delicately balanced oligarchy which Toyotomi Hideyoshi had established to keep Japan united under his descendants. The battle occurred between 8 a.m. and 4 p.m. at a mountain pass near Sekigahara, now a stop on the government railroad between Nagoya and Kyōto. Mist and wet ground hampered both sides. Defection by some of Mitsunari's forces during heavy fighting determined the outcome. *See* also JAPAN: *History*. (J. F. Ho.)

SEKONDI-TAKORADI, a seaport of Ghana, Africa, and a municipality from 1954, was formed of the old town and surf port of Sekondi and the modern deep-water port of Takoradi, opened in 1928. Pop. (1960) 120,793. Area about 24 sq.mi. Sekondi is a mixture of old and new buildings on a hilly site. Takoradi is planned as a modern town; in the harbour area is the High street with government and commercial offices and large stores. and there are estates for the workers shaded by nim trees, and a modern hospital. Two breakwaters enclose 220 ac. of water area, with six quay berths, including one used only for manganese export, and moorings for several vessels. On the seaward side of the lee breakwater are berths for the loading of bauxite and the discharge of oil. The harbour is the terminus of the western branch of Ghana railways, and motor roads link the municipality with coast and interior. The airport constructed during World War II is served by internal and external airlines. There are local light industries including timber and cocoa butter mills, railway repair shops, fishing-boat building and cigarette making. The local inhabitants are peasant farmers or small fishermen, and market and street retail trade is conducted by women.

Nothing remains of Witsen fort built at Takoradi by the Swedes in 1652–54. The Dutch and British both built forts at Sekondi in the 17th century which were destroyed in the 1690s by Ahanta Negroes, who inhabit the district. The Dutch rebuilt Fort Orange, which was bought by the British in 1872. It is the only surviving fort in the municipality and is used as a lighthouse. The rebuilt British fort passed to the French in 1779, was ceded to the Dutch in 1867 and bought back by the British in 1872, but has become a ruin. (E. A.-HA.)

SELACHIAN, a term (sometimes considered synonymous with elasmobranch) applied to the group that includes the sharks, skates and rays. *See* CHONDRICHTHYES; RAY; SHARK.

SELAGINELLA, a genus of plants of the club mosses or Lycopodiales (*see* PTERIDOPHYTA), allied to the ferns. There are about 700 species, chiefly tropical in distribution, with a much-branched, usually creeping stem, bearing roots on the lower, and leaves on the upper side, with terminal strobili. The leaves are arranged spirally or in four rows, the latter the more common method. *S. selaginoides* occurs on boggy hillsides in North America from New York to Colorado and northward to Greenland and Alaska. and also in Great Britain. Some 35 other species occur in the United States, chiefly in the southern and western states.

SELANGOR, a state of the Federation of Malaya, on the Strait of Malacca, is bounded on the north by Perak, on the east by Pahang and on the southeast by Negri Sembilan. Pop. (1957) 1,012,929; area 3,167 sq.mi.

Most of Selangor consists of a fertile alluvial plain, extending from the strait's coast to the central Malayan range along the Pahang border. Three rivers—the Selangor, Klang and Langat—drain most of the state. Large areas of mangrove swamps are found at the mouths of these rivers.

Principal agricultural crops of Selangor are rubber, rice, palm products and pineapples. Some of the richest tin deposits of Malaya are in Selangor, and coal is also mined.

Kuala Lumpur (*q.v.*), the capital of the federation, is also the capital of Selangor; 25 mi. inland at the juncture of the Gombak and Klang rivers, it had a population (1957) of 315,040. At the mouth of the Klang, downstream from the capital, lies Port Swettenham (pop. [1947] 11,300), an important seaport of the federation. Sheltered by low mangrove islands, it is the main shipping point for Selangor's products.

Selangor, originally one of the Negri Sembilan states, began trading with the Dutch during the 18th century. In 1818 it was opened by treaty to British trade. It was declared a British protectorate in 1874. Occupied by the Japanese from 1942 to 1945, it became part of the Federation of Malaya after World War II.

SELBORNE, ROUNDELL PALMER, 1ST EARL OF (1812–1895), English lawyer and statesman, who was responsible for the passage of the Judicature act of 1873, was born at Mix-bury, Oxfordshire, on Nov. 27, 1812; his father was rector of the parish. He was educated at Rugby and Winchester, and at Trinity college, Oxford. He was called to the bar on June 7, 1837, and soon had a good chancery practice. In addition he wrote for *The Times* and the *British Critic,* and took an active interest in Church affairs.

In 1847, and again in 1853, Palmer was returned as member of parliament for Plymouth, as a Peelite, and in the house of commons he took an active and, in relation to the Crimean War, the second opium war with China and religious questions, an independent part. This attitude was disapproved of by his constituency, and he gave up his seat at the election of 1857. In 1848 he married Lady Laura Waldegrave, and in 1849 he became a queen's counsel. In July 1861 he accepted from Lord Palmerston the office of solicitor general, a knighthood and a safe seat for the borough of Richmond in Yorkshire; in Sept. 1863 he became attorney general, and, as such, was adviser of the ministry, in the courts and in the house, on the questions which arose out of the American Civil War. In 1866 he advocated making household suffrage the basis of representation, an expression of opinion which probably influenced the Reform bill of the following year—in the discussions on which Palmer took a prominent part, and especially in opposition to the so-called "fancy franchises" originally proposed by its authors. In April 1868 he refused to support Gladstone's measures for the disestablishment of the Irish Church, and after the election of that year he declined Gladstone's offer of the office of lord chancellor.

The treaty of Washington cast a great duty upon Palmer. After the conclusion of the American Civil War very large claims were preferred against Great Britain for alleged breaches of her duty as a neutral power; and after long negotiations Great Britain and the United States agreed to arbitration.

In Sept 1872 Gladstone again offered him the great seal and he accepted it, with the title of Lord Selborne. In the following year Lord Selborne carried through parliament the Judicature act, the result of which was to effect a fundamental change in the judicature system. By the operation of the act one supreme court with several divisions was constituted; each division could administer the whole law; the conflict of divergent systems of law was largely overcome by declaring that, when they were at variance, the principles of equity should prevail over the doctrines of the common law. The details of this great change were embodied in a code of general rules prepared by a committee of judges, over which Lord Selborne for two years presided week by week. "If," wrote Lord Selborne in his memoirs, speaking of the Judicature act of 1873, "I leave any monument behind me which will bear the test of time, it may be this." This unification of the courts was more or less contemporary with the construction of a single building to house them; in 1882 Queen Victoria personally presided in the new law courts and handed them over formally to Lord Selborne. On this occasion he received an earldom. In 1885 he definitely broke with Gladstone over Home Rule and disestablishment. But though he never held office again, he continued to sit in the house of lords both to hear appeals and in the ordinary business.

In 1886 Lord Selborne published *A Defence of the Church of England* and in 1888 *Ancient Facts and Fallacies concerning Churches and Tithes.* He died on May 4, 1895, at his seat in Hampshire after an attack of influenza.

See his *Memorials,* ed. by Lady Sophia Palmer, 4 vol. (1896–98).

SELBORNE, WILLIAM WALDEGRAVE PALMER, 2ND EARL OF (1859–1942), son of the preceding, was educated at Winchester and University college, Oxford, where he took a first class in history. In 1883, being then Viscount Wolmer, he married Lady Beatrix Cecil, third daughter of the 3rd marquess of Salisbury. He sat in the house of commons for East Hampshire (1885–92) and for West Edinburgh (1892–95). From 1895 to 1900 he was undersecretary for the colonies, under Joseph Chamberlain. In 1900 he entered the cabinet as first lord of the admiralty, and in 1905 he succeeded Lord Milner as high commissioner for South Africa and governor of the Transvaal and Orange River colonies. He assumed office at Pretoria in May of that year. He had gone out with the intention of guiding the destinies of South Africa during a period when the ex-Boer republics would be in a transitional state between crown colony government and self-government, and letters patent were issued granting the Transvaal representative institutions. But the Liberal party came into office in England in the December following, before the new constitution had been actually established, and the decision was then taken to give both the Transvaal and Orange River colonies self-government without delay. Lord Selborne loyally accepted the changed situation, and his moderation and good sense helped to make the new regime a success. He left South Africa in May 1910, on the eve of the establishment of the Union of South Africa which he had done so much to promote.

On his return to England, Selborne took an active share in defending the house against liberal attack, and was one of the leading "diehards" who maintained an uncompromising resistance to the parliament bill. During World War I he joined the first coalition ministry in May 1915, as minister of agriculture. He appointed an expert agricultural committee under the chairmanship of Lord Milner, to report on the means of maintaining and increasing food production in England and Wales; but he and the government rejected their recommendation to guarantee farmers a minimum price of 45*s.* a quarter for four years. In June 1916 he resigned his office because he disapproved of the Irish policy of compromise accepted by Asquith's government. He did not join Lloyd George's ministry. After the war he promoted the movement of self-government in the church which culminated in the Church Enabling act of 1919. He also identified himself strongly with the policy of reforming the house of lords and reconsidering the relations between the two houses under the Parliament act. He died Feb. 26, 1942.

SELBORNE, a village 4½ mi. E.S.E. of Alton, Hampshire, Eng. It is celebrated as the birthplace and scene of the work of Gilbert White (*q.v.*), the naturalist; his house is in the village, his memorial and grave are in the ancient church. Pop. (1951) 1,233.

SELBY, WILLIAM COURT GULLY, 1ST VISCOUNT (1835–1909), speaker of the British house of commons, was born on Aug. 29, 1835, the son of Dr. James Manby Gully of Malvern. He was educated at Trinity College, Cambridge, where he was president of the Union. He was called to the bar in 1860, went the northern circuit, and took silk in 1877. In 1880 and 1885 he unsuccessfully contested Whitehaven as a Liberal, but was elected for Carlisle in 1886, and continued to represent that constituency until his elevation to the peerage.

In April 1895 Selby was elected speaker by a majority of eleven votes over Sir Matthew White Ridley (cr. Viscount Ridley, 1900), the Unionist nominee. In 1905 he resigned and was raised to the peerage with the title of Viscount Selby. He died on Nov. 6, 1909.

SELBY, a market town and urban district in the Barkston Ash parliamentary division of the West Riding of Yorkshire, Eng., 14 mi. S. of York by road. Pop. (1961) 9,869. Area 6.0 sq.mi. It is in the low-lying vale of York on the Yorkshire Ouse, there crossed by road and railway bridges, and by a toll bridge built in 1792. Communication is afforded with the Humber by the Ouse, which is also navigable to York, and with the West Riding by the Aire and Calder Navigation canal. As well as being an inland port, the town is also a railway junction.

The church of SS. Mary and Germain belonged to a Benedictine abbey founded under a grant from William the Conqueror in 1069 and raised to the dignity of a mitred abbey by Pope Alexander II. The monastic buildings have almost disappeared. The nave of the church, which became the parish church in 1618, passes from Norman to Early English in the course of its eight bays from east to west. The choir and Lady chapel belong to the Decorated period. In 1690 the central tower collapsed, destroying the south transept. In 1906 a fire destroyed the roof.

The town played a considerable part in the operations of the Civil Wars, being held at the outset by the parliamentarians, captured by the royalists, but retaken in 1644 by Lord Fairfax and his son Sir Thomas Fairfax.

Since the Dissolution agriculture has been Selby's chief industry, with corn as the main product of the area. There are mills for crushing oilseed, factories for animal foodstuffs, beet sugar and citric acid; shipbuilding yards, flour and paper mills, and dyeing and bleaching works.

SELDEN, JOHN (1584–1654), English jurist, legal antiquary and oriental scholar, was the acknowledged master of the Antiquarian society, the centre of English historical research in the 17th century. Born on Dec. 16, 1584, at Salvington, Sussex. His father, also John Selden, held a small farm. Selden was educated at Chichester grammar school and Hart hall, Oxford. In 1603 he entered Clifford's Inn, London, and in 1604 migrated to the Inner Temple; in 1612 he was called to the bar. His practice was mostly conveyancing, and he rarely went into court.

Selden's early works were: *England's Epinomis* and *Jani Anglorum facies altera* (1610), which dealt with the progress of English law down to Henry II; *Titles of Honour* (1614), which, in spite of some obvious defects and omissions, has remained to the present day the most comprehensive and trustworthy work of its kind; *Analecton Anglo-Bvitannicon* (1615): and *De diis Syriis* (1617), which immediately established his fame as an oriental scholar. For his *History of Tithes* (1618), Selden was summoned before the privy council and compelled to retract his opinions, or at any rate what were held to be his opinions. Moreover, his work was suppressed and he himself forbidden to reply to any of the controversialists who had come or might come forward to answer it.

He was first elected to parliament in 1623. Even before his election he had shown his political sympathies by assisting in the preparation of the memorable protestation on the rights and privileges of the house of commons affirmed by the house in 1621. For this he had been committed to the Tower of London. After his election he took a prominent part in the impeachment of the duke of Buckingham, was counsel for Sir Edmund Hampden in the "benevolence" case of 1627 and had a large share in drawing up and carrying the Petition of Right (*q.v.*).

In the session of 1629 Selden was one of the members mainly responsible for the tumultuous passage in the house of commons of the resolution against the illegal levy of tonnage and poundage, and, along with Sir John Eliot, Denzil Holles, Benjamin Valentine, William Strode and the rest, he was sent once more to the Tower. He was released by the intervention of Archbishop Laud. In 1628, at the suggestion of Sir Robert Cotton, he had compiled, with the assistance of Patrick Young and Richard James, a catalogue of the Arundel marbles. About this period he seems to have inclined toward the court rather than the popular party, and even to have secured the personal favour of the king. To him in 1635 he dedicated his *Mare clausum,* against the freedom of the sea, and under the royal patronage it was put forth as a kind of state paper. It had been written 16 or 17 years before but James I had prohibited its publication for political reasons; hence, it appeared a quarter of a century after Grotius' *Mare liberum,* to which it was intended to be a rejoinder. He was returned to the Long parliament without opposition for the Cniversity of Oxford.

Selden joined in the protestation of the commons for the maintenance of the Protestant religion according to the doctrines of the Church of England, the authority of the crown and the liberty of the subject. In 1643 he participated in the discussions of the assembly of divines at Westminster, and was appointed shortly afterward keeper of the rolls and records in the Tower. In 1646 he subscribed the Solemn League and Covenant, and in 1647 was voted £5,000 by parliament as compensation for his sufferings under the monarchy. He published in 1642 *Privileges of the Baronage of England when they sit in Parliament* and *Discourse concerning the Rights and Privileges of the Subject;* in 1644, *Dissertatio de anno civili et calendario reipublicae Judaicae;* in 1646 his treatise on marriage and divorce among the Jews entitled *Uxor Ebraica;* and in 1647 the earliest printed edition of the old English lawbook *Fleta.* In 1650 Selden passed the first part of De *synedriis ct prefecturis iuvidicis veterum Ebraeorum* through the press, the second and third parts being published in 1653 and 1655, and in 1652 he wrote a preface and collated some of the manuscripts for Sir Roger Twysden's *Historiae Anglicne scriptores decem.* After the death of the earl of Kent in 1639 Selden lived permanently under the same roof with his widow. It is believed that he was married to her, although their marriage does not seem to have ever been publicly acknowledged. He died at Friary house in Whitefriars on Nov. 30, 1654, and was buried in the Temple church, London. Of all the members of the Antiquarian society, the centre of historical research of the 17th century, Selden was the acknowledged master.

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SELECTION, the term applied in biology to the picking out of some variants in preference to others from a population of animals or plants. Human or artificial selection has been the chief instrument in establishing the breeds of domestic animals; natural selection has been the main agency in bringing about evolution in nature; and sexual selection has helped in producing the adornments used by animals in courtship (*see* VARIATION; EVOLUTION, ORGANIC). (X.)

ARTIFICIAL SELECTION

Artificial selection is definable as the methodical or unconscious choice by man of certain individual animals or plants as parents of the next generation. It is made possible by the facts that related individuals maintained under the same conditions exhibit dissimilarities, and that certain of these dissimilarities are hereditary. Man cannot as yet produce new hereditary characters at will, but as and when these appear he can, by appropriate breeding practices, incorporate or eliminate them from his stock. When a conspicuous and advantageous new inherited character appears, selection is reduced to the preservation of the individual or individuals exhibiting it and to the use of these for further breeding. But in most instances a new desirable character is at first only faintly pronounced; it is a slight difference in the degree of expression of a character already existing in the stock, a slightly finer quality of wool, or a slightly increased quantity or improved quality of milk, and then patience, the finest powers of discrimination and the soundest of judgments must be exercised during many years if this improvement is to be maintained. For such selection there must always be a clearly predetermined object in view, the breeder must be able to define his aim and to discriminate between slight differences. In the absence of any precise method of assessing the kind and degree of improvement, judgment can be acquired only by long experience.

Unconscious selection is the practice of preserving the more valued and of eliminating the less valued individuals without any thought of altering the general characterization of the stock. Methodical selection is the conscious and deliberate practice of modifying the general characterization of a stock according to some predetermined standard through the careful choice of certain individuals as the parents of the next generation and through the control of the matings of these individuals. Save that in one case man acts deliberately and purposefully and in the other unintentionally, there is little difference between the two kinds of artificial selection: each blends into the other. In both cases man preserves those individuals which promise to be most useful or attractive to him, and neglects the others. In methodical selection the choice of the individual for further breeding is determined by (1) its appearance, (2) the record of its ancestry (pedigree) and (3) the record of its progeny (the progeny test).

Remarkable results have been secured by this mass selection—the choice for breeding of all or many of those individuals exhibiting variation in the desired direction. This is the method of the grower of corn who, at harvest time, selects the best ears from the whole yield and from these rears his next year's crop. This selection, on the basis of appearance, though slow and uncertain, has produced the improved varieties of plants and animals. It is effective because most of the characters upon which it is employed are dependent on a large number of hereditary factors, which can be sorted out and accumulated by selection of this kind. The most rapid and permanent results of such selection are those which take the form of the sorting out of pure lines from a mixed population of self-fertilized plants, for in this case a single selection separates the inherited difference at once. This accomplishes immediately all that is possible, for selection within a pure line is ineffective. (See PURE LINE.) In animals the nearest approach to a pure line is a closely inbred strain comparatively homozygous for the characters for which selection is practised It is abundantly demonstrated that appearance alone is not a reliable guide to breeding ability. Individuals which look alike may possess different breeding records, and the only real tests for breeding ability are the performances of their relatives (pedigree) and more especially the records of their progeny (the progeny test).

Many domestic animals and plants afford striking proofs of the power of artificial selection. Thus from a wolf-like ancestor have arisen the greyhound and the bulldog, the Pekinese and the great Dane. Similarly, artificial selection has been the means of perfecting the thoroughbred, the Shetland, and the shire horse. Among plants, most cultivated species have been more or less transformed by selection; roses and hyacinths are notable instances. (See ANIMAL BREEDING; GENETICS OF POPULATIONS; MENDEL, GREGOR JOHANN; PURE LINE; HEREDITY) (F. A. E. C)

SEXUAL SELECTION

Charles Darwin (*q.v.*), after propounding the revolutionary and far-reaching theory of natural selection to account for the evolutionary origin of adaptive characters, set himself to see whether the conception was all-embracing. He came to the conclusion that the bulk of the large group of secondary sexual characters, such as the deer's antlers, the peacock's train, the lark's song, etc., could not be accounted for by the operation of natural selection, but that another type of selective mechanism, which he called sexual selection, came into operation here.

He argued that whenever any character possessed only by males conferred upon its possessor no direct advantages in the struggle for existence, but served merely to confer advantages upon one male in its struggle with other males to secure a mate, then we could not speak of natural selection, but of sexual selection. In some cases, as in polygamous birds, the two forms of selection might be in opposition, the gorgeous but cumbrous plumes favoured by sexual selection being definitely disadvantageous in the struggle for existence.

Although much attacked, the theory survives, if in a somewhat altered form, and the evidence now available makes it clear that sexual selection has undoubtedly played a considerable part in moulding the form and behaviour of higher animals.

The most important types of character which have presumably thus originated are as follows:—(I) for pursuit and capture of one sex by the other; (2) offensive and defensive weapons employed by members of one sex in fighting for the other; (3) means for making known the presence of one sex to the other; (4) characters employed in stimulating sexual emotion in the other sex; ie., organs employed in courtship of animals (*q.v.*).

As examples of these various types may be cited (1) the enlarged prehensile antennae of various small Crustacea (*Moina;* many copepods) or the enlarged limbs (*gnathopods*) with which male gammarid Crustacea seize and grip the female; (2) (a) offensive—the antlers of stags, the enlarged canines of boars and stallions; (b) defensive—the mane of the lion or of certain male baboons; (3) the chirping of male crickets and the croaking of male frogs, the drumming of certain woodpeckers, the flashing of fireflies; (4) the train of the peacock, the crest (present in both sexes) of the crested grebe, the bower of bower birds.

Naturally these different categories grade into each other; courtship characters grade into recognition marks; weapons may serve also as adornments, and the same character, *e.g.*, great strength, may serve both to fight enemies and to capture mates.

It has been suggested with some plausibility that prominent weapons may secure advantage by deterring other males from attempting combat; there seems no doubt that young stags mith poorly-developed antlers avoid battle with large-antlered males. There are a number of prominent secondary sexual characters to which no function can yet be assigned; e g., the enormous horns of the males of the Goliath and other beetles.

The fact that organs for capturing the female may grade insensibly into copulatory organs, and organs for stimulating the emotions into those facilitating the meeting of the sexes, suggests a valid criticism of the pure neo-Darwinian doctrine which maintains that sexual selection is something altogether apart from natural selection.

Certain organs and instincts are obviously necessary to a sexually-reproducing species if the race is to continue; and in so far as selection has contributed to their origin, it will, as Darwin himself pointed out, have been natural selection.

Devices for securing efficient mating and fertilization will eventually become more elaborate as we ascend the animal scale, as internal supplants external fertilization, as locomotion becomes more rapid, as the brain becomes more complex. The two chief ways to secure mating will be material force (pursuit and capture; or fighting for possession), or stimulation of the opposite sex (advertisement of a "sexual situation" by means of recognitional sounds, colours, actions or scents; or by emotionally stimulating display). In all these cases, while natural selection will see to it that the devices are reasonably efficient, there may and usually will also exist Darwinian sexual selection, as a result of competition between males, and this may intensify and exaggerate the characters. Since it will usually be impossible to disentangle the shares of natural and of Darninian sexual selection, and since they both tend to produce characters of the same type, it is perhaps better to redefine sexual selection. If, instead of making competition between members of one sex the criterion, we adopt selection with reference to successful and efficient mating as our definition, the situation clears up considerably. For sexual selection in the original sense we may then substitute the term *intra*-sexual selection.

In all recognitional and courtship characters selection is exerted *via* the brain and mind of the opposite sex, and may thus. with Lloyd Morgan. be called psychical sexual selection (as opposed to psychical selection of a nonsexual nature, such as must have operated in the genesis of conspicuous flowers by psychical selection via insects).

Sexual selection is usually unisexual, acting only upon one sex. In many cases, however (courtship decorations in herons, grebes, etc), it is mutual and affects both sexes similarly. Rarely, as in phalaropes, the male broods and cares for the young, and the female does most of the courting. We may here speak of reversed sexual selection, falling mainly upon the females, which are accordingly the more brightly coloured.

A. R. Wallace wished to discard the whole sexual selection theory, and to ascribe the development of male weapons and display characters to the hypothetical action of "male vigour." This view as it stands is undoubtedly erroneous. However, it will often be true that greater prowess in battle and greater efficiency in song or display will be associated with high vigour; and in this way sexual selection will have, as an important by-product, the selection, as fathers of the next generation, of males above the average in vigour.

The new definition above given obviates one great difficulty in the theory as originally stated. It was difficult to see how intrasexual selection could be very effective without a preponderance of males, or polygamy; and in the great majority of animals there is no polygamy, and the proportion of the sexes is nearly equal. (*See,* however, Darwin, Descent of *Man,* 2nd ed., p. 329; and E. Howard, Territory in Bird Life, p. 35.) If, however, sexual selection is primarily designed for securing efficient and speedy mating, this difficulty is removed.

The other objection which is commonly raised, that the theory of sexual selection ascribed too much taste and conscious discrimination to the female, rests upon a pure misconception. So long as the courtship display stimulates the female, a selective result will be obtained, uhether she exercise taste and judgment or be stimulated in the most automatic way.

A few examples will go to show how entangled are natural and intrasexual selection.

In the courtship of the little fly *Drosophila,* the male approaches the female while waving his wings in a peculiar manner. Sturtevant made up three series of bottles. In each of series A was placed a normal male and female; in B a female with a male whose wings had been cut off; and in C a female with one normal and one wing-clipped male. Successful mating was accomplished by the wing-clipped males in series B, but in a much longer average time than in series A; *i.e.,* the wing-waving courtship apparently has the effect of stimulating the female to sexual response more quickly than does the mere presence of a male. In series C, the average time of mating was only a trifle longer than in series A; but the wing-clipped males were almost as successful as their normal rivals. This can only be explained as meaning that, once the courtship has excited and stimulated the female, she mill be ready to accept any male. Courtship is, in this case, almost entirely an affair of natural selection; like a copulatory organ, it renders fertilization more certain, and so benefits the race, and is of little benefit to one male in competition with another.

The same appears definitely to hold good in newts, in which courtship is the preliminary to the male's depositing his sperm in a packet on the pond-bottom. Even should two or more males be courting simultaneously, and should the courtship of one be more effective than that of the rest, it would be impossible that the female should pick up his sperm packet in preference to another. In certain polygamous birds, on the other hand, although the display of the males presumably has some function in merely securing fertilization, yet intrasexual selection of one male in preference to others is predominant. This occurs in birds where there are special assembly-places for the males' display in the breeding season: the females visit these places only for the purpose of mating, and the males take no share in caring for eggs and young. Black grouse, certain birds of paradise and the ruff are examples from different orders. Because of the unique variability of male ruffs in the breeding plumage, every male on a "hill" (as the ruff's assembly places are called) can be individually recognized. Edmund Selous took advantage of this fact. He made observations on one "hill" throughout several weeks of the breeding season, and was able to establish the fact that whereas some of the cocks never succeeded in mating at all while he was watching, and others but rarely, one or two secured a large number of mates. Not only that, but the most successful cock had an exceptionally well-developed ruff, and one that to the eyes at least was very striking in its colour contrasts. In this species, then, by no means every male secures a mate, and courtship display is concerned with the securing of mates. There is a real "struggle for reproduction" among males, with resultant intrasexual selection.

In man it is obvious that sexual selection plays, and has played an important role, but in a more complex way than in most species, since not only does some degree of mutual sexual selection exist, but also some degree of intrasexual selection in both sexes separately. Sexual selection has undoubtedly helped to diversify as well as to improve human appearance.

Sexual selection has exercised a considerable secondary effect in evolution, through characters which have arisen in one sex under the influence of sexual selection, being often partially or completely transferred to the other sex under the influence of heredity. A good example is afforded by the finch family (*Fringillidae*). In general, male finches are brighter coloured than the females, but their characteristic patterns are usually reproduced in duller colours in the females. It is probable that the bright colours originated in the males through sexual selection; but their partial transference to the females (though of no functional significance in them) has resulted in the females of the different species being more different from each other than they otherwise would have been.

When, for example, the females nest in holes, bright colours can be transferred to them more completely without endangering their safety; this is so, for instance, in the European robin and the tits. When, however, as in most pheasants, the female nests in exposed situations, natural selection inhibits the transference.

Admittedly many of these conclusions are based solely on indirect evidence; but in view of the experimental work on Drosophila and newts, and the natural experiment annually staged with ruffs, which decisively point to a stimulating effect of display on the female, the cumulative circumstantial evidence must be presumed correct unless it is actually shown false. See COURTSHIP: ANIMALS; BIRD: Reproduction.

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SELENE or **MENE,** the moon-goddess, daughter of Hyperion and Theia, sister of Helios and Eos, mother of Pandia by Zeus. She was also wooed by Pan in the form of a white ram, or she had selected a white ram from his flock as the price of her favours. The most famous of her amours was with Endymion (*q.v.*). Selene was represented as driving a chariot drawn by two horses, or later by cows or oxen, herself mounted on a horse, a bull, a mule or a ram. Later, she was identified with Artemis (*q.v.*), and with Phoebe. She was worshipped on the days of the new and the full moon. The male moon-god (Mēn) is Asiatic. The Roman goddess of the moon was Luna, who possessed sanctuaries on the Aventine and Palatine hills. She had the title Noctiluca (night-shining) and her Palatine temple was lit up at night.

See W. H. Roscher, *Über Selene und Verwandtes* (1890), with *Nachträge* (1895); Preller, *Griechische Mythologie,* 4th ed., pp. 443–446 (1894); A. Legrand, s.v. "Luna" in Daremberg and Saglio, *Dictionnaire des antiquités;* G. Wissowa, *Relig. u. Kultus* (2nd ed.), p. 315 *et seq.*

SELENGA-ORKHON, a river of Central Asia, which rises in two principal headstreams, the Selenga and the Orkhon, on the plateau of northwest Mongolia in 101° E. Both flow east-northeast to their confluence near Kiakhta on the border of Mongolia and the Buryat Autonomous Soviet Socialist Republic (*q.v.*) of the U.S.S.R. From Kiakhta to its delta on Lake Baikal the Selenga flows down a gently graded slope giving access from Mongolia to the plains of Asiatic Russia. The Selenga is navigable in summer from the delta to Kiakhta (210 mi.); its total length is 621 mi. On the left it receives the Djida and the Temnik and on the right the Tola, Khara-gol, Chikoi, Khilok and Uda. For a description of its former trading importance see TROITSKOSAVSK.

SELENIUM is a chemical element closely allied in physical and chemical properties with sulfur. It was identified in 1818 by J. J. Berzelius, in Sweden. It had been found a year earlier in a red deposit that had collected on the floor of a room in which sulfur, obtained as a by-product from a copper mine, had been used; but its similarity to tellurium had caused it to be mistaken for that element. Since the name tellurium had been coined from *tellus,* the Latin word for "earth," Berzelius named his discovery after selene, the Greek word for "moon."

In 1873, it was discovered by Willoughby Smith that crystalline selenium develops a tremendous increase in its electrical conductivity when it is exposed to light, regaining its resistance immediately when the light is shut off. This discovery provided the technical basis on which talking pictures, television, the telegraphic transmission of photographs and many other devices depending on light-sensitive materials were eventually built. (See Selenium Cells and Rectifiers, below; also, the article SELENIUM CELL.)

The symbol of selenium is Se; atomic number 34; atomic weight 78.96. It is a complex element with six valence electrons ($4s^2$, $4p^4$) in the outer (N) main level; six stable isotopes with mass numbers (in order of decreasing abundance), 80, 78, 76, 82, 77 and 74; and eight radioactive isotopes, including Se^{75} (half life, 127 days) and Se^{83} (half life, 25 min.) have been prepared.

Occurrence.—Selenium is widely distributed throughout the world, although in small quantities (10%–7% in igneous rocks), being the 69th element in order of abundance, between silver and argon. It rarely occurs native; frequently it accompanies native sulfur: but is commonly found in combination with the heavy metals as selenides and accompanying the more abundant metal sulfides. The important minerals are clausthalite, $PbSe$; eucairite, $(Ag,Cu)_2Se$; crookesite, $(CuAgTl)_2Se$; naumannite, Ag_2Se and zorgite (a complex selenide containing 31% Se). When any of the selenium-containing sulfide minerals are subjected to chemical processing operations, selenium appears as a by-product.

Physical Properties. — Selenium exists in several allotropic forms including a glassy form, two monoclinic (metalloid) forms and hexagonal (metallic) selenium, all stable to some extent at room temperature. Glassy or amorphous selenium is obtained when any form is heated above the melting point and subjected to rapid cooling. No well-defined freezing point is observed, the mass gradually thickening until at 40°–50° C. a glassy mass develops. The cold glassy product is brittle, exhibits conchoidal fracture and is only slightly soluble in carbon disulfide. Rapid reduction of a cold aqueous solution containing a selenium compound yields red amorphous selenium which changes to the gray form upon heating the solution. Orange to red modifications of monoclinic selenium are obtained when the red amorphous powder is extracted with carbon disulfide and this solution is evaporated and cooled. These modifications may be changed to gray metallic selenium by heating, the orange at about 110" C. and the red at about 125° C Gray metallic selenium may also be prepared by allowing molten selenium to cool slowly to room temperature or by annealing other modifications slightly belon the melting point This form is completely insoluble in carbon disulfide, but soluble at higher temperatures in naphthalene. aniline and ethyl benzoate. It is this form of selenium which possesses the remarkable property of having its conductivity increased by light. That freshly precipitated red selenium may be amorphous is a matter of doubt. The metallic gray selenium has a melting point of 217° C. and a specific gravity of 4.79 (25° C.). It crystallizes in rhombohedra1 crystals in the hexagonal system.

Production. — In the United States and Canada the chief source of selenium is the anode slime from copper refineries, lesser amounts from the roasting of metallic sulfides. In most cases the selenium is isolated as selenious acid and elemental selenium is obtained by reduction with sulfur dioxide. Of considerable importance is the fact that selenium production is incidental to other metallurgical processes, chiefly the production of copper.

The curtailment of copper production necessarily affects production of selenium Efforts are being made to develop sources of selenium independent of copper. The chief-producing countries are the U S. and Canada.

By the late 1950s selenium in the U.S. was in excess of 1.000.000 lb. per year. As much as 15% of the production comes from secondary sources, principally burned-out rectifier units and spent catalysts. Another important secondary source is lead flue dusts from Mexico Consumption of selenium has been affectedby high prices as well as sharp inroads by competitive materials. Germanium and silicon were substituted for selenium in rectifiers; tellurium replaced some selenium in rubber and stainless steel; and mercury and cadmium are substituted for selenium in the glass and pigment industries.

APPLICATIONS

At mid-20th century by far the largest amount of selenium was consumed in the manufacture of rectifiers. particularly power rectifiers. The chemical industry was a large consumer. the most important applications being in pigments, pharmaceuticals and rubber. The glass and steel industries also used large amounts, and there was a wide range of minor applications.

Selenium Cells and Rectifiers. — In 1873 it was found that selenium changed its electrical conductance under the influence of light. Shortly thereafter, a simple electric circuit containing a selenium element was shown to generate current when the selenium was exposed to light. Not until 1930 was this idea developed to a stage where it became useful in the form of a layer-barrier cell. Such a light-sensitive cell consists of a conducting metal back of copper, aluminum or brass, etc , coated nith a thin film of metallic selenium, this in turn coated with a thin translucent layer of gold. A transparent filter usually protects the gold surface. One lead of the circuit is connected to the metal back and the other to the gold surface, the two leads being attached to a sensitive galvanometer or other measuring device. When light shines on the gold surface of the cell. sufficient electromotive force is developed to operate a sensitive galvanometer without any external amplifying circuit. This cell was used for photographic exposure meters, photoelectric colorimeters and other instruments designed to measure light. Although these cells have been improved, they are in general the photovoltaic type.

The dry rectifier differs from the selenium cell in the substitution of a low melting alloy such as Wood's metal for the gold film. During application of the alloy coat on the selenium or in annealing of the selenium, a surface develops or is provided between the selenium and the alloy uhich resists backward flow of alternating current. By alloning current to flow in only one direction the rectifier converts alternating current to direct current.

Such rectifiers are used for charging batteries, electroplating and operating a variety of direct current devices. When the rectifiers are connected in multiple units in series or parallel, they provide a wide variety of sizes and capacities. The cells operate at high efficiency over a wide range of loads.

Glass.—A large consumer of selenium is the glass industry. Selenium has replaced manganese as a glass decolorizer. The objectionable green colour produced in glass by iron is neutralized by the addition of a small amount of selenium The addition of a larger amount of selenium, either as such or as sodium selenite, imparts to glass a clear red colour useful for signal lamps.

Rubber.—Selenium is used with sulfur in the vulcanization of certain special rubber products. Crystallization of sulfur in rubber may be induced by selenium because it is isomorphous with monoclinic sulfur. In this manner. metastable solutions of sulfur are prevented and initial rapid bloom (haze surface) of uncured stocks is eliminated.

Selenium exerts a distinct accelerating action upon rubber-sulfur mixtures and increased abrasion resistance of certain vulcanizates.

Selenium Oxychloride as a Solvent.—The specific solvent properties of this reagent were studied by V Lenher. The reagent is a solvent for certain natural and synthetic resins, fish oils, etc.; it helps to distinguish between saturated and unsaturated hydrocarbons, attacking the latter but not the former. In a mixture of benzene and heptane. it dissolves the former. whereas the latter floats unchanged. Selenium oxychloride $SeOCl_2$, is a selective solvent for Cb_2O_5 in the presence of Ta_2O_5 and MoO_3 in the presence of WO_3. A solution of molybdenum trioxide in selenium oxychloride exhibits a photochemical effect, in the dark. the solution maintains the yellow colour of selenium oxychloride; exposed to light it changes to blue. The reaction is reversible.

Miscellaneous Uses. — Cadmium sulfoselenide forms a red pigment and is produced in relatively large amounts Colours ranging from orange to maroon are obtained, depending on the method of preparation The addition of a small amount of selenium to stainless steel. copper and copper-rich alloys improves machinability and is a commercially established practice. A protective coat on magnesium alloys may be made with selenium. Chemical uses include that of selenium dioxide as an oxidizing agent in organic reactions. and the use of selenium and copper selenite as catalysts in oxidizing reactions, such as the Kjeldahl digestion Ferrous selenide is used as a catalyst in cracking petroleum. The use of selenium compounds on battery plates prevents sulfation and therefore permits higher charging rates. The use of selenium in fungicides and insecticides is limited, because of the possibility of contaminating food products. With the common use of mercury in laboratories and plants, the detection of small concentrations of mercury has become important. A selenium-sulfur mixture blackens quickly in the presence of mercury vapour and is used to indicate exposure of norkers to mercury fumes Selenium has been used in flameproofing of textiles and certain cable coatings.

Some species of plants are not only tolerant of selenium but actually require selenium for growth and development. Since selenium occurs with uranium in certain types of deposits. the presence of plants nhich require selenium for growth may indicate the presence of uranium in a deposit. Such plants are sometimes called indicator plants. These plants may contain as much as 1.5% of selenium and have an offensive garliclike odour.

CHEMICAL PROPERTIES AND COMPOUNDS

Selenium reactions lie intermediate between sulfur and tellurium. At the boiling point selenium vapours consist of mixtures of Se, and Se_2. Heated in oxygen the element burns with a blue flame, selenium dioxide being formed. Direct combination of the element nith hydrogen, oxygen, halogens and many metals is common. The halogen compounds are hydrolyzable but not so easily as comparable sulfur compounds.

Selenium is a weaker reducing agent than sulfur. Solution in concentrated sulfuric acid yields a green solution of $SeSo_3$. The acid-forming tendencies of the element are most pronounced in the higher valences. The valence types of selenium compounds are -2, 0, $+2$, $+4$, $+6$. Gray selenium has a melting point of 217° C.; heat of fusion 1.56 kg.cal. per gram; heat capacity 6 0 (25° C.) cal. per gram-atom; entropy at 25° C., eutectic units 10.0; and magnetic susceptibility -0.32×10^{-6}.

Inorganic Compounds.—Hydrogen selenide, H_2Se, is a colourless gas which has a disagreeable odour and is extremely toxic. It has a boiling point of -41.3" C. and a melting point of -64° C. It burns with a blue flame, giving either red selenium or white selenium dioxide, depending on the amount of oxygen present. The gas is prepared by dropping water on aluminum selenide. the latter being prepared by direct combination of selenium and powdered aluminum. Hydrogen selenide is less stable and is a stronger reducing agent than hydrogen sulfide. This behaviour may be associated uith the fact that selenium has a larger atomic size than sulfur.

Metallic selenides are produced by direct combination of metals with selenium or by precipitation from solutions of metallic salts by hydrogen selenide. The alkali selenides are colourless but become red by addition of more selenium to form polyselenides such as Na_2Se_2.

Selenium dioxide, SeO_2, is easily prepared by burning selenium in an excess of oxygen. Impure selenium dioxide (called whispers) is obtained from dust chambers which catch the dust from roasting certain metallic sulfides. This material is contaminated with selenium and other impurities and may be purified by addition of nitric acid. removal of the excess nitric acid by fuming and finally obtaining the selenium dioxide by sublimation. The dioxide crystallizes in long colourless crystals, melts under pressure at 340° C. and dissolves in water to form selenious acid.

Selenium trioxide, SeO_3, has been prepared by the action of sulfur trioxide on potassium selenate and also by the vacuum sublimation of a 1:1 mixture of selenic acid and phosphoros pentoxide.

Selenium monoxide is a definite oxide but has been identified only in the gaseous state by spectroscopic means.

Selenic acid, H_2SeO_4, may be prepared by addition of bromine to silver selenite. This acid, the analogue of sulfuric acid, is usually seen as a sirupy liquid, but has been obtained solid (melting point 58° C.). The solid acid is prepared by desiccation of a strong selenic acid solution. It cannot be obtained pure by distillation since some of the selenic acid decomposes to form selenious acid Selenic acid has the noteworthy property of dissolving gold in the presence of oxygen. Like telluric acid, it oxidizes hydrochloric acid to give free chlorine. The selenates are similar to the sulfates; the soluble selenates are stronger oxidizing agents.

Selenium tetrafluoride, SeF_4, was obtained in the pure state (1928 by E. B. R. Prideaux and C. B. Cox) by the interaction of selenium tetrachloride and silver fluoride. It is a colourless liquid boiling at 93° C. and melting at -13.2° C. Its specific gravity is 2.77. It attacks glass and is completely hydrolyzed by water to selenious and hydrofluoric acid.

Chlorides.—Selenium forms a number of chlorides. Diselenium dichloride. Se_2Cl_2, a brownish-yellow liquid with pungent odour, is decomposed by water into hydrochloric and selenious acids with elimination of red selenium. Selenium tetrachloride, $SeCl_4$, a colourless crystalline mass, which vapourizes without melting. is produced by burning selenium in chlorine. Selenium oxychloride, $SeOCl_2$, a pale yellow liquid boiling at 177 2° C. and melting at 8.5° C., is prepared by direct chlorination of a mixture of selenium and selenium dioxide. The impure liquid is purified by distillation. Selenium substitutes for oxygen in a number of acids, forming such compounds as sodium selenocyanate.

Organic Compounds.——In many instances the equivalent of sulfur compounds are known. The following types of aliphatic compounds are known: types RSeH, R_2Se, RSeR'. and R_2Se_2, complex compounds of platinum and platinum halides with dialkyl selenides and types R_2SeX_2 and R_2SeX, R representing a variety of alkyl radicals and X various halogens. Compounds derived from aldehydes and ketones are similar to selenoacetaldehyde, CH_3CHSe, and diselenoacetone $(CH_3.CS_e\,CH_3)_2$. Selenoacetic, CH_3COSeH, and ethyl selenoformic, C_2H_5COSeH, are examples of the relatively simple aliphatic acids, and 2:4 dinitrophenylselenoacetic acid is an example of the more complex. Nitric acid oxidizes dialkyl diselenides to alkyl seleninic acids.

A large number of aromatic derivatives of selenium have been prepared. Types in which R represents a variety of aryl groups are RSeH, R_2Se, R'SeR and RSe.SeR. The interaction of selenium tetrachloride and benzene in the presence of aluminum chloride yields diaryl selenides and diaryldiselenides. Diarylsulfones heated with precipitated selenium yield diaryl selenides, mixed selenides being formed if the radicals in the sulfones are different. Compounds of the types R_2SeX_2 and R_2SeO, R being an aryl group, are illustrated by diphenyl selenium dibromide and diphenyl selenoxide. Although bromine reacts directly with diaryl selenides in carbon disulphide to form bromides, the direct union of chlorine is less usual. Nitric acid reacts with diaryl selenides or their dibromides to form nitrates. The dibromides treated with moist silver oxide yield hydroxides. When sodium hydroxide is used, the diaryl selenoxides, RSeO, are obtained. Many mixed compounds are known. Examples are phenylmethylselenium bromoiodide and phenylrnethylselenium dihydroxide. A comprehensive presentation of organometallic compounds was provided by Newton Friend and A. E. Goddard (1937).

Detection and Estimation of Selenium.—Selenium is precipitated from its inorganic compounds by hydrogen sulfide and is redissolved by ammonium sulfide. A characteristic test is the precipitation of red selenium from a hydrochloric acid solution by sulfur dioxide. hydrazine, hydroxylamine, etc. The gravimetric estimation is made by weighing this precipitate after it has been boiled to convert it to the gray modification. Selenium may be determined iodometrically, and selenious acid may be titrated with permanganate. Selenates may be estimated by distillation with hydrochloric acid. The liberated chlorine is collected in potassium iodide and the iodine thus liberated is titrated with thiosulfate. An excess of hydrazine can be added to selenious acid and the excess reagent titrated with potassium iodate to an ICI end point. Selenious acid may be reduced by hydriodic acid and the liberated iodine titrated with thiosulfate. Thiosulfate is used as a reducing agent for selenious acid and the excess reagent titrated nith iodine. Tellurium must first be removed or accounted for. Instrumental methods include potentiometric titration, polarographic determination, coulometric and spectrophotometric measurements.

Medical **Aspects.**—*Selenium* in Soils and Plants—Although the toxic nature of selenium was recognized as early as 1842, it was not until 1929 that a thorough study was initiated to determine the effects of the element in animal and human hygiene. It is recognized that plants grown on seleniferous soils may absorb selenium (see LOCOWEED). When used as food for animals or humans, the plants are toxic, causing either chronic or fatal poisoning. Affected areas have been surveyed and in some cases planting discontinued Wheat samples grown in some areas contained 30 parts per million of selenium; only 10 to 20 parts per million are necessary to produce chronic poisoning in cattle. Although the hull. bran and patent flour become separated in milling operations, enough selenium can remain in the flour to be a hazard to humans, particularly if the wheat is grown on highly seleniferous soils. Selenium poisoning in horses is accompanied by loss of hair from tail and mane and by abnormal hoof growth; extreme cases produce blind staggers or even death. In humans selenium may concentrate in the lungs, liver, kidney or spleen. Occupational dermatitis is a mild form of poisoning. Few cases of death have been reported. Recent studies indicate arsenic as a possible inhibitor for selenium poisoning. It is known that soils which are leached by abundant ground water lose some selenium and that plants grown in areas of plentiful rainfall contain less selenium, even though the soil contains the element. The Colorado river, for example, carries away some selenium from certain irrigated areas in western United States. It is interesting to note that bottom deposits and growths in the Gulf of California and the Gulf of Mexico contain notable amounts of selenium.

Protection Against Liver *Necrosis*.—Klaus Schwarz and C. M. Foltz and others have reported that liver necrosis in rats may result from low cystine and simultaneous deficiency in vitamin E and factor 3. As little as 13.33 μg. of sodium selenite in 100 g. of diet were found to afford complete protection against liver necrosis. The dose necessary for protection is less than 1% of the toxic dose. See also Index references under "Selenium" in the Index volume.

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SELENIUM CELL. The selenium cell is a photoelectric device used to generate or control an electric current through the influence of light falling upon the cell. Selenium photocells are commonly used in photographic exposure meters, burglar alarms, electronic door opening and counting devices, electronic control systems in factory assembly lines and industrial colour perceptors. In some ways (colour perception. sensitivity) the performance of selenium photocells is superior to that of vacuum-tube photocells. (For a discussion of the latter, see PHOTOELECTRICITY) The fact that selenium cells do not respond instantaneously to changes in stimuli. however, makes them unsuitable for certain purposes. such as high fidelity sound reproduction on film.

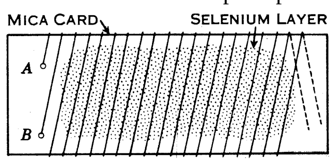


FIG 1—THE SELENIUM LAYER OF A SIEMENS PHOTOCONDUCTIVITY CELL CONDUCTS CURRENT BETWEEN THE TURNS OF WIRE (A AND B)

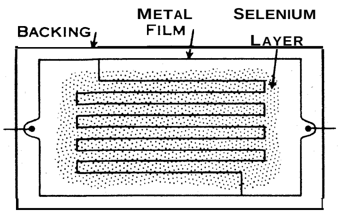
The photoelectric properties of selenium, a nonmetallic element, are exhibited in tno ways: (1) When light falls on a specimen of crystalline selenium the electrical conductance of the selenium is increased. A device employing this effect is called a selenium photoconductive cell. If such a cell is connected in a circuit with a battery, a small current. called the dark current. will flow if the cell is not illuminated. If the cell is illuminated, the increased conductance of the selenium element permits a larger current to flow. The increase in current may then be used to operate a relay, produce an indication on a current meter or perform some other useful function in the circuit associated with the cell. (2) When selenium is placed in contact with an electrode made of a suitable metal, the contact has the ability to generate an electromotive force (E.M.F.) when exposed to light. The illuminated contact thus behaves like a battery, with the selenium becoming the positive terminal and the contacting metal becoming the negative terminal. A device employing this property of selenium is called a selenium photovoltaic cell. Such a cell can be used as a photoelectric battery in a practical electrical circuit.

The photoconductivity effect in selenium was first reported in Great Britain by Willoughby Smith in 1873. Selenium was the first solid material found to exhibit this effect. Following this discovery a number of photoconductivity cell designs were developed. The discovery of the photovoltaic effect at contacts between selenium and various metals was first reported by W. G. Adams and R. E. Day in England in 1877. Shortly thereafter. in 1883, Charles E. Fritts in the U.S. constructed a practical selenium photovoltaic cell which embodied most of the features found in cells of modern design.

Unfortunately, much of this early work either went unrecognized or was lost to sight; and the selenium photovoltaic cell had to be "rediscovered" later.

Selenium is one of the elementary chemical substances (see SELENIUM). It melts at 217.4° C. When cooled from the molten state it "solidifies" into a hard, brittle, noncrystalline material in which its physical condition is actually that of an extremely viscous liquid, like glass. In this condition it is called amorphous selenium. The electrical resistance of amorphous selenium is so high as to classify it as an insulator; and in the amorphous state selenium exhibits no usable photoelectric behaviour. If a specimen of amorphous selenium is heat treated at any temperature between about 120° C. and its melting point, however. conversion to the more useful gray crystalline form occurs. The electrical resistance of gray crystalline selenium between opposite faces of a 1-cm. cube is about 1.000 ohms, the exact value depending on impurity content and on the details of the annealing treatment by which the specimen was converted to the crystalline form. It is in this form that selenium is employed in the structures of photoconductive and photovoltaic cells.

Photoconductive Cells.—The basic parts of a selenium photoconductive cell consist of an active portion of gray crystalline selenium, so disposed that the light to be detected or measured can fall upon it, with metal contacts to the selenium permitting current to flow into. through and out of it. One of the simplest of these cells was devised by the German inventor and industrialist Werner Siemens in 1876. In the Siemens cell two fine copper wires are wound around a rectangular mica card as shown in the sketch in Fig. 1. The windings are separated so that the wires do not touch each other anywhere. This assembly is then placed on a hot plate and raised to a temperature a few degrees higher than the melting point of selenium. A piece of selenium placed on this assembly soon melts to a molasseslike liquid, in which condition it is spread in a thin film over the upper surface of the mica, completely embedding the copper nires. The assembly is then removed from the hot plate and allowed to cool, the selenium hardening into an amorphous layer. To convert the selenium to the gray crystalline form, the assembly is again heated for several hours at a temperature of about 180° C.



ADAPTED FROM G P. BARNARD, '(THE SELENIUM CELL": BY COURTESY OF CONSTABLE e CO. LTD., LONDON

FIG. 2.— PHOTOCONDUCTIVITY CELL IN WHICH THE SELENIUM LAYER BRIDGES THE GROOVE SEPARATING TWO SECTIONS OF A METAL FILM

Electrical connections to this cell are made at the two contacts *A* and B; the other ends of these wires are left open circuited. Any current flowing between these terminals must flow through the selenium film between adjacent turns of the wires. Illumination of the selenium film then increases the total parallel conductance of the cell between these terminals. A Siemens-type cell with a selenium layer area of 1 sq.in. may exhibit a resistance of one or tno megohms in complete darkness. When exposed to full sunlight the cell resistance drops to a few thousand ohms.

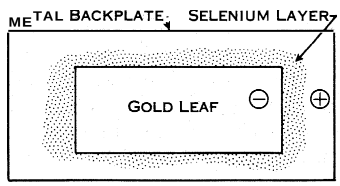


FIG. 3.—FRITTS'S PHOTOVOLTAIC CELL IN WHICH AN ELECTROMOTIVE FORCE IS GENERATED BETWEEN THE GOLD LEAF AND THE BACKPLATE UPON EXPOSURE TO LIGHT

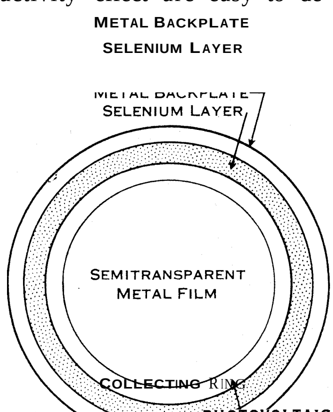
A different form of selenium photoconductive cell, shown in the sketch in Fig. 2, employs a support plate made of slate. glass or other insulating material. One side of the support plate is provided with a film of deposited metal. which is then scribed through with a sharp tool, in a zigzag line, in such a may that the metal deposit is divided into two sections separated and insulated from each other by the zigzag line. A thin film of crystalline selenium is then laid down on the surface of the metal deposit. filling in the scribed line. Light falling anymhere on the selenium increases conduction between the two portions of the metal deposit. which wires connect to the cell.

In their operation selenium photocells have some advantages over vacuum-tube photocells; they also display some disadvantages. A properly made selenium cell may be a hundred times more sensitive to a given amount of illumination than a vacuum-tube photocell. Also, the selenium cell is responsive to light throughout the entire range of colours visible to the human eye, while many vacuum-tube photocells. particularly the more sensitive ones, are responsive only to light of the green, blue or purple regions of the colour spectrum. The response of a selenium photocell, on the other hand, is not directly proportional to the amount of light falling upon it. Instead, the change in conductance is proportional to the square root of the light flux on the cell. This relationship means that the cell is relatively more sensitive for the loner levels of light intensity.

Another disadvantage exhibited by the selenium photoconductivity cell is the time lag of its response. When a selenium cell is suddenly exposed to light, the change in conductance is not instantaneous. It may require a thousandth of a second or more for the cell conductance to rise to the new value appropriate to the illuminated condition. Similarly. if the light is suddenly cut off, a comparable length of time is required for the conductance to resume its dark value. This time lag in response means that the cell cannot follow the rapid fluctuations of light intensity which must be dealt with, for example, in the high fidelity reproduction of sound on film.

Selenium photoconductivity cells must find most of their uses, therefore. in applications where the cell must distinguish between light on and light off. or where the cell is exposed to light nhich is either steady or else varying at frequencies loner than those corresponding to speech or music.

The physics of the photoconductivity effect are easy to describe. The electrical conductance of any substance is proportional, among other things. to the number of electronic particles per unit volume nhich are free to move about within the substance and which. by their motion when voltage is applied.' cause a current to flow. Selenium has a relatively small number of such free particles available in the dark. However, when light shines on a specimen of selenium and is absorbed by it, the energy of the radiation is expended in the freeing of additional numbers of conducting particles which increase the total number available and hence increase the electrical conductance of the illuminated specimen.



PHOTOVOLTAIC CELL SIMILAR TO FRITTS'S CELL (FIG. 3)

Photovoltaic Cells.—By far the most extensive modern use of selenium in photoelectric cells is in devices of the photovoltaic or self-generating variety. Fig. 3 shows a sketch of an early selenium photovoltaic cell constructed by Fritts. This cell made use of a thin layer of crystalline selenium spread out on the surface of a metal base plate. On the outer surface of the selenium layer was placed a translucent film of gold leaf. When the cell was illuminated from the gold leaf side, Fritts observed that an electromotive force (E.M.F.) appeared between the gold leaf and the base plate metal. If the gold leaf and the plate were connected through an external circuit, a current flowed as long as the illumination of the cell was continued.

Modern selenium photovoltaic cells are but little different from Fritts's early model. A thin layer of selenium is applied to one side of a supporting base plate of iron, nickel or aluminum Instead of spreading the molten selenium onto the base plate at an elevated temperature, however, present-day manufacturers apply the selenium film by vapour deposition in vacuum. Following the customary heat treatment, an outer contact of gold is then applied to the surface of the selenium layer. again by vapour deposition in vacuum. This gold film must be thin enough to permit a substantial fraction of the light to penetrate to the gold-selenium contact, yet thick enough to permit good lateral conductance for the current which the cell is to deliver. Contact to the gold film is provided in modern design by a built-up collecting ring of painted-on graphite or more heavily deposited metal around the outer periphery of the gold film.

Fig. 4 shows a section sketch of a modern selenium photovoltaic cell showing these features. A cell of this construction will deliver an open-circuit E.M.F. of 0.3 or 0.4 volt in light of 100 foot-candles intensity. Under the same conditions of illumination, such a cell having an area of 1 sq.in. will deliver a current of 250 microamperes into a 1,000 ohm external resistance. Fig. 5 shows a family of characteristics for a modern cell having an effective area of about 2 sq.in. Each curve gives the output current as a function of light intensity for a particular value of external circuit resistance. Note that in no case is the current linearly proportional to circuit resistance, but is more nearly so for the lower values of resistance. By short-circuiting the cell. one could obtain a characteristic almost completely linear, but such a circuit arrangement would draw no useful power from the cell and would correspond, therefore, to a very inefficient use of the cell.

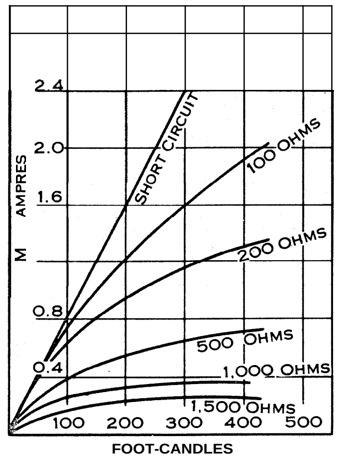


FIG. 5.—RELATIONSHIPS BETWEEN OUTPUT CURRENT AND LIGHT INTENSITY FOR A MODERN SELENIUM PHOTOVOLTAIC CELL WITH DIFFERENT EXTERNAL CIRCUIT RESISTANCES

The time lag exhibited by a selenium photovoltaic cell between sudden exposure to light and the development of the corresponding output E.M.F. is comparable with the time lags encountered in selenium photoconductivity cells. If a photovoltaic cell is exposed to interrupted light of constant intensity but variable frequency of interruption, the A.C. response of the cell drops to half its low-frequency value if the interruption frequency is somewhere in the range from 1 kc. to 10 kc.

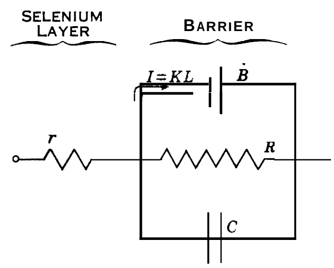


FIG. 6.—ELECTRICAL EQUIVALENT CIRCUIT EXHIBITING THE SAME TERMINAL BEHAVIOUR SHOWN BY AN ILLUMINATED PHOTOVOLTAIC CELL

The physics of the photovoltaic effect is somewhat more complicated than that underlying photoconductivity. The seat of the E.M.F. is the contact between the selenium and the overlying gold film electrode. The photoelectric property of this contact comes about because of the so-called contact potential difference between the selenium and the gold. This contact potential difference appears across a thin layer in the selenium immediately adjacent to the gold contact and within a distance of 10^{-5} cm. of the actual gold-selenium boundary Inside this layer. called the barrier layer, the physical properties of the selenium are different from those in the rest of the selenium film. When the contact is illuminated, charged electronic particles are liberated by the absorption of light in the barrier layer. These particles, acting like ions in the electrolyte of an ordinary battery. are pulled by the electric field of the barrier contact potential difference in such a direction as to cause a negative charging up of the gold electrode. From this electrode. then, electrons can flow around the external circuit, back into the support plate metal. and thence into the other side of the selenium layer, as long as the illumination is continued.

The photoelectric properties of a selenium photovoltaic cell can be described in terms of the electrical equivalent circuit shown in Fig. 6. The gold-selenium contact barrier has three parallel properties: a barrier capacitance C; a barrier resistance R; and an effective barrier battery B having the property of generatiing not a voltage but rather a current proportional to the amount of light falling on the cell and numerically equal to the product of a constant of proportionality K by the light intensity L. For modern commercial selenium photovoltaic cells, K has values in the neighbourhood of half a milliampere per lumen. In series with the barrier is the resistance *r* of the selenium layer outside the barrier. When the cell is illuminated. the current generated by the equivalent barrier battery divides, part going around the external circuit and the rest leaking backward internally across the barrier resistance R. Unfortunately, this barrier resistance is not constant, but decreases for higher values of the E.M.F. appearing at the cell terminals. Thus! for a constant load resistance in the external circuit, if the illumination is made brighter R becomes smaller and a larger fraction of the equivalent battery current is lost by internal leakage across *R*. This variable loss explains the nonlinearity of the curves of Fig. 5.

The barrier capacitance C has virtually no effect on the performance of the cell for exposure to steady light; but for interrupted light or fluctuating light this capacitance has a bypassing effect which reduces the A.C. output of the photocell. The reduction is more severe the higher the frequency of interruption or fluctuation of the light. The magnitude of this capacitance is about one-half microfarad per square inch.

Incidental Properties.—Selenium photoconductive and photovoltaic cells have approximately the same colour responses. Selenium cells are responsive to all wave lengths in the visible spectrum and also to a short range of wave lengths in the near ultraviolet. The greatest sensitivity appears in the orange and orange-red spectral region.

The output of a selenium cell is dependent on temperature, the dependence being to a considerable extent determined by the nature of the associated circuit. In a selenium photoconductivity cell the magnitude of the dark conductance increases about 2% per degree rise in temperature. while the conductance change upon illumination decreases with increasing temperature by about 1% per degree. The chief temperature dependence of the selenium photovoltaic cell is exhibited by the barrier resistance R, which decreases with increasing temperature at a rate of 6% or 7% per degree.

A selenium photovoltaic cell will deteriorate in sensitivity if it is exposed for long periods to a highly humid atmosphere. The modern practice of coating the cell surfaces with a protective lacquer film slows down this deterioration but does not prevent it altogether. Some manufacturers have experimented with complete hermetic sealing of the cell elements.

Uses of Selenium Cells.—Probably the most extensive use of selenium cells, and the one with which the layman is most likely to be familiar, is in the construction of portable exposure meters used by photographers. In this application a photovoltaic cell is used in a self-contained package with a moving coil meter and a dial or table for converting the meter reading to the correct exposure.

The employment of selenium cells in industry covers a broad range of uses in which the cells are employed to distinguish between light on and light off. For example. a selenium cell may be placed near a light source so that the passage of an article along a conveyer belt interrupts the light beam and causes registry on a counter. A safety interlock for stamping and pressing machines can be arranged with a light source and photocell so placed that as long as a workman's hands are between the dies the light beam is broken and the circuit controlling the operation of the machine is inhibited.

Another on-off application of selenium cells is found in burglar alarm systems where the interruption of a beam of light across a doorway or window trips an alarm. In department stores and public buildings a closely allied application is coming into increasing use, in which a door is automatically opened when a light beam is broken by an approaching person. Similar systems are used for counting visitors at exhibitions or counting automobiles to obtain traffic data.

There are many industrial processes which can be monitored or controlled with the aid of selenium photocells in suitable circuits. Depth of colour is often an indication of the correct proportions of a mixture, of the thoroughness of mixing or of the stage of a chemical reaction. In these cases photocells have proved more vigilant and accurate as colour perceptors than the human eye, and their employment has resulted in better product control in the chemical, pigment and textile industries.

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SELEUCIA, the name of several Hellenistic cities named after the founder of the Seleucid dynasty, Seleucus Nicator.

1. **Seleucia** on the Tigris.—This city lay on the right bank at the mouth of the Nahr-al-Malik (the royal canal). The city was founded by Seleucus Nicator in 312 B.C., and marks the definite shift of the centre of power in Mesopotamia from the Euphrates to the Tigris. Throughout the period of Sumerian times the principal city of the region had been on the Euphrates, first Kish (*q.v.*), and when the Euphrates shifted its course. Babylon. Seleucia however marks the definite end of Babylon and is closely associated with Hellenistic culture in Mesopotamia.

Seleucia is said to have been founded with the object of destroying Babylon. During the Parthian domination the city continued to be the foremost city of the east in position and trade. It was definitely opposed to and at times in open rebellion against the Parthians. The Arsacids founded the rival city of Ctesiphon. Seleucia, however, continued to survive. and eventually was burned by Avidius Cassius in A.D. 164.

2. **Seleucia Pieria,** in Syria. a port and frontier fortress on the Cilician border. The city lay 4 mi. N. of the mouth of the Orontes in 36° N. and 36° E. and was the port of Antioch. The town appears to have been of considerable size and the great road to the sea, a deep cutting through the rock, still survives. Walls, temples and amphitheatre can also be traced. The city was of considerable military importance during the wars between the Ptolemies and the Seleucids and was recognized as an independent city later by the Romans (in A.D. 70).

3. **Seleucia Tracheotis** (modern Icel), also called Trachea, a city in Cilicia in 36° N. 34° E. It lay on the Calycadnus (modern Gok Su), a few miles from the mouth of the river, doubtless as a protection against attacks from the sea. There are the ruins of a castle on the Acropolis and other considerable remains.

The city mas at one time a port with a large trade. It was built near an old site (Oldia) in 300 B.C. by Seleucus Nicator. During the third crusade Frederick Barbarossa was drowned in crossing the river (A.D. 1190). The city was captured by the Turks in the 13th century. (L. H. D. B.)

SELEUCID DYNASTY, a line of kings who reigned in Nearer Asia from 312 to 6; B.C.

Seleucus.—The founder SELEUCUS (surnamed for later generations Nicator) was a Macedonian, the son of Antiochus, one of Philip's generals. Seleucus, as a young man of about 23, accompanied Alexander into Asia in 333, and won distinction in the Indian campaign of 326. When the Rlacedonian empire was divided in 323 (the "Partition of Babylon") Seleucus was made *chiliarch* (practically = vizier) to the regent Perdiccas. Seleucus himself had a hand in the murder of Perdiccas in 321. At the second partition. at Triparadisus (321), Seleucus was given the government of the Babylonian satrapy. In 316, when Antigonus had made himself master of the eastern provinces, Seleucus fled to Egypt. In the war which followed between Antigonus and the other Macedonian chiefs, Seleucus actively co-operated with Ptolemy and commanded Egyptian squadrons in the Aegean. The victory won by Ptolemy at Gaza in 312 opened the way for

Seleucus to return to the east.

His return to Babylon in that year was afterward officially regarded as the beginning of the Seleucid empire. Master of Babylonia, Seleucus at once proceeded to wrest the neighbouring provinces of Persis. Susiana and Media from the nominees of Antigonus. A raid into Babylonia conducted in 311 by Demetrius, son of Antigonus, did not seriously check Seleucus's progress. While Antiponus was occupied in the west. Seleucus during nine years (311–302) brought under his authority the whole eastern part of Alexander's empire as far as the Jaxartes and Indus. In 305, after the extinction of the old royal line of Macedonia, Seleucus, like the other four principal Macedonian chiefs, assumed the style of king. He attempted to recover Alexander's conquests in India, but with Antigonus threatening in the nest he made peace with Chandragupta in 302, ceding him territory in Afghanistan for 500 elephants. In 301 he and Lysimachus defeated Antigonus at Ipsus in Asia Minor. A new partition of the empire followed, by which Seleucus added to his kingdom Syria and perhaps some regions of Asia Minor. The possession of Syria gave him an opening to the Mediterranean, and he founded there his new capital, Antioch, on the Orontes. Seleucia continued to be the capital for the eastern satrapies. About 293 he installed his son Antiochus there as viceroy. Demetrius fell in 285, and an invitation by Ptolemy Ceraunus gave him a chance to remove his last rival, Lysimachus, who was defeated and killed at Corupedion in Lydia (280). Seleucus then had the whole of Alexander's empire but Egypt. He left Asia to Antiochus, and crossed over to take possession of Macedonia. He reached the Chersonese, but nas murdered by Ptolemy near Lysimachia (281).

Antiochus I Soter (324 or 323–262) was half a Persian, his mother Apame being one of those eastern princesses whom Alexander had given as wives to his generals in 324. On the assassination of his father (281), the task of holding together the empire was a formidable one, and a revolt in Syria broke out almost immediately. Antiochus was soon compelled to make peace with Ptolemy, his father's murderer, abandoning apparently Macedonia and Thrace. In Asia Minor he was unable to reduce Bithynia or the Persian dynasties which ruled in Cappadocia. In 278 the Gauls broke into Asia Minor, and a victory which Antiochus won over them is said to have been the origin of his title of Soter (Gr. for "saviour"). At the end of 275 the question of Palestine, which had been open between the houses of Seleucus and Ptolemy since the partition of 301, led to hostilities (the "First Syrian War"). About 262 Antiochus tried to break the growing power of Pergamum, but suffered defeat near Sardis and died soon afterward (262).

261–223 **B.C.**—He was succeeded (261) by his second son ANTIOCHUS II THEOS (286–246), whose mother was the Macedonian princess Stratonice, daughter of Demetrius Poliorcetes. War with Egypt still went on along the coasts of Asia Minor (the "Second Syrian War"). Antiochus also made some attempt to get a footing in Thrace. About 250 peace was concluded between Antiochus and Ptolemy II. Antiochus repudiating his wife Laodice and marrying Ptolemy's daughter Berenice, but by 246 Antiochus had left Berenice and her infant son in Antioch to live again with Laodice in Asia Minor. Laodice poisoned him and proclaimed her son SELEUCUS II CALLINICUS (reigned 246–227) king, while her partisans at Antioch made away with Berenice and her son. Berenice's brother, Ptolemy III, who had just succeeded to the Egyptian throne. at once invaded the Seleucid realm and annexed the eastern provinces. while his fleets swept the coasts of Asia Minor. In the interior of Asia Minor Seleucus maintained himself, and when Ptolemy returned to Egypt he recovered Northern Syria and the nearer provinces of Iran. At Ancyra (about 235?) Seleucus mas defeated by his younger brother Antiochus Hierax, supported by Laodice, and left the country beyond the Taurus to his brother and the other powers of the peninsula. Of these Pergamum rose to greatness under Attalus I, and Antiochus Hierax perished as a fugitive in Thrace in 228 or 227. A year later Seleucus was killed by a fall from his horse. His elder son, SELEUCUS III SOTER (reigned 227–223), took up the task of reconquering Asia Minor from Attalus, but fell by a conspiracy in his own camp.

Antiochus III the Great (223–187).—Callinicus's younger son, a youth of about 18, now succeeded to a disorganized kingdom (223). Not only was Asia Minor detached, but the further eastern provinces had broken away, Bactria under the Greek Diodotus (q *v.*), and Parthia under the nomad chieftain Arsaces. Soon after Antiochus's accession. Media and Persis revolted under their governors, the brothers Molon and Alexander. The young king was in the hands of the bad minister Hermeias. and was induced to make an attack on Palestine instead of going in person to face the rebels. The attack on Palestine was a fiasco, and the generals sent against Molon and Alexander met with disaster. Only in Asia Minor, where the Seleucid cause was represented by the king's cousin, the able Achaeus, was its prestige restored and the Pergamene power driven back to its earlier limits. In 221 Antiochus at last went east, and the rebellion of Molon and Alexander collapsed. The submission of Lesser Media, which had asserted its independence under Artabazanes, followed. Antiochus rid himself of Hermeias by assassination and returned to Syria (220). Meanwhile Achaeus had revolted and assumed the title of king in Asia Minor. Antiochus decided to leave Achaeus for the present and renew his attempt on Palestine. The campaigns of 219 and 218 carried the Seleucid arms almost to the confines of Egypt, but in 217 Ptolemy IV defeated Antiochus at Raphia and compelled him to withdraw north of the Lebanon. In 216 Antiochus went north to deal with Achaeus, and had by 214 driven him into Sardis. Antiochus contrived to capture Achaeus. but the citadel held out until 213.

Having thus recovered the central part of Asia Minor—for the dynasties in Pergamum, Bithynia and Cappadocia the Seleucid government was obliged to tolerate—Antiochus turned to recover the outlying provinces of the north and east. Xerxes of Armenia was brought to acknowledge his supremacy in 212. In 209 Antiochus invaded Parthia. occupied the capital Hecatompylus and pushed forward into Hyrcania. The Parthian king was apparently granted peace on his submission. In 209 Xntiochus was in Bactria. where the original rebel had been supplanted by another Greek Euthydemus (See BACTRIA and articles on the separate rulers.) The issue was again favourable to Antiochus. After sustaining a famous siege in his capital Bactra (Balkh), Euthydemus obtained an honourable peace. Antiochus next, following in the steps of Alexander, crossed into the Kabul valley, received the homage of the Indian king Sophagasenus and returned west by way of Seistan and Kerman (206/5). From Seleucia on the Tigris he led a short expedition down the Persian gulf against the Gerrhaeans of the Arabian coast (205/4). Antiochus seemed to have restored the Seleucid empire in the east, and the achievement brought him the title of "the Great King." In 205/4 the infant Ptolemy V Epiphanes succeeded to the Egyptian throne. and Antiochus concluded a secret pact with Philip of Macedonia for the partition of the Ptolemaic possessions. Once more Antiochus attacked Palestine, and by 199 he seems to have had possession of it. Scopas recovered Palestine for Ptolemy, but was defeated at the Panium, near the sources of the Jordan, in 198. In 197 Antiochus moved to Asia Minor to secure the coast towns which had acknowledged Ptolemy and the independent Greek cities. This enterprise brought him into antagonism with Rome, since Smyrna and Lampsacus appealed to the republic of the west. and the tension became greater after Antiochus had in 196 established a footing in Thrace. The evacuation of Greece by the Romans gave Antiochus his opportunity, and he now had the fugitive Hannibal at his court to urge him on. In 192 Antiochus invaded Greece, but in 191 he was routed at Thermopylae by the Romans under M. Acilius Glabrio, and obliged to withdraw to Asia. The Romans followed up their success by attacking Xntiochus in Asia Minor, and the decisive victory of L Cornelius Scipio at Magnesia ad Sipylum (190). following on the defeat of Hannibal at sea off Side. gave Asia Minor into their hands. By the peace of Apamea (188) the Seleucid king abandoned all the country north of the Taurus, which was distributed among the friends of Rome. As a consequence of this blow to the Seleucid power, the outlying provinces of the empire, recovered by Antiochus. reasserted their independence. Antiochus perished in a fresh expedition to the east in Luristan (187).

187–164 B.C.—The Seleucid kingdom as Antiochus left it to his son, SELEUCUS IV PHILOPATOR (reigned 187–176), consisted of Syria (now including Cilicia and Palestine), Mesopotamia, Babylonia and Nearer Iran (Media and Persis). Seleucus IV was compelled by financial necessities, created in part by the heavy war-indemnity exacted by Rome, to pursue an unambitious policy, and mas assassinated by his minister Heliodorus. The true heir. Demetrius, son of Seleucus, being retained in Rome as a hostage, the kingdom was seized by the younger brother of Seleucus, ANTIOCHUS IV EPIPHAKES, who reigned 175–163. In 170, Egypt, governed by regents for the boy Ptolemy Philometor, attempted to reconquer Palestine; Antiochus not only defeated this attempt but invaded and occupied Egypt, and left Philometor as his ally installed at Memphis. When Philometor joined Ptolemy Eurgetes, Antiochus again invaded Egypt (168), but was compelled to retire by the Roman envoy C. Popillius Laenas (consul 172), after the scene in which the Roman drew a circle in the sand about the king and demanded his answer before he stepped out of it. Antiochus had resided at Rome as a hostage, and afterward for his pleasure at Athens! and had brought to his kingdom an admiration for republican institutions and an enthusiasm for Hellenic culture—or, at any rate, for its externals. There is evidence that the forms of Greek political life were more fully adopted under his sway by many of the Syrian cities. He spent lavishly on public buildings. It is his contact with the Jews which has chiefly interested later ages, and he is doubtless the monarch described in the pseudoprophetic chapters of Daniel (*q.v.*). Jerusalem, near the Egyptian frontier: was an important point, and in one of its internal revolutions Antiochus saw, perhaps not without reason, a defection to the Egyptian side. His chastisement of the city, including as it did the spoliation of the temple, served the additional purpose of relieving his financial necessities. It was a measure of a very different kind when, a year or two later (after 168), Antiochus tried to suppress the practices of Judaism by force, and it was this which provoked the Maccabaean rebellion. (*See* MACCABEES.) In 166 Antiochus left Syria to attempt the reconquest of the further provinces. He seems to have been successful. Armenia returned to allegiance, the capital of Media was recolonized as Epiphanea, and Xntiochus was pursuing his plans in the east when he died at Tabae in Persis. after exhibiting mental derangement (winter 163).

164–145 B.C.—He left a son of nine years, ANTIOCHUS V EUPATOR (reigned 163–162), in whose name the kingdom was administered by a camarilla. Their government was feeble and corrupt. The attempt to check the Jewish rebellion ended in a weak compromise. In 162 Demetrius, the son of Seleucus IV, escaped from Rome and was received in Syria as the true king. Antiochus Eupator was put to death. DEMETRIUS I SOTER (reigned 162–150) was a strong and ambitious ruler. He crushed the rebellion of Timarchus in Media and reduced Judaea to new subjection. But he was unpopular at Antioch. and fell before a coalition of the three kings of Egypt. Pergamum and Cappadocia. An impostor. who claimed to be a son of Antiochus Epiphanes. ALEXANDER BALAS (reigned 150–145). was installed as king by Ptolemy Philometor and given Ptolemy's daughter Cleopatra to wife, but Alexander proved to be dissolute and incapable, and when Demetrius. the son of Demetrius I, was brought back to Syria by Cretan condotticri, Ptolemy transferred his support and Cleopatra to the rightful heir. Alexander was defeated by Ptolemy at the battle of the Oenoparas near Antioch and murdered during his flight. Ptolemy himself died of his-wounds.

The Later **Seleucids.**—DEMETRIUS II NICATOR (first reign 145–140) was a mere boy, and the misgovernment of his Cretan supporters led to the infant son of Alexander Balas. ANTIOCHUS VI DIONYSUS being set up against him (145) by Tryphon, a magnate of the kingdom. Demetrius was driven from Antioch and fixed his court in the neighbouring Seleucia. In 143 Tryphon murdered the young Antiochus and assumed the diadem himself. Three years later Demetrius set off to reconquer the eastern provinces from the Parthians. leaving Queen Cleopatra to maintain his cause in Syria. When Demetrius was taken prisoner by the Parthians. his younger brother ANTIOCHUS VII SIDETES (164–129) appeared in Syria, married Cleopatra and crushed Tryphon. Antiochus VII was the last strong ruler of the dynasty (138–129). He took Jerusalem and once more brought the Jews, who had won their independence under the Hasmonaean family. to subjection. (See MACCABEES.) He led a new expedition against the Parthians in 130, but, after signal successes. fell fighting in 129. (See also PERSIA: History.) Demetrius (second reign 129–126), who had been allowed by the Parthians to escape. then returned to Syria, but was soon again driven from Xntioch by a pretender. ALEXANDER ZABINAS, who had the support of the king of Egypt. Demetrius was murdered at the instigation of his wife Cleopatra in 126. The remaining history of the dynasty is a wretched story of the struggle of different claimants, while the different factors of the kingdom, the cities and barbarian races, more and more assert their independence. Both Demetrius II and Antiochus VII left children by Cleopatra, who form rival branches of the royal house.

To the line of Demetrius belong his son SELEUCUS V (126), assassinated by his mother Cleopatra. ANTIOCHUS VIII GRYPUS (141–96), who succeeded in 126 the younger brother of Seleucus V. the sons of Grypus, SELEUCUS VI EPIPHAXES NICATOR (reigned 96–95). ANTIOCHUS XI EPIPHANES PHILADELPHUS (reigned during 95), PHILIP I (reigned 95–83), DEMETRIUS III EUKAIROS (reigned 95–88). and ANTIOCHUS XII DIONYSUS EPIPHANES (reigned 86?–85?), and lastly PHILIP II, the son of Philip I. who appears momentarily on the stage in the last days of confusion. To the line of Antiochus VII belong his son ANTIOCHUS IX CYZICENUS (reigned 116–9j). the son of Cyzicenus. ANTIOCHUS X EUSEBES (reigned 95–83?), and the son of Eusebes. ANTIOCHUS XIII ASIATICUS (reigned 69–65). In 83 Tigranes, the king of Armenia. invaded Syria. and by 69 his conquest had reached as far as Ptolemais. when he was obliged to evacuate Syria to defend his own kingdom from the Romans. When Pompey appeared in Syria in 64. Antiochus XIII begged to be restored to his ancestral kingdom or what shred was left of it. Pompey refused and made Syria a Roman province. Antiochus Grypus had given his daughter in marriage to Mithradates (*q.v.*). a king of Commagene. and the subsequent kings of Commagene (see under ANTIOCHUS) thus claimed still to represent the Seleucid house after it had become extinct in the male line. and adopted Antiochus as the dynastic name. The kingdom was extinguished by Rome in 72. The son of the last king. Gaius Iulius Antiochus Epiphanes Philopappus, was Roman consul for A.D. 100.

AUTHORITIES.—E. R. Bevan, *House of Srleurus* (1902), and the earlier literature of the subject there cited. In addition may be mentioned Dssa. Adalgisa Corvatta, *Divisione amministrativa dell' impero dei Seleucidi* (1901); Haussoullier, *Histoire* de *Milet et du Didymeion* (1902); B. Niese, *Gesrh. d. griech. u. maked. Staaten,* Teil 3 (1903); J. Beloch, *Griechische Geschichte,* vol. iii; G. Macdonald, "Early Seleucid Portraits," *Journ.* of *Hell. Stud.*, xxiii, p. 92 ff. (1903); A. J. B. Wace, "Hellenistic Royal Portraits," *Journ. of Hell. Stud.*, xxv, p. 86 ff. (1905). (E. R. B.; X.)

SELF-DETERMINATION, a term widely used in contemporary international relations with a variety of meanings. Historically it meant the right of people in a state to choose their own government. In this sense it is opposed to an absolute monarchy based on the divine right of kings and is instead in accord with Rousseau's doctrine that sovereignty resides in the people and not in the ruler. The French Revolution gave currency to this idea It was made explicit in the "Déclaration du droit des gens" that Abbé Grégoire submitted to the Convention on April 23. 1795. It declared that peoples are independent and sovereign and that every people has the right to organize and change its own government. The American Revolution provided another contribution to the doctrine of self-determination, It became the signal for similar anticolonial and independence movements in Latin America. though without the connotation of self-government. The congress of Vienna (1815) attempted to restore the old European system based on a balance of power and the principle of legitimacy. The Holy alliance of Sept. 26. 1815, was particularly concerned nith the latter and did not shrink from intervention on its behalf. The

Monroe Doctrine of Dec. 2, 1823, was in part at least designed to forestall any attempt at restoration of dominion over the former European possessions in the western hemisphere.

National self-determination as a political principle has evolved in the last 150 years as a by-product of the doctrine of nationalism in combination with other philosophical and political currents. Immanuel Kant's concept of the autonomy of the individual and of freedom as a condition of autonomy furnished an essential element. Johann Fichte's emphasis on the state as a condition of man's freedom and Johann Herder's idea that mankind was divided by God into different nationalities, each of which had a particular mission to fulfill, furnished the other elements. Schleiermacher, like Herder, stressed the distinctiveness of each nation based on language, character, history and culture. Nations should constitute their own sovereign state to preserve their distinctiveness and to make their preordained contribution to mankind. Mazzini argued that multinational states are artificial whereas national states are products of nature.

Nature, however. did not of and by itself produce national states. The persistent efforts of politicians acting from other motivations but drawing upon the ideological bases provided by philosophers, and the general drift of European politics resulted in a drastic redrawing of the map of Europe produced by the congress of Vienna. The Ottoman empire, a multinational and multireligious state, suffered first the impact of doctrine and politics: Greece gained independence in 1829; through the century other parts of the empire split off: Rumania, Bulgaria, Serbia. Italy was unified under the banner of nationalism and so was Germany; in the former case Napoleon III and in the latter the Prussian Chancellor Bismarck were active forces inspired by less than idealistic motives. The democratic-liberal elements looked with favour upon the spread of nationalism but, as later events showed, the new states formed on a national basis were not necessarily committed to liberal or democratic ideals or to the pursuit of peace.

World War I and the League.—In World War I the Allies, largely under the influence of Woodrow Wilson, accepted self-determination as a peace aim; the Bolshevik revolution in 1917 removed a multinational state, Russia, from their ranks and made it easier to espouse the claim of oppressed nationalities. The Bolsheviks themselves through Trotski's note to the Allied embassies in Petrograd, Nov. 21, 1917, advocated a democratic peace on the basis of "the self-determination of nations." Pope Benedict XV in his message to the heads of the belligerent governments of Aug. 1, 1917, favoured a territorial settlement taking account of the desires of the peoples. President Wilson in his address to the U.S. senate, Jan. 22, 1917, proposed among the essential terms of peace that all nations accept the Monroe Doctrine and agree "that no nation should extend its polity over any other nation or people, but that every people should be left free to determine its own polity." In his Fourteen Points, Jan. 8, 1918, Wilson listed among the peace objectives the restoration of independence to Belgium, Rumania, Serbia and Montenegro, and of Alsace-Lorraine to France, "the freest opportunity of autonomous development" for the peoples of Austria-Hungary, and a similar opportunity for the nationalities of the Ottoman empire. and the resurrected Poland should "include the territories inhabited by indisputably Polish populations." By the time of the peace conference events had outdistanced these goals and independent states emerged in the territory of the Austro-Hungarian empire and the Ottoman empire. The principle of self-determination had to be adjusted to political exigencies and promises of territorial compensation made during the war to Italy. The principle was further compromised by strategic and economic considerations and the virtual impossibility of drawing boundaries along linguistic or ethnic lines. Some of the Ottoman provinces whose existence as independent nations was provisionally recognized in Art. 22 (4) of the covenant of the League of Nations but which were not yet ready to stand alone were placed under the mandates system (see MANDATE). Contrary to the assumptions of the liberal democrats, the new order based on the principle of national self-determination proved no basis for a stable peace. The principle itself became in the hands of Adolf Hitler the chief instrument for the destruction of peace.

World War II and the UN.—In World War II liberation of the territories enslaved and occupied by Germany, Italy and Japan became one of the chief peace goals of the United Nations. Self-government was envisaged for all, including those which came within the sphere of influence of the U.S.S.R., particularly Poland. Thus the Atlantic Charter of Aug. 14, 1941, declared the desire of the United Kingdom and the United States to "respect the right of all peoples to choose the form of government under which they will live." This was reaffirmed in the declaration by the United Nations of Jan. 1, 1942, and in numerous other official statements. Be it noted that self-determination here is used in the sense of self-government but because of the participation of the Soviet Union it could not necessarily mean democratic self-government nor could it mean national self-determination for all. The Baltic republics incorporated in the Soviet Union in 1940 were not restored to independence, though the United States did not recognize their annexation. In spite of the 1945 Yalta agreement (see YALTA CONFERENCE) Poland was not granted a genuine right of self-determination. Substantial numbers of Germans from Czechoslovakia and from territories under Soviet or Polish administration east of the Oder-Neisse line were moved to Germany.

Self-determination is affirmed in the charter of the United Nations organization. One of its major purposes is "to develop friendly relations among nations based on respect for the principle of equal rights and self-determination of peoples" as one of the measures to strengthen universal peace (Art. 1, par. 2). Another is to promote co-operation in the economic, social, cultural and humanitarian fields "with a view to the creation of conditions of stability and well-being which are necessary for peaceful and friendly relations among nations based on respect for the principle of equal rights and self-determination of peoples" (Art. 55, par. 1). In pledging themselves "to take joint and separate action in co-operation with the Organization for the achievement" (Art. 56) of those purposes the members appear to assume an obligation and thereby to elevate the principle of self-determination of peoples—neither of which is defined—from the plane of politics to the level of law. More specific obligations to develop self-government and free political institutions in nonself-governing territories and to promote self-government or independence in trust territories are assumed by the members that have responsibility for their administration (Art. 73, b, and 76, b). Moreover, the general assembly of the United Nations urged the members to speed up the process and specifically recommended that the wishes of the peoples be "ascertained through plebiscites or other recognized means" (Resolution of Dec. 16, 1952). It also recommended that "the right of peoples and nations to self-determination" be included in the projected covenant on human rights (Resolution of Feb. 5, 1952). The traditional political concept of self-determination was also declared by the assembly to apply to the economic sphere.

Responding partly to the continuous pressure of the United Nations and partly to other considerations of a political and economic nature, western governments after the end of World War II embarked on a vast process of decolonization by divesting themselves of sovereignty over their dependencies in Asia and Africa and transferring it to the newly established states. By contrast the Soviet Union, clearly subordinating self-determination to the objective of promoting communism or socialism, in practice denied to the peoples under its sway either the right freely to elect their government or to form a state of their choice. The suppression of the Hungarian revolution in 1956 by armed intervention led to a condemnation by the United Nations (Resolution of Nov. 9, 1956) but not to a liberation of the Hungarian people. On the other hand. the Soviet Union adopted the policy of promoting self-determination and "national liberation" movements in other states provided they are deemed to offer sooner or later an opportunity for penetration by or are themselves bearers of the Communist ideology.

See A Cobban, *National Self-Determination* (1945); S. Shaheen, *The Communist Theory of National Self-Determination* (1956)

(L. Gs.)

SELFHEAL (HEAL-ALL) (Prunella *vulgaris*), a cosmopolitan herb with a creeping rootstock and purple two-lipped flowers.

The stems are short and branching, the leaves oblong or lanceolate. The plant belongs to the family Labiatae and was formerly used for cuts. wounds. etc.. whence the common name.

SELIGMAN, CHARLES GABRIEL (1873–1940), a pioneer in British anthropology. was born in London on Dec. 24. 1873. Educated at St. Paul's school, London, he trained in medicine at St. Thomas's hospital and specialized for a time in pathological research. Attracted, however, by anthropology. he joined a field expedition to the Torres straits in 1898 and another to southern New Guinea in 1904. With his wife, Brenda Z. Seligman. he studied the Veddas of Ceylon in 1907–08 and then made three ethnographic survey tours in the Sudan. This work resulted in Tlce *Melanesians* of *British* New *Guinea* (1910), The Races of Africa (1930), and (jointly mith his wife) The Veddas (1911) and *Pagan* Tribes of *the Nilotic Sudan* (1932). In 1910 Seligman mas appointed university lecturer and in 1913 part-time professor in ethnology at the London School of Economics and Political Science. Retiring in 1934, he was given the title of emeritus professor. He became visiting professor at Yale university in 1938, and died at Oxford on Sept. 19. 1940. Seligman's anthropological interests and scholarship were very wide, in physical anthropology. archaeology, cultural anthropology and oriental art. He was one of the first anthropologists to study the relationship between psychoanalysis and anthropology. He received many distinctions. including fellowship of the Royal society in 1919. (R. F.)

SELIGMAN, EDWIN ROBERT ANDERSON (1861–1939). U.S. economist. was born in New York city on April 25, 1861. As a child he was tutored by Horatio Alger. author of books for boys. He later attended Columbia university where he received his Ph.D. in 1885. That same year he was appointed to the faculty of Columbia where he remained as professor of political economy and finance until his retirement in 1931.

Seligman served on a number of taxation committees and his advice on economic policies was sought by countries throughout the world. In 1922 and 1923 he was an expert on the League of Nations committee on economics and finance; from 1918 to 1925 he was special adviser to the ways and means committee of the U.S. house of representatives. In 1931 he completed a report that became the basis for Cuban tax laws, noted for its omission of consumption taxes and its emphasis on direct levies. Seligman opposed all forms of the sales tax. He wrote 15 volumes on taxation and economics and was editor in chief of the *Encyclopaedia* of *the* Social *Sciences* (1930–35). He died on July 18, 1939.

SELIM I (c. 1470–1520), Ottoman sultan. surnamed YAVUZ ("Inflexible"). in 1512 he succeeded his father Bayezid II, whom he had dethroned. A bigoted Sunni, he resolved to put down the heterodox Shi'ites in Turkey and killed or imprisoned 40,000 of them. He then provoked war with Persia, where Shi'ism predominated. by a series of letters, as elegant as they were offensive: to Shah Ismail Safavi. The janissaries at first showed no enthusiasm for the fight, probably because the doctrines of the Baktashis (Bektashis), embodying many Shi'ite beliefs, were widespread among them (*see* J. K. Birge, *The Bektashi* Order of *Dervishes,* 1937). It was Selim's courage and energy that drove them on to win the victory of Chaldiran (1514), to which Turkish superiority in artillery largely contributed. His experiences in this campaign led him to begin the practice of selecting the agas of the janissaries from among the officers of his own household rather than from the corps itself.

Selim next conquered Armenia, Kurdistan, Syria and Egypt, chiefly to prevent their falling into Persian hands. He became master of the holy cities of Islam and induced the last caliph of the Abbasid dynasty to surrender the emblems of the caliphate, viz., the holy standard. the sword and the mantle of the prophet. After his return from his Egyptian campaign. he was preparing an expedition against Rhodes when he fell ill and died, on Sept. 22. 1520, near Adrianople. In a reign of less than nine years he had almost doubled the size of the empire. He combined great ferocity with high intellectual and literary ability. (G. L. L.)

SELIM II (1524–1574), Ottoman sultan, surnamed MEST ("Sot"), a son of Suleiman (Soliman) I and Roxelana, succeeded his father in 1j66. He was devoid of the strength and ability to rule that had, in varying degrees, characterized all previous Ottoman sultans. Only his poetry redeems him from being considered a dissolute good-for-nothing. The glories of his father's reign were, however. maintained by the efforts of the grand vizier Mohammed Sokollu. Selim's one noteworthy intervention in public affairs was to initiate the conquest of Cyprus in 1571. Despite the great naval defeat of Lepanto later in the year, the Ottoman navy was brought up to strength during the winter; and in 1573 Venice not only accepted the Turkish claim to the island but agreed to pay an indemnity. Sokollu was preparing for a fresh attack on Venice when the sultan's death on Dec. 13, 1574, cut short his plans. (G. L. L.)

SELIM III (1761–1808), Ottoman sultan, a son of Mustafa III, succeeded his uncle Abdul-Hamid I in 1789. Although he was thoroughly persuaded of the necessity of reforming the state, it was not until the peace of Jassy (1792) that a breathing space was allowed him in Europe. Selim profited by the respite to introduce salutary reforms into the administration, especially in the fiscal department. He sought to extend education and engaged foreign officers as instructors, who collected and trained a small corps of new troops called *nizam-i-jedid* ("new regulation"), a term originally applied to the whole body of Selim's reforms. A new treasury was created to finance the reforms, its revenues derived partly from the confiscation of fiefs whose holders had defaulted in their military obligations, partly from new taxes.

These new troops were able to hold their own in the European provinces against the rebellious janissaries, incited to disaffection by governors opposed to reform. Thus encouraged. the sultan ordered a general levy for the new troops. The janissaries revolted and defeated the new troops in Aug. 1806. The following May, the auxiliary troops known as yamaks mutinied, and in the ensuing disorders the rebels killed most of the leading advocates of reform. The sultan was prepared to sacrifice the reforms, but the *sheikh ul-Islam* declared that it was lawful to depose him. A cousin succeeded him (Mustafa IV).

Selim was imprisoned in the serai, where he was murdered a year later, just as his supporters under Mustafa Bayrakdar were forcing their way in through the gates. (G. L. L.)

SELINUS, an ancient city on the south coast of Sicily, 27 mi. S.E. of Lilybaeum (the modern Marsala). It was founded, in 6j1 or in 628 B.C., by colonists from Megara Hyblaea, and from the parent city of Megara (see SICILY: *History*). The name, which belonged both to the city and to the river on the west of it, was derived from the wild celery which grows there abundantly, and which appears on some of its coins (see NUMISMATICS: *Greek* Coins). Boundary disputes mith Segesta as early as 580 B.C. are recorded. Selinus soon grew in importance, and extended its borders from the Mazarus to the Halycus. Its government was at first oligarchical, but about 510 B.C. a short-lived despotism was maintained by Peithagoras and, after him, Euryleon. In 480 B.C. Selinus took the Carthaginian side. Thucydides speaks of its wealth and of the treasures in its temples, and the city had a treasury of its own at Olympia.

A dispute between Selinus and Segesta was one of the causes of the Athenian expedition of 415 B.C. At its close the former seemed to have the latter at its mercy, but an appeal to Carthage brought an overwhelming force under Hannibal, which took and destroyed the city in 409 B.C.; the walls were razed to the ground and only 2,600 inhabitants escaped to Agrigentum (Acragas). In 408 B.C. Hermocrates, returning from exile. occupied Selinus and rebuilt the walls. He fell, however, in 407 B.C. in an attempt to enter Syracuse, and, as a result of the treaty of 405 B.C., Selinus became absolutely subject to Carthage, and remained a mere village until its inhabitants were transferred to Lilybaeum (250 B.C.). It was never afterward rebuilt.

The ancient city occupied a sand hill running north and south; the south portion. overlooking the sea, which was the acropolis, is surrounded by fine walls of masonry of rectangular blocks of stone. which show traces of the reconstruction of 408 B.C. It is traversed by two main streets: running north and south and east and west. from which others diverged at right angles. There are, however, some traces of earlier buildings at a different orientation.

Only the southeast portion of the acropolis, which contains several temples. has been excavated; in the rest private houses seem to predominate. The deities to whom the temples were dedicated are not known. In all the large temples the cella is divided into two parts, the smaller and inner of which (the *adytum*) nas intended for the cult image. The opisthodomus is sometimes omitted. From the disposition of the drums of the columns. it is impossible to suppose that their fall was due to any other cause than an earthquake. The earliest of the acropolis temples had 6 columns at each end (a double row in the front) and 17 on each long side. Twelve of those on the north have been re-erected. From it came three archaic metopes. Portions of the coloured terra-cotta slabs which decorated the cornice and other architectural members have also been discovered, including the fragments of an enormous Gorgon mask over 8 ft. high. from the centre of one of its pediments. In front of it stood a large altar over 60 ft. long. Next to it on the north lies another temple. both having been included in one *temenos,* with other buildings of less importance: to the east of this is a large altar. Nearby is a small temple of comparatively late date; while two more lie on the south side of the main street from east to west in another *peribolos.*

At the north end of the acropolis are extensive remains of the fortifications of Hermocrates across the narrow neck connecting it with the rest of the hill. In front of the wall lies a deep trench, into which several passages descend, as at the nearly contemporary fort of Euryelus above Syracuse (*q.v.*). Outside this again lies a projecting semicircular bastion, which commands the entrance from the exterior of the city on the east, a winding trench approached by a pair of double gateways, which are not vaulted but covered by the gradual projection of the upper courses. Capitals and triglyphs from earlier buildings destroyed to make room for them have been used in the construction of these fortifications: from their small size they may be mostly attributed to private houses, but a small temple was also destroyed, fragments of five metopes of which are at the museum at Palermo (*c.* 500 B.C.). A way across the curving trench leads to an open space, where the Agora may have been situated: beyond it lay the town, the remains of which are scanty, though the line of the walls can be traced.

Outside the ancient city, on the west of the river Selinus, lie the ruins of a temple of Demeter Malophoros, with a propylon leading to the sacred enclosure: the temple itself has a cella with a narrow door and without columns; outside and in front of it was a large altar 52 ft. long. A large number of votive terra-cotta figures, vases and lamps were found in the course of the excavations. The earliest temple must have been erected soon after the foundation of the city, while the later building which superseded it dates from shortly after 600 B.C. The propylon, on the other hand, may date from after 409 B.C.

On the hill east of Selinus, separated from it by a small flat valley, lies a group of three huge temples. No other remains have been found round them, though it seems improbable that they stood alone and unprotected. It is likely that they were outside the town, but stood in a sacred enclosure. All of them have fallen, undoubtedly owing to an earthquake. A peculiarity of the construction of the oldest temple is that all the intercolumniations were closed by stone screens. In it were found the lower parts of two metopes. Next in date comes a huge temple, which, as an inscription proves, was dedicated to Apollo; though it was never entirely completed (many of the columns still remain unfluted), it was in use. The plan is a curious one; despite the comparative narrowness of the cella, it contained two rows of ten columns, which were in line with the front angles of the inner shrine. The blocks of stone were quarried from the Cave di Cusa, 8 mi. to the northwest, where similar blocks intended for it may still be seen in the quarry.

The third temple has been proved by the discovery of an inscription to have been dedicated to Hera. Its fine metopes now in the museum at Palermo belong to the beginning of the 5th century B.C. The cemeteries lay east of the acropolis, north of the city, and west of the temple of Demeter.

SELJUKS, the name given to the ruling family of the Ghuzz Turkoman tribes who invaded western Asia in the 11th century and founded a group of dynasties in Persia, Syria and Asia Minor. The history of the Seljuks forms the first part of the history of the Turkish empire in western Asia.

Tughril Beg.—During the 10th century a group of the Ghuzz (or Oghuz) under their chief Seljuk settled in the lower reaches of the Syr-Darya and embraced Islam. Incorporated after their conversion in the frontier defense forces of the Samanids (*q.v.*), they moved to the vicinity of Bukhara about 985; and after the fall of the Samanids they were established by Mahmud of Ghazni (*q.v.*) in the frontier regions of Khurasan. Under Mahmud's son Mas'ud, the grandsons of Seljuk, Chaghri Beg and Tughril (Toghrul) Beg occupied Khurasan and defeated the Ghaznevid army near Merv (1040). While Chaghri Beg remained in command of the main Turkoman body in the east, Tughril Beg formed a regular army of Turkish mamelukes and, with the support of the Persian nobles and religious leaders of Khurasan, organized a methodical campaign against the Shi'ite (Buyid) princes of western Iran and Iraq (1043–54). The Turkoman forces which cleared the way for him, under command of his brother Ibrahim Yinal, occupied Azerbaijan, entered Armenia (1048) and attacked the Byzantine frontiers. After establishing his control over the principalities to the east and north of Iraq, Tughril Beg marched on Baghdad (1055). The caliphate (*q.v.*) had long since been reduced to a shadow of its former power and for a century had submitted to the control of the Shi'ite Buyids. The last Buyid prince, al-Malik al-Rahim, surrendered the city without a struggle and was arrested, while the caliph al-Ka'im, welcoming the Seljuk as his deliverer from the rule of the heretics, bestowed on him the title of sultan, with the right to the inclusion of his name in the public prayers *(khutba)* after his own.

The new sultanate was immediately challenged from two directions. Al-Basasiri, a Turkish general of the Buyids, formed a coalition of all the forces displaced or aggrieved by the Seljuk conquests and applied to the Fatimite caliph of Cairo for support. His revolt swept Mesopotamia at a critical moment when Tughril Beg was faced with a more serious opposition. The conversion of a Turkish chieftainship into an imperial sultanate with an organized administration set the terms of a problem which the Seljuks were never able to solve. The tribesmen, upon whom their power rested in the last resort, remained unreconciled to the imposition of this new kind of control and thus created a permanent element of instability in the Seljuk empires. In 1058 their revolt was led by Ibrahim Yinal, and Tughril Beg was forced to allow Basasiri to reoccupy Baghdad while he was engaged in putting it down, with the aid of Chaghri Beg's sons from the east. Baghdad was then recovered with ease (the Fatimite caliph having sent munitions and money, but no troops, to the support of Basasiri). As a symbol of the new alliance between the religious authority of the caliphate and the temporal government of the sultanate, Tughril Beg left Baghdad as the residence of the caliph and fixed his own capital at Hamadan, from which he could more easily control the turbulent regions of northwestern Persia.

Alp **Arslan.**—On his death (1063) Tughril Beg was succeeded by Chaghri Beg's son Mohammed ibn Da'ud Alp Arslan (*q.v.*), under whom the orthodox administrative system of the new empire was developed by his famous Khurasanian vizier Nizam ul-Mulk and a new system of military fiefs introduced. The immigration of the Turkomans had brought with it a major change in the demographic structure of western Asia and, since they occupied pasture lands, carried a threat to the agricultural economy of more settled times. The military fief system, secured on the land, thus provided not only a means of paying the regular troops but also a measure of protection for the cultivators.

After 1054 the main thrust of the Turkomans in the west had been directed into Armenia and the eastern provinces of the Byzantine empire (see below). In 1064 and again in 1068 Alp Arslan took command of these expeditions. About 1070 the tribesmen began to spill over into north Syria, and Alp Arslan, after negotiating a truce with the emperor Romanus IV, marched on Aleppo. There he learned of the expedition of Romanus to recapture Manzikert and, hastily assembling the Turkomans of Azerbaijan, marched against the emperor, whom he defeated and captured at Manzikert (*q.v.*) in 1071 but, intent on his conquest of Syria, released on ransom. He was, however, recalled to the east to deal with the Kara-khanids of Transoxiana and there met his death (1072).

Malik-shah.— His son and successor Malik-shah owes his reputation as the greatest of the Seljuk "great sultans"! largely to the wise and salutary government of Nizam ul-Mulk. Like his predecessors, he had to meet and overcome a revolt on the part of a kinsman (Kavurd; see below) with Turkoman support before establishing himself, and was engaged for most of his reign in campaigns ranging from Antioch to Samarkand and Ferghana. Atsiz, chief of a Turkoman band, succeeded in occupying Palestine and seized Damascus (1076); in face of a Fatimite counterattack, Malik-shah sent his young brother Tutush to Syria, where he built up a new Seljuk principality. During hlalik-shah's reign the calendar was revised, and a new era, known as the Jalalaean. introduced, dating from his accession. His last years were troubled by the establishment of the Assassins (*q.v.*) in the Elburz mountains and by domestic rivalries, in which Nizam ul-Mulk also became involved, through the efforts of the princess Turkan Khatun to secure the succession for her infant son Mahmud. About 40 days before Malik-shah's own death. at the early age of 38, Nizam ul-Mulk mas murdered by Assassins (1092).

Barkiyarok and Mohammed.— With Malik-shah's death the instability of the Seljuk empire was revealed in the competition between the mothers of his young sons and his brother Tutush to secure the support of the army and the tribesmen. After Mahmud's death from smallpox and that of Tutush in battle (1095), the eldest son, Barkiyarok, was generally recognized. But his short reign (1094–1104) was occupied by continual conflicts with his brother Mohammed, in which he suffered dramatic changes of fortune while the outer provinces began to slip from the control of the sultanate. Mohammed (1104–18) succeeded in restoring a measure of decentralized control, largely through the good understanding between him and a fourth brother, Sanjar, whom Barkiyarok had appointed to govern Khurasan.

Sanjar.—After Mohammed's death Sanjar was the generally recognized sultan and head of the Seljuk house, and the later princes of western Persia and Iraq constituted a minor dynasty. The centre of Seljuk power was thus shifted back to Khurasan, and under the later Seljuks of Iraq local dynasties of Turkish atabegs (*i.e.*, military governors: ruling in the name of young Seljuk princes) established themselves in Syria, Mosul. Ardabil, Luristan and Fars; and from 1152 the caliphate again began to exercise political power in Baghdad and its neighbourhood.

In the Persian historical tradition the fame of Sanjar eclipses even that of Malik-shah. For nearly half a century he maintained the authority of an organized government over the forces which threatened eastern Persia from three directions. Transoxiana was recovered after an invasion of central Asian Turks in 1102, and a later revolt of its Kara-khanid prince was put down in 1130. In 1117 Sanjar occupied Ghazni and placed on its throne his own nominee, whose submission was reinforced by a second expedition in 1134; and when, in 11go, the princes of Ghor (*q.v.*) established a new power in Afghanistan under their leader Hosain, later entitled Jihansuz ("World Burner") for his sack of Ghazni, Sanjar captured and held the conqueror in captivity for two years. A more pertinacious rival was his viceroy Atsiz in Khwarizmia (Khorezmia). whose office of governor of the northern marches against the Kipchaks of the steppes required him to maintain a strong army and led him to adopt an independent attitude toward Sanjar. In 1138 Sanjar defeated Atsiz and occupied Khwarizmia, but Atsiz returned and retaliated by an attack on Bukhara. At this juncture a new and dangerous enemy appeared in Transoxiana. This was the recently founded confederacy of central Asian tribes under the Kara-Khitai (or Western Liao). The Karluk tribesmen in Transoxiana made common cause with the invaders, and Sanjar suffered a terrible defeat near Samarkand in 1141. Though Transoxiana was lost and the Kara-Khitai established a distant suzerainty over Khwarizmia as well, Sanjar succeeded in maintaining his hold over Khurasan, in spite of renewed rebellions by Atsiz; but in 11j3 he was defeated in a general revolt of the Ghuzz tribesmen and held by them as a captive for two years. This marked the end of the prosperity of Khurasan; after the depredations of the Ghuzz. it became a battlefield for contending tribal chiefs and invaders. Sanjar died in 1157, and his last Seljuk successor was killed in battle near Rayy (Tehran) in 1194 by the grandson of Atsiz.

Seljuks of **Kerman.**—The province of Kerman was one of the first conquests of the Seljuks and became the hereditary fief of Kavurd, a son of Chaghri Beg and future rival of Malik-shah. His descendants remained in possession of the province; and till 1170 Kerman, to which belonged also the opposite coast of Oman, enjoyed a \yell-ordered government, except for a short interruption caused by the deposition of Iran-shah. who had embraced the tenets of the Isma'ilis and was put to death (1101). But after the death of Tughril-shah (1170) his three sons disputed the possession of the throne and called in foreign assistance against one another, till the country became utterly devastated and fell an easy prey to bands of Ghuzz who. under the leadership of Malik Dinar (118j). marched into Kerman. Ten years later it was occupied by the troops of the Khmarizm-shah.

Seljuks of Syria.— After the death of Tutush (1095), his eldest son. Ridwan, occupied Aleppo, and a younger son, Dukak, occupied Damascus and Diarhekr. The young sons of the latter were quickly set aside by their atabeg Tughtagin ibn Buri. and the Seljuk line at Aleppo scarcely survived the death of Ridwan (1113).

Invasion of Asia Minor.—As already noted above, the invasion of Asia Minor began as an unco-ordinated movement by the Turkoman tribesmen in Azerbaijan. and the expeditions of Tughril Beg and Alp Xrslan were aimed as much at controlling the tribesmen as at conquest. Alp Arslan's victory at Manzikert (1071) destroyed the Byzantine frontier organization and enabled the Ghuzz to establish themselves in Greek territory, where they engaged as mercenaries in the struggles between the local commanders. Among a host of tribal chiefs the leading place was taken about 1075 by the sons of Tughril Beg's cousin Kutalmish, who were violently hostile to Malik-shah. During the struggles of rival generals for the throne of Constantinople (1078–81), one after another of the contestants called their aid in and opened to them the gates of their cities, including Nicaea and Nicomedia. By 1080 Sulaiman ibn Kutalmish held the greater part of Asia Minor as the ally of the emperor and rival sultan to Malik-shah. In 1084 Antioch was surrendered to him, but in 1086 he was killed near Xleppo in battle with Tutush and a coalition of Syrian princes. Malik-shah attempted to take advantage of his death, both by proposals for an alliance with Alexius I Comnenus and by military expeditions into western Anatolia, but with little success; and on his death (1092) Sulaiman's son Kilij Arslan (who had been captured by Malik-shah at Antioch). escaping from his captivity, reconstituted the sultanate. In the interval, however, northeastern Anatolia had been occupied by a rival Turkoman chief, called Danishmend, at Sivas, whose successors engaged in a prolonged conflict with the Seljuk sultans.

Sultanate of Rum.—The new sultan was immediately confronted with the first crusade. The first bands, under Walter the Penniless. were defeated at Nicaea (1096), but the Turks were severely defeated before Nicaea and at Dorylaeum by Godfrey of Bouillon (1097) and driven into the interior, while the emperor Alexius reoccupied western Anatolia. After his victory over the next wave of crusaders (1101), Kilij Arslan, tempted by the disorders which had weakened the Seljuks in Iraq, made a bid for the greater sultanate. He succeeded in capturing Mosul but was defeated by the forces of his kinsman of Xleppo and drowned in the Khabur river (1107). This event proved decisive in determining the future development of the sultanate of Rum. The Seljuks, hemmed in between the Greeks and the crusading states in Syria and increasingly isolated from the east, gradually established an organized and settled Anatolian kingdom. with a mixed population of Turks, Greeks and Armenians and institutions derived from the Seljuk sultanate in the east but modified by its Byzantine heritage. Kilij Arslan was succeeded by his son Malik-shah (1107–16), and he by his brother Mas'ud I (1116–55), who established his capital at Konia (Iconium). His long reign was occupied by resistance to the encroachments of the Greeks and with engagements and negotiations with the Danishmends, the crusaders and his Moslem neighbours. During the reign of his son and successor, Kilij Arslan II (1155–92), the Armenians established themselves in Cilicia, but the Danishmends were finally subdued and their territories annexed to the sultanate, in spite of the support that they received from the powerful atabeg of Syria, Nureddin. But his numerous sons, each of whom held the command of a city of the empire, embittered the sultan's old age by their mutual rivalry, and the eldest, Kutb ud-Din, tyrannized over him in his own capital, exactly at the time that Frederick I Barbarossa entered his dominions on his way to the Holy Sepulchre (1190). Konia itself was taken and the sultan forced to provide guides and provisions for the crusaders. Kilij Arslan lived two years longer, finally under the protection of his youngest son, Kaikhosrau. who held the capital after him (till 1196) until his elder brother, Rukn ud-Din Sulaiman, having vanquished his other brothers, ascended the throne and obliged Kaikhosrau to seek refuge at the Greek emperor's court. This valiant prince, who died in 1204, saved the empire from destruction and conquered Erzerum, which had been ruled during a considerable time by a separate dynasty and was now given in fief to his brother, Mughith ud-Din Tughrilshah. His son, Kilij Arslan III, was soon deposed with Greek assistance by Kaikhosrau. After the establishment of the Latin empire of Constantinople the Turks were the natural allies of the Greeks and the enemies of the crusaders and their allies, the Armenians. Kaikhosrau, therefore, took in 1207 from the Italian Aldobrandini the important harbour of Attalia (Adalia); but in 1211 perished in battle with Theodore Lascaris I, emperor of Nicaea.. His son and successor, Kaikaus, made peace with Lascaris and extended his frontiers to the Black sea by the conquest of Sinope (1214). On this occasion he took prisoner the Comnenian prince Alexius, who ruled the independent empire of Trebizond, and compelled him to acknowledge the supremacy of the Seljuks, to pay tribute and to serve in the armies of the sultan. Elated by this great success and by his victories over the Armenians, Kaikaus attempted the capture of Aleppo, at this time governed by the descendants of Saladin; but the affair miscarried.

Advance of the Mongols.—Soon afterward the sultan died (1219) and was succeeded by his brother. Ala ud-Din Kaikobad I, the most powerful and illustrious prince of this branch of the Seljuks, renowned not only for his successful wars but also for his magnificent structures at Konia, Alaya, Sivas and elsewhere, which belong to the best specimens of Saracenic architecture. The town of Alaya was his creation. He extended his rule as far as Seleucia and desisted from further conquest only on condition that the Armenian princes would enter into the same kind of relation to the Seljuks as had been imposed on the Comnenians of Trebizond. But his greatest military fame was won by a war which, however glorious, was to prove fatal to the Seljuk empire in the future; in conjunction with his ally, the Ayyubite prince Ashraf, he defeated the Khwarizm-shah Jalal ud-Din near Erzingan (1230). This victory removed the only barrier that checked the progress of the Mongols. During this war Kaikobad put an end to the collateral dynasty of the Seljuks of Erzerum and annexed its possessions. He also gained the city of Khelat with dependencies that in former times had belonged to the Shah-i-Armen, but shortly before had been taken by Jalal ud-Din; this aggression was the cause of the war just mentioned. The acquisition of Khelat led, however, to a new war, as Kaikobad's ally, the Ayyubite prince, envied him this conquest. Sixteen Mohammedan princes, mostly Ayyubite, of Syria and Mesopotamia, under the leadership of Malik al-Kamil, prince of Egypt, marched with considerable forces into Asia Minor against him. Happily for Kaikobad, the princes mistrusted the power of the Egyptian, and it proved a difficult task to penetrate through the mountainous, well-fortified accesses to the interior of Asia Minor, so that the advantage rested with Kaikobad, who took Kharput, and for some time even held Harran, Edessa and Rakka (1232). The latter conquests were, however, soon lost, and Kaikobad himself died in 1234 of poison administered to him by his son and successor, Ghiyas ud-Din Kaikhosrau II, leaving an empire embracing almost all Asia Minor, with the exception of the countries governed by John III Vatatzes and the Christian princes of Trebizond and Lesser Armenia, who, however, were bound to pay tribute and to serve in his armies. It was an empire containing Christian as well as Mohammedan elements, for the sultan relied in war mainly upon his Christian troops and granted extensive privileges to Christian merchants. In appearance it was so strong that the Mongols hesitated to invade it, although standing at its frontiers. Their attack was deferred until 1243, but in the next year Kaikhosrau was defeated at Kuzadag (between Erzingan and Sivas), and forced to purchase peace by the promise of a heavy tribute. The independence of the Seljuks was now forever lost. The Mongols retired for several years; but, Kaikhosrau II dying in 1245, the joint government of his three sons gave occasion to fresh inroads, till one of them died and Hulagu divided the empire between the other two, Izz ud-Din (Kaikaus II) ruling the districts west of the Halys, and Rukn ud-Din (Kilij Arslan IV) the eastern provinces (1259). But Izz ud-Din, intriguing with the Mameluke sultans of Egypt to expel his brother and gain his independence, was defeated by a Mongol army and obliged to flee to the imperial court. There he was imprisoned, but afterward released by the Tatars of the Crimea, who took him with them to Sarai, where he died. Rukn ud-Din was only a nominal ruler, the real power being in the hands of his minister, the *perwāne* Muin ud-Din Sulaiman, governor of Sinope, who in 1267 procured an order of the Mongol khan Abaka for his execution. The minister raised his infant son, Ghiyas ud-Din Kaikhosrau III, to the throne and governed the country for ten years longer, till he was entangled in a conspiracy of several amirs, who proposed to expel the Mongols with the aid of the Mameluke sultan of Egypt, Bibars. The latter marched into Asia Minor and defeated the Mongols in the bloody battle of Ablastan, the modern Albistan (1277); but, when he advanced farther to Caesarea, Muin ud-Din Sulaiman retired, hesitating to join him at the very moment of action. Bibars, therefore, in his turn fell back, leaving Sulaiman to the vengeance of the khan, who soon discovered his treason and ordered a barbarous execution. Kaikhosrau III continued to reign in name till 1283, though the country was in reality governed by a Mongol viceroy. Mas'ud, the son of Izz ud-Din, who on the death of his father had fled from the Crimea to the Mongol khan and had received from him the government of Sivas, Erzingan and Erzerum during the lifetime of Kaikhosrau III, ascended the Seljuk throne on his death. But his authority was scarcely respected in his own residence, for several Turkish amirs assumed independence and could be subdued only by Mongol aid, when they retired to the mountains to reappear as soon as the Mongols were gone.

The latter part of Mas'ud's reign was occupied by a seesaw struggle with Kaikobad III, son of his brother Faramarz, until he fell, probably about 1304, a victim to the vengeance of an amir whose father he had ordered to be put to death. The last years of the dynasty are obscure; from 1307 Konia was governed by Mongol viceroys, but Anatolia was already parcelled out among a dozen rival amirates, among them the infant Ottoman amirate which was to be the ultimate heir of the Seljuks.

Bibliography.—No adequate general studies of the Seljuks exist, and the principal oriental sources at mid-20th century were still untranslated. *See* the bibliographies under Caliphate and Turks or Turkic Peoples; also C. Cahen, "Le Malik-nameh et l'histoire des origines Seljukides," *Oriens*, vol. ii, no. 1, pp. 31–65 (Leyden, 1949), and "La Première pénétration turque en Asie-mineure," *Byzantion*, vol. xviii, pp. 5–67 (Brussels, 1946–48); J. Laurent, *Byzance et les Tures seljoucides* (Nancy, 1914); P. Wittek, "Deux chapitres de l'histoire des Turcs de Roum," *Byzantion*, vol. xi, pp. 285–302 (Brussels, 1936). (H. A. R. G.)

SELKIRK (or Selcraig), **ALEXANDER** (1676–1721), Scottish sailor, the prototype of "Robinson Crusoe," seventh son of John Selcraig, shoemaker and tanner of Largo, Fifeshire, was born in 1676. Having been summoned on Aug. 27, 1695, before the kirk-session for indecent behaviour in church, he "did not compear, being gone away to the seas." In May 1703 he joined Dampier in a privateering expedition to the South seas, as sailing master on the "Cinque Ports" galley. In September 1704 the "Cinque Ports" put in at Juan Fernandez Island, west of Valparaiso; there Selkirk had a dispute with his captain, Thomas Stradling, and at his own request was put ashore with a few ordinary necessaries. Before the ship left he begged to be readmitted, but this was refused, and Selkirk remained alone in Juan Fernandez over four years. till on Jan. 31, 1709, he was found, and on Feb. 12, taken off, by Captain Woodes Rogers, commander of the "Duke" privateer (with Dampier as pilot). who made him his mate and afterwards gave him command of one of his prizes, "The Increase" (March 29th). Selkirk returned to the Thames on Oct. 14, 1711; he was back at Largo in 1712; in 1717 he was again at sea, and in 1721 he died as master's mate of H.M.S. "Weymouth" (Dec. 12th).

See Woodes Rogers, *Cruising Voyage round the World* (1712), and Edward Cooke, *Voyage in the South Sea and round the World* (1712), the earliest descriptions of Selkirk's adventures; also *Providence Displayed, or a Surprising Account of one Alexander Selkirk . . . written by his own Hand* (reprinted in *Harl. Miscell.* for 1810, v. 429); and Funnell's *Voyage round the World* (1707). Steele made Selkirk's acquaintance, and gave a sketch of the adventurer and his story in the *Englishman* (Dec. 3, 1713). In 1719, shortly aiter a second edition of Rogers' *Voyage* had appeared (1718), Defoe published *Robinson Crusoe,* the idea of which is plainly derived from Selkirk's story.

The best modern biography is the *Life and Adventures of Alexander Selkirk* by John Howell (1829). In 1868 a tablet mas put up on Juan Fernandez at a point on the hill road called "Selkirk's Look-out."

SELKIRK, THOMAS DOUGLAS, 5TH EARL OF (1771–1820). was born at St. Mary's Isle, Kirkcudbrightshire, Scot., on June 20. 1771, and succeeded his father in 1799, his six brothers having predeceased him. He was a Whig politician. keenly interested in the condition of peasants in the Scottish Highlands, and advocated their emigration. In 1803 he went to Canada, where he founded a large and prosperous settlement on Prince Edward Island and a smaller one at Baldoon (Upper Canada). He later turned his attention to the Canadian west, and gradually acquired control of the Hudson's Bay company. In May 1811 an immense tract was granted to him in the Red River valley and he at once proceeded to send out settlers; but the hostility of the North-West Fur company seriously impeded the colony (see RED RIVER SETTLEMENT), and his rivals secured the defeat of Selkirk in various legal proceedings. His strenuous years in Canada cost him a fortune but laid the foundations of Winnipeg and Manitoba.

Copies of his papers. most of which are unpublished, are in the Canadian archives department at Ottawa. (G. S. P.)

SELKIRK, a royal and small burgh and the county town of Selkirkshire, Scot. Pop. (1951) 5,856. It lies on a hillside at the eastern edge of Ettrick forest and on the right bank of Ettrick Water, 39 mi. S.S.E. of Edinburgh by road. There are statues of Sir Walter Scott in his sheriff's robes (he was sheriff 1800–32) and of Mungo Park, the African explorer. who was educated at the grammar school; and there is a memorial of Flodden Field, where 80 townsmen fought and fell.

As its early name (*Scheleschyrche*) indicates. Selkirk originally consisted of a number of *shiels* (huts) in the forest beside which a church had been built by the Culdees of Old Melrose. David I, while prince of Cumbria, founded in 1119–24 a Benedictine abbey, which was removed in 1147–52 to Kelso. He also built a castle which was captured by Edward I. by whom it was enlarged and strengthened. It mas retaken by William Wallace in 1297, from which time it remained in the hands of the Scots till the battle of Halidon Hill (1333), when it was delivered to the English. It was prohably destroyed in 1417 when Sir Robert Cmfraville. governor of Berwick, set fire to the town. Nothing remains of the castle save some green mounds at Haining. The burgh charter granted by David I was renewed by James V in 1535. From an early period shoemaking has been the staple industry and the inhabitants have been known as souters (shoemakers). Though this craft has given way to tweed manufacture, the tradition of the shoemakers is still upheld when someone is made a "Souter" on receiving the freedom of the burgh. for he then has to "lick the birse." This entails drawing a small shoemaker's brush of mild boar's bristles; steeped in wine, between his lips. In memory of Flodden. the Common Riding takes place each June, when the bounds are ridden by a cavalcade of horsemen; at the end of the ride the standard bearers cast their colours to the strains of Selkirk's lament; "The Flowers of the Forest."

SELKIRK MOUNTAINS, a range in the S.E. of British Columbia, Canada, extending north for about 200 mi. from the American frontier with a breadth of about 80 mi. and bounded E., W. and N. by the Columbia river. Though often spoken of as part of the Rocky Mountain system, they are really distinct, and belong to an older geological epoch, and their outline too is rounder and less serrated than that of the Rockies.

On the S.E. is the Purcell range. with the main chain of the Rockies still farther E., and on the W. the Gold range, prolonged northward as the Cariboo Mountains. They do not rise much above 10,000 ft. The scenery is wild and magnificent; below the snow line, especially on the western side, the slopes are densely wooded, and enormous glaciers fill the upper valleys; of these the most celebrated is that of the Illecillewaet, near Glacier House, on the Canadian Pacific railway. The Selkirks are crossed by the railway at Rogers Pass. discovered in 1883. The engineering difficulties overcome were very great, the grades in places very steep. A magnificent series of caverns, called the Kakimu Caves, occur in the Glacier Park Reserve not far from Glacier.

SELKIRKSHIRE, a southern county of Scotland, bounded north and west by Peeblesshire, north by Midlothian, east and southeast by Roxburghshire and south and southwest by Dumfriesshire. Pop. (1951) 21.729, of whom only 50 could speak both Gaelic and English. Area 267.5 sq.mi. Almost the whole area is hilly. the only low ground occurring in the larger valleys; the rocks are Silurian and Ordovician, much folded. The highest hills are in the west and southwest. On the confines of Peeblesshire the chief height is Broad Law, with two peaks 2,723 ft. and 2,754 ft. respectively, and on the Dumfriesshire border, Ettrick Pen (2,269). A great deal of Boulder Clay covers the older rocks. This iceborne material travelled from west to east so that many of the hills show steep, bare slopes toward the west, but have gentle slopes covered with glacial deposits on the eastern side. The principal rivers are the Ettrick (32 mi.) and its left bank affluent the Yarrow (14 mi.), but for a few miles the Tweed traverses the north of the county. Gala Water (21 mi.)! though it joins the Tweed a little below Galashiels, belongs rather to Midlothian, since it rises in the Moorfoot hills and for most of its course flows in that shire. St. Mary's loch, through which runs the Yarrow, and its adjunct, the Loch of the Lowes, are the chief lakes; there are numerous small lakes in the southeast. The vales of Tweed and Yarrow and Ettrickdale are the principal valleys. The beauty of the Vale of Yarrow inspired Sir Walter Scott and William Wordsworth.

The site of a Roman camp has been confirmed near Oakwood, in the Ettrick valley; but the natives were probably held in check from the station at Newstead near the Eildons. The Standing stone near Yarrow church bearing a Latin inscription is ascribed to the 5th and 6th centuries and is only a quasi-Roman relic. No so-called British camps have been found on the upper and middle waters of the Ettrick and Yarrow, and of the few situated in the lower valleys of these streams the most important is the large work on Rink hill in the parish of Galashiels, the district containing various interesting prehistoric remains. At Torwoodlee, 2 mi. N.W. of Galashiels, are the ruins of the only example of a *broch* (round tower) in the Border counties; some Roman remains were found there. The barrier known as the Catrail, or Picts' Work, starts near Torwoodlee. whence it runs southward to Rink hill. There it sweeps round to the southwest as far as Yarrow church, from which it again takes a due south direction to the valley of the Rankle. where it passes into Roxburghshire. The history of the shire for six centuries following the retreat of the Romans is that of the whole of southeastern Scotland. The country formed part, first, of the British kingdom of Strathclyde, then of the Saxon kingdom of Northumbria, and finally, about 1020. was annexed to Scotland. The first sheriff of whom there is record was Andrew de Synton, appointed by William the Lion (d. 1214).

To the north of Hangingshaw, in the country between the Yarrow and Tweed. William Wallace constructed an earthwork in 1297, still called Wallace's trench, 1,000 ft. long, and terminating on the top of a hill in a large square enclosure. Here he lay till his plans were completed. and at last departed, his forces including a body of Selkirk archers. for a raid into the north of England. During the prolonged strife that followed the death of Robert Bruce (1329) the foresters were constantly fighting, and the county suffered more heavily at Flodden (1513) than any other district.

The lawlessness of the Borderers was at length put down by James V with a strong hand. He parcelled out the forest in districts, and to each appointed a keeper to enforce order and protect property. In 1529 the ringleaders. including William Cockburn of Henderland, Adam Scott of Tushielaw and the notorious Johnnie Armstrong, were arrested and promptly executed. This severity gradually had the desired effect, though after the union of the crowns in 1603 the freebooters and mosstroopers again threatened to he troublesome, until James VI's lieutenants ruthlessly stamped out disaffection. The Covenanters held many conventicles in the uplands. and their general. David Leslie, routed the marquess of Montrose at Philiphnugh in 164j.

Five-sixths of the county is hill land or rough grazings, divided into sheep farms extending to over 1,000 ac. and carrying hardy Blackface and South Country Cheviot flocks producing lambs for sale in autumn for feeding or crossing on better ground. In conjunction with sheep-rearing, varied but usually comparatively small cattle-breeding enterprises are carried on and on the higher hill ground herds of Galloway and other hardy cattle are an increasingly common feature. Dairying is mostly restricted to a few holdings near the principal ton-ns of Selkirk and Galashiels. Strenuous efforts are required to use the limited areas of arable land to advantage since much of it is steep and incapable of being ploughed both ways by wheeled tractor. The main crops. oats and turnips. are mostly consumed on the farm, but some barley is grown in more favoured areas.

The land between the Ettrick and the Tweed was formerly covered with forest to such an extent that the sheriffdom was described as Ettrick forest. and became the hunting ground of the Stuarts. James V, to increase his revenues. let the domain for grazing.

Woollen manufactures (tweeds, tartans. yarn and hosiery) are the predominant industry at Galashiels and Selkirk. Tanning is carried on at Galashiels.

Selkirk (pop., 1951, 5,856) is the county town and only royal burgh, Calashiels (12,496) is the largest town and the only other small burgh. There are two county districts. Selkirkshire combines with Roxburgh to return a member to parliament, and the shires of Selkirk; Roxburgh and Berwick form a sheriffdom, with a resident sheriff-substitute at Selkirk.

SELLA, QUINTINO (1827–1884), Italian statesman and financier, was born at Mosso, near Biella, on July 7, 1827. After studying engineering at Turin and Paris he became a professor at Turin. Entering the Chamber of Deputies in 1860 he became secretary-general of public instruction, and in 1862 received from Rattazzi the portfolio of finance. The Rattazzi cabinet fell before Sella could efficaciously provide for the deficit of £17,500,000 with which he was confronted; but in 1864 he returned to the ministry of finance in the La Marmora cabinet, and dealt energetically with the deficit of £8,000,000 then existing. A vote of the chamber compelled him to resign before his preparations for financial restoration were complete; but in 1869 he returned to the ministry of finance in a cabinet formed by himself, but of which he made over the premiership to Giovanni Lanza. By means of the grist tax (which he had proposed in 1865, but which the Menabrea cabinet had passed in 1868), and by other fiscal expedients, he succeeded, before his fall from power in 1873, in placing Italian finance upon a sound footing. In 1870 his influence turned the scale against interference in favour of France against Prussia, and in favour of an immediate occupation of Rome.

Sella retired from politics in 1881, and died on March 14, 1884.

His *Discorsi parlamentari* were published (5 vols., 1887–1890) by order of the Chamber of Deputies. An account of his life and his scientific labours was given by A. Cossa in the *Proceedings of the Accademia dei Lincei* (1884–1885).

SELMA, a city of Alabama, U.S., the seat of Dallas county, is located on the north bank of the Alabama river: 50 mi. W. of Montgomery. It is in the "black belt" of Alabama, an area of rich soil suitable for cotton, livestock, pecans and diversified farm products. all of which are produced in abundance. The city is a lumber and manufacturing centre; products include cotton bags and yarn, clothing, food products, cigars, toys and fertilizers. Craig air force base is located nearby. The city is also noted as a medical centre.

The place was known as Moore's Bluff or Moore's Landing in 1815; it was incorporated in 1820 by a company headed by William Rufus Devane King (vice-president of the United States in 1853), who named it Selma from a poem by Ossian.

It replaced Cahaba (capital of Alabama from 1819 to 1826) as county seat in 1865. Its chief pre-Civil War show place is the Sturdivant museum, formerly the Gilliam home. For comparative population figures *see* table in ALABAMA: *Population.*

(W. T. Jo.)

SELMECZBANYA (BANSKA STIAVNICA), an old mining town situated on the terraced slopes of a ravine in the Slovakian highlands, Czechoslovakia, and encircled by high mountains. It was colonized in the 12th century by German miners who later embraced the Reformation.

The German element was driven out during the 18th century as a result of the Counter-Reformation and its place taken by Slovaks. The mines were of great importance and quantities of gold and silver were raised but they later declined until a few silver mines were the chief relics of this former greatness. Pop. (1950) 9,542.

SELOUS, FREDERICK COURTENEY (1851–1917), English hunter and explorer in south-central Africa whose travels added to the knowledge of Rhodesia, was born in London on Dec. 31, 1851, and was educated at Rugby and in Germany. In 1871 he went to South Africa and in 1872 traveled to Matabeleland where he hunted big game. He then wrote *A Hunter's Wanderings in Africa* (1881).

For 18 years Selous explored and hunted over the country between the Limpopo and the Congo basin, collecting specimens of many kinds. In 1890 he entered the service of the British South Africa company and was active in the successful pioneer expedition to Mashonaland and in the arrangements whereby the district of Manica, near the Portuguese frontier, was brought under British control.

Selous summarized his travels in "Twenty Years in Zambesia." *Geogr. J.*, i (1893). His account of the Matabele War, in which he was wounded in 1893. was entitled *Sunshine and Storm in Rhodesia* (1896). Selous then settled in England but made hunting expeditions to many parts of the world. He was killed in action near Kisaki in Tanganyika on Jan. 4, 1917, during World War I.

See J. G. Millais, *Life of Frederick Courteney Selous* (1918).

(R. L. HL.)

SELWYN, GEORGE AUGUSTUS (1719–1791), English wit, son of Col. John Selwyn (d. 1751), of Matson, Gloucestershire, was born on Aug. 11, 1719. Educated at Eton and Oxford, he became member of parliament for the family borough of Ludgershall in 1747; and from 1754; three years after he inherited Matson, to 1780 he represented Gloucester. He obtained two or three lucrative sinecures. In society he was very popular and won a great reputation as a wit. He is said to have been very fond of seeing corpses, criminals and executions, and Horace Walpole says he loved "nothing upon earth so well as a criminal, except the execution of him."

He died in London on Jan. 25, 1791. Like the eccentric duke of Queensberry Selwyn claimed to be the father of Maria Fagniani, who became the wife of Francis Charles Seymour, 3rd marquess of Hertford.

See J. H. Jesse, *George Selwyn and his Contemporaries* (1843–44; new ed., 1882); and S. P. Kerr, *George Selwyn and the Wits* (1909).

SELWYN, GEORGE AUGUSTUS (1809–1878), English bishop, second son of William Selwyn (1775–1855), a distinguished legal writer, was born at Hampstead, London, on April 5, 1809. He was educated at Eton and at St. John's college, Cambridge, where he graduated in 1831. He returned to Eton as private tutor, was ordained deacon in 1833, and in 1841 was appointed first bishop to New Zealand, then just beginning to be colonized. He studied navigation and the Maori language on the voyage out and on his arrival gave himself up to a life of continual hardship. He spent days and sometimes nights in the saddle, swam broad rivers and provided himself with a sailing vessel.

Unfortunately, just when he had gained the confidence of the natives, his ascendancy was rudely shaken by the first Maori war. Selwyn endeavoured to mediate, but incurred the hostility of both parties.

In 1854 he returned to England for a short furlough. He returned to New Zealand with a band of able associates. including J. C. Patteson, and began to divide his large diocese into sees of more manageable proportions. The colonists came to respect his uprightness, and the Maoris learned to regard him as their father. In 1868, while he was in England to attend the first pan-Anglican synod, the bishopric of Lichfield became vacant, and after some hesitation he accepted it. On his death, on April 11. 1878, his great work for the church was celebrated by a remarkable memorial, Selwyn college, Cambridge, being erected by public subscription and incorporated in 1882.

See *Lives* by H. W. Tucker, 2 vols. (1879) and G. H. Curteis (1889) and L. von G. Creighton's, G. *A. Selwyn, D.D., Bishop of New Zealand and Lichfield* (1923).

His son, John Richardson Selwyn (1844–1898), bishop of Melanesia, was born in New Zealand on May 20, 1844. He was educated at Eton and at Trinity college, Cambridge, and was ordained deacon in 1869. The martyrdom of John Coleridge Patteson, bishop of Melanesia, led him to volunteer for service in the Australasian archipelago. After three years' service, during which the bishopric remained vacant, he was nominated as Patteson's successor (1877).

He returned to England in 1890 and became master of Selwyn college, where he died on Feb. 12, 1898.

SEMANG, a Negrito tribe (see Races of Mankind, and Asia: Anthropology: Ethnology and Languages) of Malay and of Siam. The Semang live in caves or leaf shelters formed between branches. A waistcloth for men, made of bark hammered out with a wooden mallet from the cortex of a species of wild breadfruit tree, and a short petticoat of the same for women. is the only dress worn; many go naked. Scarification is practised, by drawing the serrated edge of a sugar-cane leaf across the skin and rubbing in charcoal powder. The Semang have bamboo musical instruments, the jews'-harp and a nose flute. On festive occasions they sing and dance, decorating themselves with leaves. The Semang bury their dead simply, placing food and drink in the grave. The Semang of Patalung, called Ngo by the Siamese, are probably mixed with pre-Dravidian stock. They use the blowgun (*q.v.*) as well as the bow and spears. They have a woman chief.

See I. H. Evans, *The Negritos of Malaya* (1937); *P.* Schebesta, *Among the Forest Dwarfs of Malaya* (1929). (J. H. H.)

SEMANTICS, GENERAL. A doctrine and educational discipline developed by Alfred Korzybski (1879–1950), a Polish scholar and engineer who lived in the U.S. from 1917. The term "semantics" was used to indicate concern with the many ways in which meanings of words and other symbols influence the responses of human beings to their environment and to each other (called "evaluation" by Korzybski and his followers). The adjective "general" was added to avoid confusion with other logical and linguistic studies called semantics (see Semantics in Linguistics and Semantics in Logic).

In his chief book, Science and Sanity (1933; 3rd ed., 1948), Korzybski argued that prevailing habits of thought have lagged far behind the linguistic and logical assumptions of modern science. He drew upon relativity theory, quantum mechanics, colloidal chemistry, neurology and mathematical logic as evidence of a revolution against so-called "Aristotelian evaluative habits." Current thought and practice in nonscientific situations were held by him to be seriously hindered by defective habits traced back to Aristotle's logic and its influence on western culture. The alleged Aristotelian assumptions attacked include: (1) the claim that subject and predicate are identical (the use of "the 'is' of identity"); (2) the exclusion of any but the two truth-values of truth and falsity (as shown by the law of excluded middle); and (3) the law of contradiction (nothing is both A and not-A).

Modern science is held to have shown that these assumptions represent at best oversimplifications of the true structure of reality. The resulting "evaluative habits," resulting from an "Aristotelian orientation," are marked by dogmatism, rigidity and lack of emotional balance. These defects show themselves in confusion between symbols and the realities for which they ought to stand, inattention to the limitations of abstraction, willingness to make sharp "either-or" distinctions and uncontrolled, "trigger" responses to stimuli. The condition of disorientation thus produced deserves to be called "un-sanity," and calls urgently for therapy.

On the theoretical level, Korzybski elaborated a complex doctrine that he called "non-Aristotelian" (abbreviated to the symbol "$\bar{A}$" by general semanticists). Much emphasis was laid, however, upon practical training in better evaluative habits. As simple but useful aids to the learning of such habits, he advised the use of indexing" (so that one speaks of "man,," "man,," etc., to distinguish different senses), "dating" (*e.g.,* "Roosevelt$_{1930}$," "Roosevelt$_{1940}$") and accompanying all statements by an implicit "et cetera" (shown by the symbol".,") to indicate awareness of factors omitted in any process of abstraction. To facilitate "awareness of abstracting," he also invented an ingenious model known as the "Structural Differential."

An Institute of General Semantics (Lakeville, Conn.) was established in 1938 to give training in Korzybski's methods. The International Society for General Semantics established a quarterly journal ETC. Numerous attempts have been made to apply general semantics to the teaching of English, speech correction, psychotherapy and many other fields. The enthusiasm of many devoted adherents of general semantics is not shared by most academic scholars in related disciplines.

See I. J. Lee, "General Semantics 1952," ETC (winter, 1952), which contains useful references, and M. Black, *Language and Philosophy,* ch. x (1949). (M. Bk.)

SEMANTICS IN LINGUISTICS. The word "semantics" as a noun is a modern word, based on the Greek adjective *sēman*tzkos ("significant") which was used by Aristotle in a linguistic sense in On Interpretation. The first known use of the word as a noun appeared in a review of Arsbne Darmesteter's book La Vie des mots *étudiée dans* leurs significations (Paris, 1887) by Gaston Paris in the Journal des savants, p. 65 (Feb. 1887), but the expression used by Paris (cette *partie si* ddlicate et encore *si* neuve de la linguistique qu'on a *appelée* la *sémantique* ["this part of linguistics, so subtle and yet so new, that is called semantics"]) shows clearly that the word had been used before. It is one of a great many words for which it is possible to fix the birth date closely, but not exactly. From French the word entered quickly into other languages.

The word "semasiology," however, had already been proposed by the German Latinist Karl Reisig in his Vorlesungen *über latein*ische Sprachwissenschaft, published in Leipzig in 1839 (reprinted in Berlin, 1881–90).· A kind of study of lexicological semantics mas written by the Neoplatonist Proclus in the 5th century in his commentary on Plato's *Cratylus.* The philosophical dispute between the exponents of realism and idealism (*qq.v.*) has gone on through the ages. In modern times Lady Welby (*Significs*), George Boole, Charles S. Peirce and their successors (Bertrand Russell, Rudolf Carnap, and others) have pursued the problem of meaning with great acumen and originality. More recent is the view that there is a close connection between probability and meaning, intimately related to variation in language, which is a constant process, and to selection, which repairs the ravages of variation. Selective variation in language tends to maintain an equilibrium in meaning as in all other linguistic features. A word used nith great frequency is low in semantic value, important as it may be functionally or grammatically; content of meaning is enhanced by relative rareness, and affectivity is higher in words upon the use of which restrictions are placed by context or even by extralinguistic factors such as taboo. Meaning withal "means" something, namely intelligibility or understanding on the part both of speaker (or writer) and hearer (or reader) and this is perhaps the simplest way of describing it, as "linguistic goal-directed activity." The analogy of modern communication theory and even of servomechanisms and computing machines have pointed to and emphasized this view of what "meaning" is, and of how it is conveyed symbolically.

In the 19th century neogrammarians (*q.v.*) saw language in two aspects, a "psychological" and a "phonetic." The phonetic was considered as purely physiological, and phonetic changes, then labeled phonetic laws, were seen to be highly regular. Therefore the word "semantic" was at first opposed to the word "phonetic" as the signifying part of language, in opposition to the nonsignifying part—in the individual speech-sound. But the work of the Prague school of linguistics, since about 1920, has shown that each sound in itself—or more exactly each class of sound, *t, d, p, b,* etc.—is not indeed significant but distinctive, *i.e.*, a pair b : *p* distinguishes two meanings. If "bit" and "pit" are two different words in English, the difference in meaning hinges obviously on the difference between *b* and *p;* this difference, called opposition, is therefore distinctive. There are languages, such as the Swiss-German dialects, in which *p* and b are mere nondistinctive variations of the same phoneme. Some differences (technically, oppositions) that are such in English are not so in other languages. English distinguishes a velar ŋ (as in "sing," "wing") and a dental *n* (as in "sin," "win"); Italian or Spanish, although having the sounds ŋ and *n,* for example, in Italian *unto* and *ungo,* do not attach any really linguistic significance to this difference, which is mechanically determined by the adjoining sounds *t* and *g.* A distinction between semantic and phonetic cannot then be sharply maintained. The whole of language is a unity, and a nonsignificant part is not to be separated from the remainder.

The definition of semantics is then the study of the connection between a linguistic feature and the corresponding mental process or symbolism in the act of speaking. In English the form "I love" represents action in the present, "I loved" in the past, but the meaning of "I went" with respect to "I go" is identical to that of "I loved" with respect to "I love." The same holds true for "boy," "boys"; "mouse," "mice"; "ox," "oxen", and for "clear," "clearer"; "good," "better." English expresses the comparative or the plural or the past in different ways, for grammatical, not semantic reasons. There is no necessary invariant correspondence between form and meaning in language, which is a systematic symbolism, the meaning of which depends almost entirely upon a conventional tie between a symbol and that which it symbolizes.

Thus language tends to eliminate homonyms when homonymy becomes destructive to mutual understanding. In those regions of France where Latin *molere* "to grind," and *mulgere* "to milk," came to coincide, *mulgere* was replaced by *trahere* (traire), "to draw"; and where the names of the "cat" and the "dog" or the "cat" and the "rooster" came to have the same form, one of the two (or sometimes both) was replaced by another word (*e.g.,* "rooster" by "pheasant").

The connection between language and human mental processes has been conceived in several ways. One school of thought simply ignores all mental processes as unnecessary and confusing. According to this view, language must be studied by itself, without any reference to meaning. Apart from the obvious fact that it cannot be explained how, without some kind of mental process, anything about language can be asserted or understood, or that discussion of abstract terms usually produces significant responses only in other linguistic terms, it is clear that the theory simply "solves" the problem by suppressing the fact that the solution is itself, like language as a whole, a response to linguistic (and mental) stimuli.

A quite different opinion has been defended by the Norwegian scholar, A. Sommerfelt, who follows the French sociological school, in particular that of Emile Durkheim. "Language," says Sommerfelt, "is in principle independent of the individuals as such. It is a system of actions which the individual must learn from other older individuals, who are members of the same society as he is." However, he also admits:

Words have become something more [than actions]: [they become] the means by which society not only acts on the surrounding world, but also conceives this world. . . . Malinowski is therefore quite right when he criticizes the usual definition of language as a means of expressing thoughts. . . . The categories of thinking are based upon language. Logic and grammar are not at all identical; the confusion of the two has damaged, it is well known, the development of language study. However, we think by means of language. In logic and in language, such as we know them in the European civilisation: we find the relationship: subject-predicate. When Aristotle, in his *Logic*, operated with the categories of substance, number, or relation, he could do so because these categories were represented in the Greek language. Our [current popular] logic is based on the categories of the Indo-European languages.

This theory cannot be accepted as it stands. Animals certainly think. in their own way and in their own world, although they do not "speak." It is moreover the daily experience of everyone to think before he speaks, or without speaking at all, and without always putting his thoughts into words; and it is the experience of every speaker that he sometimes has difficulty in putting into words just what he wishes to say. There must be, however, a connection between language and thinking. It is also certain that language to some extent influences a person's way of thinking and his whole conception of the universe, and that language helps tremendously to evolve, develop, and mature his thinking, especially during childhood. It is obvious that a child learns what a dog is, or what a tree or a bird is, by hearing them called "dog," "tree" or "bird." If he did not (and in some cultures he does not), he would not connect a Pekingese with a Dalmatian, or a cherry tree with an oak, or a sparrow with an eagle; or at least he would arrive at such an abstraction much later and with much greater difficulty. It is alleged that modern Americans have a somewhat different concept of the wolf from the Italians. To the Italian the wolf denotes a person who eats too much, to the American a man who pursues women; the two metaphors are far apart, and no Italian who has not lived in the United States would be likely to understand any of the many jokes about the American wolves, or vice versa. And there is hardly any doubt that without language Plato's or Giambattista Vico's or Immanuel Kant's philosophy could never have been elaborated, and the whole intellectual edifice of our modern culture could not have been built up.

Thus the sequence is from percept to concept to verbalization. There is a constant interaction between these three elements and necessarily language partakes of this mutual interaction and reflects it historically, not least in meaning. The fundamental mistake of ancient, medieval and Renaissance thinkers was not to consider that language is, among other things, the expression of human thinking (which of course was right) but to apply grammatical categories as if they were the only true logical categories, complete in themselves, and universal. This can be seen quite clearly even today in our grammatical terminology, which has been preserved from antiquity; *e.g.,* when the word "substantive" obviously derives from "substance." The philosophers who created the term thereby attributed not only to contemporary illiterates—which is already to go much too far—but even to Stone Age men of 5,000 years ago the idea of substance. Nor does this category of substance apply well to modern English or to Old English or to any other language living or dead, nor can it possibly apply, for language is just not built that way. "No language has been formed by an assembly of logicians," as Voltaire once wrote. It may be admitted that iron is a substance, but not freedom or light or beauty. While substances are certainly indicated by means of substantives, substantives are also used to indicate many ideas that by no stretch of the imagination could be called substances. Likewise, while gender in French or Italian or German obviously indicates sex, it is also applied to the moon, a star, a tree, a stone, a revolution, a cbuntry, a bridge, a nose, a mountain and thousands of objects or concepts obviously devoid of natural sex. It was partly this difficulty that prompted Leonard Bloomfield and his followers to deny all connection between language and mental categories and to study language by itself, without any reference to the workings of the mind.

Language has a creative or poetic quality in the formation of philosophical concepts and of scientific constructs. Myth also has played, and still (under the name ideology) plays a part in the development of human thinking and of language. Abstract nouns—so difficult for a "primitive" mind to conceive—are originally often the names of gods or heroes; that is, of concrete, personal creatures. having human shape—legs, arms, head, teeth. They were only much greater. much more powerful than normal men and women, and they possessed to a maximum extent some particular quality that is found among men and women in greater or lesser degree. Aphrodite would be a most beautiful woman, Ares an extremely strong man, Athena immensely wise and so on. It was in part through myth that the human mind bridged the enormous gap from words such as "dog," "wolf," "man," "stone." to words such as "beauty," "generosity," "freedom," "width," "greatness," "virtue," "love." etc. And this helps to explain why such words, contrary to what should logically be expected, are endowed with gender—that is, with sex—in all languages that have kept such a distinction. It is the modern remainder, and reminder, of their original divine nature.

Names of actions—birth, murder, conspiracy, destruction, deliverance—also usually have gender in many languages and have a similar origin as abstracts; the suffixes are frequently the same: *cf.* Eng. "birth," "mirth," "strength." Objects or phenomena which are sexless—stone, water, thunder, star, moon—were also endowed with life for primitive man, as can easily be sho n not only by the adoration of these objects or phenomena in ancient religions (Persian, Roman, etc.) but also by the fact that they are endowed with sex, and precisely in significant couples: sun, moon; earth, sky; fire, water. It is interesting to observe that in those languages where the sun and fire are masculine. the moon and water are feminine; but when the moon and water are masculine, then the sun and fire are feminine (*e.g.,* Lat. sol m., luna f.; but Ger. die Sonne f., der Mond m.).

The category of the noun, which is unintelligible as long as substances and other logical or philosophical concepts are used, becomes quite clear in the magical realm of poetry, where stones dance and trees sing; nouns indicate persons or objects or phenomena or qualities considered as persons (or deities, which is linguistically the same). But it is not only primitive man who is a poet: in the act of speaking, all are poets. The scholar. coming back from his library, will personify his automobile, just as any primitive man might. In modern English this process is repeated every day. The suffix -er was originally used for agents, for persons who are engaged in a certain activity: "love," "lover"; "kill," "killer"; "drive," "driver"; or for means of action, and such names are continually being formed with this suffix: "starter," "steamer," "liner," "sweater," "buzzer," "fighter," "lighter," "diner." "sleeper," "propeller," "silencer," "nutcracker," "breaker," "trailer"; and the same suffix is used more and more for acts or actions: "thriller," "chiller," "shocker," "puzzler," "opener," "starter," "howler," "screamer" to denote an action or event that thrills, chills. shocks, puzzles, that opens, that starts, that simulates howls or screams. English, so to speak, treats actions and events as living things, especially in vivid. colloquial speech, and in slang. The like is true for other suffixes ("rockette," "majorette," "usherette," "kitchenette," "dinette," "stopette").

That adjectives are closely connected with substantives the ancient grammarians knew quite well, since the two words are merely two adjectives qualifying a noun: *nomen* substantiuum, *nomen adiectiuum.* The *nomen* adiectiuum is the noun that is added (adiectum) to the *nomen* substantiuum as an indication of a special quality which the noun possesses in the particular circumstance to which the speaker refers: the white cow as opposed to the black cow or the yellow cow. While the noun. when it indicates a quality, indicates the totality of it, the adjective indicates the quality in a specific and concrete situation and with reference to another noun. Or again it may itself be used as a substantive: "the good," "the true," "the beautiful."

The concept of quality requires a much greater degree of abstraction than that of object or person. It is much easier to conceive of a cow or a stone than to conceive ideas such as big or white or good. The history of philosophy, which is after all the history of human thinking, starts with the philosophies of substance (*i.e.,* objects—water, fire, air, earth) and progresses only with George Berkeley and Kant to the ideas of quality (*i.e.,* philosophically, of sensations: an object has no inner reality, it is only a bundle of sensations; it can be defined only as being white, sweet. tender, etc.). The study of Indo-European grammar confirms perfectly this evolution. Adjectives in Indo-European languages that designate qualities are used freely as nouns. The endings of the adjectives are the same as those of the nouns, and even change of gender, which is considered as peculiar to adjectives, occurs frequently also with nouns: Lat. *lupus, lupa;* equus, equa, like bonus, bona. Latin preserves at least two examples in which the development is quite obvious. Latin uber means "udder," "breast," and it is certainly an old Indo-European word (cf. Eng. "udder." Gr. outhar). But in Latin it is also normally used as an adjective (with one ending) with the meaning "productive," "fertile," "abundant"; *uber* ager is a "fertile field"—originally an "udder field"; that is, a field comparable to an udder in fertility. Likewise uetus meant originally "year" (Gr. *wetus,* Sanskrit *vatsás* "year"), and was used at first of wine, then plants or animals or humans; *uetus uinum* was a "one-year-old wine," whence later the adjectival meaning "old." In other words, adjectives were once nothing but nouns, and they testify to the metaphorical, *i.e.,* poetic nature of language. The process is reproduced in our modern languages especially by names of colours: a "violet sky" is not a sky made of violets, but a sky which has its colour in common with violets; likewise a "rose opal" is an opal which has a rosy hue. In French and in Italian such adjectives are not declined for gender—in other words, they have still the form of nouns: Fr. *une* robe rose, *un ciel* violet; It. *un* vestito *rosa, un* nastro viola.

The article, both definite and indefinite, is a very late acquisition of the Indo-European languages (and, for that matter, of many other languages). Indo-European languages had no article of any kind, and the conservative Baltic and Slavonic languages still have no article (with the isolated exception of Bulgarian). Homeric Greek had no real article; the definite article was therefore a development of classical Greek (the indefinite article arrived even later). Classical Latin had no article either, but spoken Latin certainly had it in the imperial period, and from there it spread to all the Romance languages, and the modern Germanic languages have it (though Gothic still lacked it). This grammatical device, though not indispensable, contributed to the growth both of abstraction ("the good") and of identification ("the stone" as distinguished from "stone" in general).

There was a similar evolution in the verb system. While the verbal system of Indo-European languages was based on aspect (indicating the manner of the action—perfective, imperfective, iterative, unique, inceptive, etc.), in modern languages, especially the western ones, the verb is based on the notion of time (Eng. "tense"). It is true that the English or French verb has frequently some aspectual characteristics ("I was going"), but the fact remains that no finite verbal form ("I write," "I wrote," "I shall write") in English, French, Italian or German can be conceived outside time; it must definitely be a present, a past or a future, whereas the aspectual character, rarely predominant, may even be entirely absent. The same trend from aspect to time may be observed in Semitic languages; it is impossible to reconstruct any real tenses for proto-Semitic any more than for Indo-European. This is easy to understand, for the concept of time is weak among primitives, as it is among children: "The category of aspect is more concrete than the category of time, and, in the course of the history of the Indo-European languages, we see aspect losing importance. time gaining it" (Antoine Meillet).

However, this "linguistic" time is, like every linguistic category, an imaginative, subjective quantity. Just as gender is not sex, so linguistic time is neither physical nor mathematical time. Language freely uses the future for the present ("This will be John"), the past for the present ("If I had two dollars . . ."), the present for the past (praesens *historicum*), the present for the future (praesens pro *futuro*), etc.; and these two last uses are so frequent that the Latin grammarians speak of a present present (praesens praesens).

Moreover, from a mathematical point of view, past and future are two infinite, equivalent quantities; linguistically they are quite different. In fact, the past is known; the future is unknown. The consequence is that many languages have a past, or even two or three or more, but no future (*e.g.,* Gothic); the past appears long before the future, and it is much more stable and more developed. The future not only appears at a very advanced stage of civilization, but remains shaky and evolves with great difficulty into a real prospective, objective future, equivalent to the past; it remains for a very long time either a potential or a volitive or a debilitive future, for man conceives with difficulty of future events as really happening in the same way that past events have happened; he thinks of them as events he wants to happen ("I will go"), or that must happen ("I shall go") or that may happen ("Tomorrow I may go to New York"). Even in English the future is not on the same level with the past. "I wrote" is a simple, factual form; "I shall write" or "I will write" are compound forms with verbs implying ideas different from those of simply expressing the future time.

Lexicological problems are not essentially different from morphological or syntactical problems. The history of words expressing the ideas of being and becoming furnishes a good example. It is well known that the human mind conceives much earlier and more easily essence rather than change, objects than processes. It has taken thousands of years of philosophizing to prove that the world is in perpetual flux. Ancient, medieval and Renaissance philosophers, with the exception of Heraclitus, investigated what the world is, of what substance or substances it is formed. Modern philosophy is a new philosophy of becoming. Language reflects this philosophical evolution. While the idea of being had been reached early in Indo-European (roots **es-* and **bhu-,* Eng. "I am," "I be"), the idea of becoming was late and therefore expressed in a different way in every single Indo-European group of languages: Lat. *fio,* Gr. *gignomai,* Ger. *ich werde* (akin to Lat. *uertere* "to turn," *cf.* Eng. "He turned red"). Modern Spanish and modern Russian do not have one verb to express such an idea, but use different words, proving that the concept is neither clear nor unified (Spanish *ponerse, hacerse, llegar a ser,* etc.). Even English, besides the usual "to become," has "to grow," "to turn," "to get," "to wax." Verbs meaning "to become" seem to be somewhat unstable: Old English *weorþan* disappeared, and so did Lat. *fio,* being replaced by Fr. *devenir,* It. *divenire,* etc. It is very difficult to express in Spanish the Hegelian concept of *das Werden,* as opposed to *das Sein.*

The study of lexicology shows clearly that language is not entirely the product of economic, technical, social or political and other environmental conditions. It is also the product of man's imagination, like poetry, with which it is closely allied. for both spring from the same source. Almost any word can give a shining example of this obvious truth. The American calls his automobile a car, using a word that the Celts used 3,000 years ago for a heavy, two-wheeled wagon drawn by animals; no amount of changes or technical improvements have been able to change the word. On the other hand, words for child, boy, girl! bad, small, etc., have changed several times in the last centuries, and are still changing ("kid," "bambino," "lad," "fellow," "lass," "gal," "doll," "baby," "stinker," "teeny"), although no new type of girl or boy or child has been imported from abroad or transformed through technical or genetic improvements. But the need for poetic expressiveness prompts the speaker to replace such words constantly, because the old ones soon appear prosaic and colourless, through overuse. There is an inverse ratio between frequency of usage and affectivity.

Language being a poetic creation, it is at first normally concrete, for poetry is by its nature concrete, describing things that can be seen, smelled, and touched. The process of linguistic change, although infinitely varied, is almost inevitably one that goes from the concrete to the abstract, again and again and again. It was noted above that aspect, which is concrete, was replaced progressively by tense, which is more abstract; language always uses concrete tools to express abstract thoughts. In the English "I have seen" the "have" is a purely grammatical tool, without any concrete value of its own; but its ancient concrete: plastic use can still be seen in phrases such as "I have two dollars" or even better "I have the key in my hand" (now being replaced by the addition of another more concrete verb, "I've got the key," "I've got two dollars"). Likewise, abstract words of philosophy or religion may easily be traced to concrete, sensuous expressions: "absolute" is that which is "untied" from something (like a dog); "abstract" is that which is "drawn out of somewhere" (like a loaf from the oven); "concept" is that which is "taken together" (an image reproduced in "comprehend" and now in "to grasp"); idea comes from Greek *widea,* that is, from the root **wid-* "to see" (Eng. "vision." "video," "providence." etc.). To take the verb "to become," discussed above, the English word is a compound of the preverb *by, be-* and the verb "to come"; the German *werden* is a verb once meaning "to turn." preserved in Russian *verte't'* and Lat. *uertere* "to turn," whence Eng. "convert," "pervert," "extrovert" (cf. for the meaning Eng. "He turned red"); Spanish *ponerse* is "to put oneself"; Gr. *gignomai* contains the root *gen-,* "to generate," "to engender," denoting a biological phenomenon.

Since language is a poetic creation, it follows that every semantic change may be classified under the categories called rhetorical figures, or figures of speech, under which all the metaphors of the poets were once catalogued. To say that a man is no good, meaning that he is a rascal, is to use a litotes; to say irons for fetters, or glasses for spectacles, is to use a metonymy; to say that a woman dancer is terrific or devastating, or that a man is a lady-killer, is to use a hyperbole—since ladies generally will survive such amorous experiences. All of language is a living metaphor, which is not noticed, precisely because metaphor is so amalgamated into it that it appears natural and inevitable.

See also LANGUAGE; LINGUISTICS.

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(*G.* **U.** B.; J. WH.)

SEMANTICS IN LOGIC aims at the building of an abstract theory of the relation between signs and what they mean. *Semiotic,* the study of signs and languages, is divided into three parts. *Pragmatics* studies the way languages are used. In *semantics* we abstract from usage, and are interested only in the relations between signs of a language and their meaning. In *syntax* we further abstract, and consider signs aside from what they mean. Semantics can be further divided: We either study existing languages or aim at an abstract theory. The former study is a branch of empirical science *(see* SEMANTICS IN LINGUISTICS), while the latter (*pure semantics)* belongs to logic.

The semantic structure of an ordinary (or natural) language is hopelessly complex because of the fact that its syntactic structure is not precisely determined and that it employs many ambiguous and vague expressions. Hence pure semantics deals only with fully formalized languages. Such languages aim at a reconstruction of ordinary discourse, trying to free it from the pitfalls of natural languages. Pure semantics in turn aims at a rigorous theory of the way in which signs in a formalized language have meanings, and at the solution of the many problems raised by the meaning-relations. It is hoped that this theory can also be formalized, and hence pure semantics aims at the establishment of (one or more) formalized semantical systems which are adequate for a comprehensive theory of the meaning-relations and of related concepts. The most important of these semantic concepts are discussed below.

For an explanation of the logical terminology and symbols used in this article *see* LOGIC.

PARADOXES

The next sentence is true. The previous sentence is false.

If you consider either one of the foregoing sentences, you note that it is a perfectly simple and clear sentence of the English language. And yet the two sentences together constitute a paradox; they are a version of the ancient paradox of the liar. A (declarative) sentence must be either true or false. and cannot—of course—be both. Let us suppose that the first sentence is false. That means that the second sentence is not true. But to say that "The previous sentence is false" is not true is equivalent to the assertion that the previous sentence is not false. This in itself is not a paradox; from the assumption that the first sentence is false we have derived a contradiction. which shows only that our assumption was wrong. Hence the first sentence is not false. That implies that it is true, which means that the second sentence is true. But if "The previous sentence is false" is true, then the first sentence is false. We have now derived two contradictory results using only the rules of logic.

Another type of semantic paradox is due to Kurt Grelling. Let us classify the adjectives of the English language as to whether they are self-applicable or non-self-applicable. An adjective is self-applicable if it has the property it expresses; *e.g.*, the adjective "short" is self-applicable since it is a short word, but "long" is non-self-applicable since it is not a long word. Every adjective is either self-applicable or non-self-applicable, and cannot—of course—be both. Which is the case for the adjective "non-self-applicable"? Suppose that it is self-applicable. Then it has the property which it expresses, *i.e.*, it is non-self-applicable, contrary to our supposition. Hence it is non-self-applzcable. This means that it does not have the property it expresses, the property of non-self-applicability. But this is just another way of saying that it is not non-self-applicable. We have again arrived at two contradictory results.

Paradoxes are often treated as if they were harmless amusements. But this is far from a correct evaluation of them. The above paradoxes show that English allows the derivation of contradictory conclusions by means of the rules of logic; *i.e.*, that English is inconsistent. Since it can be shonn that in an inconsistent system anything at all, true or false, can be proved (this is a consequence of the law of denial of the antecedent; see LOGIC), we have to conclude that ordinary English is a language not suitable for logical arguments. And it is not the case that some simple trick will remove this inconsistency.

The root of the difficulty lies in the fact that English, in common with other natural languages, allows us to formulate its own semantic theory. We can discuss such concepts as being a true sentence (of English) and prove the basic truths about these concepts. While this appears at first to be a highly desirable feature of natural languages, Alfred Tarski showed that any language having this feature is necessarily inconsistent. He has shown for a wide variety of languages that if they enable us to discuss semantic problems about themselves and to prove at least the most basic expected results. then a paradox can be formulated in the language. Indeed, if the reader will re-examine the way we arrived at the tno sets of contradictions above, he will find that we have appealed only to the most elementary semantic truths.

We are forced to the conclusion that we must never attempt to formulate the semantic system of a formalized language within the same language; we must employ a second language which is used to talk about the first one. This second language must enable us to express and prove anything that can be expressed or proved in the first language, and in addition it must be able to do more. namely it allows us to formulate a semantic theory of the first language.

The lesson me learn from the semantic paradoxes is that in order to formulate a comprehensive semantic theory ior a given language we must employ a second, stronger (or richer) language.

META-LANGUAGE

The second language introduced to talk about a given language is known as the meta-language, while the first language is called the object *language*. It is important to note that these are relational terms: It is nonsense to ask whether a given language is a meta-language; we can only say that it is being used as a meta-language of another language at the moment. The meta-language can in turn be studied. in which case it is used as an object language, and the previous object language can be the meta-language of a third language.

When a language is used to formulate a semantic theory for a given object language. we call it a *semantic* meta-language. Thus the lesson of the semantic paradoxes is that a semantic meta-language must always be stronger than its object language. This makes the task of formalized semantics very complex: If we want to formulate a semantic theory of a given language. we employ a second, stronger language. If we want to study the semantic structure of this second language as well, Tarski's result shows that we must use a third language even stronger than the second one. This new language can, in turn, only be studied in a fourth language, etc. We are led to an infinite hierarchy of stronger and stronger languages in which each (after the first) serves as a meta-language of the previous one, and in turn serves as an object language. We cannot escape the conclusion that if the aim of a comprehensive formalized theory of the semantic structure of languages is at all attainable, it can only be achieved by means of infinitely many formalized languages.

The Model Language L.—In the following discussion we will always suppose that we are discussing some given formalized language. Since the discussion will take place in English, English is our meta-language. We have already noted that this is an unsuitable language from the logical point of view, but it is used for the sake of ease of presentation. To make some of the points more concrete, we will employ a simple language L as an example of an object language. L is a simple applied singulary functional calculus of the first order (see LOGIC), which is designed for tasks like the taking of a census. It has predicates A, B, C, . . . which express properties of human beings. and individual names a, b, c, . . . which are names of human beings; *e.g.*, B, M, and R express the properties of being a bachelor, married, and red-haired, respectively, while b, r, and s are names of John Brown, Robin Robinson, and Jim Smith. The simplest sentences of L are exemplified by $B(r)$, expressing that Robin Robinson is a bachelor, and R is), expressing that Jim Smith has red hair. (We will assume that the latter is true and the former is false.) More complex sentences are formed by means of sentence connectives and universal quantification; *e.g.*, $R(b) \cdot \sim B(b)$ expresses that John Brown has red hair and is not a bachelor. (We will assume that as a matter of fact he is the only red-haired non-bachelor.)

While it will be helpful to illustrate various points throughout this article in terms of L, we must at all times keep such examples distinct from the general discussion which applies to any formalized language.

AXIOMATIC TREATMENT

Denotation, satisfaction, determination, and truth are some of the fundamental semantic concepts. We will use these to illustrate the axiomatic treatment of semantics.

Denotation is the relation between a constant of the formalized language and the object to which it refers; *e.g.*, an individual constant denotes the individual of which it is a name. In L, s denotes Jim Smith, while B denotes those human beings collectively who happen to be bachelors—the class of bachelors. Classes are taken in extension; *i.e.*, n-e do not distinguish between two classes having the same membership. Were it the case that all bachelors hate women and all woman-haters are bachelors, then we could also say that B denotes the class of woman-haters.

Satisfaction and Determination are relations between a propositional form and an object. A given object satisfies a propositional form if putting a name of the object in place of the variable of the form turns the form into a true sentence. The form determines the object if the object is the only thing that satisfies the form. Thus, in **L**, Jim Smith satisfies $R(x)$, Robin Robinson satisfies $\sim B(y)$, and R (x). $\sim B(x)$ determines John Brown.

Truth is a property of sentences. This use of the word "true" agrees with common-sense usage, and must he distinguished from certain other recent uses of the word. We say, *e.g.*, that a certain theory is true when it is only highly probable. In semantics we want to admit the possibility that a highly probable theory may be false and an improbable one may be true. We must also distinguish truth from opinion, no matter what the grounds of belief may be; and we must not identify the concept with that of usefulness. We are using "true" in the time-honoured sense in which Aristotle uses it in the quotation: "To say of what is that it is not, or of what is not that it is, is false; while to say of what is that it is, or of what is not that it is not, is true."

The four concepts are interrelated. For example, we can define the other three in terms of satisfaction: (1) A form *determines* an object if the object satisfies the form, and if it is the only object satisfying the form. (2) Truth is a property of sentences rather than of forms, but it is easy to find a propositional form equivalent to a given sentence. We may, *e.g.*, replace the sentence S by the form $S \cdot [x = x]$. A sentence S is *true* if any object satisfies $S \cdot [x = x]$. (3) For a definition of denotation we must distinguish between various types of constants; *e.g.*, R denotes the class of all objects satisfying the form Rx, while r denotes the one object (person) satisfying $r = x$. (These definitions presuppose that the object language has an equality sign.)

Axioms for Truth.—First we must have axioms specifying the conditions under which individual sentences are true. We are indebted to Tarski for giving the first precise formulation. This is perhaps the most frequently misinterpreted result of formalized semantics. On the one hand the conditions have such an appearance of obviousness that we may think them trivial; but it is often the iate of great discoveries that after they have been made we forget that it took thousands of years to find them. On the other hand many philosophers have tried to assign too great a role to these conditions; they have been taken as a definition of truth, which they are not.

What are these conditions? For any given sentence it is easy to give the condition for its being true: $R(s)$ is true if and only if Jim Smith has red hair, $B(r)$ is true if Robin Robinson is a bachelor, and "all swans are white" is true if all swans are white. These conditions are of the form

(I) X is true if and only if Y,

where in place of X we have the name of a sentence, and in place of Y we have a statement (in the meta-language, of course) of what the sentence asserts. Thus, roughly speaking, a sentence is true if and only if what it asserts is the case. We have a complete set of conditions if in (I) we have an axiom for each sentence of the object language. Thus (I) is an axiom schema, which is normally infinite. In the exceptional cases where there are only a finite number of sentences in the object language. (I) may be replaced by a conjunction of its instances. which will serve as a definition of truth. But in the usual case, including all nontrivial languages. the list of axioms is infinite and no such conjunction can be formed. Only this case will be discussed from here on.

While (I) determines the truth or falsity of every sentence, even the siinplest generalizations do not follow from it. We need

(II) For all sentences S, S is true if and only if $\sim$S is not true,

as an additional axiom, for example. While for any one sentence we can prove that it is true if and only if its negation is not true, we are unable to derive the generalized result (II) from (I). We know from the schema (I) in the meta-language of **L**; *e.g.*, that $B(r)$ is true if and only if Robin Robinson is a bachelor, and that $\sim B(r)$ is true if Robin Robinson is not a bachelor, hence $B(r)$ is true if and only if $\sim B(r)$ is not true. But we can prove that (II) itself does not follow from (I): Let us suppose that it does follow; *i.e.*, there is a proof of (11), given (I). Since a proof contains only a finite number of steps, only a finite number of instances of (I) can be used in the proof. But then (II) must follow from a finite number of instances of (I). Such a finite list says nothing at all about most of the sentences, hence a result about all sentences cannot be a consequence. This proves that we were mistaken in supposing that (II) follows from (I).

Similarly we will have to add

(III) For all pairs of sentences S and S', S$\vee$S' is true if and only if S is true or S' is true.

Since all the remaining sentence connectives can be defined in terms of $\sim$ and $\vee$, we can derive corresponding results for them from (II) and (III). It is also worth noting that some famous "laws of thought" are consequences of these axioms; *e.g.*, if we define a sentence to be *false* if its negation is true—as is customary—then it is an immediate consequence of (II) that every sentence is either true or false. See THOUGHT, LAWS OF.

An additional axiom which we may want to introduce is: $(\mathbf{x})\mathbf{Fx}$ is true if and only if every sentence of the form Fa is true, where Fx is a propositional form, and Fa results from **Fx** by replacing the variable **x** of the form by the constant a. While this seems to have the same intuitive appeal as (II) and (111), it can only be introduced in exceptional cases. If in L every human being has a name, then the axiom is correct. But let us suppose that the individual names of L mere taken from telephone books, and that **P** expresses the property of being listed in at least one phone book; then every sentence of the form Pa is true. but $(x)Px$ is false! In this case, which represents the usual situation, the proposed axiom must be rejected.

These axioms are only the bare beginning of an axiomatic treatment of truth; *e.g.*, in general it will not' follow that all theorems of the object language are true; we will need one or more additional axioms to assure this. These axioms can be further strengthened by combining them with axioms of *satisfaction.* From such a set of axioms it is possible to derive the equivalences that make up Tarski's definition (see the next section). But a complete treatment is not to be expected, since it can be shown that no matter what list of axioms is laid down, there will be true statements about truth which do not follow from the axioms.

DEFINITION OF SEMANTIC CONCEPTS

Tarski showed that the above semantic concepts can also be introduced by definition in the meta-language. It is convenient to start with a very broad notion of satisfaction. We consider not only forms with one free variable, but we allow any number of free variables. "x is white" is a propositional form with one free variable. "x is between y and z" has three free variables, while a sentence like "all swans are white" may be considered an extreme case of a form with no free variables. Since we allow several free variables, the relation holds not between a single object and a form, but between a list of objects and the form. Since forms are built up by step-by-step procedures, our definition also proceeds in this way.

Let us give the definition for L. Given a form F. me must define what we mean by having its various parts satisfied by a given list of people. We associate one member of the list with each variable (free or boundj of F. The simplest parts of any form are of the type $\mathbf{P}(a)$ or $\mathbf{P}(\mathbf{x})$. $\mathbf{P}(a)$ is satisfied by any list if the person whose name a is has the property expressed by **P**, while $\mathbf{P}(\mathbf{x})$ is satisfied by the list if the person associated with the variable **x** has this property. We may require that all more complex forms be formed by means of negation. disjunction, and universal quantification. The negation of a form is satisfied by the list if and only if the form itself is not satisfied. The disjunction of two forms is satisfied if and only if the list satisfies at least one of the original forms. $(\mathbf{x})\mathbf{Gx}$ is satisfied by the list if and only if every list differing from the given one only in the person associated with xsatisfies **Gx.** (Note that in this case it makes no difference which person was associated with **x** in the given list!) Thus we define step-by-step the satisfaction relation for all parts of **F,** and hence for **F** itself. We can do the same for every propositional form in **L**.

Given the definition of satisfaction, we can define the other concepts in terms of it, as indicated above; *e.g.*, we note that it makes no difference which person was assigned to a bound variable of **F.** Hence if the form happens to be a sentence—which has no free variables—then it is either satisfied by all lists or by none. In the former case it is true. in the latter false. From this definition we can derive all instances of (I). and also such generalizations as (II) and (III). We also see from this that our definition agrees with the intuitive meaning of "true," since only in this case can it yield all the instances of (I).

In most cases these definitions are the best basis for a theory of the concepts discussed so far.

ANALYTIC TRUTH

There is a second group of semantic concepts, related to each other, which are more difficult to define than the previous ones. No entirely satisfactory treatment of these is available, and there is still considerable controversy concerning them. Rudolf Carnap gave us the first systematic approach to semantics as a whole; *i.e.,* to both concepts. Many of his ideas are used in this article.

The central concept in this group is that of analyticity. A sentence is analytically true (false) if it is true (false) purely on the basis of the meaning of its words. Opposed to these are synthetic sentences, whose truth (falsity) depends on information about the physical world. "All white swans are white" and "all bachelors are unmarried" are examples of analytic truths, while "the earth is a planet of the sun" and "Jim Smith has red hair" are synthetic truths. The negations of these sentences are examples of analytically and synthetically false sentences, respectively.

In order to define these concepts we must consider not only the intended interpretation of the symbols, but all logically possible interpretations; *e.g.,* we intend to interpret R as denoting the class of red-haired people and r to denote Robin Robinson; but it is logically possible to let R denote the class of bachelors and *r* to denote John Brown, as long as no axiom of **L** is violated. It will turn out that some of the constants in the object language have only one possible interpretation (these are logical *constants*), but that the constants used to express facts (extra-logical *constants*) by their very nature have many interpretations. While we have a right to decide that R should express the property of red-hairedness, it takes factual information to determine which class it denotes. As far as logic is concerned, there is no reason why the people who happen to have red hair should be the redheads of the world, it could just as easily have happened that the people who happen to be bachelors fulfill this role. This possibility (and hence the corresponding interpretation) can be eliminated only by an axiom about the membership of these classes; *e.g.,* that John Brown belongs to the class of redheads, but not to the class of bachelors. But this is a factual assertion, and is therefore not suitable as a logical axiom.

In L an interpretation tells us (1) which class of human beings each predicate denotes; (2) which human being is denoted by each name; (3) which operation on a propositional form is denoted by negation; (4) by universal. quantification; and (5) which operation on a pair of forms is denoted by disjunction. Given this information, we can define satisfaction—as we did above—relative to these meanings of the constants. A form satisfied by all lists is said to be valid under this interpretation. If all axioms are valid under the interpretation, if the rules allow us to infer only valid conclusions from valid premisses, and unless the interpretation is trivial in the sense that it makes all sentences valid, we then call the interpretation a *sound* interpretation, or a *model* of **L**. It is possible to show that negation, disjunction, and universal quantification have the same denotation in all models, while the predicates and individual names all have a wide range of possible interpretations.

A sentence that is valid in all models is analytically true; a sentence valid in no model is *analytically* false (or self-contradictory). An *analytic* sentence is one that is analytically true or analytically false. By the Law of the Excluded Middle, a sentence is either analytically true or not analytically true: but the latter by no means assures us that it is analytically false. in this "middle" lies the vast group of *synthetic* (or *factual*) sentences, which are valid in some but not all models. $R(r) \vee \sim R(r)$ is analytically true; no matter what class R denotes and no matter who *r* is. he either does or does not belong to this class. But $R(r)$ is factual; it is valid if R denotes the class of redheads and r denotes Jim Smith, and it is not valid if R denotes the class of bachelors and r denotes Robin Robinson.

It is a consequence of the above definitions that all theorems of L are analytically true! and that all analytically true sentences are theorems. But the latter does not hold for all formalized languages, due to the impossibility of giving a complete formalization of advanced branches of logic. (See **LOGIC.**) This is the source of many difficulties in the general definition of analyticity: Because of the incompleteness of our axioms certain logical constants admit more than one interpretation, and the definition of analyticity cannot be as simple as for **L**. There is every reason to hope, however, that semantics will overcome these difficulties.

Many concepts can be defined in terms of those just discussed. A few of these are: S and S' are logically equivalent if $\mathbf{S} \equiv S'$ is analytically true. S' is a logical *consequence* of **S** if $\mathbf{S} \supset \mathbf{S}'$ is analytically true. **S** and S' are *consistent* if $\mathbf{S} \cdot \mathbf{S}'$ is not analytically false. Two constants are *synonymous* if they are given the same interpretation by every model. A formalized language is complete if every analytically true sentence is a theorem. (This last definition must be modified somewhat in languages having restrictions on quantification.)

Criticism of These Concepts.—The above concepts have been severely criticized from various points of view. W. V. Quine has even presented a strong argument to show that no sharp distinction can be made between analytic and synthetic sentences. The arguments of Quine, and of a number of other philosophers, are based on examples from natural languages in which we are unable to say whether a given sentence is analytic or synthetic. It is admitted by these critics that a certain class of sentences, the so-called logical *truths,* are clearly analytically true. Thus there is no objection to sentences like $B(r) \supset B(r)$. But what of a sentence like $B(r) \supset \sim M(r)$? How do we know that this is true purely on the basis of the meaning of the constants? We could interpret B to be the class of redheads, give M its usual meaning, and let *r* denote John Brown; then the sentence is false.

"All swans are white" is a good test case for these objections. The word "swan" was for a long time applied only to certain heavy-bodied, long-necked, aquatic birds with white plumage. Then a new species was discovered in Australia that was just like these, only the birds were black. The English language could have developed along either of two lines: We could use "swan" in a broader sense from then on, and speak of black swans (which is what has happened), or we could give a new name to the Australian species, say "gwan," and describe gwans as just like swans except in their colour. It certainly takes factual information to know which line was followed, but this type of factual information is no more relevant to the question of analyticity than information about how the axioms were chosen. What is relevant is that if the former line is followed, then "all swans are white" is factual and false; while under the latter procedure whiteness is part of the meaning of "swan," hence the sentence is analytically true. This sentence is analytic if and only if it is true, hence we cannot accept its classification as true or false without accepting its classification as analytic or synthetic.

The lesson to be learned from this example is that we must have complete information about the meaning of all the words in the object language, hence we must have axioms not only for the logical constants, but also for extra-logical constants; *e.g.,* me will have $B(x) \supset_x \sim M(x)$ as an axiom of **L**. Then $B(r) \supset \sim M(r)$ is analytically true, because any interpretation under which it is not valid fails to make one of the axioms valid, and hence is not a model. Axioms which restrict the usage of extra-logical constants are called *meaning postulates.* It can be shown that the examples constructed to demonstrate that the concept of analyticity is unsound show rather that there is some question about the meaning postulates; *i.e.,* of the way certain words are used. This is riot at all surprising since the examples are always chosen from a natural language. These difiiculties are resolved by the fact that a language is not considered fully formalized unless all the axioms, including the meaning postulates, are explicitly stated.

TWO KINDS OF MEANING

We are indebted to J. S. Mill and even more to Gottlob Frege for showing clearly that names have two kinds of meaning. On the one hand we could take the meaning of *R* to be the object to which it refers, the class of red-haired people, on the other hand me could take as the meaning the idea which it calls to our minds, namely the concept of red-hairedness. The former is the *denotation* of *R*, the latter is its *sense* (or *connotation*). (*See* MEANING, and CONNOTATION and DENOTATION.) Let *R'* denote the class of all those red-haired people who have no more than 1,000.000.000 hairs. Since it so happens that no one has more than 1.000.000.000 hairs, *R* and *R'* have the same denotation. But since their definitions are not logically equivalent. they have different senses. The denotation of *R* is a class of human beings; and its sense is a concept of this class. The sense of a term determines its denotation, but the same object may have many different concepts.

This distinction is closely related to the distinction between analytic and synthetic truth. If in an analytically true sentence we replace a term by another having the same sense, the result is also analytically true. If me substitute a term with the same denotation but a different sense, the result must again be true, but it need not be analytically true. This is due to the fact that while the sense uniquely determines the denotation, it takes factual knowledge to find out what this denotation is. Hence in order to establish the truth of the resulting sentence we may need factual information concerning the identity of the two denotations. "Woman" and "adult female human being" have the same sense, while "woman under ten feet tall" has the same denotation but a different sense. "All women are women" is analytically true, and so is "all women are adult female human beings"; but while "all women are women under ten feet tall" is true, we must have factual information to establish its truth.

Individual names also have two kinds of meaning, which is more easily seen for descriptions than for proper names. "The 32nd president of the U.S.A." and "the first person to be elected president of the U.S.A. four times" both denote Franklin Delano Roosevelt, but they have different senses as can be seen from the fact that we must know some American history to know that they have the same denotation. The distinction can even be extended to sentences: A sentence is said to denote its truth-value (*i.e.*, truth or falsity), and to have as its sense the proposition which it expresses. (In this usage propositions are both abstract and objective.)

Any theory of meaning must overcome certain difficulties raised by descriptions. "The so-and-so" has a clear-cut denotation only if there is one and only one so-and-so. What is the denotation, *e.g.*, of "the king of England in 1953"? And how are sentences containing such descriptions to be classified as true or false? A second type of difficulty is raised by sentences like "I know that Franklin Delano Roosevelt was the 32nd president of the U.S.A." This sentence differs from "I know that Franklin Delano Roosevelt was Franklin Delano Roosevelt" only in the interchanging of two terms having the same denotation, hence the former must be true, since the latter is. But if I am sufficiently ignorant the former sentence is false.

Bertrand Russell suggested a way of overcoming these difficulties by a new analysis of descriptions. He asserted that a sentence containing a description is a condensation of a more complex sentence; *e.g.*, "Franklin Delano Roosevelt was the 32nd president of the U.S.A." is an abbreviation of "there was one and only one person who was the 32nd president of the U.S.A., and Franklin Delano Roosevelt was this person." Under this analysis all sentences of the form "the so-and-so is . . ." are false if there is no so-and-so or if there is more than one. Thus the sentences "the king of England in 1953 was tall" and "the king of England in 1953 was not tall" are not contradictories, but are both false. According to Russell, descriptions do not function as names, and there is no need to assign a denotation to them. And if we rewrite the first "I know . . ." sentence according to Russell's analysis, we see that it has an entirely different structure from the second one.

Though this approach overcomes the difficulties without using the Frege distinction, it raises certain problems of its own which have induced other investigators to return to Frege's approach. The difficulty of the denotation of "the king of England in 1953" is overcome by Frege by assigning denotations to such descriptions by some arbitrary convention. The two major systems that employ this procedure differ as to the way in which they treat the second difficulty. Carnap maintains a distinction between the *extension* and *intension* of terms which is very similar to the distinction between denotation and sense. But Carnap's rule of substitution (of a term for another having the same extension) is restricted so that it cannot be applied in contexts like "I know. . . ." Alonzo Church worked out a suggestion of Frege's according to which names in contexts like "I know . . ." are not used in the customary manner, but *obliquely*. This means that they are used not as names of their denotation, as usual, but as names of their sense. Thus the sentence above is not about the person F. D. Roosevelt, but about two different concepts of this person.

While this analysis seems like the most natural one, it obligates us to build a formalized language in which a name is not used with different denotations at different times. This means that we need a name for the sense of each name. And then, of course, we need a name for the sense of the new name, etc. This leads to a very complex hierarchy of names and concepts. Such an *intensional* system mas formulated by Church, and to anyone who accepts the Frege analysis this system represents as much progress over the usual (extensional) formalized languages, as those represent over unformalized languages. But, because of the very great complexity of the Church system. it remains to be seen whether it can stand the test of detailed scrutiny.

Abstract Entities. — The problem of treating abstract entities, like the sense of a name, is the most controversial topic in semantics. Many logicians have strong philosophical objections to the treatment of concepts as in any sense on a par with physical objects. Quine in particular has devoted considerable effort to a reconstruction of logic along nominalist lines (*see* NOMINALISM), trying to rid the foundations of what are usually called Platonic doctrines. So far the nominalist systems have only been able to cope with a small part of logic. On the other hand, the type of Platonist system advocated by Church or Carnap runs the serious risk of being inconsistent. It remains to be seen whether nominalist or Platonist systems prove more successful in the formalization of semantics.

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SEMAPHORE, a method of signaling by means of flags, lights or arms. Before the invention of the telegraph, semaphore signaling from high towers was used to transmit messages between distant points. Movable arms, or rows of lights simulating arms, displayed from towers and used to signal railroad trains are modern semaphores. Semaphore signaling between ships is accomplished by men who hold a small flag in each hand and, with arms extended, move them to different angles to indicate letters of the alphabet. While such signaling has been largely superseded by radio it will probably continue in use at times when radio silence is necessary.

See SIGNAL COMMUNICATION. (M. R. D.)

SEMARANG, one of the chief towns and ports of Java, Indon., a centre of commerce situated, almost centrally, on the north coast 250 mi. E. of Djakarta (Jakarta). It is the capital of the province of Central Java. The population was 217,796 according to the 1930 census and was estimated at 389,970 in 1956.

Semarang is on the banks of the Semarang river, and is connected by railway with Surakarta, Jogjakarta, Madiun and Surabaja, and by steam streetcar with Tjirebon. where connection is made with the railway to Bandung and Djakarta. Semarang, like Djakarta. is divided into tn-o parts: the old native town near the coast, thickly housed. with narrow streets, but with some good shops, hotels. European business houses and churches (in former times it was surrounded by a moat, with forts): and a newer town, further inland. where there are various government and public buildings, including a military hospital, and also a club, hotels, restaurants. and. in the large town square, *aloon*, a mosque; the square also has recreation grounds.

The two districts are connected by the fine Bojong road. South of Bojong road there is a beautiful residential hill suburb (Tjandi), 500 ft. above the sea. Of interest in the vicinity of Semarang are Demak and Salatiga. Although Semarang is the third port in Java, the harbour is unprotected against the northwest monsoon, which may cause suspension of port operations.

Vessels anchor about 3 mi. out, and, for the protection of the lighters into which they discharge their cargo. there is a harbour, the western pierhead of which extends 5,249 ft. into the sea, to prevent the mouth from silting up and to retain a sufficient depth of water. This harbour has a broad front, branching to the shore in two customhouse basins, and a fishing vessel harbour; there are godowns, bonded stores and storage sheds. with cranes and a small dry dock.

The port is connected by rail and road with the hinterland; and by cable with Djakarta. Surabaja and Balikpapan, in Borneo. The river between the town and the sea is canalized for traffic.

Industries included the manufacture of machinery and textiles. Rubber, coffee. sugar and other agricultural products are exported.

During World War II Semarang was occupied by the Japanese from 1942 to 1945. (E. E. L.; X.)

SEMBAT, MARCEL (1862–1922), French public official, was born Oct. 19, 1862. at Bonnières (Seine-et-Oise). and educated at the Collège Stanislas. In 1893 he became Socialist deputy for the 18th *arrondissement* of Paris. and attached himself to the Blanquist faction of the party headed by Edouard Vaillant. On the constitution of the United Socialist party. however, in 1905, under Jaurès, Sembat became one of a brilliant body of extremist debaters which made the Radical-Socialist party the strongest political force in France. On the outbreak of World War I, Sembat became minister of public works in the Ministry of National Defence in Xug. 1914. He died at Chamonix on Sept. j, 1922.

Among his published works are *Matisse et son oeuvre* (1920) and *La victoive en déroute* (Eng. tr. 1925).

SEMBRICH, MARCELLA (1858–1935), Polish-born operatic soprano known for her performance in coloratura roles. Born at Wisniewczyk, Galicia, on Feb. 18, 1858, she was the daughter of Kasimir Kochanski with whom she studied the piano and violin, but later adopted her mother's maiden name. Encouraged by Liszt, she studied singing under Victor Rokitansky and G. B. Lamperti, and in 1877 made her début in Athens in Bellini's *I Puritani.* In 1878 she established her reputation in Dresden in the coloratura role of Donizetti's *Lucia* di *Lammermoor* which she sang in London in 1880 and in New York ,in 1883.

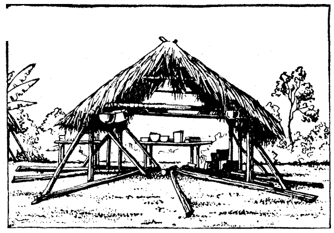
From 1883 to 1909 she was known throughout Europe and the United States for many roles in the operas of Mozart, Verdi and others. She continued her concert career until 1917, and died in New York on Jan. 11, 1935.

SEMELE, in Greek mythology, daughter of Cadmus and Harmonia. and mother of Dionysus by Zeus. *See* DIONYSUS.

SEMENOV, NIKOLAI NIKOLAEVICH (1896–), Russian physical chemist. who was awarded the 1956 Nobel prize in chemistry, jointly with Sir Cyril Hinshelwood, for work on the kinetics of chemical reactions. was born at Saratov on April 15, 1896. He graduated from Petrograd university in 1917 and worked in the Leningrad Physical Technical institute (1920–31) where he became professor in 1928. In the following year he became corresponding member, and in 1931 full member. of the Academy of Sciences of the U.S.S.R. Semcnov later became director of the Institute of Chemical Physics in Moscow.

Semenov had long been known to chemists for his outstanding work on the mechanism of chemical transformations. In his book *Chemical Kinetics and Chain Reactions* (published in England in 1935) he gives an exhaustive analysis of the applications of the chain-theory to varied reactions. and especially to those involved in combination processes. He also put forward the idea of degenerate branching. in terms of which some of the mysterious phenomena associated with the induction periods of oxidation processes can be understood. Less well known is his work on the propagation of explosive waves, which appeared only in Russian. Semenov was the first Soviet citizen to be awarded a Nobel prize.

SEMINOLE, an American Indian tribe. formed in the 18th century by splitting away from the Creek (*q.v.*). The name means "seceders." They occupied the territory of the destroyed Apalachi in northern Florida and fought the United States bitterly in 1817–18 and under Osceola in 1835–42. In 1950 they numbered about 3.000 in Oklahoma and 800 in southern Florida. both bodies much mixed with Negro blood. (*See* MacCauley, *Bur. Am. Etkn. Rep. V.*, 1887.)



BY COURTESY OF THE HEYE FOUNDATION
A SEMINOLE OPEN THATCHED HOUSE IN FLORIDA

SEMIPALATINSK, (1) formerly a province of the general-governorship of the Steppes, now included in the Kazakh S.S.R. (*q.v.*); (2) a town of Asiatic Russia in the Kazakh S.S.R. in lat. 50° 28' N., 80° 13' E., on the Irtysh river, in a sandy waste at an altitude of 686 ft. Pop. (1959) 155.000.

Its position on the Irtysh, with steamer routes to Omsk and Lake Zaisan made it a Kirghiz centre for trade in livestock. wool and tallow. It has a dock, wharves and repair shops. The river is 2jo yd. wide and is frozen from Nov. 26 to April 30. The opening in 1915 of the railway line from Novo-Sibirsk to Semipalatinsk greatly increased its prosperity; a like line running southward links up with the railway systems of the Russian Central Asiatic Republics. The town has breweries. leather works. flour mills and a sheepskin factory and is the centre of a district of the same name.

SEMĪRAMIS (c. 800 B.C.), a famous Assyrian princess, round whose personality a mass of legend has accumulated. It was not until 1910 that the researches of Professor Lehmann-Haupt of Berlin restored her to her rightful place in Babylonian-Assyrian history. The legends derived by Diodorus Siculus, Justin and others from Ctesias of Cnidus were completely disproved, and Semiramis had come to be treated as a purely legendary figure. The legends ran as follows: Semiramis was the daughter of the fish-goddess Atargatis (*q.v.*) of Ascalon in Syria, and was miraculously preserved by doves, who fed her until she was found and brought up by Simmas, the royal shepherd. Afterwards she married Onnes, one of the generals of Ninus, who was so struck by her bravery at the capture of Bactra that he married her, after Onnes had committed suicide. Ninus died, and Semīramis, succeeding to his power, traversed all parts of the empire, erecting great cities (especially Babylon) and stupendous monuments, or opening roads through savage mountains. She was unsuccessful only in an attack on India. At length, after a reign of forty-two years, she delivered up the kingdom to her son Ninyas, and disappeared, or, according to what seems to be the original form of the story, was turned into a dove and was thenceforth worshipped as a deity.

The name of Semiramis came to be applied to various monuments in Western Asia, the origin of which was forgotten or unknown. (*See* Strabo xvi. *I.* 2.) Ultimately every stupendous work of antiquity by the Euphrates or in Iran seems to have been ascribed to her—even the Behistun inscriptions of Darius (Diod. Sic. ii. 3). Semiramis appears as a goddess, the daughter of the fish-goddess Atargatis, and herself connected with the doves of Ishtar or Astartē. The same association of the fish and dove is found at Hierapolis (Bambyce, blabbog), the great temple which, according to one legend, was founded by Semiramis (Lucian, De dea *Syria,* 14), and where her statue was shown with a golden dove on her head (33, 39). The irresistible charms of Semiramis, her sexual excesses (which. however, belong only to the legends: there is no historical groundwork), and other features of the legend, all bear out the view that she is primarily a form of Astartē, and so fittingly conceived as the great queen of Assyria.

Professor Lehmann-Haupt, by putting together the results of archaeological discoveries, has arrived at the following conclusions. Semiramis is the Greek form of Sammuramat. She was probably a Babylonian (for it was she who imposed the Babylonian cult of Nebo or Nabu upon the Assyrian religion). A column discovered in 1909 describes her as "a woman of the palace of Samsi-Adad, King of the World, King of Assyria, . . . King of the Four Quarters of the World." Ninus was her son. The dedication of this column shows that Semiramis occupied a position'of unique influence, lasting probably for more than one reign. She waged war against the Indo-Germanic Medes and the Chaldaeans. The legends probably have a Median origin. A popular etymology, which connected the name with the Assyrian *summat,* "dove," seems to have first started the identification of the historical Semiramis with the goddess Ishtar and her doves.

See F. Lenormant, *La Ltgende de Sémiramis* (1873) ; *A* H. Sayce, "The Legend of Semiramis," in Eng. *Hist. Rev.* (January, 1888).

SEMITIC LANGUAGES. The "Semitic" languages, so named in 1781 by A. L. Schlozer because most of the people who spoke them were descended from Shem or Sem (Gen. x–xi), were spoken in Arabia, Mesopotamia, Syria and Palestine, from which they spread, beginning with the 1st millennium B.C., into Ethiopia and later into Egypt and northern Africa. The Semitic languages go back to a "proto-Semitic" language, the general structure of which can be derived from the historically attested features of the various Semitic languages. In all probability, proto-Semitic was at no time a unified language, but had dialectal variants. No single Semitic language can be said to be the representative of the proto-Semitic type. In phonology one language may come the closest to the proto-Semitic type (as is probably the case of epigraphic South Arabic) whereas for certain morphological features other languages may be considered representatives of it.

Since the Semitic languages go back to a common origin the question of the location of the speakers of this proto-Semitic language is of importance. Various regions have been so considered: Kurdistan, Mesopotamia, northern Syria (the country of ancient Amurru), Arabia and Africa. No definite answer, however, can be given to this question. The likeliest regions are those of Arabia and Mesopotamia.

Hamito-Semitic. — Semitic is a part of a larger language group, namely Hamito-Semitic. The language families that belong to Hamito-Semitic are: Semitic, Ancient Egyptian, Berber (spoken in North Africa) and Cushitic (that is, the non-Semitic languages spoken in Ethiopia). The genetic relationship among the various members of Hamito-Semitic is evident in the phonology, morphology and vocabulary. Whereas the relation between the various Semitic languages can be compared with that of, say, the various Germanic or Romance or Slavic languages, Hamito-Semitic would have more or less the role of Indo-European. (See AFRICAN LANGUAGES.)

Classification. — The Semitic languages are classified as North Semitic and South Semitic. North Semitic, in turn, is divided into Northeast Semitic with Akkadian as its only representative, and Northwest Semitic which includes Canaanite (Hebrew, Moabite, Phoenician), Ugaritic, Amorite and Aramaic. South Semitic is divided into Southeast Semitic. including South Arabic and Ethiopic, and into Southwest Semitic with Arabic as its representative. Of these languages, Arabic, Modern South Arabic, Hebrew, Ethiopic and Aramaic, to a limited extent, are still spoken. It is interesting to note that nearly all the Semitic languages continued to be employed as literary languages long after they had ceased to be spoken. The general features of Semitic will be discussed after the survey of the various languages.

Akkadian or Assyro-Babylonian. — This is the oldest attested Semitic language. The name Akkadian comes from Akkad, the ancient capital of Mesopotamia. The documents in the language range from 2500 B.C. to the beginning of the Christian era. There are various periods in its development. Old Akkadian is the language of the documents from *c.* 2500 to 1950 B C. During that period the Akkadians lived side by side with the Sumerians. Toward the end of the Old Akkadian period the language divided into Babylonian and Assyrian dialects. Within the Babylonian dialect one can distinguish the following periods: Old Babylonian (c. 1950–1530). Middle Babylonian (c. 1530–1000), Neo-Babylonian (c. 1000–625) and Late Babylonian (after 625). In the last period Aramaic was the spoken language and Late Babylonian was the literary language. The various linguistic stages of Assyrian are: Old Assyrian (c. 1950–1750); Middle Assyrian (c. 1500–1000), strongly influenced by Babylonian; Neo-Assyrian (c. 1000–600). Inscriptions represent an important documentation of the literature, history, religion, magic, law, science and commerce of Mesopotamia. Because of the cultural prestige of Babylonia. Akkadian was also used in the neighbouring countries, such as Cappadocia, Elam, Canaan (Tel el Amarna letters), the Hittite empire (Bogazkoy) and Mitanni (Nuzi). Akkadian was also for a time the international language of the near east. (See AKKADIAN LANGUAGE.)

Canaanite. — This name came from the word Canaan, the ancient name for Palestine, Phoenicia and part of Syria. The languages that are considered Canaanite and known through direct sources are: Hebrew, Moabite and Phoenician. The older stage of Canaanite is known indirectly through the Tel el Amarna letters. (For a description of Hebrew, see HEBREW LANGUAGE.)

Moabite.—There is a single inscription in Moabite dating from the 8th century B.C. It is a report of Mesha, king of Moab (to the southeast of the Dead sea), on his relations with the king of Israel.

Phoenician. — This language was current in ancient times in the Phoenician cities of Tyre, Sidon, Byblos and neighbouring towns. Comparatively few inscriptions have been found in Phoenicia itself. The earliest known decipherable inscriptions are those of the kings of Byblos from the 10th century B.C. The bulk of material from Phoenicia proper consists largely of royal stelae dating from the 5th to the 2nd century B.C. Many inscriptions have been found at points along the Mediterranean shores — at the sites of the ancient Phoenician colonies, on Malta, in Carthage, and in other cities of the North African coast, as well as in Karetepe in Anatolia. The linguistic stage of Phoenician of the North African coast is called Punic and dates from the 5th to the 2nd century B.C.

Another important source of information are the transcriptions of Phoenician words into the scripts of other languages such as Egyptian, Akkadian and Hebrew. The most fruitful external source is to be found in classical literature. Phoenician words appear mostly in Greek literature; Punic in both Greek and Latin. Among the earliest are the names of the letters of the alphabet, which the Greeks took over together with the "Phoenician" alphabetic signs, perhaps in the 9th century B.C. A connected Phoenician discourse in transcription is found in Poenulus of Plautus (end of 2nd century B.c.). Since the "Phoenician" alphabet does not include vowels, these sources serve especially to give a picture of the vocalization of the language.

Ugaritic.—In Ras Shamra. on the coast of Syria, about seven or eight miles to the north of Latakia, another Semitic language was discovered in 1929. As a result of epigraphical and archaeological work, it soon became clear that the ancient name of the city of Ras Shamra was Ugarit, hence the name Ugaritic for that language. The history of Ugarit ended c. 1200 B.C. with the invasion of the Philistines. Ugaritic was written in an alphabetic cuneiform using about 30 simple signs which, on the whole, present single sounds rather than syllables or ideograms. A few tablets in Ugaritic script were also found in Palestine. The bulk of the texts is epical in content, and the language as well as the content throw considerable light on the Hebrew language and literature of the biblical period. The exact position of Ugaritic is not certain, some opinions being that it is "Early Hebrew," "Early Phoenician," "North Canaanite," an early dialect of Canaanite, an independent Northwest dialect or an Amorite dialect.

Amorite.—There is a term "MAR.TU" appearing in Sumerian texts of the 3rd millennium B.C. In the Akkadian texts of the 2nd millennium B.C., it appears as "Amurru." It is not yet definitely established whether at that time the term was to be limited to a "western" region or people or to a specific population element. Outside of Babylonia proper the term also appears in the texts of Mari (modern Tell el Hariri) on the Euphrates: these texts date from the 19th and 18th centuries B.C. In the Tel el Amarna letters of the second half of the 2nd millennium B.C., "Amurru" designates a district of Syria embracing the area of the Lebanon and Anti-Lebanon. The linguistic documentation of Amorite consists of proper nouns (with specific grammatical forms) and also of some words dispersed throughout the various Old Babylonian documents. These proper nouns and their morphological forms are interpreted as belonging to an "Amorite" dialect or, according to some scholars, an "East Canaanite" dialect.

Aramaic. — The Aramaeans appear in the cuneiform texts of the 14th century as *aḫlamē*, later *aḫlamī armaya*. They extended their conquest from Mesopotamia to Syria-Palestine and northern Arabia. Aramaic superseded the various languages of the conquered countries and beginning with the 8th century B.C. it became the international language of the near east. as well as the official language of the Persian empire. The period of its greatest extension was from c. 4th century B.C. to the 7th century A.D. at which time it mas supplanted by Arabic. Until the beginning of the Christian era there were no outstanding dialectal variations in the language called Common Aramaic. The language was then divided into West Aramaic and East Aramaic. The documents of Common Aramaic are various in kind. The inscriptions of principalities of Syria, such as the kings of Hama between Damascus and Aleppo and of the kings of Samal found in Zinjirli to the north of Aleppo, date from the 9th to the 8th century B.C. The inscriptions of the Jewish colony of Elephantine (Aswan) in Egypt date from the 7th to the 4th century B.C. The Aramaic sections of the Bible (Ezra iv, 8–vi, 18; vii, 12–26; Daniel ii, 4–vii, 28, and isolated sentences) date from the 4th to the 2nd century B.C.

The dialects of West Aramaic are: Judeo-Aramaic, Samaritan, Palestinian-Christian, Nabataean, Palmyrene and Western Neo-Aramaic. Judeo-Aramaic is the dialect of certain Aramaic works found among the Dead Sea scrolls; of the Palestinian Targums, *i.e.*, the translations of the Bible into Aramaic; of the Palestinian Talmud compiled in the 5th century A.D.; and of some inscriptions. Samaritan is represented by the translation of the Pentateuch in the 4th century A.D., and by some other prayers and religious works. Palestinian-Christian is the dialect of sections of a translation of the Old and New Testaments, and of some religious texts translated by the Christian Melkites of Palestine in the 8th and 9th centuries A.D. Nabataean is the Aramaic dialect used by Arabs of Arabia Petraea and of Hauran to the east of Palestine, in the inscriptions found on the caravan roads through Sinai. northern Arabia. Transjordania dating from the 1st century B.C. to the 4th century A.D. Palmyrene is the dialect of the inscriptions of Palmyra, to the northeast of Damascus. dating mainly from the first three centuries A.D. Western Aramaic is still spoken in the mountainous regions of the Lebanon and Anti-Lebanon in the villages of Maʿlūla (Christian). and Bah'a and Ǧuba'din (Moslem).

East Xramaic includes Syriac. the Aramaic of the Babylonian Talmud. Mandaic. and Eastern Neo-Aramaic. Syriac was the language of Edessa (modern Urfa). the centre of Christianity at the end of the 2nd century. Since the 5th century A.D. owing to theological differences. Syriac-speaking Christians have been divided into Nestorians or East Syrians under the Persian sphere of influence, and Jacobites or Rest Syrians under the Byzantine sphere. These two groups became linguistically distinguished by certain differences in pronunciation. The greatest period for Syriac literature was between the 3rd and 7th centuries. (See SYRIAC LANGUAGE.) The Xramaic of the Babylonian Talmud, compiled in the 6th century, is another important dialect of the East Aramaic group. Mandaic is the dialect of a gnostic sect (also called Sabaeans) of lower Mesopotamia. An East Aramaic dialect is still spoken in the regions between Lake Urmia and Lake Van (by Nestorians, sometimes called Assyrians), in the district of Tur Abdin (Jacobites), and in the region north of Mosul. Catholic and Protestant missions have tried to develop the Mosul dialect as a literary language.

South Arabic. — Epigraphic South Arabic. — This language is represented by about 5.000 stone inscriptions found in the region of modern Yemen, Hadramaut, and the Aden Protectorate. Since the tribe of Himyar of southern Arabia gained some importance before the Islamic period, the name "Himyarite" is also used for Epigraphic South Arabic. There are two main dialects in South Arabic: Sabaean and Minaean. The dialects of Qatabanite-Awsanite and of Hadramaut are related to Minaean. The main difference between Minaean and Sabaean consists in the usage of the morphemes of the causative and of the independent and suffixed pronouns of the third person. These elements are h in the Sabaean group, and *s* in the Minaean group. Minaean inscriptions were also found in the northern Hijaz, in the neighbourhood of El ʿÖla and Tebuk. The Sabaean inscriptions, also discovered in the region of Aksum and of Yeha in Ethiopia, help reconstruct the political, cultural and religious history of the ancient kingdoms of "Arabia Felix," the most important being Maʿin. Saba, Qataban and Hadramaut. The most ancient Minaean inscriptions are probably from the 8th century B.C., the Sabaean later.

Modern South Arabic. — There is a non-Arabic dialect cluster spoken in certain regions of southern Arabia between Hadramaut and Oman. Conventionally called "Modern South Arabic," these dialects are: Mahri (spoken in Mahra); Botahari and Harsusi (close to Mahri); Shahari (also called Qarawi, Ehkili), east of Mahri; Kuria Muria (close to Shahari), a group of five islands off the coast of Arabia; and Sokotri (spoken on the island of Sokotra in the Gulf of Aden). Their relationship to Epigraphic South Arabic remains to be established. Since the Modern South Arabic dialects are surrounded by Arabic dialects, they are considerably influenced by them, especially in vocabulary.

See also ARABIC LANGUAGE.

Ethiopic.—The indigenous language of Ethiopia was not Semitic. Cushitic was the language group of the geographical area. It was some time in the first millennium B.C. that Semites (called Ḥabašat) from south Arabia entered Ethiopia. The region of their origin is not known nor is it known whether a single Semitic language was imported into Africa from south Arabia or several related tongues. The South Arabic speakers imported a Semitic language and a Semitic script, and it is this language that developed into Semitic-Ethiopic. Since the indigenous language group of Ethiopia was Cushitic, there was a very strong influence of Cushitic on the phonology, morphology, syntax and vocabulary of Semitic-Ethiopic. This influence is stronger in the south than in the north. The Semitic-Ethiopic languages are: Geez. Tigre, Tigriña, Amharic, Argobba. Harari. Gurage and Gafat. From the descriptive point of view a division into North Ethiopic (including Geez, Tigre and Tigrifia) and South Ethiopic (including Amharic, Argobba, Harari, Gurage and Gafat) is appropriate.

Geez or Ancient Ethiopic is no longer spoken; it is the language of the liturgy. The oldest Ethiopic inscription, in unvocalized script. is that of Matara from the 3rd or 4th century A.D. The following inscriptions, in vocalized script. cover the period from the 4th to the 9th century. Between the 5th and 7th centuries the Bible was translated. No literary documents of the period from the 9th to the 13th century have come to light. Even though Geez ceased to be spoken sometime between the 10th and 12th centuries, it continued to be the literary language of Ethiopia. The classical period of Geez literature was between the 13th and 17th centuries. It is important to note that there is a traditional pronunciation of Geez used by the priests. This pronunciation, however. seems to be a reflection of the speech habits of the various vernaculars rather than any concrete evidence of the ancient pronunciation of Geez.

The languages closely related to Geez are Tigre and Tigrifia. Tigre is mainly spoken in the eastern and western lowlands of

Eritrea, including the Massawa region and the Dahlak Islands in the east and up to the Kassala province and in the border regions of the Sudan in the west. The only literary documents are some religious texts printed by Swedish and Catholic missions. Tigriña is spokén in the province of Tigre in northern Ethiopia. Tigrifia literature is still in its beginnings. As in the case of Tigre, various mission societies have printed biblical and religious texts in Tigriña. In addition textbooks and other literary specimens are currently printed in the language.

Amharic (*q.v.*) is the national language of Ethiopia. Argobba is closely related to Amharic. It is spoken in the region of Ankober, to the north of Addis Ababa. It is decreasing in favour of Amharic. Argobba was also spoken to the south of Harar, but disappeared completely in favour of Galla, a Cushitic language. There is no literature in the language. Harari is spoken in the city of Harar in eastern Ethiopia. Because of its geographical position the Harari vocabulary has many Amharic and Galla loanwords. There are religious texts in Harari written in Arabic characters. Gurage is a dialect cluster spoken in the region of Gurage, to the southwest of Addis Ababa. There are three main groups: (1) Eastern Gurage made up of Selti, Wolane, Ulbarag, Inneqor and Zway; (2) Western Gurage including Chaha, Eža, Ennemor, Endegeñ, Muher, Masqan and Gogot; (3) Northern Gurage with Aymellel as its only representative. Since Gurage is a Sidamo enclave, the vocabulary has a considerable number of Sidamo loanwords. There is no literature in Gurage other than a catechism in Chaha written in Ethiopic characters. Gafat was spoken in the region of the Blue Nile in the province of Godjam. The language disappeared completely in favour of Amharic and very few speakers remain.

GENERAL FEATURES

Phonology. — The consonant phonemes of proto-Semitic are: labials b, *p, m;* dentals d, t, *ṭ*, lateral (?) d; interdentals *ḏ, ṯ, ṯ̣;* sibilants, z, *s, š, ṣ,* lateral (?) *ś;* velars g, k, q, spirants g, *ḫ*, liquids l, *n*, r; laryngeals and pharyngeals *', ʻ,* h, *ḥ;* semivowels *w*, y.

As can be seen. labials are not abundant. They are: *b, m, p.* In Hebrew-Aramaic *f* is a phonetic variant of *p;* indeed, *p* after a vowel becomes a spirant j. In South Semitic the original *p* became *f* in all positions. Ethiopic developed secondarily a *p* (beside f) and a glottalized *p̣*. There was no v in proto-Semitic.

The interdental series *ḏ, ṯ,* and *ṯ̣* remained only in Arabic and South Arabic. In the other languages the interdentals became either dentals or sibilants; this also occurred in some Xrabic dialects. The correspondences for the ancient interdentals is as follows:

Proto-Semitic	Akkadian	Hebrew	Aramaic	Ethiopic
ḏ	*z*	*z*	*d*	*z*
ṯ	*š*	*š*	*t*	*s*
**ṯ̣*	*ṣ*	*ṣ*	*ṭ*	*ṣ*

The original laryngeal series (', ʻ, *h, h)* is preserved only in some Aramaic dialects, ancient Hebrew, Arabic, South Arabic, and North Ethiopic.

Phonemes of uncertain pronunciation are d and *ś;* they were perhaps laterals. They are preserved in Hebrew (*ś*), Geez (d), South Arabic (*ḍ*, s,), and in Arabic (d).

The correspondences are as follows:

Proto-Semitic	Akkadian	Hebrew	Aramaic	Ethiopic	South Arabic	Arahic
ḍ	*ṣ*	*ṣ*	ʻ(*q*)	*ḍ*	*ḍ*	*ḍ*
ś	*š*	*ś*	s	*š*	s_2	*š*

A characteristic feature of Semitic is the triadic system: voiced-voiceless-emphatic (mostly voiceless). Thus d-t-f; g-k-q; *z-s-s.* Ethiopic *b-p-p* is a secondary development.

Concerning the emphatic pronunciation there are two types: there is the emphatic-velarized type of Arabic (t, *q, ṣ*), and the glottalized type of Ethiopic (*t'*, k', s'). It is difficult to determine which was the original pronunciation of proto-Semitic

In the vocalic system, proto-Semitic had the phonemic pattern of the vowels, a, i, *u* and *ā*, i, *ū*. The various languages developed vocalic variants.

Morphology and Syntax. — Roots. The meaning of a root lies in the consonants. the vowels serving to express shades of the basic meaning. This is unlike English, for instance, where love, live and leave have different meanings. In Semitic from the root ktb "write" are obtained kataba "he wrote." katib "the writing one," *kutiba* "it was written," kitab "book," the vowels expressing only shades of meaning without changing the basic meaning of the root. The Semitic root consists mainly of three radicals. There are. however, signs that there were more biradicals in ancient Semitic than at present. It is only in the course of linguistic development that many biradicals became secondarily triradicals. Ancient biradicals still preserved in the language are essential elements of the vocabulary, such as *'ab* "father." dam "blood," yad "hand." and many more. Likemise many biradical verbs of the type *qām* "stand." and *mad(d)* "stretch" became perhaps only secondarily triradicals through the addition of a semivowel *w*, y (*qawama*) or the repetition of the last radical. A typical example of an ancient biradical "squeezed" into the triradical system is the Arabic diminutive yzrdayy "small hand" (of dialectal Arabic) from the biradical yad "hand" or the Ethiopic denominative *lab(b)awa* "understand" for *ləbb* "heart." In addition there are many roots the basic meaning of mhich lies in the two radicals, as in prq "break," and *prṣ* "break," *prs* "separate," *pšr* "dissolve."

Nouns and Articles. — Proto-Semitic seems not to have had a definite article. It was formed secondarily in the various Ianguages, The article is al- in Arabic, ha- (perhaps **hal-*) in Hebrew, a suffixed *-ā* in Aramaic, and so on. Akkadian has no definite article. While Geez has no definite article, the various modern Ethiopic languages employ various elements for the expression of the article.

Cases. — Proto-Semitic had three cases: a subject (nominative) case *-u*, an adnominal or possessive (genitive) -i, and a relational case mostly for the expression of the direct complement (accusative) -a. These case endings are also traceable in the plural. The case endings are completely preserved only in certain stages of Akkadian and in classical Arabic; the other languages preserve only traccs of them.

Gender.—Semitic has a masculine and a feminine gender. The feminine is characterized by the suffixed morpheme -*(a)t* becoming -*å* in the absolute state of Hebrew and -a in spoken Arabic. The feminine morpheme is most consistently used with the adjective. Special classes of nouns (such as parts of the body, geographical terms and others) are treated as feminine without having the feminine ending -t. Also words denoting female beings very often have no feminine ending (**'umm* "mother").

Number.—Proto-Semitic had three numbers: singular, dual and plural. The dual was originally used for parts of the body going in pairs. It is preserved in Akkadian, Hebrew, South Arabic and Arabic (where it extended to all nouns). Traces of the dual are to be found in the other languages. There are two kinds of plurals: an external plural and an internal plural. The .external plural consists of the addition of a suffixed morpheme to the singular base. Its basic form for the masculine was probably *-ū* (or -i, *-ā*) with the consonant addition *-n* or *-m,* the feminine plural morpheme is *-āt:* Arabic *malik* "king," pl. *malik-ūna;* Hebrew *męlęk* "king," pl. *məlåḵīm;* fem. Arabic *malik-āt,* Hebrew *məlåk-ōṯ*. The internal plural consists of the vocalic change of the singular base; thus, for instance, *kitāb* "book," but *kutub* "books." The internal plural is preserved only in Arabic, South Arahic and in North Ethiopic. Traces of it are preserved in the other languages.

Numerals.—A puzzling feature in the usage of the numerals is the fact that the feminine form of the numeral is used with masculine nouns. while the masculine form of the numeral is used with the feminine nouns; thus, *'arbåʻå 'aḥ-īm* "four brothers" (*'arbåʻ-å* is the feminine form), *'arbaʻ 'ăḥåyōṯ* "four sisters."

Verbs.—The majority of the verbs are triradical (ktb) although there are some biradicals (*qām*) and quadriradicals (Omani *ḫarwaṣ* "stamp"). The modern languages make extensive use of the quadriradicals forming them either by total or partial repetition (1.2.1.2: Hebrew *gilgel* "roll"; or 1.2.3.3: Tigre *ṭbll* "envelop") or by inserting a liquid *n* or *l, r* into the triradical (Arabic zan'aq "shout," root z'q; Egyptian *ta-'arqal* "be bent," root *'ql; ḫalbaṭ* "hit." root *ḫbṭ*).

The basic stem of a triradical verb in the perfect has the structure CaCaC- (C = consonant), as in Arabic qatala "he killed," and also CaCiC- and CaCuC-, as in Arabic *fariḥa* "he was joyful," *ḥasuna* "he was (is) beautiful." (In Hebrew the original *-i-* became -e- and *-u-* became *-o-*, thus *kåḇeḏ* "he was heavy." *qåṭon* "he was small".) Basically it would seem that the type CaCaC- expresses an action, be it transitive or intransitive (Hebrew *kåṭaḇ* "he wrote." Arabic *kaḏaba* "he lied"), whereas the types CaCiC- and CaCuC- express a state or condition that is completed (Hebrew *kåḇeḏ* "he was heavy." *qåṭon* "he was small") or uncompleted (*ḥåpeṣ* "he found delightful, he was delighted with a thing, he wished"). However, there are many exceptions to this principle.

Aspects or Tenses.— Proto-Semitic had aspects, not tenses. The aspects were: completed (perfect) and uncompleted (imperfect) action. Only at a later stage did the perfect come to express the past, while the imperfect expressed the present or future. Persons. numbers and genders were expressed in the perfect by suffixes; in the imperfect by prefixes and suffixes. In Akkadian alone the completed and uncompleted actions are both expressed by forms with prefixes (*ikšud* "he has conquered," *ikaš(š)ad* "he conquers. he will conquer"), whereas duration ("the permansive") is expressed by a suffixed form (*kašd-ū* "they are, were, will be conquering"). Note that Ethiopic has the same syllabic structure of the prefixed forms hut with different functions: *yĕnag(g)ĕr* "he speaks, he will speak," *yĕngĕr* "may he speak."

Stems.—An important feature of the Semitic verb is the formation of derived stems to express various modifications of the basic meaning. These stems are formed either by vocalic change (*qātala* against qatala). by gemination of the second radical (*qat*-tala) or by prefixed morphemes. The varieties in the formation of the derived stems in the various languages are considerable and no basic pattern can be given for proto-Semitic. An illustration will be taken from Xrabic, but it should not be considered as representative of the general pattern of Semitic. Basic stem: *qaṭa'a* "cut." The intensive is formed by the gemination of the second radical: *qaṭṭa'a* "cut to pieces"; however, this form also expresses occasionally a causative: hassana "embellish," from *ḥasuna* "be pretty." The conative meaning is formed by changing the vowel a of the first radical into *ā:* kataba "correspond" against kataba "write." The causative is formed by a prefixed 'a-: 'a-glass "cause to sit down, seat," from *ǧalasa* "sit down"; the other languages express the causative either by ', h or *s*, S. The reflexive-passive of the basic stem is formed either by prefixed *n* or by infixed *t*, from the intensive and conative it is formed by a prefixed t-, from the causative it is formed by a prefixed st-: in-qufa'a "be cut" (from qata'a), *iǧ-ta-ma'a* "come together, be united" (from *ǧama'a* "gather"), ta-qatta'a "be cut to pieces" (from *qaṭṭa'a* "cut to pieces"), *ista-ḫbara* "inquire, take information" (from *'aḫbara* "inform"). The passive meaning is also formed in Xrabic and in Hebrew (but not in the other languages) by an internal vocalic change: *kutiba* "it was written" against kataba "he wrote." The reciprocal is formed by ta- added to the basis of the conative: *ta-qātala* "fight with one another."

Vocabulary.—A short list of common words will illustrate the closeness of relationship.

TABLE.—*Common Words*

English	Akkadian	Hebrew	Aramaic	Ugaritic	Ethiopic	Arabic
brother	*aḫu*	*'ah*	*'ahā*	*aḫ*	*'ĕḫʷ*	*'aḫ*
master	*bēlu*	*ba'al*	*ba'lā*	*b'l*	*bā'ĕl*	*ba'l*
dog	*kalbu*	*kẹlẹḇ*	*kalbā*	*klb*	*kalb*	*kalb*
fly	*zumbu*	*zəḇūḇ*	*dabbāḇā*		*zĕmb (Amh)*	*ḏubāb*
seed	*zēru*	*zẹra'*	*zar'ā*	*dr'*	*zarĕ'*	*zar'*
head	*rēšu*	*rō(')š*	*rēšā*	*riš*	*rĕ'ĕs*	*ra's*
eye	*ēnu*	*'ayin*	*'aynā*	*'n*	*'ayn*	*'ayn*
tongue	*lišānu*	*låšōn*	*liššānā*	*lšn*	*lĕsān*	*lisān*
tooth	*šinnu*	Sen	*šənānā*		*sĕnn*	*sinn*
sky	*šamū*	*šåma-yim*	*šəmayyā*	*šm(y)m*	*samāy*	*samā'*
night	*līlātu*	*laylå*	*lelyā*	*ll*	*lelit*	*layla*
water	*mū*	*ma-yim*	*mayyā*	*my*	*māy*	*mā'*
house	*bītu*	*bayiṯ*	*baytā*	*bt*	*bet*	*bayt*
peace	*šalāmu*	*šålōm*	*šəlāmā*	*šlm*	*salām*	*salām*
name	*šumu*	*šem*	*šəmā*	*šm*	*sĕm*	*ism*

Scripts.— There are three scripts used in the Semitic languages: cuneiform writing, North Semitic writing and South Semitic writing. Cuneiform writing was used in Akkadian. It seems that the invention was that of the Sumerians of Mesopotamia and it was from them that the Assyrians and Babylonians took over the script. In the beginning the symbols were pictorial. At a later stage the symbols were used as word-signs (or ideograms) representing also abstract ideas; so, for instance, the solar disc came to indicate the idea of "day" and "time." As a further development the word-signs represented the phonetic value of words without any regard to their meaning as pictures.

Thus a syllabary was produced without achieving, however: an alphabetic system.

Cuneiform signs were also used in Ugaritic for which a particular cuneiform alphabet was developed, not dependent on the Sumerian-Assyrian-Babylonian. The symbols represented only consonants with the exception of three *alephs* with vowels ('a, *'i*-'e, *'u- 'o*).

The North Semitic script has two main branches: the Canaanite and the Aramaic. The offshoots of the Canaanite branch are "Early Hebrew" and "Phoenician." (For the "Early Hebrew" script, *see* HEBREW LANGUAGE.) The script of the Moabite stone is closely related to Early Hebrew writing, the Samaritan alphabet is a descendant of Early Hebrew script.

The earliest written document in Aramaic is from the 9th century B.C. In the second half of the 1st millennium B.C. it became the most widespread script of the entire near east. The Semitic offshoots of the Aramaic alphabet are: Square Hebrew (which developed into the modern Hebrew script), Nabataean-Sinaitic-Arabic (with its two main branches of Naskhi and Kufic), Palmyrene. Syriac-Nestorian and Mandaean.

All these alphabets express only consonants. The vocalic symbols of Syriac, Xrabic and Hebrew were probably introduced in the 8th century A.D.

South *Semitic Alphabet.*—The South Semitic alphabet was used for Epigraphic South Xrabic and for the North Arabic inscriptions of Thamudenic, Lihyanite and Safaitic. The South Arabic alphabet passed into Ethiopia in the 1st millennium B.C. But whereas the South Arabic alphabet is consonantal. the Ethiopic alphabet is syllabic, that is, there is a single symbol for the consonant with vowel.

The problems of the origin of the South Semitic alphabet and the invention of the Ethiopic vowels are still unsolved.

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SEMLER, JOHANN SALOMO (1725–1791), German church historian and biblical critic, the son of a clergyman in poor circumstances. was born at Saalfeld in Thuringia on Dec. 18, 1725. He grew up amidst pietistic surroundings. which powerfully influenced him his life through. though he never became a Pietist. In his 17th year he entered the university of Halle, where he became the disciple, afterward the assistant, and at last the literary executor of the orthodox rationalistic professor S. J. Baumgarten (1706–1757). In 1749 he became editor, with the title of professor. of the Coburg official Gazette. But in 1751 he was invited to Altdorf as professor of philology and history, and in 1752 he became a professor of theology in Halle. After the death of Baumgarten (1757) Semler became the head of the theological faculty of his university, and the fierce opposition which his writings and lectures provoked only helped to increase his fame as a professor. His popularity continued undiminished for more than 20 years, until 1779. In that year he replied (*Beantwortung* der *Fragmente eines Ungenannten*) to the *Wolfenbüttel Fragmente* (see REIMARUS, HERMANN SAMUEL) and to K. F. Bahrdt's confession of faith, a step which was interpreted by the extreme rationalists as a revocation of his own rationalistic position. Even the Prussian government, which favoured Bahrdt, made Semler painfully feel its displeasure at this new but really not inconsistent aspect of his position. But, though Semler was really not inconsistent with himself in attacking the views of Reimarus and Bahrdt, his popularity began to decline, and toward the end of his life he felt the necessity of emphasizing the apologetic and conservative value of true historical inquiry. He died at Halle on March 14, 1791, worn out and disappointed at the issue of his work. Semler was a pioneer in the criticism of the traditional canon of Scripture, in the search for the origins of the books of the New Testament, and in church history.

Tholuck gives 171 as the number of Semler's works, of which only two reached a second edition, and none is now read for its own sake.

SEMMELWEIS, IGNAZ PHILIPP (1818–1865), Hungarian physician, whose influence on the development of knowledge and control of infection was cited by Joseph Lord Lister, the father of modern surgery: "Without Semmelweis my achievements would be nothing. To this great son of Hungary Surgery owes most." He was born at Buda on July 1, 1818, and educated at the universities of Pest and Vienna, where he attracted the attention of Joseph Skoda and Karl von Rokitansky. He graduated M.D. at Vienna in 1844 and was appointed assistant in the first obstetric clinic under Johann Rlein.

Puerperal infection was the scourge of maternity hospitals throughout Europe. Although most women delivered at home, a few women who had to seek hospitalization because of poverty, illegitimacy or obstetrical complications faced a mortality rate of 3% to 25% because of childbed fever, or puerperal infection. Although its cause was unknown, it was thought that it was induced by overcrowding, poor ventilation, the onset of lactation or a "miasma."

Semmelweis, during his student days, became interested in this great killer of young mothers and as an assistant he proceeded to investigate its cause despite the serious objections of Klein, the chief of the maternity. Two or three times as many women who delivered in the First division died of childbed fever as those who delivered in the Second division, although the two maternities were identical with the exception that students were taught in the First and midwives in the Second. Semmelweis reasoned that perhaps the students carried something to the patients they examined during labour. The death of his friend Jakob Kolletschka, a pathologist, from a wound infection incurred during the examination of a woman who died of puerperal infection, and the similarity of the findings in his friend and in the women who died of puerperal infection, provided Semmelweis' first breakthrough. He concluded that students, who came directly from the dissecting room to the maternity, carried infection from mothers who had died of this dread complication to healthy mothers they examined during labour.

Semmelweis promptly instituted thorough washing of the hands with soap and water prior to examination of a woman in labour and later introduced ablutions with chlorinated lime. The mortality of the First division promptly dropped below that of the Second division. The outstanding success of this simple measure to combat puerperal infection failed to impress Klein, who, blinded by ignorance, vanity or jealousy, restricted Semmelweis' activities, underhandedly prevented his promotion to assistant professor and drove him from Vienna.

In 1850 Semmelweis was appointed obstetric physician in the maternity department at Pest, where his ideas promptly reduced the high maternal mortality to 0.85%. He developed a private practice among influential people, married and seemed reasonably content. However, he continued to be plagued by the failure of the profession to accept his doctrine and thereby save the lives of countless young women.

He died on Aug. 17, 1865, from a wound of the right hand, a victim of the very disease for which he had sacrificed his health, fortune and peace of mind.

Semmelweis' chief publication was *Die Ätiologie der Begriff und die Prophylaxis des Kindbettjebers* (1861), Eng. trans. by F. P, Murphy.

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SEMMERING PASS, the lowest of all the great passes across the Alps. The hospice, near the summit, was founded about 1160, but the pass was certainly used at a much earlier date. Between 1848 and 1854 a railway line (the first in any sense to cross the Alps) was constructed, but passes 282 ft. below the summit of the pass (3,215 ft.) by a tunnel about 1 mi. long. The line runs from Wiener Neustadt (30½ mi. from Vienna) past Bruck to Graz (139 mi. from Vienna), whence it is 227 mi. by rail to Trieste.

SEMMES, RAPHAEL (1809–1877), U.S. naval officer who commanded the Confederate ship "Alabama" during the Civil War was born in Charles county, Md., on Sept. 27, 1809. He was appointed midshipman in the navy in 1826, and while waiting for orders studied law and in 1834 was admitted to the bar. Semmes served in the war with Mexico; was active in superintending the landing of Gen. Scott's troops at Vera Cruz in March, 1847, and later, as volunteer aid to Gen. Worth, took an active part in the battles of the Valley of Mexico. These experiences are interestingly told in his books *Service Afloat and Ashore During the Mexican War* (1851) and *Campaign of Gen. Scott in the Valley of Mexico* (1852). In 1855 he was promoted to commander and afterward was made naval secretary of the Lighthouse board at Washington, in which service he was when the Civil War broke out. When Alabama, his adopted state, seceded, he resigned his commission and received an appointment of the same rank in the Confederate navy. He fitted out the packet "Sumter," in which he captured as many as 17 Korthern merchant vessels, chiefly along the South American coast. Later he commanded the more famous "Alabama," a 1.016-ton ship built in England for the Confederacy, with which he made a series of daring and successful cruises lasting two years. Finally, he met the Northern ship "Kearsarge" in the English channel, and after a 70-minute battle was forced to surrender. Twenty minutes later the "Alabama" sank and Semmes was rescued by an English yacht.

When Semmes returned home he was commissioned rear-admiral and assigned to the Confederate fleet in the James river. When Richmond was captured he blew up his ships and, with his men, joined the army of Gen. Johnston. When Johnston surrendered Semmes returned to his home in Mobile and opened a law'office, to which practice he devoted the greater part of the rest of his life. He died on Aug. 30, 1877.

In addition to his books on the Mexican War he wrote *The Cruise of the Alabama and Sumter* (1864) and *Memoirs of Service Afloat* (1869).

SEMNAN, a town in Iran, was administrative headquarters of the former province known as "Semnan wa Damghan," in Mazandaran Ostan. The town is 145 mi. E. of Tehran on the high road to Meshed, in 35° 34' N. and 53° 22' E., at an elevation of 3,740 ft. The water supply comes from the streams that run down from the Elburz and the principal crop of the surrounding plain is tobacco. Pop. (1956) 29,049.

Semnan is mentioned by Ptolemy as *Samina* and cited by the oriental geographers for the rivulets running through the streets, for the making of soft stuffs of cotton and for its sweet paste made from almonds and figs. There is a minaret with rich ornamentation of raised brick that dates from the 12th century and remains of a rebuilt mosque of the same period.

SEMOIS (also spelled SEMOY and SEMOYS), a river 120 mi. long rising near Arlon on the Belgium-Luxembourg frontier and flowing in a sinuous course across the lower Devonian strata of the southern Ardennes. The last 20 mi. of its course are in France where at Monthermé it joins the Meuse on its right bank. Bouillon is the only town on its banks; it is not navigable.

SEMOLINA, the principal material used in the manufacture of macaroni, vermicelli, spaghetti and other alimentary pastes.

In English speaking countries the article sold as semolina is the wholly granular product used for making semolina puddings. The New *English* Dictionary gives a quotation showing that so long ago as 1797 semolina was used in this way. It is obtained from hard wheats, generally those of the race *Triticum Durum,* and consequently possesses certain distinctive characteristics, notably a certain toughness when it is made into a dough, and an intensely yellow colour. This toughness is essential for manufacture of the best macaroni.

See also FLOUR; MIDDLINGS. (A. E. HU.)

SEMON, SIR FELIX (1849–1921), English. laryngologist. was born at Danzig on Dec. 8, 1849, and studied medicine at Heidelberg. He served in the Prussian guard during the Franco-German War, afterward continuing his medical studies in Vienna. Paris and London. After some years on the staff of the Hospital for Diseases of the Throat, Golden square, London, he was appointed head of the throat department of St. Thomas' hospital. where he quickly gained a wide reputation.

The *Internationales* Centralblatt *für* Laryngologie *und Rhinologic* was founded by him in 1884. and he continued to edit it until 1909. In 1885 he was elected a fellow of the Royal College of Physicians. In 1888 he obtained an appointment as laryngologist to the National Hospital for the Paralysed and Epileptic, where he was associated with Sir Victor Horsley in researches which led to the formulation of Semon's law, "that in all progressive organic lesions of the centres and trunks of the motor laryngeal nerves, the abductors of the vocal cords succumb much earlier than the adductors." From 1894 to 1896 he was president of the Laryngological Society of London, which he helped to found in 1893. He was knighted in 1897 and became a naturalized British subject in 1901.

He retired in 1911, and died near Great Missenden on March 1, 1921.

Semon's researches led to the thyroid treatment of myxedema, and his early diagnosis of cancer of the larynx enabled him to perform many successful operations by laryngo-fissure.

SEMO SANCUS DIUS FIDIUS, an obscure Roman deity; a god Fisios or Fisovios Sancios was also worshiped in Umbria, and appears to be the same. He had a temple at Rome on the Quirinal, in which was an ancient statue of a woman, said to be Gaia Caecilia, or Tanaquil, wife of Tarquinius Priscus. His functions are very obscure. The four parts of his name seem to be connected respectively with seed *(semen)*, purity or holiness (*sancus* and sanctus are from the same root), Jupiter (or simply brightness, or celestial nature; Dius, root *Div*), and faith *(fides)*. Hence perhaps "the spirit of sowing (or seed), pure, Jovian (or bright, or celestial). faithful." Of his ritual we know only that oaths by him were taken in the open air, the formula being *medius fidius,* cf. *mehercule,* "by Hercules"; that there was an opening in the roof of his temple; and that certain disks of metal were kept in the temple. The first two facts perhaps suggest a sky god, but we know that certain deities undoubtedly not celestial (for example. Terminus. the spirit of boundaries) had similar ritual. The disks might possibly be solar symbols On the whole the balance of the very scanty evidence is rather in favour of supposing him to be a god of the sky. perhaps connected. as Wissowa supposes, with Jupiter, who had power to influence seed corn (by sending rain in season?) and. being able to see what went on in the world was a natural witness to solemn oaths. The ancients, wrongly supposing the last two members of his name to signify "son of Zeus." identified him with Hercules, an error which some moderns also have fallen into.

SEMPER, GOTTFRIED (1803–1879), German architect and writer on art who initiated the neo-Renaissance style, was born in Hamburg. on Nov. 29, 1803. He studied in Munich and Paris and practised architecture in Dresden from 1834 until 1848 when. because of revolutionary activities, he was forced into exile to Paris and London. He headed the architecture department of the Zurich Polytechnikum (1855–71) and between 1871 and 1876 participated in the rebuilding of Vienna. His work marks the transition away from the classicism of his friend Karl Schinkel. As an eclectic. he achieved powerful solutions. Among his main works were the Dresden opera house (1837–41, rebuilt 1871–78); the Zurich Polytechnikum (1858–64); and with Karl von Hasenauer, the Vienna Burgtheater (1874–88) and the tno imperial museums in Vienna (1872–81). In his influential writings. principally Der *Stil* in den technischcn und tektonischen *Kunsten* (1860–63) he stressed a rational interpretation of techniques as a source of style. recommending colour in decorative arts and architecture He died in Rome on May 15, 1879.

His nephew KARL SEMPER (1832–1893) was a zoologist, noted for his studies of Philippine fauna. (A K. P.)

SEMPILL, the name of a Scottish family long seated in Renfrewshire. An early member, Sir Thomas Sempill (d. 1488), was killed while fighting for James III at the battle of Sauchieburn. and his son John (d. 1513), who was made a lord of parliament about 1489, fell at Flodden. John's grandson, Robert, 3rd Lord Sempill (*r.* 1505–72), assisted the Scottish regent, Mary of Lorraine, in her struggle with the lords of the congregation and was afterward one of the partisans of Mary, queen of Scots; about 1566, however, he deserted the queen against whom he fought at Carberry Hill and at Langside. Hugh. 12th Lord Sempill (d. 1746), fought in Spain and in Flanders, and held a command in the English army at Culloden; in 1747 he was made colonel of the Black Watch. The title passed into the Forbes family (Forbes-Sempill) in 1836.

SEMPILL OF BELTREES, a family of Scottish poets. SIR JAMES (1566–1626) was born in 1566 and brought up with the young King James VI, and like him was tutored by George Buchanan. He went to St. Andrews university, and became ambassador to England (1599) and to France (1601). He was knighted in 1600 and died at Paisley in Feb. 1626. His nritings include a few controversial tracts, but he is remembered rather for his satirical poem *The* Pack-mans Pater *Noster,* an antipapal dialogue between a pedlar and a priest. written in English in rhyming couplets. This poem. when reprinted in 1669. contained additions by his son ROBERT (c. 1595–*c.* 1665), who was born c. 1595, was educated at Glasgow university, fought for the royalists during the Great Rebellion and wrote the elegy on Habbie Simson. "The Life and Death of the Piper of Kilbarchan." This humorous poem in Scots was included by James Watson in his *Choice Collection* (1706) and its fame was assured when Allan Ramsay called its metre "Standart *Habby*" and used it himself in several poems. "Standart *Habby*" was later known, after its greatest exponent, as the Burns stanza. Robert Sempill died c. 166j Little is known of FRANCIS (*c.* 1616–1682), son of Robert, except that he was born c. 1616, was made sheriff-depute of Renfrenshire some time before 1677 and died at Paisley on March 12. 1682. He is reputedly the author of some popular and entertaining Scots poems. "The Blythsome Bridal," "Maggie Lauder" and "Hallow Fair."

An earlier ROBERT SEMPILL (c. 1530–1595), also a poet, has no proved connection with the Sempills of Beltrees. He was born *c.* 1530 and appears to have held some office at the Scottish court, being mentioned in the treasurer's accounts in 1568. From the evidence of his poems he was probably present at the sieges of Leith (1560) and of Edinburgh (1573). He probably died in 1595.

Sempill wrote many vigorous, bitter and often coarse satirical Scots poems on religious and social topics of the day; his work is violently Protestant and suited to his description of himself as "rakles [reckless] Robert."

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SÉNAC DE MEILHAN, GABRIEL (1736–1803), French writer, son of Jean Sénac, physician to Louis XV, mas born in Paris in 1736. He entered the civil service in 1762; two years later he bought the office of master of requests. He was successively intendant of La Rochelle, of Aix and of Valenciennes. In 1i76 he became intendant-general for war, but was soon compelled to resign.

Sénac's first book was the fictitious *Mémoires d'Anne* de *Gon-*

zague, princesse palatine (1786), thought by many people at the time to be genuine. In the next year followed the *Considérations sur le luxe et les richesses,* combating the opinions of Necker, and the more valuable *Considérations sur l'esprit et les moeurs,* a book which abounds in sententious but often excessively frank sayings.

Sénac witnessed the beginnings of the Revolution in Paris. but emigrated in 1790. making his way first to London, and then. in 1791, to Aix-la-Chapelle. In 1793, while his recollections of the Revolution were still fresh. Sénac wrote a novel. *L'Émigré* (4 vol., 1797; reprint 1904). At the invitation of Catherine II Sénac went in 1792 to Russia and thence to Hamburg and to Vienna, where he found a friend in the prince de Ligne. He died in Vienna on Aug. 16, 1803.

SÉNANCOUR, ÉTIENNE PIVERT DE (1770–1846), French author, was born in Paris in Nov. 1770. His father desired him to enter the seminary of Saint-Sulpice preparatory to becoming a priest. but Sénancour. to avoid a profession for which he had no vocation, went on a visit to Switzerland in 1789. At Fribourg he married in 1790 a young Frenchwoman, Mademoiselle Daguet, but the marriage was not a happy one. His absence from France at the outbreak of the Revolution was ill interpreted, and his name was included in the list of emigrants. He visited France from time to time by stealth, but he only succeeded in saving the remnants of a considerable fortune. In 1799 he published in Paris his *Rêveries sur la nature primitive de l'homme,* a book containing impassioned descriptive passages which mark him out as a precursor of the romantic movement. His best known work *Obermann* (2 vol., 1804), was to a great extent inspired by Rousseau, was edited and praised successively by Sainte-Beuve and by George Sand, and had a considerable influence both in France and England. It is a series of letters supposed to be written by a solitary and melancholy person, whose headquarters are placed in a lonely valley of the Jura. He returned to France in 1803 and died at St. Cloud on Jan. 10, 1846. He wrote late in life a second novel in letters *Isabelle* (1833).

SENATE, the assembly of old men (Lat. *senatus,* from root, *sen-*, as in *senex,* old). originally the heads of the chief families, and hence the upper council in a governmental system. The Latin word corresponds with the Greek *gerousia* (*q.v.*), the name of the council of elders at Sparta. The Athenian Areopagus (*q.v.*) may in some ways be compared to the Roman senate; the Cleisthenic council *(see* BOULE) at Athens was in all respects a different body. The word. applied primarily to the Roman council *(see* below), is also used to designate the upper chamber in the legislatures of France, Italy, and the United States (*q.v.*); in the British legislature it is represented by the house of lords *(See* PARLIAMENT. For a discussion of the U.S. senate *see* CONGRESS, UNITED STATES.) The title is used for the governing bodies of the universities of Cambridge and London, and also certain American colleges and universities. In the Scottish universities, the governing body is the *senatus academicus.* The College of Cardinals is the senate of the Holy See.

THE ANCIENT ROMAN SENATE

History. — The senate or council of elders formed the most permanent element in the Roman constitution. The authorities ascribe its origin to Romulus, who chose out 100 of the best of his subjects to form an advisory council. In 509 B.C. it contained 300 members. and a distinction existed within it between *patres maiorum gentium* and *minorum gentium,* the heads of the greater and the lesser families. Throughout the monarchical period the senate consisted entirely of patricians. Probably the rise in the number of the senators was due to the incorporation of fresh elements into the patrician community and the new clans were the *gentes minores* (lesser families). The appointment of senators depended entirely upon the king, who possibly might change his advisers during his reign; a new king could certainly abstain from summoning some of those convened by his predecessors. The powers of the senate at this time were very indefinite.

Under the Republic.—With the abolition of monarchy the senate became the advisory council of the consuls, meeting only at their pleasure, and owing its appointment to them; it remained a power secondary to the magistrates. Few. if any, plebeians were introduced into the senate at this time. but the existence of an elderly plebeian senator is attested in 401 B.C. In one respect, substitution of consuls for kings tended to the subordination of the chief magistrates to the senate. The consuls held office only for one year, while the senate was a permanent body; in experience and prestige, its individual members were often superior to the consuls of the year. The magistrate would seldom venture to disregard the advice of the senate, especially as he himself would, in accordance with steadily growing custom, become a senator at the end of his year of office. It was probably in their capacity of former magistrates that plebeians first entered the senate. Of the two powers which the senate inherited from the monarchy, the interregnum and the *patrum auctoritas* (senatorial claim to ratify), the first had become rarer of exercise than before; for if either consul existed, interregnum could not be resorted to. The *patrum auctoritas,* however, developed into a definite right claimed by the patrician senators to give or withhold their consent to any act of the *comitia* (*q.v.*). The influence which it had long exercised over foreign policy increased the importance of the senate in a period of constant warfare with the peoples of Italy. But in the early republic the senate remained an advising body and assumed no definite executive powers.

In the last two centuries of the republic, a great change took place in the position of the senate. It became a self-existent. automatically constituted body, independent of the annual magistrates, a recognized factor in the constitution, with extensive powers. About the year 312 B.C. the selection of senators *(lectio senatus)* was transferred from the consuls to the censors (*q.v.*), who normally chose former magistrates. In 81 B.C. Sulla secured an automatic composition for the senate by increasing the number of quaestors to 20, and enacting that all former quaestors should pass at once into the senate. The senate's powers had then extended far beyond its ancient prerogatives of appointing an interrex and ratifying decisions of the *comitia.* The first of these powers had fallen into practical disuse and the second had become a mere form by the last century of the republic. But the senate had acquired more effective control through the observance of certain unwritten rules regulating the relation between senate and magistrates, to whom it formally gave advice. It became the chief governing body in Rome and tendered advice on home and foreign policy, on legislation and on financial and religious questions. It acquired the right to assign duties to the magistrates, to determine the two provinces to be entrusted to the consuls. to prolong a magistrate's period of office *(prorogatio imperii)* and to appoint senatorial commissions to help magistrates to organize conquered territory. Its earlier influence upon foreign policy developed into a definite claim to conduct all negotiations with a foreign power, although the formal declaration of war and ratification of treaties were referred to the people. It often acted as arbitrator in disputes among Italian communities, provincials or client-states. Though individual senators after 218 B.C. were debarred from trading, the control of finance was in the senate's hands. Three circumstances had combined to bring this about. The censors, who were only occasional officials, were entrusted with the leasing of the public revenues; the senate could order them to redraft contracts. The details of public expenditure were entrusted to the quaestors, young and inexperienced magistrates whom the senate could guide. Third, the general control exercised by the senate over provincial affairs implied its direction of the income derived from the provinces. It also claimed the right of granting occupation and decreeing alienation of public lands. Every branch of state finance was therefore in its hands: it controlled revenue and expenditure and supervised the treasury (*aerarium*). In matters of criminal jurisdiction, the senate claimed the right, in times of crisis, to set free by its decree *senatus consultum de republica defendenda* or *SC Ultimum* ("resolution concerning the defense of the state" or the "Last Decree") the full powers of *coercitio* (the right to compel obedience to orders or enactments) contained in the *imperium* (supreme administrative power) of a magistrate, but limited normally in capital cases by laws of appeal.

The first certain use of this right, which amounted to a declaration of martial law, concerned Gaius Gracchus; the last was in 40 B C. This ever-widening influence and power of the senate was challenged by tribunes, from the time of Tiberius Gracchus onward (133 B.C.); and more particularly by the military leaders, from Marius onward. who pitted their *imperium* against the *auctoritas* of the senate. Despite the short-lived attempt of Sulla to reinstate the senate's ascendancy *(see* ROME: *Ancient History)*, the republic collapsed under these repeated blows at the authority of the senate. As a result of the civil war the number of senators, which Sulla had raised to 500 or 600, was seriously depleted. Julius Caesar revised the list and increased the senate to goo, naturally filling it with his own supporters. This reflects the practice by which the early magistrates had chosen their own body of councilors. The composition of the senate thus undenvent a considerable change. few of the optimate senators. who had opposed Caesar, survived; the new senators included many *eguites* and municipal Italians and even a few provincials from Gaul.

Under the Empire.—Since Augustus officially "restored the republic" (27 B.C.), it was essential to preserve the prestige of the senate, which came to be regarded in the early principate as the representative of republican institutions. With this object, and also in order to provide an adequate body of administrators, Augustus established a *senatorius ordo* (senatorial order), limited to men of personal integrity. who had completed a term of military service and who possessed a minimum property qualification of 1,000,000 sesterces. From this *ordo* men who had served in the armv and had then held one of the minor magistracies. known as the vipintivirate, could enter the senate at the age of 2j through the quaestorship. The *senatorius ordo* tended to become a hereditary body because normally only sons of senators could become senators. Since the election of magistrates was transferred from the people to the senate, to a large measure under Augustus and completely under Tiberius, the senate became a self-recruiting body, whose numbers were reduced to 600. The emperor could influence the quaestorian elections; he also had the right of appointing *(adlectio)* as ne members of the senate men uho had not been magistrates. Most of the important offices in the state were filled by senators, whose careers depended largely on the good will and confidence of the emperor. Augustus did not share his basic power with the senate. but he did allow it to co-operate with him in most of the spheres of government. It was left at the head of the ordinary administration of Rome and Italy, together with those provinces which did not require any military force or present special administrative difficulties. It continued to administer the *aerarium,* but was soon overshadowed by the emperor who allowed it to supervise the copper coinage alone. The senate received judicial functions and for the first time became a court of law, competent to try cases of extortion in the senatorial provinces and with criminal jurisdiction over offenses by its own members. The legislative powers of the *comitia* became very gradually extinct. and *senatus consulta* (decrees of the senate) came to take the place of *leges* in ordinary matters although they did not at first acquire full recognition as laws. On the other hand the senate lost all its control of foreign policy and though occasionally consulted by the emperor, it was entirely subordinate to him in this department. The emperor could convene and preside over the senate, his report *(relatio)* taking precedence; he was also *princeps senatus* (*i.e.,* his name headed the list of senators). Relations varied with the different emperors. but although recognition by the senate provided formal acceptance of an emperor's claim to rule, the senate in practice lost independence of action and freedom of discussion declined. The number of Italian and provincial senators increased (especially under Vespasian), but the Italians were not outnumbered by the provincials until after the reign of Septimius Severus. At first the provincials came predominantly from Spain and Narbonese Gaul, but later there were more orientals and Africans. Under Gallienus senators lost the right to command legions and much of their part in provincial administration. Under Constantine they were virtually amalgamated with the *equites* who had benefited from these changes. The number of the new senators, whose authority was improved. rose in the 4th century to about 2,000. That the senate was still regarded as a representative and necessary part of the constitution is shown by Constantine's creation of a duplicate senate in Constantinople. The most important members of the senate were the great landowners throughout the empire. whose position became almost feudal. A great number of them failed to leave their estates to attend meetings, and the senate often acted—as it had in the early days of the republic—merely as a town council for Rome, under the chairmanship of the prefect of the city. Senators were free from municipal burdens, but not from all taxation. Many of the great senatorial landowners were men of culture who represented Roman civilization amid increasing barbarism and tried to uphold paganism in Italy. In the jth century. however, some of them helped the barbarian leaders against the imperial authority. In the 6th century the Roman senate disappears from view. it is last mentioned in A.D. 580.

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(X.; H. H. SD.)

SENEBIER, JEAN (1742–1809), Swiss pastor remembered for his contributions to the knowledge of photosynthesis. was born at Geneva on May 6, 1742. The observation by C. Bonnet of bubbles of oxygen on the leaves submerged in aerated water induced Joseph Priestley, Jan Ingenhousz and Senebier to carry out a series of experiments showing the influence of light on vegetation. Senebier deposited his conclusions in his most important work, *Physiologie végétale,* 1800.

Senebier proved that the presence of carbonic acid is a deciding factor in the development of oxygen by green plants in sunlight and that with decomposition of carbonic acid oxygen is liberated. Thus he was first to give a connected view of the whole process of vegetable nutrition. He died at Geneva on July 22, 1809.

(V. C. As.)

SENECA, ANNAEUS (praenomen unknown, called the Elder, *c.* 54 B.C.–A.D. 39), rhetorician, of Corduba in Spain, father, by Helvia, of L. Annaeus Seneca and granduncle of the poet Lucan. His life was mostly passed at Corduba, but on two occasions he spent some time in Rome, uhere he heard Ovid and Asinius Pollio. The date of his death is approximately inferred from the fact that it occurred before his son. the younger Seneca, was banished by Claudius in A.D. 41. Besides a lost historical work he wrote *Controversiae* (ten books) and *Suasoriae* (one book).

The *Controversiae* discussed 74 imaginary legal cases. exemplifying the approved method of presenting them, and illustrating various rhetorical devices. The prefaces discussed individual rhetoricians. Books I. II. VI, IX and X are extant and we have an epitome of the whole (4th or 5th century).

In the *Suasoriae* (exercises in hortatory or deliberative oratory), he discussed the question whether certain things should or should not be done. His lost historical work contained the history of Rome from the beginning of the civil wars almost down to his own death, after which it was published by his son.

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(A. W. Ma.; X.)

SENECA, LUCIUS ANNAEUS (*c.* 4 B.C.–A.D. 6j), second son of Seneca the elder, statesman and philosopher. was born at Corduba. He studied at Rome under the Stoic Attalus (Senec. *Ep.* 108, "When I listened to Attalus declaiming against the vices, the errors, the evils of life, I often pitied humanity and regarded him as a lofty figure beyond the stature of mankind. He used to say he was a king, but to me he seemed more than a king who could pass judgment upon kings") and Sotion (Senec. *l.c.,* "I shall not be ashamed to confess what love for Pythagoras Sotion inspired in me"). Devoting himself to rhetoric and philosophy he rapidly attained eminence at the bar, and his popularity attracted the attention of Caligula who, "despising the milder and more polished style of oratory." described Seneca's compositions as "mere prize exercises (commissiones *meras*), sand without lime." His career was interrupted when in A.D. 41 Claudius, at the instigation of Messalina. banished him to Corsica. In A.D. 49 Agrippina secured his recall to become tutor to her son Domitius, afterward the emperor Nero, at that time 11 years of age. When Nero came to the throne, Seneca and Afranius Burrus had paramount influence with the youthful emperor and Seneca was probably concerned in the promising manifesto with which Nero inaugurated his reign. The death of Burrus (A.D. 62) greatly impaired Seneca's influence for virtue lost its strength when one of its companions, so to speak, was taken away, and Nero began to turn to worse advisers. His enemies pointed out to Nero the vast and increasing wealth of Seneca, his popularity with the citizens, his rivalry with the emperor in oratory and poetry, which latter art he had cultivated more assiduously since Nero commenced poetry, his disparagement of Nero both as an equestrian and a singer: "How long was everything of distinction in the State to be attributed to the invention of Seneca? Nero surely was no longer a boy but in the flower of adult manhood. Let him doff his pedagogue — in his ancestors he had teachers enough." Seneca requested an interview which was granted. His speech and Nero's reply are given by Tacitus. The interview ended amicably, but Seneca practically withdrew into private life and was rarely seen in Rome, "as if detained at home by his weak health and his philosophic studies." Finally, in A.D. 65, on a charge of complicity in the conspiracy of Piso, he was ordered by Nero to end his life. When the fatal message reached him, "undismayed he asked for tablets to make his will. When this was refused by the centurion, he turned to his friends and said that, since he was prevented from rewarding their services, he would leave to them the one thing, and yet the best thing, that he had to leave — the pattern of his life. . . . At the same time he reminded his weeping friends of their duty to be strong, now by his conversation, now by sterner rebuke, asking them what had become of the precepts of wisdom, of the philosophy which through so many years they had studied in face of impending evils. . . . Then he embraced his wife and, with a tenderness somewhat in contrast to his fortitude. entreated her to moderate her grief and not nurse it for ever, but in the contemplation of a well-spent life to find honourable consolation for the loss of her husband."

The most important of Seneca's works are his philosophical writings, a series of essays on practical ethics, or lay sermons, as they might be called, preaching a modified Stoicism. These, with the approximate dates of composition are: *Ad* Marciam de *consolatione* (A.D. 40–41); *De Ira,* 3 books (41–44); *Ad Helviam de consolatione* (42); *Ad Polybium de consolatione* (43–44); *De brevitate vitae* (49); *De constantia sapientis* (55–56); *De clementia,* 2 books (55–56); *De vita beata* (58–59); *De beneficiis,* 7 books (62–64); *De tranquillitate animi* (62–63); *De otio* (63); De providentia (63–64); *Epistulae* Morales ad *Lucilium* (63–64). Enjoying in his own time an unrivaled popularity as a writer, Seneca, it is abundantly clear, did not maintain his vogue.

Quintilian, in his review of Greek and Roman writers suitable for the reading of the student of oratory, defers Seneca to the last on account of the erroneous report that he condemned him utterly. The remaining works may be dismissed briefly: (1) *Naturales Quaestiones,* 7 books (written *c.* A.D. 63), a popular sketch of astronomy and meteorology; (2) *Ludus de morte Claudii* (*apotheosis, apocolocyntosis*) (written about A.D. 54), a short and not unamusing skit on the deification of the emperor Claudius, introducing. in the manner of the Menippean satire, snatches of verse. both Greek and Latin, in the midst of the prose. (3) Nine tragedies—*Hercules Furens, Thyestes, Phoenissae, Phaedra* (Hippolytus), Oedipus, Troades (*Hecuba*), *Medea, Agamemnon, Hercules Oetaeus*—modeled on Greek exemplars, show the rhetorical characteristics of his prose and are of small poetic merit. The Octavia, the only extant specimen of a fabula *praetexta* (a historical drama on a Roman subject), is proved by internal evidence to be by a later writer. (4) A number of epigrams have come down to us under Seneca's name — nine lamenting his exile in Corsica, after the fashion of Ovid in the Tristia, are printed in Haase (Teubner) vol. i, p. 261, seq.

The letters of Seneca to St. Paul — which were known to Jerome and Augustine — are universally admitted to be a forgery.

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(A. W. MA.)

SENECA, a tribe of North American Indians of Iroquoian stock. They call themselves Tshoti-nondawaga, "people of the mountain." The French called them *Tsonnontouan.* Their former range was in western New York state between Seneca lake and the Genesee river. They were one of the Six Nations League of the Iroquois (*q.v.*), and eventually became the most important tribe. On the defeat of the Erie and Neuter tribes they occupied the country west of Lake Erie and south along the Allegheny to Pennsylvania. They fought on the English side in the War of Independence. In 1950 there were about 3,800 on reservations in New York state, 900 mixed with Cayuga in Oklahoma and a few on Grand River reservation, Ontario.

See NORTH AMERICA: Ethnology; INDIAN, NORTH AMERICAN.

SENECIO, a genus of plants of the composite family Compositae, the groundsels or ragworts. One of the most numerous of all flowering-plant genera, it embraces about 1,450 species, widely distributed throughout the world. It includes herbs, shrubs and even trees, a number of which are cultivated for their flowers, foliage or ivylike habit. The leaves are alternate and sometimes all basal. The flower heads are single or clustred, variously coloured and usually with fertile rays. but sometimes rayless. The surrounding bracts (involucre) are usually arranged in a single series, reinforced at the base with calyxlike shorter bracts (bracteoles). The dry fruits (achenes) are crowned with a pappus of soft, whitish, often very numerous, bristles. Nine species are found in Great Britain, including S. vulgaris, the common groundsel, and *S.* jacobaea, the tansy ragwort; both are pernicious weeds in European fields and along roadsides. The two-foot-tall tansy ragwort is a showy plant with heads of bright yellow flowers; naturalized in North America, it is called staggerwort. Upward of 70 species occur in North America, most numerously in the southern and western parts of the United States. Representative American species are S. aureus (golden ragwort or swamp squawweed). a conspicuous, golden yellow wild flower, a one- to two-foot-high perennial inhabiting swamps and wet meadows; S. pseudo-arnica (sea-beach groundsel); *S. obovatus* (round-leaved squawweed); S. *pauperculus* (balsam groundsel); and S. *lobatus* (cress-leaved groundsel). Among the more widely cultivated species are *S.* cineraria (dusty miller); *S.* cruentus (cineraria, *q.v.*); S. *petasites* (velvet groundsel); and *S.* mikanioides (German ivy), a native of South Africa, naturalized in California.

See GROUNDSEL.

SENEFELDER, ALOIS (1771–1834), German inventor of lithography, was born at Prague on Nov. 6, 1771, his father Peter being an actor at the Theatre Royal. Unable to pay for the engraving of his compositions, he attempted to engrave them himself. He made numerous experiments with little success; tools and skill were alike wanting. Copperplates were expensive, and the want of a sufficient number entailed the tedious process of grinding and polishing afresh those he had used. But his attention was accidentally directed to a fine piece of Kelheim stone which he had purchased for the purpose of grinding his ink. His first idea was to use it merely for practice in his exercises in writing backnard. the ease with which the stone could be ground and polished afresh being the chief inducement. While he was engaged one day in polishing a stone slab on which to continue his exercises, his mother entered the room and desired him to write her a bill for the washerwoman, who was waiting for the linen. Neither paper nor ink being at hand, the bill was written on the stone he had just polished. The ink used was composed of wax. soap and lampblack. Some time afterward, when about to wipe the writing from the stone, the idea all at once struck him to try the effect of biting the stone with aqua fortis. Surrounding the stone with a border of wax. he covered its surface with a mixture of one part of aqua fortis and ten parts of water. The result of the experiment was that at the end of five minutes he found the writing elevated about the tenth part of a line ($\frac{1}{120}$ in.). He then proceeded to apply the printing ink to the stone. using at first a common printer's ball, but soon found that a thin piece of board covered aith fine cloth answered better, communicating the ink more equally. He was able to take satisfactory impressions, and, the method of printing being new, he hoped to obtain a patent for it, or even some assistance from the government. For years Senefelder continued his experiments, until the art not only became simplified, but reached a high degree of excellence in his hands. In later years the king of Bavaria settled a handsome pension on Senefelder.

Senefelder died at Munich in 1834, having lived to see his invention brought to comparative perfection.

SENEGA, the dried root of *Polygala senega,* official in the *National Formulary* and the *British Pharmacopoeia.* The active principles are saponins. It is used chiefly as an expectorant in bronchitis and asthma. In overdoses it acts as an irritant poison producing violent vomiting and purging.

SENEGAL, former overseas territory in French West Africa, and an autonomous republic of the French community from Nov. 1958, was recognized by France as an independent state in Sept. 1960. It lies between lat. 14° and 18° N. and between long. 14° and 20° W. and is bounded on the north by the Senegal river, which separates it from Mauritania. on the east by the Falémé river, which separates it from the Mali Republic, on the south by Guinea and Portuguese Guinea and on the west by the Atlantic ocean. The British colony of the Gambia stretches from the coast toward the interior of the republic and almost separates the northern part. or Senegal proper, from the southern, or Casamance. The total area has been estimated at 76,124 sq.mi. Dakar, the capital of French West Africa under the French union, in 1958 became the capital of the republic in place of Saint-Louis.

Physiography. — The eastern border and the southeastern part of Senegal belong geologically to the Pre-Cambrian period. But most of the country was once covered by a gulf of the sea, later clogged by Cretaceous and Tertiary sediments (marl and limestone, sandstone, sand and clay). The valley of the Senegal river and the coastal region, particularly the Saloum, are overlaid by Quaternary .alluvial deposits. The Cape Verde peninsula was formed by volcanic action in the Tertiary and later period (craters of the Mamelles and the island of Gorée).

Brown soils of the steppe type extend over the north and the west; they are often covered by sand. Along the coast there are vast dunes with saline depressions. The south. the east and Casamance have savanna soils of ochreous or beige colour. In the southeast the upper Gambia valley has great barren stretches of laterite covering. Having once been a gulf of the sea. the country is flat. Except in the far southeast, it is nowhere more than 656 ft. above sea level.

The Senegal river: which has its source in the Sudan, enters Senegal at its confluence with the Falémé. It flows first over ancient rock (the Bakel ridge, 485 mi. from its mouth), then makes its way through the alluvial deposits, between steep banks. with many branchings. Its fall is very slight. From Dagana it wanders among the dunes, feeding the lake of Guiers on its left bank, then flows parallel to the coast, separated from the sea by the narrow strip of sand known as the Langue de Barbarie. Its mouth has changed much, and a bar makes access difficult. The river is in flood from July to Nov., during which time it spreads over much of the valley. In the dry season the tide goes 280 mi. upstream.

The valleys of the former tributaries of the Senegal (*e.g.,* the Ferlo) are now dry, as are those of. the little coastal streams, including the Saloum, whose mouth alone is navigable because the sea flows into it. Of the Gambia river, only the upper reaches, 300 km. or 186 mi. from the sea. are included in Senegal; they are not navigable. The Casamance river is also an estuary of the sea for most of its course.

The coast. made uniform by the Canaries current, is low and bordered by dunes, over which little humid depressions called *niaycs* are scattered. The rocky peninsula of Cape Verde, with Gorée and the Madeleines, provides the only shelter. To the south there is another chain of dunes, the Petite Côte, which is continued up to the promontory of Sangomar. Finally. in the Saloum and in Casamance. the region of the Rivières du Sud begins: this is partly invaded by the sea, cut up into islets and clogged with mud.

The climate is tropical, with a rainy season from June to Oct. The sub-Canarian climate prevails on the coast from Cape Verde to the mouth of the Senegal and gives a relatively cool winter and slight rainfall. The Sudanic climate, very hot and dry, prevails in the hinterland, with its greatest humidity in the Saloum. In lower Casamance, the Guinea climate prevails, hot and damp.

Vegetation is distributed over three zones. In the north is the Sahelian, which consists of low steppe, with mimosa and gumtrees and, in the Senegal valley, large trees such as tamarinds and acacias. South of latitude 15° N. lies the Sudanic zone, with short-lived plants and scattered trees, among which the baobab is characteristic, though there are also species of commercial value. such as the African mahogany (*Khaya senegalensis*). Lower Casamance has the same tropical type of vegetation as the rest of Guinea. with clusters of forest trees, huge plants and palms and, along the streams, mangroves.

The fauna is that of the Sudan: there are several species of monkey and antelope, warthogs, lions, panthers, hyenas, wild hunting dogs and hippopotami. The numerous birds include partridges, guinea fowl, spur-winged geese and also the tiny *mangemil,* which does great damage to crops. Among reptiles are crocodiles. turtles and tortoises, monitors, chameleons, huge boas and pythons and the hooded cobra. Great centipedes, millipedes and scorpions are among the numerous kinds of insects.

Despite its flatness: the country presents a variety of aspects due to differences of climate and of soil. The Senegal valley is very hot and dry but benefits from regular flooding and can be cultivated. The Ferlo, between the Senegal and latitude 14° N., is a vast sandy tract of the interior, mostly desert. The belt of fertile sand along the coast is 50 km. or just a little more than 30 mi. wide in the north (where it forms the Cayor, between Dakar and Saint-Louis) and 100 km. or 60 mi. wide in the south (the Baol, on the same latitude as Dakar). The coastal region of the Sine and the Saloum is damper. An island region of hot, dry savanna lies south of lat. 14° N. Lower Casamance. with the climate of Guinea, presents a year-round green landscape.

History. — Man has occupied Senegal since very ancient times. Numerous paleolithic axes have been found in the Senegal valley, neolithic two-headed axes and arrows near Dakar, and stone erections as well as copper and iron objects in the Sine-Saloum region.

The first Negroes of whom there is historical mention are the Toucouleur (Tokoror; *see* TUKULOR), who occupied the Senegal valley in the 9th century. The name Senegal appears to be derived either from that of their town Senegana or from that of the Zenaga Berbers of Mauritania. The Sarakolle empire of Ghana lay to the east. between the Senegal and the Niger. Toward 1040 the Zenaga established, perhaps on an island of the river, the Mohammedan monastery in which the Murabti sect was to have its origin. This sect converted the Toucouleur, destroyed Ghana and conquered Morocco. Pagan invasions began in the 13th century. About 1400 some Peuls founded a dynasty on the middle Senegal, in the region thereafter known as Fouta-Toro. In the 18th century the Moslem Toucouleur revolted and set up a feudal theocratic republic.

On the coast and in the Cayor the Ouolof (Wolof), who had previously been subject to the Toucouleur. founded an independent kingdom in the 14th century; this was later divided. The Serers in the Sine and in the Saloum were organized into a state by Mandingo chiefs, the Guellawar. The other peoples did not form any large states.

Portuguese navigators reached Cape Verde in 1444. They set up factories at the mouth of the Senegal, at Gorée (opposite the modern Dakar), at Rufisque (Rio Fresco), at Joal, at Portudal, in the Saloum and in Casamance (Casa Mansa). Their main centre was in the Cape Verde Islands. They tried to convert the natives to Christianity and instituted the slave trade. From the 16th century they had to compete with French and English pirates and merchants. With the decline of Portuguese power at the end of that century. the English were able to establish themselves on the Gambia and the French at Rufisque.

In 1633 Cardinal Richelieu founded the French Senegal company. In 1645 a French factory was set up at the mouth of the Senegal. Destroyed by a flood, this was rebuilt on N'Dar. an island in the river, which was to become Saint-Louis du Sénégal. The Dutch meanwhile had set themselves up on the island of Gorée, which the French took over in 1677, after which the French agent J. B. Ducasse managed these factories and did much to promote trade. Dealers from Saint-Louis began business on the lower reaches of the river, where they bought gums and slaves. Gorée bought slaves in the Cayor, on the Petite CBte and in Gambia, where the harbour of Albreda had already been constructed.

In 1693 the English destroyed Saint-Louis and Gorée; next year the French blew up the English fort on the Gambia. The French factories were rehabilitated under the direction of André Brue, who spent 25 years trying to penetrate the hinterland by journeys up the Senegal. In 1700 he built Fort Saint-Joseph near the Falémé confluence and began to buy gold from the Bambouk region east of the Falémé. After his death the fort was destroyed by the Negroes and the factories' activity declined. But the French botanist Michel Adanson spent five years exploring the interior before publishing his *Histoire* naturelle du *Sénégal* (1757).

The English occupied the factories in 1757, during the Seven Years' War, and gave only Gorée back at the conclusion of peace in 1763. The marquis de Vaudreuil (Louis Philippe Rigaud) recovered Saint-Louis in 1779; its first governors were the duc de Lauzun (Armand Louis de Gontaut), then M. de Repentigny and then the chevalier Stanislas de Boufflers (whose love letters to Mme. de Sabran contained descriptions of the country). François Blanchot de Verly, who became governor in 1787. had to endure a blockade and great privations but nevertheless was able to repel several English assaults. He died in 1807, and Saint-Louis surrendered two years later. The English governor had a mausoleum built for the gallant Blanchot.

In 1816 Saint-Louis and Gorée were returned to France. The shipwreck of "La Méduse," which gave rise to Théodore Géricault's famous painting, was an incident of an expedition to Senegal. Julien Schmaltz, as governor, founded a station up the river at Bakel. Schmaltz also tried to grow cotton in the neighbourhood of Saint-Louis, and his successor Baron Roger continued this experiment, but it came to nothing; after which trade was confined to gum. Between 1835 and 1837 two stations were acquired in Casamance; viz. Carabane and Sedhiou.

The precarious position of the governors, local wars and the cupidity of the Negro kinglets, who exacted a burdensome tribute, all combined to reduce trade to very little. Under the second republic the slaves were emancipated and given French citizenship. In 1854, at the request of the businessmen of Saint-Louis, Comdt. L. L. C. Faidherbe was appointed governor. To put an end to insecurity, Faidherbe pacified the Oualo (Walo) east of Saint-Louis and then conquered the Moors on the right bank of the river. But the Toucouleur Marabout Omar el-Hadji was threatening the river. Faidherbe established a station at Médine (across the Falémé) and left there a small garrison under Paul Holle, a mulatto from Saint-Louis. Holle strenuously resisted attacks of the marabout's thousands until the rising of the high water enabled Faidherbe to reach him with reinforcements. In 1857 Capt. Protet, of the French navy, founded a station at Dakar. Faidherbe occupied the Petite Côte and the Saloum and then annexed the Cayor, thus uniting the several parts of the colony. In 1865 he went back to France, having organized Senegal and laid the foundations of native policy based on respect for existing usages.

His successor, Col. J. M. E. Pinet-Laprade, consolidated his work. Peanuts had been introduced into the Cayor and were being exported from Rufisque. The Gambian fort of Albreda had been ceded to England in 1857. In 1886 the last Ouolof king, the darnel Lat Dior, had been killed during an insurrection, and Col. J. S. Gallieni was destroying the power of the marabout Mamadou Lamine in the east. France's possession of Casamance was recognized by Portugal in 1886 and its possession of upper Gambia by Great Britain in 1904. Faidherbe's creation of the Tirailleurs Sénégalais marks the beginning of France's use of Senegal as a base for expansion into the Sudan and toward the Rivières du Sud. Dahomey was conquered by Alfred-Amédée Dodds, another mulatto soldier from Saint-Louis. The Gouvernement Général de l'Afrique Occidentale, established by decrees of 1895 and 1904, was at first the responsibility of the governor of Senegal, resident at Saint-Louis, but was later raised to the status of a separate authority based on Dakar. The latter town grew rapidly, to become the main port for Senegal and for the French Sudan.

In World War I the Negro deputy for Senegal, Blaise Diagne, helped to enlist large numbers of riflemen. In World War II the governor-general, Pierre François Boisson, at first remaining loyal to the Vichy government, held Dakar against a British attack in 1940; but he transferred his allegiance to the Allied side in Nov. 1942. In 1946 all Senegalese became French citizens. whereas previously this right had been restricted to natives of the four ancient communes, Saint-Louis, Gorée, Dakar and Rufisque; and the colony became an "overseas territory" of France. In 1958 Senegal became an autonomous republic within the French Community; in Sept. 1960, after a short period of federation with the Sudanese Republic in the Mali federation, Senegal was recognized as an independent state by France.

Population. — By 1955 Senegal was estimated to have 2,223,861 inhabitants, including 42,861 European. The density was therefore 10.6 per square kilometre (less than 3 per square mile) on an average over the whole territory but varied considerably, being between 3 and 10 on the river, less than 1 in the Ferlo, between 20 and 50 in the Cayor and in the Baol. 400 in the Cape Verde peninsula, between 1 and 2 in the east and between 5 and 15 in Casamance. Apart from the Europeans and Asians and a few thousand Moors in the north, the inhabitants are all Negroes of various races and languages.

The Ouolof (Wolof), who number about 750,000, occupy the coast from Saint-Louis to the south of Cape Verde, the Cayor, the Baol and the west of the Ferlo, spreading southward into Gambia. Tall, thin and very dark, they grow crops and live in square huts built of straw. They were the first to come into contact with the French; the large towns are in their country; and they are prominent in local politics. They are Moslems, and their Marabouts are influential; peculiar sects include the Mourides of the Baol, for whom agriculture is a collective obligation. As their importance grows, so their language spreads.

The Toucouleur (Tukulor; 200,000) live in the valley of the Senegal river. Pious Moslems, they are divided among feudal chieftainships and into castes. They speak a Peul dialect.

The 290,000 Peul (Fula), who are also Moslems, are divided into two groups: that of the west and of the Ferlo has a pastoral economy and is mingled with Ouolof and Toucouleur; that of the east and of Upper Casamance consists of feudal conglomerations not unlike those of Fouta Djalon.

The Serers (280,000) are related to the Ouolof but most of them are still pagan. They live in the Sine and the Saloum. They are efficient farmers. The Lebou, who are fishermen, are found on the Petite CBte south of Dakar.

In the east are the Mandingo or Malinké (90,000) and some Sarakolé (80,000), who are like those of the Sudan. Many Sarakolé find work in Dakar.

Lower Casamance is populated by very different races, wilder and almost unclothed (whereas the Senegalese wear ample *boubous*). The Diola (150,000) have adopted agricultural methods derived from the islands of the river mouth, which are largely saline. They are mostly pagan, with a few Christian communities.

The major town is Dakar (*q.v.*), the former federal capital and, from 1958, capital of Senegal. By 1955 the total population, with that of the suburbs, was 230.887. Farther to the east stand the towns of Rufisque (37.442, commune) and Thiès (42,503, commune). Saint-Louis, the former capital. had about 52,99j inhabitants by 1955.

Kaolak (46,570. commune) is the port of the Saloum.

Government. — Between 1957 and its independence in 1958, Senegal was one of the semiautonomous territories of French West Africa. The first territorial assembly, elected on March 31, 1957, by universal suffrage, was composed of a large Christian Democratic majority and a Socialist minority. The assembly elected an executive council composed of a vice-president and ministers. the governor remaining president. The assembly met twice a year, voted the budget and the taxes. made decisions on loans and on concessions and was consulted about projected rulings by the administration.

In Paris. Senegal's two deputies in the national assembly were elected by the citizens through direct suffrage; but its three members of the council of the republic and its three members of the assembly of the French union were elected by the territorial assembly.

The territory was divided into 11 cercles (Saint-Louis, Podor and Matam on the river; Lingukre in the Ferlo; Thiks and Diourbel in the west; Kaolak in the Saloum; Tambacounda and Kédougou in the east; and Ziguinchor in Casamance) and one *délégation* (Dakar). At the head of the cercles and of the de'lkgation, as also at the head of the 28 subdivisions of the cercles, were civil servants of overseas France.

The communes of Dakar, Saint-Louis, Rufisque and Thiks elected their own municipal council and their mayor.

The high commissioner of French West Africa, with his administrative services, resided at Dakar. The court of appeal for French West Africa were also at Dakar. The assize courts (for criminal offenses) sat at Dakar and at Saint-Louis. There were tribunals at Dakar. at Saint-Louis, at Kaolak and at Ziguinchor.

Higher education is provided by the University of Dakar. The Institut Français d'Afrique Noire undertakes research into numerous scientific questions.

Economy. — Senegal is essentially the country of peanuts. Exploitation of this crop began in 1834. Before World War II the country produced almost nothing else and had to import most of its food. Subsequently a change was brought about, so that the volume of production decreased. Peanuts are grown in the Cayor, in the Baol. in the Saloum, along the railway, in the Sudan and in upper Casamance. In the two last-named regions mechanization has been introduced; elsewhere Senegalese peasant smallholders turn the soil over with their indigenous tool, the iler or *hilaire,* an iron angle with a long handle. They also employ temporary workers from the Sudan, known as navktanes (*i.e.,* "people of the rainy season"). Peanuts used to be exported in their shells, but are now for the most part shelled or pressed in the local oil works, notably concentrated around Dakar and Kaolak. A small proportion of the yield is retained for local consumption, the rest is sent abroad.

Millet is the traditional food crop and the only one grown in the dry regions that do not produce peanuts, particularly the valley of the river. Manioc is grown in the damper areas. Rice is imported to meet the food shortage, and the cultivation of it has been begun in the Sudan, in Guinea and even in Senegal. Secondary crops include cotton. tobacco, sisal and *bérèf* (watermelon) in rather small quantities; there is also some market gardening near Dakar. On the other hand gum arabic from an acacia growing in the Senegal valley, and almonds and palm oil from lower Casamance may be regarded as important.

Livestock in the late 1950s included about 1,000,000 cattle, 700.000 sheep, goats, asses, horses and a few camels. The sea is full of fish, and fishing is carried on by the coastal peoples, who use curious long-prowed pirogues.

Titanium, ilmenite and zircons are mined in the sand along the coast near Rufisque. Considerable phosphate deposits are located around Thiks.

The foreign trade of Senegal cannot be separated from that of the Sudan or from that of Guinea, which pass through it. Exports are mainly shelled peanuts, peanut oil and caked peanuts. Imports include hydrocarbons, coal and coke, cement, metal goods, rice, sugar, flour, wine, cotton goods and motor vehicles.

Transportation. — Road making is difficult across the sands in the west. By 1953 there were 1,056 mi. of metaled roads and 837 mi. of tracks practicable in certain seasons.

The Sudan railway (800 mi.) starts at Dakar and runs along the northern frontier of Gambia. It has branches to Saint-Louis (120 mi.), Kaolak, Touba and Lingukre.

The Senegal river has a bar at its mouth, where the depth is about 2.5 m. (just over 8 ft.). The Messageries du Sénégal run a service up to Kayes (574 mi. from Saint-Louis) for ten weeks while the river is in flood. The Saloum is navigable up to Kaolak to ships drawing 12½ ft. The Casamance is navigable up to Sedhiou; cargo boats drawing 15¼ ft. can reach Ziguinchor, despite the bar at the mouth.

Dakar (*q.v.*) is the main port of French West Africa and a major focus for air transport. (Hu. De.; X.)

SENEGAL, a river of West Africa, entering the Atlantic about 16° N., about 10 mi. below Saint-Louis, after a course of fully 1,000 mi. It is formed by the junction of the Bafing or Black river and the Bakhoy or White river, and its chief affluent is the Falémé. North of the Senegal the Sahara reaches the coast, and for more than 1,000 miles no river enters the ocean.

The Bafing rises in the Futa Jallon highlands about 2,400 ft. above sea level, in 10° 28' N., 10° 5' W., its source being within 125 mi. of Konakry on the Gulf of Guinea. A little south of 12° N. the Bafing is a large stream 250 yd. wide. The Bafing follows a northward course for about 350 mi., during which it descends by a series of rapids till it reaches a level of 360 ft. above the sea. The headstreams of the Bakhoy rise between 11° 30' and 12° N. and 9° 20' and 9° 50' W. on the northeast versant of the hills which there form a narrow divide between the basin of the Senegal and that of the upper Niger. The Bakhoy, in its upper course much interrupted by rapids, flows northeast, but about 12° 15' N. turns northwestward. Its principal affluent, the Baule (Red river), and its headstreams rise farther east on the northern slopes of the hills which above Bamako shut in the Niger. The eastern headwaters of the Senegal thus drain a large area adjacent to the upper Niger. The Baule flows north and in a series of Ioops reaches 14° 20' N., where it turns westward and in about 13° 30' N. and 10° W. joins the Bakhoy. After receiving the Baule, the Bakhoy, now a river of fine proportions, flows west by north through rocky country in a narrow valley. In 11° 55' W. and 13° 48' N. it unites with the Bafing. At the confluence the Bakhoy is 800 ft. wide, the Bafing at this point having a width of 360 ft.

After the junction of the Black and White rivers the united stream is known as the Senegal. The confluence is called Bafulabé, *i.e.,* "meeting of the waters." Below Bafulabé the river flows northwest through a valley bordered on either side by hills which throw out rocky spurs, over which the Senegal descends in a succession of falls, those of Guina (160 ft.) and of Felu (50 or 60 ft.) being the most important. From the south it is joined by the Falémé, a considerable river which rises in hilly country in about 11° 50' N. and 11° 30' W. The first rise of the lower Senegal is due to the rains in the source region of the Falémé, the flood water passing down that stream more quickly than down the Bafing because of its shorter course. A short distance below the Felu Falls is the town of Kayes on the left bank of the river. Between the falls and Bakel (85 mi.) there are 27 "narrows," of which several, such as that at Kayes, are difficult. Kayes is the limit of navigability from the sea. From that town a railway connects with the navigable waters of the middle Niger at Kulikoro.

Below Bakel the river passes through flatter country and presents a series of great reaches. Numbers of divergent channels (called marigots) form several islands, the largest being that of Morfil, 110 mi. long. The river attains its most northerly point, 16° 30' N., in about 15° 10' W. Thereafter it runs southwest and finally due south. In the last 10 mi. of its course it runs parallel to the sea, from which it is separated by a narrow line of dunes. On an island at the head of this 10 mi. is Saint-Louis, the former capital of the French territory of Senegal. At this point the right branch of the river is only 500 ft. from the open

Atlantic. A marigot, called the Ndiadier or Maringiouins. leaves the river 40 mi. above Saint-Louis, pierces the dunes at flood time and reaches the sea 50 mi. N. of the mouth of the river. The Senegal indeed has nhat is styled an interior delta, but with the exception of the marigot named, all the divergent branches rejoin the main stream before the sea is reached.

The comparative scantiness of its sources, the steepness of its upper course and the rapid evaporation which takes place after the short rainy season would make the Senegal an insignificant stream for more than half the year; but natural dams cross the channel at intervals and the water accumulates behind them in deep reaches, which thus act as reservoirs. In the rainy season the barriers are submerged in succession, the reaches are filled and the plains of the lower Senegal are changed into immense marshes. Lake Cayar on the right side of the lower Senegal and Lake Panieful (Guier) on the left constitute reserve basins, receiving the surplus waters of the river during flood and restoring them in the dry season. Because of these natural "locks," the Senegal never discharges less than 1,700 or 1,800 cu.ft. per second.

From July to October the level of the Senegal shows a series of fluctuations, with, however, a general increase till the end of August or beginning of September, when the maximum occurs.

The existence of the Senegal appears to have been known to the ancients. It is usually regarded as the Chretes or Chremetes of Hanno. The mouth of the Senegal, then called Senaga, was entered in 1445 by the Portuguese navigator Diniz Diaz (who thought it a western arm of the Nile), and in 1455 Cadamosto ascended the river for some distance. Leo Africanus rightly describes its lower course as "severing by its winding channel the barren and naked soil from the green and fruitful." It was not until 1637 that the explorations of the upper river began, Jannequin, Sieur de Rochefort, in that year ascending the river about 200 mi. above Saint-Louis. In 1697 André Brue reached the island of Morfil, and in 1698 he penetrated past the Felu falls. At that period geographers regarded the Senegal as the termination of the Niger, a theory held until Mungo Park's demonstration of the eastward course of that stream. Park himself added much to the knowledge of the upper basin of the Senegal. In 1818 the source (*i.e.,* of the Bafing) was located by Gaspard Mollien.

SENESCHAL, a medieval title equivalent to "steward." The seneschal began presumably as the major-domo of the German princes who settled in Roman lands and was predecessor of the mayors of the palace of the Merovingian kings. But the name seneschal became prominent in France under the Capetian dynasty. The seneschal, called in medieval Latin the dapifer, was the chief of the five great officers of state of the French court between the 11th and the 13th centuries. His functions were described by the terms *major* regiae *domus* and regni Franciae pvocurator—major-domo of the royal household and agent of the kingdom of France. The English equivalent was the lord high steward, but the office never attained the same importance in England as in France. Under the earlier Capetian sovereigns the seneschal was the second person in the kingdom. He inherited the position of the mayor of the palace—had a general right of supervision over the king's service. was commander in chief of the military forces. steward of the household and presided in the king's court in the absence of the king. The office of seneschal of France, which had belonged to several great houses (Rochefort, Garlande). was from the end of the 13th century left as a rule with no appointed holder, because of the risk that it might increase too much one family's power to the detriment of that of the king. The great vassals and even the bishops and abbots had seneschals of their own. Moreover, the seneschals of certain great fiefs were maintained by the king when, in the 13th century, those fiefs were regained by the crown. Belonging to local nobility, these seneschals assumed the functions of baillis, principally in regard to military matters, and, like the baillis, they were the local representatives of the king's authority.

SENIGALLIA or SINIGAGLIA (anc. *Seña* Gallica), a city and episcopal see of the Marches, Italy, in the province of Ancona, on the coast of the Adriatic, 15 mi. N. of Xncona by rail Pop. (1951), 16,365. It is 14 ft. above sea level. The castle, originally built by Cardinal Albornoz (1355), was restored by Baccio Pontelli (see OSTIA) in 1492. The ancient *Sena* Gallica was a city of Umbria. The name Gallica distinguishes it from Saena (Siena) in Etruria. A colony was founded there by the Romans after their victory over the Senones. about 280 B.C. It was destroyed by Pompey in 82 B.C. Ravaged by Alaric, fortified by the exarch Longinus and again laid waste by the Lombards in the 8th century and by the Saracens in the 9th, Senigallia was at length brought so low by the Guelph and Ghibelline wars. and especially by the severities of Guido de Montefeltro, that it was chosen by Dante as the typical instance of a ruined city. In the 15th century it was captured and recaptured again and again by the Malatesta and their opponents. Sigismondo Malatesta of Rimini erected strong fortifications around it in 1450–55. Sixtus IV assigned the lordship of the town to the Della Rovere family. After 1631 it formed part of the legation of Urbino.

SENIOR, NASSAU WILLIAM (1790–1864), English theoretical and applied economist of the classical period, was born at Uffington, Berkshire. on Sept. 26, 1790. He was educated at Eton and at ilfagdalen college, Oxford, and called to the bar in 1819. From 1825 to 1830 he was the first occupant of the Drummond chair of political economy at Oxford, and he held it again from 1847–52, in the meantime serving on many royal commissions, notably those on the poor law (1832–34) and the hand loom weavers (1837–41). He died at Kensington, London, June 4, 1864.

Senior was one of the first to formulate explicitly the method of political economy as that of an abstract, deductive science based on a very few fundamental self-evident propositions. Since the conclusions of the political economist related to wealth only, they were neutral as between political ends and "do not authorise him in adding a syllable of advice." On value Senior was highly critical of David Ricardo's emphasis on labour, and he stressed the role of utility and scarcity. His contribution to the analysis of capital and interest was important. in particular his concept of "abstinence" as a factor of production, which he defined as "that agent, distinct from labour and the agency of nature, the concurrence of which is necessary to the existence of Capital, and stands in the same relation to Profit as Labour does to Wages." (See his *An* Outline of the Science *of* Political Economy, new ed., 1938.) In the field of policy Senior was one of the main architects of the Poor Law Amendment act of 1834; he advocated the suppression of trade unions, while toward contemporary factory legislation his attitude was uncertain.

See Marian Bowley, Nassau Senior and Classical Economics (1937).
(T. W. H.)

SENLIS, a town of northern France, capital of an arrondissement in the *département* of Oise, on the right side of the Nonette, a left-hand affluent of the Oise, 34 mi. N.N.E. of Paris. Pop. (1954) 6,760. Senlis can be traced back to the Gallo-Roman township of the Silvanectes, which afterward became Augustomagus.

Christianity was introduced by St. Rieul, probably about the close of the 3rd century. During the first two dynasties of France, Senlis was a royal residence and generally formed part of the royal domain; it obtained a communal charter in 1173. In the middle ages local manufactures, especially that of cloth, were active. The burgesses took part in the Jacquerie of the 14th century, then sided with the Burgundians and the English, whom they afterward expelled. The Leaguers were there beaten in 1589 by Henry I, duke of Longueville, and François de La Noue. The bishopric was suppressed at the Revolution.

Senlis lies in a valley in the midst of the three great forests of Hallatte, Chantilly and Ermenonville. The old cathedral of Notre Dame (12th, 13th and 16th centuries) was begun in 1155 on a vast scale, but the transept was finished only under Francis I. The episcopal palace dates from the 13th century; the old collegiate church of St. Frambourg was built in the 12th century.

SENNA, a popular purgative, consisting of the leaves of two species of Cassia (natural order Leguminosae): C. acutifolia and C. *angustifolia.* These are small shrubs about 2 ft. high, with numerous lanceolate leaflets arranged pinnately on a main stalk with no terminal leaflet; the yellow flowers are borne in long-stalked racemes in the leaf axils and are succeeded by broad flattish pods about 2 in long. C *acutifolia* is a native of many districts of Nubia in the Sudan but is grown also in 'Timbuktu, French West Africa, and Sokoto province, Nigeria.

The leaflets form the Alexandrian senna of commerce and *C. angustifolia* affords the Bombay. East Indian, Arabian or Mecca senna of commerce. This plant grows wild in the neighbourhood of Yemen and Hadhramaut in the south of Arabia, in Somaliland and in Sind. Pakistan, and the Punjab, India. It is also cultivated in the extreme south of India, and there grows larger leaves, which are known in commerce as Tinnevelly senna.

The laxative principles are apparently two glycosides. sennoside A and sennoside B. The leaves contain at least two other glycosides, sennapicrin and sennacrol, but as these are insoluble in water, they are not contained in most of the preparations of senna.

Senna was introduced by the Arabs and its cathartic properties were described in Arabian writings of the early 9th century.

SENNACHERIB, son and successor of Sargon. mounted the throne of Assyria on the 12th of Ab. 705 B.C. His first campaign was against Babylonia, where Merodach-baladan had reappeared. The Chaldaean usurper was compelled to fly and Bel-ibni was appointed king of Babylon in his place. In 701 B.C. came a great campaign in the west: which had revolted from Assyrian rule. Sidon and other Phoenician cities were captured, but Tyre held out, while its king Lulia (Elulaeus) fled to Cyprus. Ashdod, Ammon, Moab and Edom submitted, but Hezekiah of Judah with the dependent Philistine princes of Ashkelon and Ekron successfully defied the Assyrian army (see HEZEKIAH). The following year Sennacherib made his son Assur-nadin-sum king in place of Belibni and drove Merodach-baladan out of his refuge in the marshes. A few years later he had a fleet of ships built near Birejik on the Euphrates by his Phoenician captives; these were manned by Ionians and transported overland to the Euphrates and so to the Persian gulf. They sailed to the coast of Elam. and there destroyed the colony of Merodach-baladan's followers at Nagitu. In return for this unprovoked invasion the Elamites descended upon Babylonia, carried away Assur-nadin-sum (694 B.C.) and made Nergalyusezib king. Three years later a great battle was fought at Khalulē on the Tigris between the Assyrians on one side and the Elamites and Babylonians on the other. Both sides claimed the victory, but in 689 B.C. Sennacherib captured Babylon and razed it to the ground. Some time previously he had overrun the mountain districts of Cilicia.

On the 20th of Tebet 681 B.C. he was murdered by his two sons. who fled to Armenia after holding Nineveh for 42 days. He is famous as the builder of the palace of Kuyunjik at Sineveh (*q.v.*).

(A. H. S.)

SENNAR, the name of the area between Subia and Abyssinia, was not known before the 16th century. It was derived from Sennar, capital of the Fung kingdom (1504–1821), a Moslem dynasty known as the Black Sultanate, which with an Arab (Abdallab) viceroy ruled most of what became the Anglo-Egyptian Sudan. The Fung kingdom replaced the southern Christian kingdom of Alwa which had gradually collapsed after the Moslem conquest of the Christian kingdom of Dongola in the 14th century. Before the coming of Christianity the area had been part of the kingdoms of Napata and Meroe. On the Turko-Egyptian conquest in 1821, part of the area became the Sennar province of the Sudan, later being further curtailed to a district. (A. J. AL.)

SENOI, a Veddoidlike people found in the Malay peninsula, and in small groups along the coastal plains of Siak in Sumatra. Traces of such a people also appear in the eastern islands of Indonesia. Apparently they are remnants of a once wide-spread population which followed the Negrito into this area. They are sometimes known as the Sakai, a derogatory term applied by the Malays. In the peninsula they speak a language apparently related to or influenced by Mon-Khmer, but in Sumatra they have adopted the language and matrilineal institutions of the Menangkabau (*q.v.*). There are indications that the Senoi entered the area with a well-developed dry land agriculture; and that they lived in communal houses and had some degree of political development. Despite these advances they are everywhere mainly dependent on hunting and food gathering. In the hunt they employ the blowgun and poison darts, like the neighbouring Malay and Negrito of the peninsula. Their highly developed religious beliefs and practices stand in sharp contrast to their rather primitive material culture. Where there has been little intermixture the Senoi differ markedly from their neighbours. They are slight in build, short in stature, with long heads and. in general, lighter skin colour and narrower noses than the Malay or Segrito. Their long hair is allowed to grow until it falls in curls over their shoulders. They do not weave or do metal work of any kind. *See* also MALAYA: Anthropology.

See H. H Bartlett, "The Problem of Negrito and Vedda Elements in the Population of Sumatra," *Proceedings,* Fifth Pacific Science Congress (1934); F. C. Cole, *Peoples* of *Malaysia,* with bibliography (1945).

(F.-C. CE.)

SENONES, a Celtic people of Gallia Celtica, who in Caesar's time inhabited the district which now includes the departments of Seine-et-Marne, Loiret and Yonne. From 53–51 B.C. they were engaged in hostilities with Caesar. In 51 B.C. a Senonian named Drappes threatened the Provincia, but was captured and starved himself to death. From this time the Gallic Senones disappear from history. In later times they were included in Gallia Lugudunensis. Their chief town was Xgedincum (later Senones, whence Sens).

A branch of the Senones. called Σένωνες, Senōnes, by Polybius, crossed the Alps about 400 B.C. and settled on the east coast of Italy from Ariminum to Ancona. in the so-called ager *Gallicus,* and founded the town of Sena. In 391 B.C. they invaded Etruria and besieged Clusium. The Clusines appealed to Rome. whose intervention led to war, the defeat of the Romans at the Allia (July 18, 390 B.C.) and the capture of Rome. For 100 years the Senones were at war with Rome, but were finally subdued and expelled (283 B.C.) by P. Cornelius Dolabella.

SENS (sons), a town of north-central France, capital of an *arrondissement, département* of Yonne, 70 mi. S.E. of Paris. The population in 1954 was 17,184. Sens (Agedincum) was the capital of the Senones, one of the most powerful peoples of Gaul. It was not finally subdued by the Romans until after the defeat of Vercingetorix. On the division of Gaul into 17 provinces under the emperor Valens. Agedincum became the metropolis of the 4th Lugdunensis. Theatres, circuses, amphitheatres, triumphal arches and aqueducts were all built in the town by the Romans. It was the meeting point of six great highways. The inhabitants, converted to Christianity by the martyrs Savinian and Potentian, held out against the Alamanni and the Franks in 356, against the Saracens in 731 or 738. and finally against the Normans in 886. The early feudal government of Sens was by counts. hereditary in the middle of the 10th century, and their quarrels with the archbishops, etc., were serious until, in 1055, the countship was united to the royal domain. Several councils were held at Sens, notably that of 1140, at which St. Bernard and Xbelard met. The burgesses in the middle of the 12th century formed themselves into a commune which carried on war against the clergy. This was suppressed by Louis VIII, and restored by Philip Augustus. Sens massacred the Protestants in 1562, and it was one oi the first towns to join the League. Henry IV entered it in 1594 and deprived the town of its privileges. In 1622 Paris, hitherto suffragan to Sens. was made an archbishopric, and the bishoprics of Chartres, Orléans and Meaux were transferred to the new jurisdiction. In 1791 the archbishopric was reduced to a bishopric of the department of Yonne. Suppressed in 1801. the see was restored in 1817 with the rank of archbishopric. The town was occupied by the Allies in 1814 and by the Germans in 1870–71.

Sens stands on the right bank of, and on an island in, the Yonne near its confluence with the Vanne. The cathedral of St. Étienne (1140–16th century), one of the earliest Gothic buildings in France, is additionally interesting because the architecture of its choir influenced through William of Sens, the architect, that of the choir of Canterbury cathedral. The west front is pierced by three portals; that in the middle has good sculptures, representing the parable of the virgins and the story of St. Stephen. The right-hand portal contains remarkable statuettes of the prophets.

The treasury. one of the richest in antiquities in France, contains a fragment of the true cross presented by Charlemagne, and the vestments of St. Thomas of Canterbury. It was in the cathedral of Sens that St. Louis, in 1234, married Marguerite of Provence, and five years later deposited the crown of thorns.

To the south of the cathedral are the 13th-century official buildings, restored by Viollet-le-Duc, on the first story of which is the synod hall, vaulted with stone and lighted by beautiful grisaille windows. A Renaissance structure connects the buildings with the archiepiscopal palace, of the same period. The church of St. Savinian, the foundation of which dates from the 3rd century, has a Romanesque crypt. The museum of Sens contains some precious mss., notably a famous missal with ivory covers, and a collection of sculptured stones from the old Roman fortifications, themselves built from the ruins of public monuments at the beginning of the barbarian invasions.

Among the industries are flour milling, tanning and the manufacture of iron goods, boots and shoes, brushes, chemicals and cutlery; there is trade in wine, grain, wood, coal and wool, shared by the port on ,the Yonne.

SENSATION is the conscious experience that follows immediately upon the stimulation of a sense organ or a sensory nerve. The word is also used as indicating the general class of all such experiences. Many psychologists and physiologists regard sensation as a concept defined in terms of dependent relationships between characteristics of discriminatory responses of organisms and properties of the physical stimulus. By training the animal or human being to respond differentially to various aspects of the stimulus, his sensory functions and capacities may be determined.

During the 19th century, sensation was distinguished from perception by the specification that perception refers to an external object, whereas sensation does not, although both perception and sensation depend upon the immediate stimulation of a sense organ. This distinction. originally made by the Scottish philosopher Thomas Reid (in 1765) fitted in with the associationists' theory that objective reference is given by the formation of associative compounds. Both Bishop George Berkeley (1709) and James Mill (1829) held that objective reference and meaning are given to a sensation by the addition to it of either sensations or images (memories of sensations), as when the smell of a rose is identified by the associated visual image of a rose. This was. indeed, the accepted doctrine of the 19th century: (1) perception is more complex than sensation, being composed of sensations and images; (2) perception refers, as sensation does not, to an object and may also have other meaningful implications; and (3) the complexity of perception is the means by which meaningful reference is added to it. That view of the distinction betneen sensation and perception was also common during the first two decades of the 20th century. Thereafter the differentiation of sensation from perception became less certain and of less systematic or theoretical significance. Discrimination in respect of fundamental dimensions of stimuli such as wave length or intensity of light, for example, are said to be dealing with sensation; discriminations of more complex stimulus patterns such as speech sounds, visual space or shape are said to be perceptions. The distinction is not sharp; the terms are often interchanged.

Senses.—Aristotle distinguished five senses—sight, hearing, smell, taste and touch. This classification is still valid except that touch is known not to be simple. It must be expanded to include not only the cutaneous sensations of pressure, temperature and pain, but in addition, the organic sensations which are sometimes grouped together under the term somaesthesis. Organic sensations are subdivided into kinaesthetic sensations, vestibular or static sensations and visceral sensations. Kinaesthetic sensation, so named because it mediates the awareness of bodily movement and posture as well as perception of weight, arises from sense organs in the muscles, tendons and joints. Its function is to furnish the sensory clues necessary for the execution of precise movements. The vestibular or static sense has to do with the maintenance of balance and bodily posture and with sensations of rotation and dizziness. Its sense organs are situated in the vestibule and semicircular canals of the inner ear. The kinaesthetic and vestibular senses are often classified together as the proprioceptive senses. They are stimulated primarily by the movement and posture of the body itself. The visceral sensations constitute the basis for such experiences as hunger pangs, nausea and sexual feelings. Throughout the body are free nerve endings, unattached to specialized sensory cells, which mediate sensations of pain. Indeed Aristotle's fifth sense, the sense of touch, is divisible into a considerable number of sensory modalities.

H. L. F. von Helmholtz suggested that sensory experience be divided into modalities according to a qualitative criterion. All sensory qualities within a single modality can be put in a single continuum with no breaks in it, like the colours, where the oranges unite the reds and yellows and the grays form a continuum between black and white. Discrete qualities for which no intermediates exist must be placed, Helmholtz argued, in separate modalities.

How many modalities are there if Helmholtz' definition is accepted? That is a question that cannot be answered with precision. Vision is one modality and only one. All the hues and all the brightnesses and saturations of them, as well as the blacks, whites and grays, can be represented in a solid figure with the intermediates between any two quite clear. The tones constitute a continuum, for the pitches form a linear series from low to high. Smell is a puzzle. Hans Henning's researches (1915) led him to believe that all the odours could be represented on the surface of a triangular prism, with the fragrant, spicy, ethereal, resinous, putrid and burnt odours at the six corners. If Henning was right, smell is a single modality. Henning also placed the four principal tastes (bitter, sour. salt and sweet) at the corners of a tetrahedron, asserting the existence of intermediate tastes and making the gustatory sense a single modality instead of four separate ones. It is doubtful whether intermediate qualities can be found between the four principal cutaneous qualities (pressure, pain, warmth and cold). It would seem that all deep sensibility, from the muscles and joints. from the viscera, from the inner ear, are pressure-pain patterns and add nothing new to the organism's repertory of qualities.

The modern approach to the problem of the classification of the senses is physiological, dealing independently with the mechanisms of the separate sense organs and the neural systems which they directly serve.

Attributes.—A sensation is characterized by its attributes; that is to say, by the conscious dimensions in respect of which it can vary independently. The chief attributes of sensation are quality, intensity, extensity and duration.

Sensations are generally identified and named by their qualities. Examples of different qualities are red, blue, C-sharp, B-flat. fragrant, putrid, sweet, bitter, tickle, ache.

Any one of these qualities can vary in degree of intensity. Tones can be soft or loud, odours faint or strong, pains weak or intense. There is some question about the attribute of intensity for vision, but it would seem that vision has two intensitive attributes, brightness and saturation. A red or a gray may be either light or dark; that variation is brightness. A red may, honever, also vary in saturation, in the intensity of its redness which is opposed to its weakness or grayness, without becoming either lighter or darker.

Visual and tactual sensations certainly possess the attribute of extensity. Space perception is based upon this dimension. There is also convincing evidence that tones and perhaps smells vary in volume. Low tones tend to be large, high tones small. Loud tones tend to be large. faint tones small. Hence a faint low tone may be matched in size to a loud high tone.

All sensations have duration or "protensity," and can be compared in respect of their duration or brevity.

In the 19th century it was supposed that the attributes of sensation must correspond to the dimensions of its stimulus. This is not true. Most of the attributes depend upon the joint variation of two or more dimensions of the stimulus. For instance. while the loudness of a tone varies with the energy put into the tone, it also depends on the frequency. A very low or very high tone requires more energy than a tone in the middle range of pitches for the two to be equally loud. Pitch depends more on frequency than on anything else, yet pitch will alter slightly when the energy of the stimulus is changed and the frequency is kept constant. Thus the three attributes of tone (pitch, loudness and volume) can be altered at will by varying frequency and energy, two dimensions of the stimulus.

Sensitivity.— Sensitivity in respect of the various attributes of sensation is measured by determination of absolute thresholds and differential thresholds. An absolute threshold marks the limit of some sensory series, like the lowest or the highest audible tone, the limits of the visible spectrum and the least noticeable intensity of any sensation. A differential threshold is the just noticeable difference between two stimuli, the *jnd*. Since sensitivity varies from moment to moment, every threshold is an average value—or *jnd* may be defined as the difference which is sensed just as often as it is not. Sensory thresholds are statistically determined quantities.

The differential thresholds for intensity are often expressed by what are called Weber fractions. For instance, if 51 candles are just as often as not discriminably brighter than 50 candles, then the *jnd* is 1 candle and the Weber fraction is $\frac{1}{50}$ or 0.02. Weber's lam assumes that this fraction is constant at all intensities, that the *jnd* would be 10 candles for a stimulus of 500 candles and $\frac{1}{10}$ of a candle at 5 candles, but actually the law does not hold exactly, especially at the lower intensities. Good determinations of the minimal Weber fraction for seven kinds of stimulation are as follows: subcutaneous pressure 1/77; visual brightness 1/62; weights lifted by hand 1/53; tones 1/11; smell of rubber 1/10; cutaneous pressure 1/7; taste of salt 1/5. (See also PSYCHOPHYSICAL METHODS.)

The determination of absolute intensity thresholds shows that the organs of sense can be very sensitive indeed under optimal conditions of excitation. A faint star, just visible out of the corner of the eye when in the dark, delivers to the eye about 10^{-8} microwatt (100,000.000 millionths watt). A tone can be heard at certain frequencies when the eardrum moves only 1,000 millionths of an inch. If the ear mere a little more sensitive, it could actually hear the random movements of the molecules of the air.

Physiology.— Basic problems of sensory physiology concern the mechanisms of translation of physical stimuli into nervous impulses and the neurophysiological mediation of characteristics of discriminative responses.

Like the microphone that translates sound waves into electrical waves, sense organs are transducers that translate a variety of physical stimuli into nervous impulses. Sense organs are selectively "tuned" to be most sensitive to specific forms of energy, their adequate stimuli. The mechanoreceptors initiate impulses in their associated sensory nerves when the receptor cells or their processes are mechanically deformed. The pressure receptors, kinaesthetic and static receptors and the receptor cells of the ear are mechanoreceptors. The skin contains receptors, not yet unequivocally identified. which respond differentially to inward and outward gradients of heat—the thermoreceptors. Sense organs of taste and smell are chemoreceptors. Their adequate stimuli are chemical properties, which are not yet known in detail, of sapid and odorous substances. The receptor cells, rods and cones of the retina are photoreceptors. It has been estimated that the absorption of one quantum of light by the photochemical substance in a rod is sufficient to cause that rod to discharge and thus generate a nerve impulse. It requires many more than one impulse, however, to cause a sensation of light.

No general account of sensation can detail the specific neurophysiological mechanisms mediating sensory discriminatory responses. It is, however. possible to indicate the state of expert opinion concerning the neural correlates of each of the four principal sensory attributes.

What difference in nervous events accounts for differences in perceived sensory quality? The primary distinction in respect of quality is, of course, the difference between modalities, betneen colour and tone and odour and taste. The Greeks believed that objects are perceived because they give off faint copies of themselves. copies nhich are conducted by the nerves to the sensorium which perceives them directly Some such view nas still prevalent enough in the early 19th century for Johannes Müller to combat it in his theory of specific nerve energies. Müller held that for the five senses there are five kinds of nerves, each of which has its own specific kind of energy. The sensorium perceives, he argued, not the objects themselves, but those energies which the objects excite in the nerves. He offered in evidence the fact that a nerve of any one sense always gives rise to its own peculiar quality and never to the quality proper to a different sense. Thus pressure on the eyeball gives a perceived pattern of lights, not perceived pressure only. Later, when the nerves were found to be all alike in their properties and the importance of sensory centres in the brain had been discovered, the specificity that determines modality was seen to be merely the region to which the sensory nerve fibres lead, the cerebral projection area. At mid-20th century, there seemed to be no better theory of modal quality than this gross statement that there is a specific cerebral projection area for each of the five sensory modalities. Presumably, therefore, the existence of modalities means that the organism can react discriminatively to the general region of sensory cerebral excitation.

There remains the question of the nature of qualitative differences within the single sense department, the differences between tones or between colours. In 1852 Helmholtz extended Muller's theory of specific nerve energies to the separate fibres within the nerve and the separate qualities within the sense. In vision he assumed, as had Thomas Young before him (1801), three kinds of fibres, one for each of three physiologically primary colours. Later he was bold enough to argue for the existence of a separate fibre in the auditory nerve for every distinguishable pitch—several thousand specific energies. Research more than half a century later, especially in the 1930s, tended to support Helmholtz' view about the specificity of sensory fibres, but at mid-century it was still not clear what happens in the brain. There was some evidence that different pitches (especially the high ones) depend on different regions of excitation within the auditory projection area, but in the visual area difference of localization implies difference in perceived position, size or shape, not a difference in colour.

Using microelectrodes investigators have been able to record the electrical responses to stimulation from single cells in various sense organs and sensory nerve fibres. There are ganglion cells in the retina that discharge only to stimulation from a relatively narrow band of wave length of light; others show a much broader response sensitivity to wave length. There are fibres in the optic nerve that discharge during stimulation; others discharge only briefly at the beginning and end of a flash of light; and a third type responds briefly only at the cessation of the stimulus. Microelectrode studies of other modalities indicate a similarly complex situation. It seems that sensory qualities are encoded into nerve impulses in terms of complex patterns or combinations of impulses from receptor types rather than simply in terms of specific receptor and fibre types for each quality.

Intensity seems definitely to depend upon the amount of neural excitation. Since a single nerve fibre operates under the all-or-none law (*q.v.*), giving rise either to its maximal excitation or to none at all, neural transmission of intensitive differences requires some explanation. It appears that when an increase in intensity is transmitted from the sense organ to the brain, sometimes the number of fibres involved in the transmission is increased. sometimes the rate of successive impulses sent along each fibre is increased. Often both principles work together. for the effect of a strong stimulus is likely to spread and thus to involve more and more fibres as its intensity is increased; and it is also true that a strong stimulus produces a faster series of impulses in a nerve fibre, since with a strong stimulus the fibre has to recover less fully after one discharge before it is ready for the next.

In respect of extensity it may be noted that in vision the point-to-point correspondence of the retinal field with the visual area of the brain is quite well established. This correspondence is topological, not topographical; that is to say. the order of points in one field matches a corresponding order in the other, but shapes and sizes need not be the same in the two. If a pattern be drawn on thin rubber membrane and then the membrane be stretched unevenly over an irregular surface, the distorted pattern will be topologically the same as the original pattern, but not topographically. The distortion changes shapes and distances but not orders.

Spatial differences in loci of stimulation on the retina result in different loci of excitation in the brain.

It is assumed that tactual space perception is mediated in a manner similar to visual. Like the retina, the body surface is topologically projected on the cerebral cortex. In the spinal cord nerve fibres are sorted into separate bundles according to the various modalities (pressure, pain, proprioception, temperature). When the projection fibres reach the cortex, however, they are arranged not according to modality but spatially in terms of the projective map of the body. In general, spatial difference in perception suggests the existence of spatial difference in cerebral excitation.

Since duration can be perceived, it follows that the organism can respond differentially to different periods during which stimulation is continued. How the brain adds up such a duration while it is occurring, so that there can be a reaction to it as a whole when it is finally complete, is not known.

See EAR. ANATOMY OF; EQUILIBRIUM, ANIMAL; EYE, HUMAN; HEARING; OLFACTORY SYSTEM; SKIN, SESSORY FUNCTION OF; SIGHT, SENSE OF; SMELL AND TASTE; TOUCH, SENSE OF; VISION; PSYCHOLOGY. PHYSIOLOGICAL. See also Index references under "Sensation" in the Index volume.

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SENTENCE, in law, the term signifying a judgment of a court of criminal jurisdiction imposing punishment in the form of a fine, probation or imprisonment.' The judge presiding at the trial ordinarily has discretion as to type and severity of sentence, provided that he stays within the legislatively prescribed limits for the offense of which the person has been convicted. A sentence may be invalid if it violates the "cruel and unusual punishment" provision common to most constitutions of the states of the United States. Typically this has been applied only to .unusual punishments, such as sterilization where there was an insufficient showing that the criminal traits of the defendant were in fact inheritable.

If the judge imposes a prison sentence in a case where the offender has been convicted of more than one crime, he may make the sentences run concurrently, which is the customary practice, or consecutively. If made to run consecutively the prisoner must serve the first sentence before he becomes eligible for parole at the expiration of a portion of the second sentence. (F. J. R.)

SENTIMENT (Latin *sentire,* Old French sentiment, "feeling") denotes not feeling as such, but the composite mental attitude determined by a group of feelings. The first British philosopher to attempt a systematic discussion of feelings and emotions was David Hume. Following Descartes he takes "passion" as the generic term and distinguishes between the "direct" and simpler passions (*e.g.,* grief, fear, anger or sex) and the "indirect" and more complex (*e.g.,* humility, ambition, hatred of evil and love of truth and beauty). J. Sully uses "emotion" as the generic term: "passion" he reserves for the stronger and more direct feelings, especially those associated with the primitive instincts; and he applies "sentiment" to the calmer and more continuous states which arise from, or are influenced by, the higher intellectual processes. Colloquially, "sentiment" and its derivatives ("sentimental," etc.) often imply a shallow, romantic or even unbalanced emotional attitude.

Twentieth-century psychologists use the term to denote an organized system of emotions (see EMOTION) relating to some particular object of thought or perception. This interpretation, first clearly defined by A. F. Shand, was accepted by other British writers, notably G. F. Stout and W. McDougall, who emphasized the importance of such complex emotional systems in the development of character and personality. Thus "emotion" refers to feelings as they are actually experienced, whereas a "sentiment," as thus defined, refers to a disposition or tendency to feel emotions, but is not itself experienced. Moreover, the tendency to react with a primitive emotion. such as fear or anger. is instinctive, whereas the more complex dispositions. described as "sentiments," are gradually built up during the course of individual experience.

Typical examples are the sentiments of love or hate. In ordinary speech "love" may refer either to the emotion felt (for which modern psychologists commonly use a different uord, *e.g.,* "tenderness") or to the acquired "sentiment" (*e.g.,* the love which a child bears toward its mother.) In this case the word designates not a passing emotion but a permanent attitude.

4 similar account of the way a group of emotions may become organized around a specific idea was later put forward by psychoanalytic writers, notably Carl Jung and Sigmund Freud. Such a system they usually called a "complex." Since, however, they were concerned chiefly with abnormal or morbid behaviour, the term "complex" is, as a rule, confined to organized systems of emotions which have become repressed and so issue in conduct that appears irrational and at times unaccountable. The sentiments of the normal person, on the other hand, are usually intelligible and more or less rational, and an adult is generally aware of what his sentiments really are. The distinction has been neatly expressed by saying that "a complex is an untidy sentiment and a sentiment a tidy complex." There is, however, no sharp distinction between the two; the conduct of even the most normal persons is seldom wholly rational.

The earliest to develop are sentiments for other people; but of all the "personal" sentiments the most powerful is that which the child acquires for himself—his "self-regarding sentiment"—and which comes to regulate much of his day-to-day behaviour. Other sentiments are meanwhile acquired, some temporary, others permanent. for hobbies, games, special subjects—in short, what are ordinarily called "interests." Later still sentiments develop for highly abstract concepts. Many modern psychologists (*e.g.,* J. Sully and E. B. Titchener) recognize three main classes of sentiment, corresponding to the three fundamental types of value; namely, the logical, the aesthetic and the ethical or moral.

The acquisition of such sentiments introduces some degree of purpose and consistency into a person's general conduct; without them his actions would be a disorderly sequence of primitive emotions and impulses. At times, however, the tendencies implicit in different sentiments may clash and, if no higher harmony is achieved, the result may be a nervous or moral breakdown. In the normal and stable person, however, the sentiments become organized into a hierarchy which gives the dominating sentiment—often the ego-ideal—a priority, whenever there is a likelihood of conflict. To understand a man's character and conduct, therefore, one of the most important clues is the study of his ruling sentiments. See also ATTITUDE.

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SENTINUM, an ancient tonn of Umbria, Italy, lying to the south of the modern town of Sassoferrato, in the low ground. The foundations of the city walls are preserved, and a road and remains of houses have been discovered, including several mosaic pavements. In the neighbourhood the battle took place in which the Romans defeated the combined forces of the Samnites and Gauls in 295 B C. It was taken and destroyed in 41 B.C. by the troops of Octavian. but revived under the empire. The people of Sentinum had many of the rights of Roman citizenship.

SENUFO, a tall. longheaded people, with long, wide noses, of the Sudanese Republic and Ivory Coast. The Senufo have numerous subdivisions, notably the Minianka, Pomporo, Tagwana, Djimini, Diamala, Nafana, etc.. all speaking a language related to the Volta group. Each tribe is subdivided into clans having each its taboo animal, and the tribes are split up into independent chiefdoms The Senufo have a number of age classes with progressive initiation, and they are animist in religion though a few are Moslem. They are agriculturalists and live in houses that are either thatched or have platform roofs. Inheritance goes to the uterine brother or maternal nephew; the son is excluded.

See Delafosse, "Le peuple siena ou Senoufo," *Revue des études ethnographiques et sociologiques*, vol. i, ii (1908–09).

SENUSSI and **SENUSSITES,** or SANUSI and SANUSIYA. are the names, respectively, of a Moslem family (and especially its chief member) and of the fraternity or sect recognizing the authority of the chief. In this article the form as-Sanusi (otherwise es-Senussi) will be used only in reference to individual chiefs.

The First **Sheikh.**—Mohammed ben 'Ali ben as-Sanusi al-Khattabi al-Hasari al-Idrisi al-Muhajiri, the founder of the order, commonly called Sheikh as-Sanusi, was born near Mostaganem, Alg., and was called as-Sanusi after a much venerated saint whose tomb is near Tlemçen. The date of his birth is given variously as 1791, 1792, 1796 and 1803. He was a member of the Awlad Sidi Abdullah tribe of Arabs and his descent is traced from Fatima, the daughter of Mohammed. As a young man he spent several years at Fez, where he studied theology. When about 30 years old he left Morocco and travelled in the Saharan regions of Algeria, preaching a reform of the faith. From Algeria he went to Tunisia and Tripoli. gaining many adherents, and thence to Cairo. where he nas opposed by the ulema of al-Azhar, who considered him unorthodox. Leaving Egypt as-Sanusi went to Mecca. where he joined Mohammed ben Idris al-Fasi. the head of the Khadirites, a fraternity of Moroccan origin. On the death of al-Fasi, as-Sanusi became head of one of the two branches into which the Khadirites divided; and in 1835 he founded his first monastery at Abu Kubais, near Mecca. While in Arabia as-Sanusi visited the Wahhabis, and his connection with that body caused him to be looked upon with suspicion by the ulema of Mecca. It was at Mecca, however, that as-Sanusi gained his most powerful supporter, Mohammed Sherif, a prince of Wadai, who became in 1838 sultan of his native state, then the most powerful Mohammedan kingdom in the central Sudan. Finding the opposition to him at Mecca too powerful, as-Sanusi quitted that city in 1843 and settled in Cyrenaica, where in the mountains near Derna he built the Zawiya al-Baida, or White Monastery. There he was in close touch with all the Maghribin, gaining many followers among the Tripolitans and Moroccans. The spread of the fraternity mas, however, not viewed with favour by the Turks, who at that time ruled Cyrenaica. Probably with the desire to avoid pressure from the Turks, as-Sanusi removed in 1855 to Jaghbub, a small oasis about 30 mi. northwest of Siwa. There he died in 1859 or 1860, leaving two sons, one, Mohammed Sherif (named after the sultan of Wadai), born in 1844, and the other, al-Mahdi, horn in 1845. To the second son was left the succession. It is related that as the younger son showed a spirit in all things superior to that of his brother the father decided to put them to the test. Before the whole zawiya at Jahgbub he bade both sons climb a tall palm tree and then adjured them by Allah and His prophet to leap to the ground. The younger lad leaped at once and reached the ground unharmed; the elder boy refused to spring. To al-Mahdi, "who feared not to commit himself to the will of God," passed the birthright of Mohammed Sherif, who appears to have accepted the situation without complaint and held the chief administrative position in the fraternity under his brother until his death in 1895.

The Second **Sheikh.**—As-Sanusi al-Mahdi, only 14 when his father died. enjoyed all his father's reputation for holiness and wisdom, attributes consistent with all that is known of his life. Mohammed Sherif, the sultan of Wadai, had died in 1858, but his successors, Sultan 'Ali 'Ali (who reigned until 1874) and Sultan Yusuf (reigned 1874–98), nere equally devoted to the fraternity. Under as-Sanusi al-Mahdi the *zawiyas* of the order extended from Fez to Damascus, to Constantinople and to India. In the Hejaz members of the order were numerous. In most of these countries the Senussites occupied a position in no respect more powerful than that of numbers of other Moslem fraternities. In the Hausa states (*i.e.,* north Nigeria) they made little headway, the Moslems there acknowledging the headship of the sultan of Sokoto. In the eastern Sahara and in the central Sudan the position was different: from the western borders of Egypt south to Darfur, Wadai and Bornu, west to Bilma and Murzuk and north to the coast lands of Tripolitania, as-Sanusi al-Mahdi became the most powerful sheikh, acquiring the authority of a territorial sovereign. The oases in the Libyan desert were occupied and cultivated by the Senussites, trade with Tripoli and Benghazi (Bengasi) was encouraged, law and order were maintained among the savage Bedouin of the desert. But the eastern Sahara is among the most desolate and thinly populated parts of the world, and of more importance to the order was the influence possessed by the sheikh in the central Sudan.

Although named al-Mahdi by his father there is no evidence to show that the younger as-Sanusi ever claimed to the the mahdi, though so regarded by some of his followers. When, however, Mohammed Ahmed, the Dongalese. rose against the Egyptians in the eastern Sudan and proclaimed himself the mahdi, as-Sanusi was disquieted. He sent an emissary via Wadai to Mohammed Ahmed, this delegate reaching his camp in 1883 soon after the sack of El Obeid. "The moral and industrial training of the Senussi [delegate]," wrote Sir Reginald Wingate, "revolted from the slaughter and rapine he saw around him. The sincere conviction of the regeneration of the world by a mahdi whose earnest piety should influence others to lead wholesome and temperate lives, the dignity of honest labour and self-restraint, these were the sentiments which filled the mind of the emissary from Wadai" (*Mahdiism and the Egyptian* Sudan, 1891).

As-Sanusi al-Mahdi, there is reason to believe, shared the lofty views which Wingate attributes to his agent. He decided to have nothing to do with the Sudanese mahdi, though Mohammed Ahmed wrote twice asking him to become one of his four great khalifas. To neither letter did as-Sanusi reply; he warned the people of Wadai, Bornu and neighbouring states to abstain from Sudanese affairs. The Darfur revolt of 1888–89 against the khalifa Abdullah was nevertheless carried out in the name of the Senussites.

Contact with the French.—The growing fame of the Senussi sheikh once more aroused anxiety among the Turks, Sultan Abdul-Hamid II seeing with alarm that in many parts of Tripolitania and in Benghazi the power of the sheikh was greater than that of the Ottoman governors. In 1889 as-Sanusi al-Mahdi was visited at Jaghbub by the pasha of Benghazi at the head of some troops. This event led the sheikh (1894) to leave Jaghbub and fix his headquarters at Jawf in the oases of Kufra, a place sufficiently remote to secure him from any chance of sudden attack. By this time a new danger to the sect had arisen: the French were advancing from the Congo toward the western and southern borders of Wadai. In 1898 the sheikh, wishing to range together all the states menaced by the French advance, sought to reconcile Rabah Zobeir (*q.v.*) and the sultan of Bagirmi; neither of those chieftains belonged to the Senussi order and the sheikh's appeal was unavailing. In Wadai, Sultan Yusuf's successor, Ibrahim, who ascended the throne in 1898, showed signs of resenting the advice of the sheikh, stirred, perhaps, by the overthrow of the khalifa Abdullah at Omdurman. As-Sanusi retaliated, says Capt. Julien in his history of Wadai, by prohibiting the people of Wadai from smoking tobacco or drinking merissa, the native beer, "which is to the Wadaiin what the skin is to the body." Sultan Ibrahim rejoined that his people would fight and die for *merissa;* rather than give it up they would renounce Senussi doctrine. The sheikh had the wisdom to give way, declaring that in response to his prayers Allah had deigned to make an exception in favour of the faithful Wadaiin. Ibrahim died in 1900, and his successors fell again under the influence of the sheikh.

In 1900 as-Sanusi al-Mahdi left Kufra for Dar Guran, on the western confines of Wadai. There, at Geru, on the top of a rocky hill, he built and strongly fortified a *zawiya.* His object was to try to stem the advance of the French, who in this same year had slain Rabah in battle and occupied Bagirmi. The sheikh sought to prevent the French from occupying Kanem, a country northeast of Lake Chad and bordering the Sahara, impinging in fact on what was considered Senussi land. Thus for the first time the Senussites came into conflict with a European power. There had been for some time a belief among certain French and British travellers in North Africa that the Senussites would proclaim a jihad or holy war and that they would have the support of all the Moslems of North and West Africa. This belief was founded partly on the supposed tenets of the order and partly on an exaggerated conception of the strength of the Senussites. The Senussi warriors proper, those who owed direct allegiance to the head of the order, numbered a few thousand at most. For the rest the Senussi sheikh depended upon his spiritual influence and its effect in inducing the peoples who had embraced his doctrines to act as he wished. Moreover, the record of the first and second Senussi chiefs shows them to have acted on the defensive. As-Sanusi al-Mahdi, in opposing the French, undertook no war of aggression, nor was there any great rally of the tribes to his banner. In Kanem he was left to fight with his Bedouin followers and such help as the people of Kanem were able to give. A *zawiya* was built at Bir Alali (an *entrepôt* for the trade of Tripoli with the Chad countries) and strongly garrisoned. War ensued and continued for more than a year, but after a severe engagement Bir Alali was captured by a French column in Jan. 1902. Al-Sanusi al-Mahdi was much discouraged by the loss of Kanem and died shortly afterward, on May 30, 1902, at Geru. There he was buried, in the Zawiya at-Taj. But for years the Bedouin believed him to be alive and to have gone on a secret journey.

At the time of the death of as-Sanusi al-Mahdi his sons were minors and the chieftainship went to his nephew, Ahmed ash-Sherif, an ambitious man, not without ability but lacking the wisdom of his predecessors. Ahmed continued his uncle's policy of resisting the French, but despite his efforts after a long and bitter struggle lasting from 1904 to 1911, Wadai was conquered by them. (See WADAI.) In the central Sudan the prestige of the Senussites waned and the advances made by Sheikh Ahmed to 'Ali Dinar, the sultan of Darfur, were not at that time reciprocated. With Egypt and with the British authorities there the Senussi maintained friendly relations. Ahmed, in view of the activity of the French, had again fixed his headquarters at Jawf in the Kufra oases, and in these and the other oases of the Libyan desert he was master. That the desert had been recognized by France as within the British sphere gave him no concern. In Egypt the number of adherents to the order was increasing, and at Alexandria Mohammed al-Idris, the eldest son of as-Sanusi al-Mahdi, lived in some state, receiving Senussi notables from many lands.

The Invasion of **Egypt.**—Meanwhile Sheikh Ahmed had succumbed to the pan-Islamic movement which Sultan Abdul-Hamid II of Turkey had revived and his successor continued. In consequence the Senussites gave substantial aid to the Turks when in 1911 the Italians invaded Tripolitania and Cyrenaica. After the Turks had been compelled to acknowledge defeat Ahmed continued the war with Italy, helped by Turkish troops which, in violation of the first treaty of Lausanne, had remained in the country. When World War I began the Italians held only a strip of coast land; the Senussites were masters of the interior of Cyrenaica. Terms of accommodation were discussed in the latter half of 1914, and an arrangement might have been reached had not Ahmed refused to accept the position of a protected bey. In the spring of 1915 the Senussites were again attacking Italian ports.

At this time a number of Turkish officers and Arabic-speaking German officers had been smuggled into Cyrenaica, and by heavy bribes and gross flattery they worked upon the vanity and cupidity of Sheikh Ahmed to proclaim a jihad and invade western Egypt. Ahmed hesitated; his hesitation was known to the British in Egypt, and in Nov. 1915 Mohammed al-Idris was sent from Alexandria to his cousin to arrange with him "to get rid of his Turkish advisers in return for a sum of money." It was too late: Ahmed was already well supplied with Turco-German gold and armaments. At the end of 1915 Ahmed invaded western Egypt. The *muhafiziya* or Senussi regular troops numbered at most 5,000, the Turkish troops about 1,000; but the real danger was that any Senussite success might cause a rising among the Bedouin of western Egypt and in the Nile valley. Because of the prompt measures taken by Gen. Sir John Maxwell (commanding in Egypt) the Senussites failed to gain victories; the invaders were eventually repulsed and by Feb. 1917 Ahmed—who in Nov. 1916 had been given by the Turks the title of viceroy of Africa—was completely defeated. He retired to the oasis of Jaghbub.

The failure of this invasion seemed to show definitely that the Senussite brotherhood was not so powerful, either politically or spiritually, as had been imagined. The Germans and Turks had done their utmost by exploiting Senussi influence to cause trouble in directions other than Egypt. In the Sudan 'Ali Dinar, the sultan of Darfur, had been won over, but he was decisively beaten by an Egyptian force under Maj. P. V. Kelly in May 1916; and elsewhere in the Anglo-Egyptian Sudan the Senussi had few adherents. Further west, toward Lake Chad, there was some trouble, but the French, pushing north from Kanem, had seized the Saharan borderlands and captured Ain Gallaka (in Borku), the Senussi southern base, in Nov. 1913. During World War I this and other French outposts formed an effective barrier against Senussi raids. In the hinterland of Tripolitania Senussi influence was strong, and, the Italians being compelled to withdraw to the coast, Mohammed al-Abid, a brother of the Senussi sheikh, ruled in Fezzan until the summer of 1917. Discords in Tripolitania, however, showed clearly that tribal rivalries were stronger than religious bonds.

Relations with the Italians.—Mohammed al-Idris and other Senussi chiefs had not approved Ahmed's invasion of Egypt; al-Idris from his residence in Egypt had gained a knowledge of affairs which Ahmed lacked, and he was a peaceably inclined man. With al-Idris the Italian and British governments entered into an agreement in 1917; the Senussi chiefs acknowledged al-Idris as grand Senussi; and in Aug. 1918 the defeated and discredited Ahmed found it convenient to quit Cyrenaica. He was conveyed by a German submarine from Misurata to Pola, It., whence he went to Turkey, still claiming to be head of the brotherhood. Al-Idris' sent his brother Rida on an embassy to Rome in 1919 and, by the agreement of ar-Rajma (Regima) in Oct. 1920 acknowledged Italian suzerainty. He was given the hereditary title of amir (prince): with jurisdiction over the oases of Kufra, Jaghbub, Jalo, Aujila and Ajadabiya. Peaceful relations continued for some time, but Italy under fascist rule found the situation irksome. There was also evidence that al-Idris was encouraging the insurgents in Tripolitania who in July 1922 had invited him to become their leader and prince. Declaring the position incompatible with the national dignity of Italy, the fascist government denounced the agreements with the Senussi early in 1923. Al-Idris himself had in January of that year withdrawn to Egypt, where he remained. Seemingly he suffered no loss of spiritual prestige, upon which his friends declared he set more store than on temporal authority. In Cyrenaica Senussite resistance to the Italians was organized by Sheikh Rida. It was of a guerrilla character.

The Italians, however, were placed in an advantageous position to control Senussi activity by an agreement made with Egypt on Dec. 6, 1925. This agreement gave them the sovereignty over the oases of Jaghbub, while south of that place the frontier was drawn through longitude 25° E., thus including Kufra in Cyrenaica. Jaghbub was occupied by Italian troops in Feb. 1926 without opposition. It is important as containing the tomb-mosque of the founder of the Senussi sect and a *zawiya* for the training of the ikhwan (brethren).

In 1927 the Italians undertook a regular campaign in Cyrenaica, with such effect that on Jan. 3, 1928, Sheikh Rida surrendered. He was exiled to Sicily. In the spring of the same year Jalo and other oases were occupied. Operations against the tribesmen were continued with vigour, so that by 1929 Kufra alone remained to the Senussites. These remote oases were visited in 1920–23 by Hassanein Bey, Rosita Forbes and Bruneau de Laborie. All three drew a pleasing picture of Senussi culture, which, however, included slavery. The only other Europeans known to have visited Kufra except a French prisoner of war were Gerhard Rohlfs and Anton Stecker, who ventured there in 1879 and had to flee for their lives.

The Senussi exiles in Egypt and their adherents in Cyrenaica co-operated freely with the British forces during the western desert campaigns of World War II in 1940–43. In Oct. 1946 the British government recognized the title of amir as applied to Mohammed al-Idris and on June 1, 1949, invited him to form a Cyrenaican government; he became king of the new United

Kingdom of Libya (*q.v.*) on Dec. 24, 1951.

Tenets of the Order. — The order is in a sense an outcome of the Wahhabi movement but appears, for instance from the writings of the Tunisian sheikh Mohammed al-Hashaishi and others, to be neither mystical nor Puritan. There is less secrecy about their rites than is usual in Moslem fraternities. While they profess to belong to the Maliki rite (one of the four orthodox sects of Islam), the Senussites are charged by the ulema of Cairo with many deviations from the true faith; chiefly they are accused of interpreting the Koraq and Sunna without consulting one of the recognized glosses. Thus the Egyptian theologians regard the Senussites as inaugurating a new rite rather than forming a simple fraternity. Apart from their theological beliefs their chief work, before they were confronted by the activities of European powers, seems to have been colonization and the encouragement of trade.

The missionary zeal of the Senussites is undoubted. Outside the regions adjacent to their headquarters adherents of the order are drawn from a higher social rank than the generality of Moslem secret societies. Its chief agents are personages of wealth and importance and highly educated in oriental lore. They are in general on good terms with the rulers of the countries in which they live. These agents tour the various *zawiyas* and expound Senussi doctrines at Moslem universities.

See E. E. Evans-Pritchard, *The Sanusi of Cyrenaica (1949).*

(F. R. C.; X.)

SEOUL (KYONGSONG; Jap. KEIJO), the capital of the Republic of Korea, at 3i° 34' N. and 127° 6' E. and an altitude of 120 ft.. is 25 mi. from Chemulpo (*q.v.*), its seaport. Pop. urban area (1960) 2,444,883. It lies in a basin among granite hills of 2,000 to 3,000 ft., remarkable for their craggy peaks and barren slopes. Seoul was the capital of Yi dynasty (1392–1910). Shortly after its founding, a stone wall pierced by eight gates, 20 to 30 ft. in height and about 11 mi. in circuit, was built upon the natural base of the hills. The city is 3 mi, N. of the Han river, upon which it depended for its major water supply in early days. The northern part of the old city against the highest hills mas the site of the wall-enclosed palace grounds of the Yi family. It was laid out in wards after the pattern of Peking. Above the flat skyline of single story houses rose the city gates and palace walls.

With the opening of Korea to the outside world in 1876 and particularly after the annexation of Korea to Japan in 1910, many changes came to the city. The city walls were not preserved, and the gates became isolated symbols of the past. A railroad centre was developed between the south gate and the Han river; residential suburbs sprang up, some of them across the Han. An imposing granite Japanese government-general building was built on one of the palace grounds; other brick and stone buildings for bank and commercial concerns modified the appearance of the city. A streetcar system was developed. A university was established on another palace ground in the northeast of the city, and other educational establishments were opened. The Christian missionary influence can be seen by the many churches, including the imposing Roman Catholic cathedral.

After World War II, with Korea divided by the 38th parallel, Seoul became the centre of the U.S. military government and on Aug. 15, 1948. the capital of the Republic of Korea. Refugees from Communist-dominated North Korea flooded into the city. New buildings were constructed and the population spread into the suburbs.

Seoul was an immediate target for attack at the outbreak of the Korean war and was occupied by Communist forces on June 28, 1950, three days after they crossed the 38th parallel. The bridge across the Han was dynamited by Republic of Korea (R.O.K.) forces as a delaying action. The UN forces re-entered Seoul on Sept. 29. 1950, but it was occupied again by Communist troops on Jan. 4, 1951, though it was retaken on March 14, 1951. Great damage was inflicted, especially to the major buildings. After 1951 reconstruction progressed, broad streets were laid out and new buildings were erected. Seoul again became the political, industrial, financial and cultural centre of the republic. It forms a special governmental unit. equivalent to a province. (S. McC.)

SEPARATION OF POWERS. The separation of powers, an essential feature of constitutional government, was classically expounded by Montesquieu in a celebrated chapter of the Esprit *des lois* (1748). In his discussion of the English constitution. he drew a sharp, logical distinction between the legislative, the executive and the judicial powers and insisted that they should be handled by separate and distinct bodies. A variant of this doctrine had been previously stated by the English philosopher John Locke. It would appear ultimately to have derived from ancient and medieval concepts of mixed government (see below).

Locke was concerned with making sure that only one power, the legislative power, be divided between the king and parliament. Before him, the 17th-century political theorist James Harrington had advocated a more abstract notion of a necessary balance of power, which he elaborated in his *Oceana* (1656). Harrington's work shows more clearly than that of the later theorists how the separation of powers derived from the theory of mixed government. The advantages of combining monarchy, aristocracy and democracy had been a commonplace of political thought ever since Aristotle and Polybius. Indeed. it was a doctrine which the most diverse writers agreed upon, including St. Thomas Aquinas and Marsilius of Padua, Machiavelli and the Machiavellians and Monarchomachs. But it lacked precision until it was transformed into the doctrine of the separation of powers.

Following Montesquieu, the separation of powers was given institutional expression in many constitutions, notably the United States constitution of 1787, the French constitutions of the Revolutionary period and various monarchical constitutions of western Europe in the post-Xapoleonic period. It was most fully elaborated in the United States by John Adams. who refined it by a rather flexible doctrine of "checks and balances." Kant gave it its most abstract philosophical form. by interpreting it as the institutionalization of a logical syllogism.

In the light of subsequent constitutional experience, it became clear that the triple separation of powers was only one means of solving a broader constitutional problem: how to insure the restraint of governmental power by dividing such power without carrying division to an extreme incompatible with effective government. Federalism (see FEDERAL GOVERNMENT), the division of power between coexisting territorial jurisdictions. was another means of achieving this purpose. When seen as part of this broader design, the classical functional division of power loses some of its rigidity and dogmatic purity. Any comparative study of modern constitutional systems discloses a great variety of arrangements, as illustrated by the very divergent treatment of the judicial power in the U.S., British, French and Swiss systems, and the organizing and structuring of the legislative power is a problem whose solution likewise varies according to circumstances.

The concept of the separation of powers was sharply attacked, in the name of both democracy (*q.v.*) and efficiency. by fascists and communists who radically rejected the idea of dividing governmental power and insisted upon the need of concentrating it in the hands of ruling party groups dedicated to the revolutionary transformation of society. Other critics, from Jeremy Bentham onward, objected to the inhibiting effect of the separation of powers, insisting that it does not actually operate, that it cannot be effecuated. Thus J. Allen Smith, in The *Growth* and Decadence of Constitutional Government (1930), a penetrating critique focused upon the serious disequilibrium resulting from large-scale modern industry. announced the impending demise of the time-honoured scheme However. experience with the totalitarian dictatorships of the interwar and post-World War II era persuaded many to reconsider. One conclusion was clear. constitutional democracy presupposed a balanced system of divided powers, for only within such a system could the citizen hope to enjoy a measure of independence and freedom through a guarantee of civil liberties.

(C. J. FH.)

SEPARATOR, MAGNETIC, a device for the separation of iron or steel and of feebly magnetic ores, for the purification of materials and the prevention of damage to machines. There are a great many designs of machines, including numerous continuous feed types for handling large quantities of material. One common form has a rotating drum carrying magnets on which the material falls; the magnetic portions cling to the drum and are then brushed off. Another type has a belt passing over two pulleys, the belt being fitted with magnetized feelers. A larger type with long conveyor belt is employed in mining practice for the separation of weakly magnetic minerals from nonmagnetic, such as wolfram from tin, etc. A series of magnets above the belt deal n·ith the material in its passage below them. Some machines are portable and may be made at dumps or tips. while for treating house refuse a rather large fixed separator supplied by a conveyor belt lifts tins and other iron pieces out of the waste and places them automatically into a chute. Used foundry sand can be dealt with by a machine which recovers small splashes of iron. brads. chippings, etc.. and also sieves and grades the sand ready for use again. Mixed iron and brass turnings are separated in the rotary drum class of apparatus. while some separation, as for the pottery and china trade, is effected in a wet trough device. Many kinds of pon-ders and seeds, cocoa beans, tea, tobacco. etc.. are treated by a magnetic separator. Substances that have to go through a crusher are treated magnetically to avoid the risk of damage by "tramp" iron.

SEPHARDIM, ASHKENAZIM AND ORIENTAL JEWS are the three major divisions of the Jewish people.

The Sephardim are the Jews whose ancestors lived in the middle ages in Spain (Sepharad in Hebrew). After their expulsion from Spain (1492) they settled in France, Holland, England, Italy, Greece, Turkey. Palestine and Sorth Africa as well as overseas, where they have continued to live. They preserved everywhere their own customs, religious ritual and the Ladino (Judeo-Spaniolic) language, a form of medieval Spanish with some Hebrew terms. written in Hebrew characters. The Sephardim numbered about 500.000 by the 1960s.

The Ashkenazim (from the Hebrew *Ashkenaz*, Germany) are the Jews whose ancestors lived in the middle ages in German lands and migrated thence to east and west Europe, and. in the 19th and 20th centuries, abroad. Their customs and religious ritual differ markedly from those of the Sephardim. Up to the end of the 19th century most Ashkenazim everywhere spoke Yiddish or Judeo-German. a form of medieval German with a certain percentage of Hebren- expressions. written, like Ladino. in Hebrew characters. The total number of Ashkenazim in the 1960s was estimated at 10,000,000, including almost all the 5,000,000 Jews in the U.S. and some 3,000,000 in the Soviet orbit.

The oriental Jews, more varied in their ethnic characteristics than either the Sephardim or the Ashkenazim, are the descendants of Jews who, following the Assyrian, or Babylonian, or Roman exile from Palestine. settled in countries of the middle east and Sorth Africa. In Arab lands (Lebanon, Syria. Palestine. Iraq. Yemen, Hadhramaut, Egypt, Libya, Tunisia. Algeria and Morocco) they acquired. and have retained, Arabic as their mother tongue: in Persian-speaking lands (Iran: Afghanistan. Bukhara). Persian: in Kurdistan. Neo-Aramaic. From Iraq oriental Jews moved on to India, and from Afghanistan and Bukhara into other parts of central Asia and even into China. In some oriental Jewish communities (notably those of Yemen and Iran) polygyny has been practised. Following the establishment of Israel in 1948 practically all the Yemenite. Iraqi and Libyan Jews and major parts of the Turkish. Tunisian. Algerian, Moroccan and Syrian Jewish communities were resettled in Israel. The oriental Jews numbered in the 1960s about 2,000,000.

Some minor Jemish groups do not fit into the above threefold division. These comprise the 2.000-year-old Italian-speaking Jewish communities; the even older Greek-speaking Jewish communities (mostly destroyed during the Nazi occupation): the Falashas (*q.v.*) or black Jews of Ethiopia: and the Bene-Israel (*q.v.*) or black Jews of India, of obscure origin. (RA. P.)

SEPIA is a dark brown pigment obtained from the ink sacs of cuttlefish (Gr. *sepia*, "cuttlefish.'! *q.v.*). The ink sacs (which are speedily removed on capture and dried to prevent putrefaction) are digested with dilute alkali. the solution is filtered and the colour precipitated with dilute hydrochloric acid. washed, filtered and dried. It is fairly permanent and inert and is used as an artists' water colour particularly in monochrome.

SEPOY. The Anglo-Indian word for a native soldier of the former British native army of India in contradistinction to *gorā*, a "fair-complexioned (European) soldier." The word is derived from the Persian. *Sipahi*, from *Sipah*, "soldiers." "an army." The expression "sepoy" was in use in southern India before the East India company had troops in Bengal, and was probably introduced by the Portuguese. (See INDIAN MUTINY, THE.)

SEPSIS means. literally. putrefaction or decay and implies illness from the absorption of noxious substances. It is too inexact a word to convey the specific meaning required by modern medical nomenclature and is used usually as a descriptive adjective (septic) to denote a special appearance or attitude. A diagnosis of sepsis at the bedside of a patient would be as untenable as that of biliousness. diarrhea or headache. The word "toxic" is frequently used synonymously but it is not altogether correct. Toxins (poisons) may be synthetic. such as various synthetic drugs: elements. such as the metals (lead and arsenic); or they may be elaborated by plants (curare). animals (cobra) or bacteria (tetanus, diphtheria). Toxins are introduced from without, whereas the victim of sepsis is carrying the responsible focus within his body. An example of this is a patient whose bowel is obstructed: he is absorbing back into his system products which normally should be eliminated.

To appreciate sepsis in the proper light, the older view of simple putrefaction as the sole cause must be rejected and the role of bacterial agents in the process considered. Before bacteria were discovered and before the communicable nature of disease was known, putrefaction and fermentation were considered the basis of the septic state. Theodor Schwann in 1836 found that putrefaction was caused by living organisms and of course Louis Pasteur finally laid to rest the old belief.

Sapremia.—When dead inert protein material lies static within a hollow viscus (intestine) or in a body cavity (abscess of the lung. liver, blood clot) certain bacteria gain access to it. Such access may be by direct inoculation, as with a needle or instrument used to evacuate the cavity, or by direct extension through membranes which are in contact with the outside (bronchial tubes, intestinal tract, skin). These bacteria are called saprophytes because they live and multiply in such a necrotic environment and are incapable of invading healthy tissue. They are not pathogenic (capable of originating disease) in the human body. Having gained access to this suitable medium. these bacteria multiply. use the protein content for food and elaborate waste products. The body, then. through the blood and lymph vessels, absorbs these waste products and a state of sapremia. a form or subgroup of sepsis, is thereby set up. The body's response is loss of appetite and weight, depletion of energy. slight to moderate fever; in other words, the usual clinical picture of chronic illness. If such a situation continues for a period of years, irreversible cellular changes such as amyloid degeneration may take place in the liver and kidneys particularly, thus making complete recovery. even with proper care, virtually impossible. Early diagnosis. prompt evacuation of the putrid contents under strict aseptic conditions, the prevention of secondary infection by pathogenic organisms during the application of dressings. and the building of an adequate protein and vitamin reserve will usually bring about complete recovery from the sapremic state.

Septicemia. — It is not always possible to know definitely by the symptoms and signs shown that the putrefactive or saprophytic bacteria are entirely responsible; and other subgroups of sepsis must then be considered. Pathogenic bacteria may also invade the putrid cavity and from it gain access to the body. They are capable of living and multiplying in otherwise healthy tissue and originating a disease known as septicemia. To make an exact diagnosis of this state the identity of the organism must be established. For instance, we may have streptococcal septicemia, pneumococcal septicemia. typhoid septicemia. etc. This identification is usually accomplished by cultures of the blood or of the discharge from the wound at the portal of entry. Unlike sapremia, the bacteria that cause septicemia do not need a large putrefying cavity as a base of operation. The highly virulent streptococcus. for instance, may gain entrance through a scratch or prick of which the individual was barely aware, or, indeed, the portal from which the blood poisoning originated may never be established. Occasionally, sudden "lighting up" of a focus inside the body will be a factor, as an abscess at the root of a tooth, infected tonsils, sinuses. gall bladder, prostate, etc.

Pyemia.—Another subgroup under the broad heading of sepsis is pyemia. The bacteria causing pyemia are like those causing septicemia; that is, they are pathogenic in the body but they are also pyogenic, which means they are capable of local tissue destruction and pus formation. The most common causative organism in this subgroup is the staphylococcus. On gaining access to the blood stream they are carried by the circulation throughout the body. to become lodged finally in the small end arteries where they set up local abscesses in the bones. joints. lungs, brain, liver or actually in any tissue. If their number in the circulating blood is small, it may not be possible to make identification by blood culture. Pyemia is a frequent disease of children and is the forerunner of the common affliction of bone in childhood. hematogenous osteomyelitis (blood-borne infection of bone).

Bacteria, then, form the background of sepsis. and bacteriology is the branch of science through which they are studied. Their effect on the body is both local and general and the intensity of this effect will be determined by the virulence of the organism and the resistance of the individual host. The more virulent the organism the more likely it will be to gain entrance, multiply, ravage and destroy, to a point beyond the tolerance of body tissues. The person whose resistance is low for any reason may be unable to withstand such an onslaught.

Bacteria of many kinds are ever-present in and on the body and throughout its environment. and when they remain in their natural habitat they are not only harmless but actually beneficial. However, when they leave this natural locale, they may set up an infection which may cause subsequent sepsis. For instance, the colon bacillus is harmless and useful in the intestine. but is capable of producing serious disturbances in the genitourinary tract; the staphylococcus is present in great numbers and is harmless on the skin, but if it invades a hair follicle a boil or carbuncle may follow. The pneumococcus is frequently found in routine culture of the throat and nasopharynx in healthy persons and it is not considered significant, but if it encroaches on the lung fields pneumonia will follow.

The local reaction set up by the invaded tissue is known as inflammation, and this is simply the body's response to injury. (See INFLAMMATION.) Such inflammation. may be initiated by any injury, whether it be bacterial invasion) a wound or thermal or chemical insult. It is characterized by redness, swelling. increase in regional heat and pain. These phenomena are the result of the stimulation and activation of nature's defenses. The rate of blood flow to the part is quickened and the white cells of the blood (defenders! are mobilized. The small blood vessels and capillaries become more permeable and permit an outpouring of cells and plasma into the involved tissues. If the invaders are pyogenic bacteria. pus (suppuration) is produced. This is a combination of destroyed and liquefied tissue. blood serum, dead bacteria and white blood cells. Before the relationship of bacteria to suppuration was understood, this material was called laudable pus, probably with the inference that the invader was not highly virulent and that the invasion was at least contained, if not thwarted altogether. Then again. laudable pus probably indicated to the physician of those days a more favourable prognostic sign than did the thin serous discharge of highly virulent streptococci. If the suppurating area has a sufficiently large absorptive surface, the systemic effects are then produced, and these are those of the septic state. The symptoms of fever, chills, malaise. etc., are the result of the absorption of the broken-down tissue at the point of infection, or the result of toxins stored in the bacterial bodies and released after their death and destruction by the white blood cells.

Treatment. — It is evident that in the management of the septic state the exact diagnosis of the subgroup of sepsis must first be made. Treatment and prognosis will depend on the differentiation between sapremia, septicemia and pyemia. As mentioned before, the sapremic state will usually be caused by the presence of a cavity containing putrescible material under tension. When the tension is relieved and drainage is instituted, improvement will begin; but not until complete evacuation, sterilization and obliteration of the cavity have taken place will a cure be effected. Evacuation is accomplished by incision and drainage. This allows the local defense forces to phagotize (neutralize and destroy) the bacteria and render the cavity sterile. The reparative process then obliterates the cavity with scar tissue and no vestige of the original disease remains. Aside from general supportive measures no specific treatment need be used other than surgical drainage.

If cultures of the cavity discharges or the blood indicate that pathogenic bacteria are present, surgery is not indicated until the infection is definitely localized. To make an incision in or otherwise harshly handle an area of diffuse infection is to risk the danger of opening more channels for invasion. and of breaking down the barriers nature has already set up to keep the infection localized. The involved part is rested, splinted if necessary. and moist warm dressings are applied to increase the blood flow and prevent the discharges, if any, from crusting and thus interfering with free drainage. Sulfa drugs and appropriate antibiotics such as penicillin. streptomycin, etc.. are useful supplements.

The treatment of the other subgroup. pyemia. does not vary from that outlined above because. as stated. pathogenic bacteria are in the blood stream and they are capable of setting up abscesses in any part of the body (see ABSCESS). If. when and where such abscesses will occur cannot be predicted. and diagnosis of their presence cannot be made nor treatment instituted until clinical signs are evident. When such abscesses do occur each must be treated as a separate entity. and such treatment will depend in great measure on the type of tissue in which the abscess is located. This is readily seen when one considers the difference between bone, brain, lung, liver, etc. The best weapons for sterilization of the blood stream and the prevention of formation of such abscesses are the antibiotics. See also BACTERIAL AND INFECTIOUS DISEASES. (J. K. SK.)

SEPTARIUM, a subspherical concretionary body an inch to a foot or more in diameter found in some shales and characterized by an internal network of veins. The network is irregular but commonly is radial — the veins widening inward from the surface — and also concentric. Vein fillings are generally calcite; less commonly barite, selenite, pyrite and marcasite. The veins do not extend to the exterior. However, septaria released from their matrix and transported by streams or waves may be eroded until the vein structure is visible from the outside. The symmetrical arrangement displayed by the veins has given rise to the erroneous identification of the septarian bodies with fossils. They have been called turtle backs. Septaria occur in many places; they are common in the shales of the Coal Measures of the Carboniferous system in England.

The origin of the septarian structure is obscure. The veins are believed to be the result of precipitation of mineral matter in a shrinkage crack system. The mineral matter is perhaps extracted from the surrounding rocks and reprecipitated in the septarium nodules. *See* also CONCRETION. (*F.* J. P.)

SEPTEMBER, the ninth month of the modern calendar. with 30 days. As is shown by its name (from Lat. *septem*), it was the seventh month in the early Roman calendar. which began with March. In the United States the first Monday of September is celebrated as Labour Day (*q.v.*), and the weekend in which it falls has become a major holiday, conventionally regarded as the end of the summer season. Michaelmas. the feast of the archangel Michael. is Sept. 29. An old saying runs, "If you eat goose on Michaelmas Day, you will never want money all the year round." The autumnal equinox occurs in this month. (F. R. WN.)

SEPTUAGINT, THE, the earliest Greek translation of the Old Testament, so named from the legend of its composition by 70 (Lat. *Septuaginta*, lxx). or more exactly 72. translators sent from Jerusalem to Alexandria at the request of Ptolemy II Philadelphus (288–247 B.C.) by the high priest Eleazar. The

Letter of *Aristeas* to Philocrates which unfolds a fantastic story is certainly spurious, though it contains some elements of truth; *e.g.,* that the work was the result of collaboration and was approved by the Jewish community in Alexandria. The king's share in the business is quite secondary, but we know that Ptolemy Philadelphus was a ruler of eclectic literary tastes, and he may well have encouraged an enterprise which not only appealed to his own curiosity but would promote the use of the Greek tongue among the large Jewish population of his city.

That population had been steadily increasing since the time of Alexander the Great, and while remaining loyal to the Hebrew faith had lost its knowledge of the Hebrew tongue, without acquiring that Aramaic equivalent which had become the common speech of Palestine, and in which the law and the prophets were expounded in the synagogues of Palestine. Faced by sheer necessity, the pious Jews of Alexandria were resolved to understand the Scriptures which were read to them in their own synagogues, and they overcame the age-long prejudice of the authorities at Jerusalem against the writing of Scripture in any but the old holy form.

It was natural to begin with the law, and the Greek version of the Pentateuch dates from the beginning of the 3rd century B.C. In the 2nd century B.C., when it had become customary to read not only the law but the prophets in public worship, the bulk of this second section of the Hebrew scriptures was similarly translated. In each case the work was done by a small company, but afterwards the enterprise became more casual. From the prologue to Ecclesiasticus we learn that about 130 B.C. portions of the third division of the Hebrew Bible—the "Writings"—were also extant in Greek, but these were private ventures made not so much to meet the direct need of the synagogue as those of a public now becoming interested in the growing series of translations of the Hebrew sacred books. Philo (c. A.D. 40) seems to have known the Greek versions of all the O.T. books except Esther, Ecclesiastes, Canticles and Daniel.

As the work of translation went on so gradually, the compass of the Greek Bible came to be somewhat indefinite. The law always maintained its pre-eminence as the basis of the canon; but the prophetic collection changed its aspect by having various writings incorporated with it according to an arbitrary arrangement by subjects. In some books the translators made considerable additions to the original, *e.g.,* those to Daniel, and these became a part of the Septuagint. To some extent the widening of the O.T. canon in Greek must be laid to the account of Christians. The Septuagint does not keep the triple Hebrew division of law, prophets (which included history) and writings, but groups its books according to subject-matter, law, history, poetry, prophecy, a divergence which was important for the history of the O.T. canon in the Christian Church. The early Christians generally accepted the LXX. canon, which through the Old Latin, despite Jerome's Vulgate adoption of the Hebrew canon, passed into the West and into Latin Bibles, where the Apocrypha are still included.

After the destruction of the temple at Jerusalem in A.D. 70 there was a reaction against the LXX., a movement connected with the strict definition of the canon and the fixing of an authoritative Hebrew text by the rabbis of Palestine. But long usage had made it impossible for the Jews to do without a Greek Bible, and to meet the need a new version was prepared in accurate correspondence with the Pharisaic text and canon. This was the version of Aquila, which took the place of the LXX. in the synagogues, and long continued in use there. Later versions were produced by Theodotion (whose Daniel even got into LXX. mss.) and Symmachus (see BIBLE: Canon and Text).

The vocabulary and accidence of the Greek of the Septuagint are substantially those of the *κοινὴ διάλεκτος* or Hellenistic Greek spoken throughout the empire of Alexander. The language of the Pentateuch attains the higher level of the papyri of the early Ptolemaic age; that of the prophets reflects the less literary style of the papyri of *c.* 130–100 B.C. In the latest parts of the translation Dr. St. John Thackeray notes two opposing influences: (a) the growing reverence for the letter of Scripture, tending to a pedantic literalism; *(b)* the influence of the Atticistic school, strongest in free writings like 4 Macc. but leaving its mark also on 4 Kings. In syntax especially the LXX. is strongly tinged with Hebraisms, and there are many passages where it is almost impossible to extract any rational meaning.

In some cases a book bears the marks of two hands, *e.g.,* Jeremiah i.–xxviii. is from another hand than xxix–li., and so with Ezekiel, where xxviii.–xxxix. stands apart from the remainder. In these cases probably one man dictated, the other translated, and then they changed over. Isaiah is more akin to classical Greek; like the Pentateuch and 1 Macc., *i.e.,* is good *κοινή*. The two chief mss. of Judges vary so much as to point to different recensions. In some books, especially Jeremiah xxv.–li., the order of the LXX. is totally different from that of the Massoretic Hebrew (cf., also Proverbs xxiv.–xxix.). In some cases, *e.g.,* Job, the original LXX. text was much shorter than that of the Massoretes; in Esther and Daniel there are numerous additions. Apart from its being the oldest translation of considerable extent that ever was written, the Septuagint was "the first step towards that fusion of the Hebraic with the Hellenic strain which has issued in the mind and heart of modern Christendom;" It is also the starting point for the history of Jewish interpretation and the Jewish view of Scripture. Hence its importance as a document of exegetical tradition, especially in lexical matters, may be easily understood. It was largely composed before the close of the O.T. canon, and in it alone are preserved several Jewish writings that never became canonical. As the book which at last codified the dialect of biblical Greek, it is a key to the N.T. and its dependent literature. To many its chief value is that it is the only independent witness for the text of O.T. which we have to compare with the Massoretic text. Its critical value is unfortunately greatly impaired by the corrupt state of its own text. As we have not the version itself in authentic form we cannot reconstruct with certainty the Hebrew text from which it was made. The difficulties in getting behind the confusion of versions and recensions and of weighing the patristic evidence are very formidable. The chief uncial mss. are, as for N.T. ℵ A, B, of which A and B are largely complete, but though both of Egyptian origin, vary considerably. A may represent the edition of Hesychius, B that of Origen. When the arduous task of reconstructing the text of LXX. has been achieved, there still remains the problem of its relation to the Hebrew. The Hebrew text from which the LXX. translators worked was often divergent from that represented by the Massoretic text, but we need not assume that in cases of difference the Greek is to be preferred. The LXX. translators made some palpable mistakes; their knowledge of Hebrew was often inadequate; they occasionally interpreted as well as translated, and they sometimes introduced local colour. Yet there is no doubt that much (*e.g.,* in 1 Sam.) may be learned from the Septuagint; all one can say is that each case must be treated on its own merits.

Amongst recent studies of the Septuagint may be mentioned the theory of Dr. M. Gaster that it is a Palestinian work, a first step towards a Targum, written for the masses rather than for synagogue worship, and "an answer to Greek pretensions," a carrying of the war against Hellenism into the enemy's camp. But neither this nor the quaint notion of Wutz that the LXX. translators worked not from Hebrew mss. but from a transliterated text, *i.e.,* Hebrew written in Greek characters, has met with any acceptance. More fruitful are the suggestions made by Dr. St. John Thackeray as to the "liturgical" aspect of the Greek Bible. The LXX. was first printed in the Complutension Polyglot (1514–17), but before this was published in 1521, Aldus had published another edition in 1519. H. B. Swete's compact edition in 3 vols. (1887–94; revised 1895–99) gives the text of B so far as available, then A or ℵ, with variant readings from the chief uncials. The larger Cambridge edition (1906, in progress) by A. E. Brooke and N. McLean follows the same plan with the text, but its apparatus includes all the uncials, the best minuscules and the chief versions and patristic quotations.

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(A. J. G.)

SEPULCHRE, CANONS REGULAR OF THE HOLY, an order said to have been founded in 1114 (or, according to other accounts, during the rule of Godfrey of Bouillon in Jerusalem) on the rule of St. Augustine. Pope Celestine III., in 1143, confirmed the Church and Canons of thk Holy Sepulchre in all their possessions, and enumerated several churches both in the Holy Land and in Italy belonging to the Canons.

See the *Catholic Encyclopaedia,* article "Sepulchre, Canons Regular."

SEPULCHRE, THE HOLY. The authenticity of this site has been much disputed. From N.T. data it is evident that the tomb of Joseph of Arimathea was near Calvary, which adjoined a high road and was outside the City walls, but perhaps quite near, as the Romans crucified criminals in such situations. On which side of the City it lay is not recorded. There is no reference in Christian literature of the first three centuries to the "empty tomb." Even if the tomb was venerated—as one might suppose probable—there must have been a break in the possibility of access to it at the destruction of Jerusalem by Titus (A.D. 70) and again in the more complete devastation after Bar Kokba's rebellion and whether any tradition regarding the site survived is doubtful. When (A.D. 135) Hadrian rebuilt the City, calling it Aelia Capitolina, he is stated by Eusebius to have erected a Temple of Xphrodite over the site of the Holy tomb. In A.D. 325 the remains of this pagan shrine were removed by Macarius and under these were found an ancient Jewish tomb. The rock around was cut away, the tomb chamber was isolated and a circular building—the Anastasius—was erected around it. That this is the same tomb as that shown today is indisputable though the actual roof and much of its walls were destroyed (A.D. 1010) by orders of the Chalif Hakim.

The situation of this tomb presents topographical difficulties. Thus the site is now so much the centre of Jerusalem as to make it difficult to accept its genuineness. It must however be remembered that in earlier times the City extended further south and the present position of the walls is in no small measure the result of veneration for the Traditional Sacred Sites. The course of the ancient northern walls is one which is still unsolved. The "First Wall" ran from the neighbourhood of the existing Jaffa Gate eastwards to the wall of the Temple enclosure and the "Second Wall," which began at the Gate Ganath—a site on the "First Wall" unidentified—ran round the northern quarter of the City to the fortress of Antonia. It is admittedly difficult—but not impossible—to plot out a wall running this course, which would exclude the Holy Sepulchre, but actually, no remains of a City wall following such a possible course have been found. Some authorities claim that the existing northern City wall is not, as many suppose, on the general lines of the third wall, but on those of the second wall, making the traditional site impossible. This view has certainly been strengthened by the recent excavation of extensive remains of a more northern wall, which by position and construction may be the third wall built, but not completed by King Herod Agrippa (about A.D. 41).

The traditional,view being so difficult, speculation naturally suggested alternative sites. Thus—among others—in 1730 Korte of Altona suggested one west of the Jaffa Gate, Clarke in 1812 one south of the Zion Gate and Barclay one east of St. Stephen's Gate. In 1842 Otto Thenius promulgated his theory that the Crucifixion must have taken place above Jeremiah's Grotto, outside the Damascus Gate. This theory—with the addition of a tomb to the west of this hill claimed to be the true Sepulchre—has had many supporters notably General Gordon. It must be admitted that no site lends itself better to a spectacular reconstruction of the Crucifixion Story but it presupposes that the centuries have made but little change in the topography of the City and the archaeological evidence is entirely against it. The fact is that while the claims of the Holy Sepulchre rest upon uncertain tradition and the archaeological evidence raises difficulties, no other site can be said to have any serious validity.

The Church of the Holy Sepulchre is a collection of buildings mainly of mediaeval origin and only the most scanty traces of the work of Constantine the Great have been found. The circular building, round the little Greek Chapel covering the tomb, is certainly in the original position of the Circular Anastasius of the fourth century. The various ancient branches of the Church hold property in the collection of buildings around, and all have rights in the rotunda and the Sepulchre itself—a position which has led to many bitter disputes.

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Guide books, especiallv Baedeker and Meistermann. Also various articles in the *Quarterly statement* of the Palestine Exploration Fund.

(E. W. G. M.)

SEQUANI, in ancient geography, a Celtic people who occupied the upper basin of the river Arar (Saône), their territory corresponding to Franche-Comté and part of Burgundy. Before the arrival of Caesar in Gaul, the Sequani had taken the part of the Arverni against their rivals the Aedui, and hired the Germans under Ariovistus to help them (71 B.C.). But although they thus defeated the Aedui, the Sequani were worse off than before, for Ariovistus deprived them of a third of their territory and threatened to take another third. The Sequani appealed to Caesar, who drove back the Germans (58), but at the same time compelled the Sequani to surrender all that they had gained from the Aedui. The Sequani therefore joined in the revolt of Vercingetorix (52) and shared in the defeat at Alesia. Under Augustus, the district known as Sequania formed part of Belgica. After the death of Vitellius, the inhabitants refused to join Iulius Civilis and Iulius Sabinus in revolt against Rome and drove back Sabinus, who had invaded their territory. A triumphal arch at Vesontio (Besançon), which in return for this service was made a colony, possibly commemorates this victory. Diocletian added Helvetia, and part of Germania Superior to Sequania, which was now called *Provincia maxima Sequanorum.* Fifty years later (A.D. 355) Vesontio was sacked by the barbarians. Under Julian it recovered some of its importance as a fortified town, and was able to withstand the attacks of the Vandals. Later, the Sequani became merged in the newly formed kingdom of Burgundy.

BIBLIOGRAPHY.—*See* T. R. Holmes, *Caesar's Conquest of Gaul,* p. 483 (1899); A. Holder, *Altceltischer Sprachschatz,* ii. (1904); Mommsen, *Hist. of Rome* (Eng. trans.), bk. v. ch. vii.

SEQUENCE DATING. A sequence date (adopted in Germany as *Staffelzahl*) is a dating by relation to things earlier and later in arbitrary units, not by years. All history is mainly concerned with the order of events; the dates A.D. are of much less consequence than the connection of cause and effect. To know that the Armada preceded the Stuarts is essential; that it was 15 years earlier is a detail. In ages where no dated history exists our endeavour must be to put what we know into its true order.

The most obvious kind of evidence of sequence is in geology, when strata lie deposited one on the other, and similarly in human settlements when buildings or refuse heaps are superimposed. Such evidence is finally conclusive, where accidents do not occur. (See STRATIGRAPHY.) But changes do occur, and may upset the evidence. Strata may be deficient where contact is sought, or may have been separated by a sill of molten rock, or have suffered overthrust by compression, or even been altogether inverted. In strata of man's works burrowing animals or men may upset order and let objects shift far down, or throw them up; dyed wool occurred in a prehistoric grave, but it had been carried down by a rat for lining its nest; the Persians dug granaries 20 feet deep through many centuries of town levels.

Another kind of evidence of sequence is that from the style of objects. Suppose in a great mansion that the room in which each master had died was left with its furniture untouched. If we could thus compare the surroundings of each generation we should have little or no doubt as to the sequence of the rooms. The changes of fashion — Victorian, Regency, French Revolution, Georgian — would make it impossible to mistake the order, so as to put a Chippendale sofa between the '51 and '62 Exhibition periods. There is the ancient equivalent of such successive rooms in the funeral outfit for the dead. Each generation varied the forms of its objects — pottery, weapons, ornaments — and the connection of the varieties can thus be traced. (*See* TYPOLOGY.)

Establishing a Dating. — If, then, we are able to put a large number of graves into their relative order, we need to be able to denote each part of the series. This may be done by dividing a series of, say, 1,000 graves into 50 parts, of about 20 graves in each part. Thus we have a series of divisions that may be numbered consecutively, and so form a chain of periods, though not of equal periods of years; they are periods of equivalent mortality or productivity. Yet such numbers of the periods, or sequence dates, constitute as true a history as if they specified the date in years. The stages of perceptible change are not so close together as single years; they may be most nearly generations, or centuries, or even millennia in early ages of man. The method of numbering them in order gives the handle by which to use the history of prehistoric ages, as familiarly as we refer to the years or centuries of written history. An ancient dating by numbers is already familiar in the naming of the successive dynasties of Egypt from 1 to 30; a mode of reference which avoids the differences of opinion about the dates in years.

The Material for Study. — The basis for starting the sequence dates must be a simple notation of all the variations of common objects, especially pottery. A set of drawings of every form of pottery dealt with must be put into some systematic order (such as from the most open plate to the most closed bottle). Each principal form must be numbered (say, 1 to 99), lesser variations having a letter, as 34c, 34m. This notation can be applied to each different kind of pottery. Thus every pot found can be expressed, for instance, as B17d (Black pottery, form 17, variety d), or F85t. This numbered series of drawings is termed a corpus, and with it the pottery in a grave can be recorded completely for future study, without taking it away. Such records are necessary material for discovering the sequence of the graves.

The Method **of** Working. — Some starting connection is needful, either in a related series of forms or a link to historic times, or some stratification of a site. For instance, a long series of degradations of a globular pot to a cylinder and of a handle into a cord pattern, served to start the interpretation of the later prehistoric pottery of Egypt. Or, on the other method, the Badarian settlement was divided by a layer of rock chips, while it was deserted; the pottery from under the chips was certainly then the older.

Having got thus some intimation, by style or by place, which of two groups A and B is the older, the next stage is to group all graves containing A types and none of B, and arrange them in order of the proportion of A types; those with 5, 4, 3, 2, 1 or 0 types like A being ranked in that order. Similarly those with B types on the other side away from A. In this way the order is arranged as forms like A, 0, 1, 2, 3, 4, 5, 6, then A, A and B types conjoined, B, 6, 5, 4, 3, 2, 1, 0 like B. Thus a rough breaking up into many groups in approximate order can be made statistically.

Having a rough classing the next process is to deal with each type individually. It is obvious that if a series were arranged in true order of succession, a disturbance to a false order would be more likely to scatter types than to concentrate them in their range. Hence the shortest possible range of each type is the most probable. Then outlying examples of each type in the series of graves must be examined to see whether that grave could be brought nearer to the other examples of the type, without dispersing any other type which is associated with it. This process may be graphically imagined by supposing that every example of a type is tied to all other examples of it by an elastic cord in tension. Then a scattered type will tend to pull itself together, provided it does not increase the tension of the cord of another type. The whole process might be solved mechanically by such a model.

Method in Practice. — The wav to handle all this material is to take for each grave a slip of card, about 7in. long and ½in. high. Rule it into as many spaces as there are kinds of pottery, A, B, C, etc., about half a dozen. Enter in its respective space the number of each type of pot in the graves, in order of numbers. Then place all the cards in a column, so that a hundred grave contents can be reviewed in a height of 25in., laid on a tray. Ten such trays allow of a review of every pot in a thousand graves at once, on a table about six ft. wide. Usually only two or three trays need to be seen at once. Each type is searched in turn, every example noted (by putting a drawing pin point up at each place); the earliest and latest are then examined to see what associated types are with them, and if moving these extreme slips will make divergence in other types. This is a process which has to be repeated many times, each time getting a better concentration of each type. Where several types found together have to be searched in all their connections, a different pattern of drawing pin can be used to mark each type.

Results. — The eventual result is a classing of, say, 1,000 graves in nearly their original order. Each selected grave should contain at least five different types of pottery. Next the whole series can be divided into numbered groups, modifying the groups so as to divide at the beginning or end of prominent types. When these groups are consecutively numbered, then each type of pot can have its limits in sequence dates; say from 42 to 48. Some simple types will have a very long range; other decorated types may have been made by only one generation. The more elaborate a type the more it demands concentration. In mechanical parallel the tension of the elastic cord will be greatest for the peculiar types.

The Sequence Date of Graves. — The different types of pottery in a grave will each give a fresh limitation of the possible range, as in the following cases, from Abydos:—

B 22b 30–37	W 55 72–78	B 38a 43–66
B 25f 30–50	R 26 55–80	W 42 62–72
P 11a 31–63	L 17c 51–78	R 23c 36–80
P 11b 35–71	L 36a 58–80	R 65a 49–68
	L 53a 48–74	R 80 41–72
		L 53c 54–80
Limits 35–37	72–74	62–66

These dates of graves serve then to date all the other objects found in the grave. A fresh series of graves will sometimes slightly extend one or two of the ranges already found for a type; but the graves with sufficient varieties work out with a very small range of uncertainty. The scale of 50 parts, 30–79, which was adopted for Egypt, is not at all too minute in its subdivision, as the resulting dates work out to two or three units. Twenty-five years after this was done the scale has been continued back to S.D. 20–29 to include the still earlier prehistoric age of Badari.

Precautions. — In forming a corpus, various of the 99 numbers should be left unused where a large step lies between types, so as to leave numbers for future discoveries; similarly in assigning letters for varieties, especially where a large difference exists. In ages where a good dating is already known by records, it is best to make larger groups (as 33–37), and place all the forms in order of date, as this will point to their true relation.

For applying the system of sequences precautions are needed. First, there must be a sufficient series of dated graves, each containing many varieties of pottery. For an entirely fresh country at least 500 grave groups are wanted; for joining on an extension to an existing system a few dozen graves will give a preliminary view, useful as a framework for fresh evidence. Secondly, all kinds of evidence must be taken into account, not only forms, but decoration, relation to other forms, descent of a type, peculiar personalities in the work, and not only pottery but all other material of which there may be enough to give an indication, as ivory, stone, flintwork, and metal. Thirdly, the historical view should have consistency. If there is a large change of types at any point of the dating, this may modify the arrangement of the slips.

The final aim of archaeology is to have a separate corpus of types of each great period of each country, not only for pottery but for all other classes of objects. Thus the whole of the material products of the past can be put in an organized connection, and so give a definite basis for our knowledge of man's ability and purpose. (W. M. F. P.)

SEQUESTER, VIBIUS (4th or 5th century A.D.), the supposed author of an alphabetical list of geographical names occurring in the Roman poets. Several of the names given cannot be traced; the compiler perhaps had access to sources no longer extant.

Editions by C. Bursian (Zürich, 1867), and in A. Riese, *Geographi Latini minores* (1878); *see* also Teuffel, *Hist. of Roman Literature* (Eng. trans., 1900), 445, 1.

SEQUESTRATION. In law, the term "sequestration" has many applications; thus it is applied to the act of a belligerent power which seizes the debts due from its own subjects to the enemy power; to a writ directed to persons, "sequestrators," to enter on property of defendant and seize goods (*see* PRACTICE AND PROCEDURE); to taking profits of a benefice to satisfy the creditors of the incumbent. Since the goods of the church cannot be touched by a lay hand, the writ is issued to the bishop, and he issues the sequestration order to the churchwardens, who collect the profits and satisfy the demand. Similarly when a benefice is vacant the churchwardens take out sequestration under the seal of the Ordinary and manage the profits for the next incumbent. In the Scots law of bankruptcy the term "sequestration" is used of the taking of the bankrupt's estate by order of the court for the benefit of the creditors.

SEQUIN, the French form of Ital. *zecchino,* a Venetian gold coin, first minted about 1280, and in use until the fall of the Venetian republic. Worth about nine shillings, it bore on the obverse a figure of St. Mark blessing the banner of the republic, held by a kneeling doge, and on the reverse a figure of Christ. Milan and Genoa issued gold sequins. The word in Italian was formed from *zecca,* Span. *zeca,* a mint, an adaptation of Arabic *sikka,* a die for coins. (*See* also MONEY, MEDIAEVAL.)

The term "sequin" is used for small discs made of thin metal, tinfoil, celluloid or other composite material, highly glazed and brightly coloured, and applied as trimming for ladies' dresses.

SEQUOIA, a genus of conifers (*q.v.*) of the bald cypress family (Taxodiaceae), comprising two species, *S. sempervirens* (redwood), and *S. gigantea* (big tree). (Buchholz put *S. gigantea* in a separate genus. *Sequoiadendron.*) Redwood is native in the fog belt of the Coast Ranges from southern Monterey county, California, to southern Oregon, and the big tree occurs native in scattered groves at 3,000 to 8,500 ft. altitude on the westerly slopes of the Sierra Nevada from Placer to Tulare counties. Fossil remains of *Sequoia* as old as Jurassic are widely dispersed in the northern hemisphere. The bald cypress (*Taxodium distichum*) and dawn redwood (*Metasequoia glyptostroboides*) are closely related to *Sequoia.*

The generic name commemorates a talented Cherokee Indian, Sequoya, who developed the first alphabet used by his tribe.

SEQUOIA SEMPERVIRENS. SHOWING BRANCH WITH GREEN CONES AND MALE CATKINS, (A) LONGITUDINAL SECTION OF A FEMALE CONE

The redwood, *S. sempervirens,* is among the tallest of trees, often exceeding 300 ft., and the trunk diameters range to 15 ft., or exceptionally to 20 ft., measured above the swollen bases. The insect, fungus and fire resistant bark is reddish-brown, fibrous, deeply furrowed, and to 12 in. or more thick on old trees. The bases of the trees form massive buttresses, and hemispherical burls occur on some trunks. Beautifully grained veneer, bowls, trays and turned articles are made from large burls, and small ones send forth decorative green sprays if sawed from the tree and placed in a tray of water. Young trees are conical in form and clothed to the ground with densely leaved. slightly drooping branches: in age the lower limbs fall away, leaving a columnar clear trunk to a height of 100 ft. or more. When a tree is cut, numerous shoots arise from the sapwood below the cut surface and grow into trees in 30 to 60 years if protected from fire; vigorous leaders grow as much as 8 ft. in length during a year. The needlelike leaves are dark green above, whitish beneath, one-third to one inch long, arranged in two-ranked sprays, and remain functional three to seven years. Cones are one to two inches long and produce tremendous seed crops, but germination rarely exceeds 25%. Thus seedlings are rare in the forests and reproduction is mainly vegetative. The sapwood is thin, white, and decays readily, but heartwood is reddish-brown, evenly fine grained, strong and durable. It resists attack by fungi, termites and other insects. Some redwood fence posts have lasted at least 50 years.

Heavy cutting beginning in the 1860s has drastically reduced the original 1,454,000 ac. of redwood forests, but extensive stands still exist. Logging continues, but the annual cut dropped after World War II. Yields run about 150,000 bd.ft. per acre in normal stands, but cuts as high as 1,500,000 bd.ft. per acre are on record, Second-growth timber on favourable sites produces nearly 140,000 bd.ft. per acre in 60 years, thus making the greatest volume growth of any known softwood.

The big tree, *S. gigantea,* is the largest of all trees in bulk and long was reputed to be "the oldest living thing." Many reports about the great age of the trees were exaggerations for the largest stumps accurately examined yielded counts of about 4,000 years. The largest specimen is the General Sherman tree in Sequoia National park. measuring 101.5 ft. in circumference at the base; a mean base diameter of 32.2 ft.; diameter 27 ft., 8 ft. above the ground; diameter 18 5 ft. 100 ft. above ground; 272.4 ft. tall; diameter of largest branch (130 ft. above ground) 6.5 ft.; total estimated weight 6,167 tons. A few specimens are over 300 ft. high, but have less bulk than the General Sherman tree Although several big tree groves mere cut, the lumber is more brittle than that of the redwood so it has been easier to save the big trees from destruction Most of the 70 distinct groves now are under the protection of state or national forests and parks. The groves contain as few as 4 and as many as 3,500 mature trees each, and seedlings and young trees are very numerous in some of the groves.

The earliest known mention of the big trees is a narrative of Walker's expedition of 1833 published in 1839. Others must have seen the big trees in the interim, but the Calaveras grove first became known generally in 1852.

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SEQUOIA NATIONAL PARK, a reservation of 386,560 ac. in the Sierra Nevada mountains of California, was established by act of the U.S. congress on Sept. 25, 1890, in order to protect groves of *Sequoia gigantea,* giant sequoia or big tree, among the largest members of the vegetable kingdom. Until specimens of bristlecone pine were discovered to be older, *Sequoia gigantea* was also believed to have the oldest living members of any species on earth, some specimens being over 3,500 years old.

Sequoia gigantea is not known to exist anywhere outside the Sierra Nevadas, and between elevations of 3,000 and 6,000 ft. It does not reproduce rapidly, very few of the seeds taking root. The great girth and lack of taper of mature specimens of *Sequoia gigantea* account for its achieving a greater bulk than any other species. although other species grow taller.

Dimensions of the General Sherman tree, largest in the park, are: mean base diameter 32.2 ft.; height 272.4 ft.; estimated weight 6,167 tons.

Repeated efforts have been made to save the redwoods from the lumberman's saw. The Mariposa grove, adjacent to Yosemite valley, was set aside by congress in 1864. The General Grant National park was created in 1890 and assimilated in Kings Canyon National park when the latter was created in 1940. Other groves are in California state parks.

Sequoia National park is accessible by automobile and bus from

Fresno, Visalia or Tulare. Accommodations are available at Giant Forest throughout the year.

Lodges and camping areas are open elsewhere from June to September. Fishing, hiking and horseback riding are among the recreations. (J. E. CL.)

SERAING, town, province of Likge, Belg. Pop. (1955 est.) 42,377. It is on the Meuse, above Likge, and owes its importance to John Cockerill, who, in partnership with King William I of the Netherlands, founded what is still called the "John Cockerill company," making machinery, with headquarters in the old summer-palace of the prince-bishops of Likge.

The company in 1890 established a shipbuilding branch at Hoboken on the Scheldt river. The Val S. Lambert glassworks are also famous.

SERAJEVO, the capital of Bosnia in Yugoslavia. *See* SARAJEVO.

SERAMPORE (Serampur), a town in Hooghly district, West Bengal, India, on the right bank of the Hooghly river, opposite Barrakpore, 12 mi. N. of Calcutta. Pop. (1951) 74,324. The Danes settled there as early as 1676 but, their trading operations being unsuccessful, closed their factories in 1714. They re-established themselves in 1755. With the rest of Danish India Frederiksnagar was purchased by the English in 1845. Serampore is important as a centre of the jute industry and as the seat of Serampore college (1818), chartered in 1827.

SERAO, MATILDE (1856–1927), Italian novelist and journalist, was born at Patras in Greece. Her father was an Italian, a political emigrant, and her mother a Greek. She was a telegraph clerk in Naples, but early attracted notice by short stories contributed to the press. Her novel, *Fantasia* (1883), first definitely established her as a writer full of feeling and analytical subtlety. She spent the years between 1880 and 1886 in Rome, where she published volumes of short stories and also novels, all dealing with the life of the people: *Cuore Infermo* (1881), *Fior di Passione* (1883), *La Conquista di Roma* (1885), *La Virtu di Checchina* (1884) and *Piccole Anime* (1883). With her husband, Edoardo Scarfoglio, she founded *Il Corriere di Roma,* the first Italian attempt to model a daily journal on the lines of the Parisian press. The paper was short-lived, and when it was given up Matilde Serao established herself in Naples, where she edited *Il Corriere di Napoli* and in 1891 founded *Il Mattino,* which became the most popular daily paper of southern Italy. Between 1890 and 1902 she produced *Paese di Cuccagna, Ventre di Napoli, Addio Amore, All' Erta Sentinella, Castigo, La Ballerina, Suor Giovanna della Croce, Paese di Gesù,* novels in which the character of the people is rendered with sensitive power and wide sympathy. Most of these have been translated into English. She died on July 25, 1927. *See* B. Croce, *La letteratura della nuova Italia,* III, pp. 32–72 (Bari, 1929).

SERAPHIM, plural of the Hebrew noun *sārāph,* is the name of the supernatural beings attendant upon Yahweh in Isaiah's vision, Isaiah vi. 2, 6. Each has six wings, and apparently human feet, hands and voice. They chant in antiphon the praise of Yahweh. Representations of such mixed figures were to be found at the entrance to oriental temples, where they served as guardians of the gate, and they also are depicted upon coins of the Roman period. It is not unlikely that this feature in the prophet's vision was due to his seeing such figures at the entrance to the Temple and hearing the chants of the choir immediately before he passed into ecstasy. It is noteworthy that "the thresholds were moved" (*v.* 4) at the voice of the seraphim. The singular noun is used in Numbers xxi. 8, Isaiah xiv. 29, xxx. 6, where it is rendered "fiery serpent": accordingly it has been supposed that the seraphim were originally serpentlike in form.

SERAPION or SARAPION (*fl. c.* 350), bishop of Thmuis in the Nile Delta and a prominent supporter of Athanasius in the struggle against Arianism (sometimes called, for his learning, Scholasticus), is best known in connection with a prayer-book or sacramentary intended for the use of bishops. This document, contained in a collection of Egyptian documents in an 11th-century ms. at the Laura on Mount Athos, was published by A. Dmitrijewskij in 1894, but attracted little attention until independently discovered and published by G. Wobbermin in 1899. It is a celebrant's book, containing thirty prayers belonging to the mass (19–30, 1–6), baptism (7–11, 15, 16), ordination (12–14), benediction of oil, bread and water (17), and burial (18), omitting the fixed structural formulae of the rites, the parts of the other ministers, and almost all rubrication, except what is implied in the titles of the prayers. The name of Serapion is prefixed to the anaphora of the mass (1) and to the group 15–18: but whether this indicates authorship is doubtful; for whereas the whole collection is bound together by certain marks of vocabulary, style and thought, 15–18 have characteristics of their own not shared by the anaphora, while no part of the collection shows special affinities with the current works of Serapion.

But his name is at least a symbol of probable date and provenance: the theology, which is orthodox so far as it goes, but "conservative," and perhaps glancing at Arianism, shows no sign that the Macedonian question has arisen; the doxologies, of a type abandoned by the orthodox, and by *c.* 370 treated by Didymus of Alexandria as heretical; the apparent presupposition that the population is mainly pagan (1, 20); the exclusive appropriation of the mass to Sunday (19; cp. Ath. *ap. c. Ar.* 11), whereas the liturgical observance of Saturday prevailed in Egypt by *c.* 380: the terms in which monasticism is referred to—together point to *c.* 350; the occurrence of official interpreters (25) points to a bilingual Church, *i.e.,* Syria or Egypt; and certain theological phrases (ἀγέννητος, ἐπιδημία, μόνη καθολικὴ ἐκκλησία) characteristic of the old Egyptian creed, and the liturgical characteristics, indicate Egypt; while the petition for rains (23), without reference to the Nile-rising, points to the Delta as distinguished from Upper Egypt. The book is important, therefore, as the earliest liturgical collection on so large a scale, and as belonging to Egypt, where evidence for 4th-century ritual is scanty as compared with Syria.

The rites form a link between those of the *Egyptian Church Order* (a 3rd- or early 4th-century development of the Hippolytean Canons, which are perhaps Egyptian of *c.* 260) and later Egyptian rites—marking the stage of development reached in Egypt by *c.* 350, while exhibiting characteristics of their own.

See J. Wordsworth, *Bishop Sarapion's Prayer-Book* (1899).

SERAPIS, a famous Graeco-Egyptian god. The statue of Serapis in the Serapeum of Alexandria was of purely Greek type and workmanship—a Hades or Pluto enthroned with a basket or corn measure on his head, a sceptre in his hand, Cerberus at his feet, and (apparently) a serpent. It was proclaimed as the anthropomorphic equivalent of a much revered and highly popular Egyptian beast-divinity, the dead Apis, assimilated to Osiris. The Greek figure probably had little effect on the native ideas, but it is likely that it served as a useful link between the two religions. The god of Alexandria soon won an important place in the Greek world. The anthropomorphic Isis and Horus were easily rendered in Greek style, and Anubis was prepared for by Cerberus. The worship of Serapis along with Isis, Horus and Anubis spread far and wide, reached Rome, and ultimately became one of the leading cults of the west. The destruction in A.D. 385 of the Serapeum of Alexandria, and of the famous idol within it, after the decree of Theodosius, marked the death-agony of paganism throughout the empire.

It is assumed above that the name Serapis (so written in later Greek and in Latin, in earlier Greek Sarapis) is derived from the Egyptian Userhapi—as it were Osiris-Apis—the name of the bull Apis, dead and, like all the blessed dead, assimilated to Osiris, king of the underworld. There is no doubt that Serapis was before long identified with Userhapi; the identification appears clearly in a bilingual inscription of the time of Ptolemy Philopator (221–205 B.C.), and frequently later. It has, however, been contended by an eminent authority (Wilcken, *Archiv fur Papyrusforschung,* iii. 249) that the parallel occurrence of the names Sarapis and Osorapis (Userhapi) points to an independent origin for the former. But doublets, *e.g.,* Petisis-Petēsis, are common in Graecisms of Egyptian names. *See* EGYPT: *Religion.*

See ISIS; A. Bouché-Leclercq, *Histoire des Lagides,* i. (1903), ch. iv.; J. G. Milne, *History of Egypt under Roman Rule* (1898), p. 140;

G. Lafaye, *Histoire du culte des divinités d'Alexandrie hors de l'Égypte* (Paris, 1884).

SERBIA (*Srbiya*), formerly an inland kingdom of south-eastern Europe, situated in the north of the Balkan Peninsula, now incorporated in Yugoslavia (*q.v.*). The frontier, as defined by the Berlin Treaty of 1878, was, roughly speaking, indicated by rivers in the north, and by mountains in the south. In the north, between Verciorova and Belgrade, the Danube divided Serbia from Hungary for 157 m.; and between Belgrade and the border village of Racha the Save divided it from Croatia-Slavonia for 80 m. In the north-west the Drina flowed for 102 m. between Bosnia and Serbia; in the north-east the Danube, for 50 m., and the Timok for 23 m., constituted respectively the Rumanian and Bulgarian boundaries. Various mountain ranges marked the frontiers of Bosnia on the west, Turkey on the south-west and south, and Bulgaria on the south and south-east. According to the survey carried out by the Serbian general staff in 1884 the area of the country was 18,782 sq.m.

HISTORY

The Serbs (*Srbi,* as they call themselves) are a Slavonic nation, ethnically and by language the same as the Croats (*Hrvati, Horvati, Croati*). The Croats, however, are Roman Catholics and use the Latin alphabet, while the Serbs belong to the Orthodox Church and use the Cyrillic alphabet, augmented by special signs for the special sounds of the Serb language. (*See* SLAVS.)

The earliest mention of the Serbs is to be found in the ninth century; the origin of the name which appears alike in Lusatia and the Balkans is obscure. Nothing is known of their earlier history except that they lived as an agricultural people in Galicia, near the source of the river Dniester. In the beginning of the 6th century they descended to the shores of the Black Sea. Thence they began to move westerly along the left shore of the Danube, crossed that river and occupied the north-western corner of the Balkan Peninsula. According to the emperor Constantine Porphyrogenitus, the emperor Heraclius (610–640) invited the Serbs to settle in the devastated north-western provinces of the Byzantine empire and to defend them against the incursions of the Avars. According to newer investigations, Heraclius only made peace with them, confirming them in the possession of the provinces which they already had occupied, and obtaining from them at the same time the recognition of his suzerainty. Their known history as a Balkan nation begins towards the middle of the 7th century.

The Zhupaniyas.—In their new settlements the Serbs did not form at once a united political organization. The clans more or less related to each other, occupied a certain territory, which as a geographical and political unit was called *Zhupa* or *Zhupaniya* (county), the political and military chief of which was called *Zhupan.* The history of the Serbs during the first five centuries after their arrival in their present country was a struggle between the attempts at union and centralization of the Zhupaniyas into one state under one government, and the resistance to such union and centralization. The more powerful Zhupan was tempted to subjugate and absorb the less powerful Zhupaniyas. If successful, he would take the title of *Veliki Zhupan* (Grand Zhupan). But such unions were followed again and again by decentralization and disruption. The earlier history of the Serbs on the Balkan territory is especially turbulent and bloody, one of the minor causes being the struggle between the ancient Slavonic order of inheritance, according to which a Zhupan ought to be succeeded by the oldest member of the family and not necessarily by his own son, and the natural desire of every ruler that his own son should inherit the throne.

This internal political process was complicated by the struggle between the Greek Church and Greek emperors on the one side and the Roman Catholic Church and the Roman Catholic Powers (Venice and Hungary) on the other, for the possession of exclusive ecclesiastical and political influence. The danger increased when the Bulgarians came, towards the end of the 7th century, and formed a powerful kingdom on the eastern and south-eastern frontiers of the Serbs. Practically from the 8th to the 12th century the bulk of the Serbs was under either Bulgarian or Greek suzerainty, while the Serbo-Croat provinces of Dalmatia acknowledged either Venetian or Hungarian supremacy.

The Visheslav Dynasty.—The first Serb princes who more or less successfully united several Zhupaniyas into one state, belonged to what might be called "the Visheslav dynasty." Zhupan Visheslav lived in the beginning of the 9th century, and seems to have been the descendant of that leader of the Serbs who signed the settlement treaty with the emperor Heraclius towards the middle of the 7th century. His ancestral Zhupaniya comprised Tara, Piva, Lim (the neck of land between the Montenegro and Serbia of pre-war days). Visheslav's son Radoslav, his grandson Prissegoy, and his great-grandson Vlastimir, "the first clear personality" of Serbian history, continued his work. Vlastimir successfully defended the western provinces of Serbia against the Bulgarians, although the eastern provinces (Branichevo, Morava, Timok, Vardar, Podrimlye) were occupied by the Bulgars. The Bulgarian danger, and probably the successful operations of the Greek emperor Basil the Macedonian (867–886), determined the Serbian Zhupans to acknowledge again the suzerainty of the Greek emperors. One of the important consequences of this new vassalship to the Byzantine empire was that the entire Serbian people embraced Christianity, about 879—a process begun, however, by Latin priests between 642 and 731. In all important transactions the Serbians were led by the Grand Zhupan Mutimir Visheslavich (d. 890). During the reign of his heirs almost all the Serbian provinces were conquered by the Bulgarian Tsar Simeon (924). In 931 Chaslav, one of the princes of the Visheslav dynasty, liberated the largest part of the Serbian territory from Bulgarian domination, but to maintain that liberty he had to acknowledge the Byzantine emperors as his suzerains.

The Princes of Zeta and the First Serb Kingdom.—Towards the end of the 9th century the political centre of the Serbs was transferred to Zeta (or Zenta: *see* MONTENEGRO) and the Primorye (Sea-Coast). The prince (sometimes called king) of Zeta, Yovan Vladimir, tried to stop the triumphal march of the Bulgarian Tsar Samuel through the Serb provinces, but in 989 was defeated, made prisoner and sent to Samuel's capital, Prespa. The historical fact that Vladimir married Kossara, the daughter of Samuel, and was sent back to Zeta as reigning prince under the Bulgarian suzerainty, forms the subject of the first Serb novel, *Vladimir and Kossara,* as early as the 13th century. Vladimir, who seems to have been a noble-minded man, was murdered by Samuel's successor, the usurper Tsar Vladislav (1015). By the Christians of both churches in Albania he is to this day venerated as a saint. But after the death of Samuel the Bulgarian power rapidly lost the Serb provinces, which, to get rid of the Bulgarians, again acknowledged the Greek overlordship. About 1042, however, Prince Voislav of Travuniya (Trebinje), cousin of the assassinated Vladimir of Zeta, started a successful insurrection against the Greeks, and united under his own rule Travuniya, Zahumlye (the modern Herzegovina) and Zeta. His son Michael Voislavich annexed the important Zhupaniya of Rashka (Rascia or Rassia), and in 1077 was addressed as king (rex) in a letter from Pope Gregory VII. His son Bodin enlarged the first Serb kingdom by annexing territories which up to that time were under direct Greek rule. After Bodin's death the civil wars between his sons and relatives materially weakened the kingdom. Bosnia reclaimed her own independence; so did Rashka, whose Grand Zhupans came forward as leaders of the Serb national policy, which aimed at freedom from Greek suzerainty and the union of all the Serb Zhupaniyas into one kingdom under one king. The task was difficult enough, as the Byzantine empire, then under the reign of the energetic Manuel Comnenus, regained much of its lost influence. About the middle of the 12th century all the Serb Zhupaniyas were acknowledging the suzerainty of the Byzantine emperors.

The Nemanyich Dynasty and the Serb Empire.—A change for the better began when Stephen Nemanya became the Grand Zhupan of Rashka (1159). He succeeded in uniting all the Serb countries except Bosnia under his rule, and although he never took the title of king, he was the real founder of the Serb kingdom and of the royal dynasty of Nemanyich, which reigned for nearly 200 years. His youngest son, Prince Rastko, secretly left his father's court, went to a convent in Mount Athos, where Stephen Nemanya died as the monk Simeon at Chiliandarion in 1200, became a monk, and afterwards, under the name of Sava, the first archbishop of Serbia. As such he established eight bishoprics and encouraged learning. He is regarded as the great patron of education among the Serbs, as a saint, and as one of the greatest statesmen. After Stephen Nemanya and Sava the most distinguished members of the Nemanyich dynasty were Stephen Urosh I. (1243–76), his son Milutin (1281–1321) and Stephen Dushan[1] (1331–1355). Urosh married Helen, a daughter of the exiled Latin Emperor of Constantinople, Baldwin II., and through her kept friendly relations with the French court of Charles of Anjou in Naples. He endeavoured to negotiate an alliance between Serbs and French for the partition of the Byzantine empire. His son Milutin continued that policy and increased his territory by taking several fortified places from the Greeks; but later he joined the Greeks under the emperor Andronicus against the Turks. Milutin's bastard's son, Stephen Dushan, was a great soldier and statesman. Seeing the danger which menaced the disorganized Byzantine empire from the Turks, he tried to prevent the Turkish invasion of the Balkan peninsula by replacing that empire by a Serbo-Greek empire. He took from the Greeks Albania, Epeiros, Thessaly and Macedonia (excepting Salonika). Towards the end of 1345 he proclaimed himself "emperor of the Serbs and the Greeks," and was solemnly crowned at Skoplje on Easter Day 1346. At the same time he raised the archbishop of Ipek (Petch), the primate of Serbia, to the dignity of patriarch. Three years later he convoked the Sabor (parliament) at Skoplje to begin a codification of the laws and legal usages. The result was the publication, in 1349, of the *Zakonik* Tsara Dushana (Tsar Dushan's Book of Laws), a code of great historical interest which proves that Serbia was not much behind the foremost European states in civilization. In 1355 Dushan began a new campaign against the Greeks, the object of which was to unite Greeks, Serbs and Bulgars and prevent the Turkish power taking root on European ground. While making preparations for a siege of Constantinople he died suddenly at Deabolis on Dec. 20, 1355. Under his only son Stephen Urosh V., a young man of nineteen, his brother Simeon Urosh and some of the powerful viceroys of Dushan's provinces made themselves independent. The most prominent amongst them was Vukashin, who proclaimed himself king of Macedonia. He wished to continue Dushan's policy and to expel the Turks from Europe, but in the battle on the Maritza on Sept. 26, 1371, his army was destroyed and he was slain. Two months later Tsar Urosh died, and the rule of the Nemanyich dynasty ended.

The Turkish Invasion: **Kosovo.**—After a few years of indecision and anarchy the Sabor met at Ipek in 1374 and elected Knez (count) Lazar Hrebelyanovich, a kinsman of Urosh, as ruler of the Serbs. He tried to stop the further disruption of the empire and to organize a Christian league against the Turks. This was the real cause of the Turkish attacks on Bulgaria and Serbia in 1389, which resulted in the subjugation of Bulgaria and in the defeat of the Serbs at Kosovo (June 15, 1389). No event has made such a deep impression on the Serbs as the battle of Kosovo—probably because the flower of the Serb aristocracy fell in that battle, and because both the tsar of the Serbs, Lazar, and the sultan of the Turks, Murad I., lost their lives. The Sultan was killed by the Serb knight or voyvode Milosh Obilich (the later alteration of the inelegant Kobil "son of a brood-mare") There exists a cycle of national songs—sung to this day by the Serb bards (*guslari*)—concerning this battle.

The Despotate.—After the battle of Kosovo Serbia existed for some seventy years (1389–1459) as a country tributary to the sultans but governing itself under its own rulers, who received from the Greek Emperor and bore the Greek title of "despot." The first despot was Tsar Lazar's eldest son, Lazar II. or "Stephen the Tall," who was an intimate friend of Sigismund IV., king of Hungary and emperor of the Germans. Being childless, Stephen appointed his nephew, George Brankovich, to be his successor. George worked to establish an alliance between Serbia, Bosnia and Hungary. But before such an alliance could be arranged, Murad II. attacked Serbia in 1437 and forced George to seek refuge in Hungary, where he continued to work for a Serbo-Hungarian alliance and organized an expedition, under the joint command of the Despot George and of Hunybdi János, which defeated the Turks in a great battle at Kunovitsa in 1444. The sultan was forced to restore all the countries previously taken. At the age of ninety George was wounded in a quarrel with the Hungarian governor of Belgrade, Michael Szilagyi, and died on Dec. 24, 1456. His youngest son Lazar III. succeeded him, but only for a few months. Lazar's widow Helena Palaeoliogina offered Serbia to the pope, hoping thereby the secure the assistance of Roman Catholic Europe against the Turks. Indeed, for a few months, a Roman Catholic prince, Stephen Tomashevich, son of the king of Bosnia, who had married Lazar III.'s daughter, was "despot" at the then capital of Semendria. But no one in Europe moved a finger to help Serbia, and Sultan Mohammed II. occupied the country in 1459, with the aid of the anti-Catholic Serbs, making it a pashalik under the direct government of the Porte.

For fully 345 years Serbia remained a Turkish pashalik, enduring all the miseries which that lawless régime implied (see TURKEY: History). But the more or less successful invasions of the Turkish empire in Europe by the Austrian armies in the 18th century—invasions in which thousands of Serbs always participated as volunteers—prepared the way for a new state of things.

1400–1909

The defeat of Kosovo reduced Serbia to a passive rôle: she looked on helplessly when the Turks overran Bulgaria (1393) and when Sigismund of Hungary's new crusade ended in the disaster of Nicopolis (1396). The Turks thus entrenched themselves firmly to the south and east, and all that Stephen Lazarević could hold was the country lying between the Danube, Save, Drina and Timok, as far south as Niš. Stephen paid tribute to the Sultan and served as his vassal at Angora (1402), afterwards escaping to Byzantium and receiving from Manuel II. the title of Despot. In this dignity he was succeeded in 1427 by his nephew George Branković, who married a Cantacuzene and maintained himself by alliance with the Eastern Empire and Hungary. King Sigismund seized Belgrade and forced George to transfer his capital to the Danubian fortress of Smederevo (Semendria), but compensated him with huge grants of land in Southern Hungary. Though he gave his daughter Mara in marriage to Sultan Murad (1433), George was attacked and expelled by the Turks in 1439 and only recovered his dominions thanks to King Ladislas of Hungary's victorious Balkan campaign in 1443. The Turkish triumph at Varna next year ended all hope of a general Christian Coalition, and the rest of George's reign is filled by precarious intrigue and negotiation with Turk, Hungarian and Venetian, with Skanderbeg and the new ruler of Hercegovina. George died at the age of 80 in 1456, in the same year that John Hunyády died after his successful defence of Belgrade against Mohammed II. George's son Lazar only survived him one year, the succession was disputed, and in 1459 Smederevo and all Serbia were finally overrun by Mohammed. The fall of Bosnia (1463) and of Hercegovina (1483) set the seal to Turkish predominance in the Balkans. The only fragments of Southern Slav territory to retain independence were the Ragusan Republic (Dubrovnik) and Montenegro. Under the Sultans Selim I. (1512–20) and Suleiman I. (1520–66) the Turks resumed the offensive northwards: in 1521 Belgrade was wrested from Hungary, and in 1526 the battle of Mohács broke Hungary's powers of resistance, and led to her partition. The numerous Serb colonies which had been formed along the Danube and in Southern Hungary after the conquest of Serbia, shared the fate of the Magyars: the Banat of Jajce, Syrmia and parts of Croatia and Dalmatia were also seized by the Turks, whose constant raids into Croat and Slovene territory forced the Habsburgs to organize the defensive Military Frontiers (*q.v.*).

[1]*Dushan* is a term of endearment, derived from *dusha,* "the soul," and not, as formerly believed by Western philologists, from *dushiti,* "to strangle."

Serbia **Under** Turkish Rule.—Serbia, like Bulgaria, felt the full weight of Turkish rule, for they were the direct road of strategic advance westwards. The Serbian aristocracy was wiped out—save in Bosnia, where it accepted Islam to save its lands and thus became a-national in feeling: the peasantry was bled mercilessly by the *haratch* (bloodtax), their children thus supplying the Turkish army with recruits and becoming the instrument of their own subjection. Only the Church kept the national spirit alive. In 1557 the grand Vizier Mohammed Sokolović, a native of Herzegovina, revived the Patriarchate of Peć (Ipek) in favour of his brother Makarij: and this See avoided the Hellenizing influences which submerged the Bulgarian sister Patriarchate of Ohrid. Native literature almost ceased to exist, though fragments of culture survived in the monasteries. During the 16th century Serb was still the *lingua franca* of the Peninsula, spoken by the local Begs and Pashas and freely used in correspondence between the Porte and Ragusa or John Zápolya of Hungary: this explains the attempt of the Slovenes, Primus Truber and Baron Ungnad, to win over to Protestantism the Balkan Slavs, and even the Turks, by issuing from Urach and Tiibingen Slav books in Latin, Cyrillic and Glagolitic type. Under Turkish rule the Serbs were increasingly agricultural, Balkan trade being mainly in the hands of Vlachs and Ragusans. The mining industry was abandoned, and Sarajevo, Mostar and Novipazar grew in importance. Ragusan efforts declined rapidly after the earthquake of 166;: while colonies of exiled Sephardim Jews from Spain became prominent trading factors. In the 17th century there grew up a class of broken men, known as Hajduks, round whom popular legend and poetry centred: the most notable examples were in Montenegro (*q.v.*) and among the Uskoks (*q.v.*), of Dalmatia.

In the long war waged by the Habsburgs to recover Hungary, Croat and Serb soldiers played a great part in the Imperialist armies. It seemed as though Leopold I. might emancipate at least the western half of the Balkan Peninsula. In 1690 he issued a proclamation to the Christian population, urging them to rise against their oppressors and promising his protection: and on the strength of this the Patriarch, Arsen Crnojević, with 36,000 Serbian families, migrated to Hungary. Two charters assured their recognition as a nation, freedom of religion and the right to elect their patriarch and voivode. These privileges were not observed, Arsen's successors were not allowed to call themselves Patriarchs, and the office of voivode remained unfilled. But the tide of Serb emigration continued; in the 18th century the Serbs formed flourishing centres at Karlovci (Karlowitz), Novi Sad (Neusatz), Kikinda etc.; and in the repeopling of the Banat and Bačka under Charles VI. and Maria Theresa they played a part only second to the Germans.

The Treaty of Karlowitz (1699) restored all Hungary save the Banat to Habsburg rule: after Eugène's victories the Treaty of Požarevac (Passarowitz, 1718) not merely won back the Banat, but converted Belgrade and the northern portion of Serbia (known as the Sumadija) into an Austrian province. During the next zo years the hopes of the whole race turned towards Vienna, and such culture as the Serbs possessed centered in the towns of southern Hungary and the Military Frontiers. But the constant diversions of western policy and the exhaustion following the long wars prevented the Habsburgs from extending their conquests farther southwards: and when in 1737 they renewed hostilities with Turkey, they suffered reverses and by the Treaty of Belgrade (1739) restored to the Porte all territory south of the Danube and Save. This, following upon the abortive rising in 1735 (due to non-fulfilment of the Leopoldine charter), increased the disillusionment of the Serbs, who henceforth turned their eyes increasingly towards Russia; numerous Serb colonies were founded north of Odessa by the Empress Elizabeth. In the Turkish war of 1769–74 Catherine the Great issued a manifesto to the subject Christian populations, while Austria remained inactive: and the Treaty of Kuchuk Kainardji (1774) formally recognised Russia's claim to champion Orthodox and Slav interests. In 1787, when Russia and Austria again made joint cause against Turkey, the Serbs formed irregular bands in the latter's service, and Loudon's capture of Belgrade was the chief exploit of the war. When foreign complications forced Leopold II. to conclude peace and restore Belgrade (1792), the Serbs again saw their hopes dashed: but a new spirit was stirring, and the Turkish commissioner who saw one of the fortresses evacuated by a well armed and drilled detachment of native Serbs, exclaimed in just alarm to the Austrians, "Neighbours, what have you made of our rayah?"

Serbia's War of Independence.—During the next decade the rapid decay of the central Turkish authority placed outlying provinces at the mercy of insubordinate and rapacious soldiers: in Serbia there was a sharp conflict between the Pasha of Belgrade, Hadji Mustafa, and the Janissaries quartered throughout the country. These latter allied themselves with Pasvan Oglu, the Pasha of Vidin, who successfully defied two sieges by regular Turkish armies (1796–98) and on his reconciliation with the Porte induced it to support the Janissaries against Mustafa, whose mildness had earned him the name of "Mother of the Serbs." Finally the four "Dahis," or military chiefs, murdered Mustafa in Dec. 1801, subjected Serbia to their lawless rule, and when the Serbs protested to Constantinople, organized a massacre of many of their foremost leaders (Feb. 1804). Fortunately a notable substitute was found in Karageorge (*q.v.*), who led an insurrection against the Dahis and decisively defeated the Pasha of Bosnia at Mišar in Aug. 1805, storming the citadel of Belgrade in the following December. Though at first the insurgents professed loyalty to the Sultan, the breach became irreparable when in March 1807 Suleiman Pasha and his 200 Janissaries, after having duly evacuated the fortress, were treacherously murdered on their way to the frontier. This was followed by the complete ejection of the Turks from the whole Pashalik of Belgrade. Karageorge, combining in a primitive manner the functions of commander-in-chief and chief of state, summoned the first Skupština or assembly of notables, created a Senate on western models and laid the rudiments of administration and education. Finding his overtures to Vienna (through Archduke Charles and the Aulic War Council) rejected, he turned to Russia, and in July 1807 negotiated a convention with Rodofinikin, the first Russian agent in Belgrade. The young state gallantly cooperated with Russia in her war with the Porte, and the Treaty of Bucharest (1812) included clauses which are the first international recognition of Serbia, secured to her a limited autonomy and to Russia a permanent right of interference on her behalf. On the other hand, its reinstatement of Turkish garrisons in Belgrade and other fortresses was a bitter disappointment to the Serbs, who had hoped for complete independence. Moreover, the withdrawal of Russian forces in the south owing to Napoleon's Moscow campaign encouraged the Porte to attempt the reconquest of Serbia in the summer of 1813. By October all resistance was crushed, and Karageorge forced into flight. But the new Pasha, Suleiman Skopljak, revived many of the worst features of the old regime, defied the Treaty and in Dec. 1814 beheaded or impaled nearly 200 of the younger notables. On Palm Sunday 1815, then, Miloš Obrenović (*q.v.*), again raised the standard of revolt. By August Serbia was virtually free, and Miloš by diplomatic tact and moderation secured his recognition by the Porte as "Supreme Chief" (Vrhovni Knez) of Serbia. He further reassured the Porte by arranging the secret assassination of Karageorge, who had returned from exile in the hope of heading a movement for full independence. Thus began the long feud between two rival dynasties.

Serbia as Autonomous State.—In 1817 Miloš secured from the Skupština the recognition of his hereditary right, but this status was confirmed by the Sultan only in 1830. after the Convention of Akkerman (1826) and the Treaty of Adrianople (1829) had provided for Serbian autonomy on fuller lines than those laid down at Bucharest in 1812. The *hatti sherif* of 1830 still further defined that autonomy and in 1833 Miloš was able to occupy the Six Districts till then in dispute with the Turks. Turkish garrisons were retained in Belgrade, Šabac, Smederevo, Užice and two other places, and Turkish residents were henceforth restricted to these towns. In home affairs Miloš developed highly autocratic tendencies, opposed representative institutions and used his position to enrich himself. In 1835, however, a serious conspiracy forced him to summon a Skupština, and though the new constitution which it voted never came into force owing to the hostility of the Porte and the Powers, another was promulgated by *hatti sherif* of the Sultan in 1838, instituting a Council of State or Senate and a Cabinet of four ministers. These years witnessed the curious spectacle of the two autocracies, Russia and Turkey, working to restrict the Prince's autocratic powers, while the Western Liberal Powers, Britain and France, favoured their extension. Fortunately the efforts of Palmerston's agents, Colonel Hodges and Lord Ponsonby, were unsuccessful. In 1839 Miloš was forced to abdicate and withdraw, and government was carried on by the so-called "Defenders of the Constitution" (Ustavobranitelji), led by Vučić and Petronijević, first in the name of Miloš's eldest son Milan, and on his death a month later, of the second son Michael (*q.v.*). In 1842 Michael also was abandoned by the army and popular feeling and driven into exile. The Skupština, instead of electing Thomas Vučić as he himself had hoped, now summoned to the throne Alexander, son of Karageorge, a man of mediocre ability and weak will. The hostility of Tsar Nicholas delayed recognition for many months, but in June 1843 a newly elected Skupština unanimously confirmed the election of Prince Alexander.

Alexander **Karageorgević**.—The new reign was a period of growth and transition, in which a civil code was promulgated (1844), the judicial system completed (1846), a state printing press set up, the National Museum and Serbian Scientific Society founded. Primary and secondary education was encouraged, and an increasing number of young Serbs began to visit French and German universities. The publication of Vuk Karadžić's version of the New Testament (1847) was a landmark in literary progress: and his great services in collecting popular tales, ballads and proverbs and issuing the first scientific Serbian grammar and dictionary were crowned by his philological reforms and a new phonetic Serbian orthography, which, following parallel lines with Gaj's revision of Croat orthography, made Serbo-Croat literary unity a reality and thus laid the basis for political unity.

In foreign policy Alexander leaned towards Austria. The racial war in Hungary which followed the revolution of 1848 (see HUNGARY and CROATIA-SLAVONIA) caused great excitement in Serbia, numerous volunteers flocking across the river to help their Serb kinsmen against the Magyars—notably the Senator Stephen Knitanin. There were close confidential relations between Alexander, the Patriarch Rajačić and Meyerhofer, the Austrian Consul-General, who afterwards became governor of the autonomous *Vojvodina* established by Austria (1849–59). The Prince's chief minister Garašanin, an enthusiast for Western culture, but also infected by the Slavophil ideas current in Prague, travelled to the Court of Napoleon III. to appeal for French help, but Tsar Nicholas regarded him as a pupil of Kossuth and Mazzini and forced his dismissal upon the reluctant Prince. In the Crimean War Serbia found it difficult to choose between her suzerain and her protector, and maintained an uneasy armed neutrality which at least prevented an Austrian occupation. The Treaty of Paris (1856) brought Serbia one stage nearer to independence: she was now placed under a special guarantee of the signatory Powers, and was assured full autonomy in administration, legislation, religion and trade. The Turkish garrisons remained, but armed interference in Serbian affairs was henceforth forbidden, save by consent of the Powers (§ 21). Thus a quite illogical situation arose, in which the sovereign rights of the Porte were restricted by the Powers, who substituted a virtual protectorate of their own for that of Russia.

The Return **of Miloš** and Michael.—In 1858 discontent against Alexander's weak rule culminated in an attempt of the oligarchy to establish a kind of Kaimakamate or regency. But the new Assembly through which they hoped to secure this result, was almost as hostile to Vučić and his friends as to the Prince, and in December, after proclaiming Alexander's deposition, promptly recalled Miloš Obrenović, who skilfully secured the Porte's approval before returning. The leading oligarchs were imprisoned, and Vučić died in prison under suspicious circumstances. Miloš, now nearly eighty, governed as highhandedly as ever, but was quick enough to check any encroachments on the part of the Porte. In September 1860 he was succeeded by Michael, Serbia's ablest modern ruler, who introduced more Western methods of government, but set himself to strengthen the princely power: by the new Constitution of 1861 he had the right to nominate and dismiss members of the Council, and ministers were responsible to him and to it jointly, not to the Skupština. Helped by a French officer, Captain Mondain, as Minister of War, he completely reformed the Serbian army, and in 1862 when the Turks in the fortress of Belgrade bombarded the town, he pressed the question of complete evacuation upon the Powers. The opposition of Britain and Austria postponed a solution, though the Turkish garrisons were reduced to four and the Turkish civil population withdrawn from Serbia. But in 1867 (Austria having lost prestige after the war of 1866 and Stanley following less Turcophil lines than Russell) the Powers persuaded the Porte to hand over the four fortresses, though the Turkish flag was still to fly beside the Serbian. Michael meanwhile pursued far-reaching designs of policy, negotiated with Kossuth and Cuza, worked out plans with the exiled Bulgarian committee for a joint Serbo-Bulgarian state, corresponded with the Croat and Serb leaders in Habsburg territory and concluded secret alliances with Montenegro, Greece and Rumania, for joint action against the Turks. These ambitious dreams suddenly collapsed on June 10, 1868, when Michael was murdered in the park of Toptider, outside Belgrade, by adherents of the rival dynasty.

Prince Milan and the Eastern Crisis.—The conspiracy failed, and Michael's cousin and only male heir, Milan (*q.v*), was elected Prince at the age of 14. The Regency, led by Blaznavac, the Minister of War, and Jovan Ristić, governed till Milan's majority in 1872. The new constitution which it introduced in 1869, by abolishing the senate and giving wider powers to the Skupština, was a step towards parliamentary government: but in certain directions the princely power was still further entrenched, and the demand for constitutional revision dominated internal politics during Milan's reign. In foreign policy the regency showed Austrophil leanings, but the visit of Prince Milan to the Tsar at Livadia in Oct. 1871 marked a turn in favour of Russia. Milan, a man of real ability, but a neurasthenic, lacking in morals or powers of endurance, failed to win the affection of the nation, preferred the amusements of Paris or Vienna, and saw his dynasty steadily losing ground. The Bosnian insurrection of 1875 (whose leaders aimed at union with their kinsmen in Serbia and Montenegro), and the resultant European crisis aroused intense excitement in Serbia, and the prince would have risked his throne had he left the insurgents to their fate. In May 1876 the Liberal cabinet concluded an alliance with Montenegro, and answered the Porte's refusal to entrust Milan with the administration of Bosnia-Hercegovina, by declaring war. But the Serbian army, though swelled by Russian volunteers and led by a Russian general, was ill prepared and unable to resist the Turks, whose victory at Aleksinac forced the prince to appeal to the tsar's protection. Turkey only consented to grant Serbia an armistice after Russia had addressed an ultimatum to the Porte (October) and Serbia's position remained in suspense during the Conference of Constantinople (December), but after its failure she found it necessary to conclude peace with Turkey on the basis of the status quo (March 1, 1877) and thus was reduced to a passive rôle throughout the critical period of the Russo-Turkish War. On Dec. 15, five days after the fall of Plevna, Milan again declared war upon Turkey, but was coldly received by the Russians, who were now much more interested in Bulgaria than in Serbia. Hence the Treaty of San Stefano, imposed by victorious Russia on March 3, 1878, provided a purely "Big Bulgarian" solution of the Balkan problem, Serbia acquiring only Niš and Pirot, and Bosnia-Hercegovina being reserved for special autonomy. The opposition of the Great Powers prevented the enforcement of San Stefano, and the Congress of Berlin decided the fate of the Balkans for another generation. Serbia saw her Bosnian kinsmen, for whom she had unsuccessfully waged war, assigned by European mandate to Austria-Hungary, who also obtained the right of garrisoning the Sanjak of Novipazar, thereby securing her strategic line of advance upon Salonica and separating Serbia from Montenegro. Serbia herself obtained only the recognition of full independence, and the right to annex Niš, Pirot and Vranje, Austria vetoing her possession of Kosovo and "Old Serbia," and Russia not merely opposing her exaggerated claim to Vidin, but wishing to assign Niš to Bulgaria. The Russian delegates at Berlin, Gorchakov and Shuvalov, received Ristić with indifference and urged him to come to terms with Austria-Hungary. Ristić, completely disillusioned at the failure of a Russophil policy, resigned office in 1880, and Milan henceforth looked to Vienna.

Serbia and **Austria-Hungary.**—On June 28, 1881, a secret alliance for ten years was signed between Serbia and Austria-Hungary, by which the former undertook not to conclude any political treaty without Vienna's previous consent, and to prevent on her territory any "political or religious agitation" against the Dual Monarchy. The latter, in return, promised to use "her whole influence" in favour of the Obrenović, to recognise Serbia as a kingdom, and in the event of fresh Balkan complications to sanction her expansion in the Vilayet of Kosovo and Central Macedonia, though not in Novipazar. Behind the back of the Premier Piroćanac, Milan gave a still more explicit personal pledge and offered Haymerle a secret declaration "in whatever terms you care to notify to me, and annulling completely the effect of" the Premier's qualifying note. Milan's dealings with the court of Vienna are among the most humiliating incidents in Serbian history. They culminated in May 1885 in a contingent offer to withdraw from Serbia in favour of the Habsburgs and a request that in the event of his own death Austria-Hungary should prevent his son Alexander from mounting the throne as a minor, and should take charge of his education, or if she could not obtain possession of his person, should occupy Serbia by force of arms. Neither Kalnoky nor Francis Joseph responded, rightly regarding the offer as the outcome of an unbalanced mind.

Serbia Under King Milan.—On Feb. 22, 1882, the Skupština proclaimed Serbia a kingdom. But the internal situation remained unsatisfactory. The compensation to Turkish landlords in the new territory, and the building of railways, under the terms of the Berlin Treaty, necessitated foreign loans, and hence increased taxation. An attempt was made on Milan's life in 1882, and in 1883 there was an abortive rising at Zaječar, which was used as a pretext for savage measures of repression against the newly formed Radical Party. Milan by his favouritism and personal policy envenomed the party struggle, and the scandals of his private life and his undignified quarrel with Queen Natalie undermined the prestige of the dynasty. Serbia's rash and unprovoked attack upon Bulgaria, after the union of Eastern Rumelia in 1885, was mainly the work of Milan himself, who hoped to regain popularity by foreign conquest and regarded Bulgarian unity as a blow to the Balkan balance of power. The Serbian advance on Sofia was suddenly arrested by Prince Alexander's victory at Slivniča: the Bulgarian army in its turn invaded Serbia and thanks to unpreparedness, bad leadership and panic on the Serbian side, would probably have entered Belgrade, had not Austria-Hungary threatened armed intervention. Kálnoky explained to his German ally, who feared increased Austro-Russian friction, that he had acted not for the sake of Serbia or Milan, but on account of the moral effect upon Serbia's kinsmen inside the Dual Monarchy. The Treaty of Bucharest (March 1886) restored the *status* quo, but Serbia's prestige in Europe was effectually eclipsed for over two decades. King Milan's personal situation was undermined, and the divorce scandals of 1888 were the last straw. In the winter of that year he initiated a new and more liberal constitution (Dec. 22, 1888—N.S. Jan. 5, 1889), which provided for an extended franchise, closer parliamentary control, irremovability of judges and liberty of the press. From Milan's point of view this was devised as a *beau geste,* such as might rehabilitate the dynasty in popular favour. It was followed by his abdication (March 1889) in favour of his only child Alexander, then only 13: and a regency was formed by the veteran Ristil, with Generals Protić and Belimarković. A month before withdrawing from Serbia, Milan renewed the secret treaty with Austria-Hungary for another six years: as redrafted, it pledged the latter to protect the Obrenović dynasty, especially against "hostile incursions directed from Montenegro," and in the event of a Balkan upheaval to support Serbia's "territorial extension" southwards. Her definition of this as meaning "the valley of the Vardar as far as circumstances shall permit," amounted to the endorsement of Serbian as against Bulgarian claims in Macedonia.

King **Alexander.**—The regents, despite their own conservative leanings, found it necessary to entrust power to the Radical Party, under General Sava Grujif, which had a strong majority behind it: and its first achievement was to improve Serbian finances, reducing the deficit from 14,000,000 dinars in 1889 to 4,000,000 in 1890 and to 686,000 in 1891. But internal progress was still delayed by the constant interference and public wrangling of Milan and Natalie, and even after the ex-king's solemn renunciation had been endorsed by parliament (March 1892) he plotted in the background, with Austrian backing. The party struggle between Radicals and Liberals had reached a deadlock, when on April 14, 1893, the young king, by a sudden *coup d'état* ejected the regents, proclaimed himself of age and superseded the Liberal cabinet by one drawn from the moderate Radical wing. As, however, its first act was to impeach some of its predecessors, party feeling ran as high as ever, and turned into anti-dynastic lines. Alexander, whose character bore traces of a hereditary taint and whose education had suffered fatally from his parents' misconduct, grew up suspicious, callous and arbitrary. Early in 1894 he recalled Milan from his Parisian amusements, and on his advice suspended the constitution of 1889, reestablishing the more reactionary one of 1869. The Radicals went into violent opposition, but the situation was temporarily saved by a cabinet under the Progressive leader Stojan Novaković, whose position was however undermined by the King's refusal to sanction his project of constitutional reform, on a two-chamber basis, and also by friction with Austria-Hungary, the secret treaty with whom lapsed in 1895. At the elections of 1897 the Radicals maintained their majority, but Alexander refused to call them to power and formed a Cabinet under Dr. Vladan Gjorgjević, the doctor and intimate friend of King Milan, and known as a pronounced Russophobe. Milan was appointed commander-in-chief, and though he increased the army by one-third, and worked hard at its reorganization, his methods of favouritism did much to introduce the spirit of faction and conspiracy into the officers' corps. An attempt on his life in 1899 was used as a pretext for drastic measures against all the Radical leaders, some of whom, without serious proof, were sentenced to banishment or hard labour.

The End of the **Obrenović** Regime.—Dr. Gjorgjević's efforts to secure the succession by finding Alexander a wife from some reigning dynasty were checkmated by the King's rash decision in the summer of 1900 to marry his mistress Draga Mašin (née Lunjevica), the widow of a Czech engineer, a woman much older than himself. This decision led to a final breach between Alexander and Milan, who ended his dissolute existence at Vienna early in 1901: it led the Gjorgjevif cabinet to resign out of protest at so suicidal a step: it was keenly resented in the country and isolated the dynasty in Europe. Emancipated from his father's influence in foreign policy, Alexander now flung himself into the arms of Russia and in return induced the Tsar to stand sponsor at his marriage. But at home he was the object of universal aversion, and only made matters worse by dabbling in illegal political experiments. In April 1901 he promulgated a new constitution, based on an adaptation of the Novaković project, establishing a second chamber and guaranteeing liberty of the press and of association. But in the winter of 1902 he reverted to open reaction, appointed General Cincar Marković premier, and in April 1903 suddenly suspended his own Constitution, removed all the officials and senators appointed under it, dissolved both Chambers and then declared the Constitution to be once more valid. In June new elections were conducted under such official terrorism that the whole opposition held aloof. The country was full of unrest, wild rumours circulated, and it was widely believed that Queen Draga intended to secure the succession for her two brothers. Prompted by this untenable situation, a widespread military conspiracy was hatched, and on June 10, 1903, Alexander and Draga were assassinated in the palace of Belgrade, under peculiarly atrocious circumstances. Draga's two brothers, the Premier and the Minister of War shared the same fate. The details of the plot had been worked out in a well-known café in Vienna, and there is reason to believe that both the Austro-Hungarian and Russian Governments were aware of what was on foot, but allowed matters to take their course.

Serbia After the Murders of 1903.—The Obrenović régime was held in such universal odium in Serbia that the removal of its last representative, and hence of the old and grievous dynastic feud, was greeted with relief rather than horror. The regicides at once formed a cabinet representing all parties, reestablished the constitution of 1901 and convoked parliament for June 15. It unanimously elected Prince Peter Karageorgević, son of the ex-Prince Alexander to the vacant throne, and then restored the constitution of 1889, acknowledged as the most liberal of all those under which Serbia had been governed. Thus the shortlived senate disappeared, the franchise was extended, and the practice of tampering with such fundamental institutions as the bench, the press and the right of assembly received a salutary check. The new king found himself in a position of extreme delicacy, for the regicides were at first all-powerful politically. Austria-Hungary and Russia, indeed, at once congratulated him on his accession, but in Dec. 1903 all the Powers represented at Belgrade protested against the Government's weak attitude towards the regicides, and it was not till 1906 that a British Minister was appointed to return to Belgrade. The sinister incident of the murder of the Novaković brothers in the Belgrade state prison caused a reaction of feeling against the regicides, and the Radical Party, predominant since the murder, split into two sections, the Old and the Young, the former evolving steadily towards extreme conservatism. Their chief merit was a further reform of the finances; in 1903 there had been a deficit of 11,500,000 dinars, in 1904 and 1905 there were surpluses of 6,500,000 and 4,700 000 Under Dr. Paču as finance minister confidence revived both at home and abroad.

In foreign policy the Radicals concluded in June 1905 a customs convention with Bulgaria. which was intended to lead to a political alliance and common action in the Balkans. But it was prematurely disclosed (probably by the deliberate design of Prince Ferdinand) just as negotiations between Vienna and Belgrade for a new commercial treaty were nearing the final stage Early in 1906 Austria-Hungary peremptorily vetoed Serbia's ratification of the Bulgarian agreement, and when the Government demurred, broke off the Austro-Serbian negotiations and closed her frontiers to Serbian imports. The result was a prolonged tariff war, due largely to the increased political influence of the Agrarians both in Austria and Hungary and their desire to prevent Serbia from extending her market for livestock and agricultural produce in Vienna and other cities. Serbia was also embarrassed by Austria-Hungary's further demand that she should order the guns and munitions which she required, at the Skoda works rather than in Western countries. This too was firmly resisted, and the orders were placed with Schneider-Creusot. In the end Serbia was surprisingly successful in finding fresh markets, *e.g.,* in Egypt: in the first year of the tariff war her foreign trade only diminished by 300.000 dinars, in 1907 it had again increased by 10,000,000 dinars, and after a drop in 1908, which was still inferior to the pre-war figure, it continued to grow steadily, keeping pace with improved finances.

The Bosnian Crisis.—The "Pig War" touched every Serbian peasant in his pocket, and was a heavy blow to such Austrophil sentiments as still lingered. Friction between Serbia and Austria-Hungary became more acute when in October 1908 Baron Aehrenthal proclaimed the annexation of Bosnia-Hercegovina, without consulting the other signatories of the Treaty of Berlin, on which Austria-Hungary's mandate of occupation rested. During the prolonged international crisis that followed (Oct. 1908–March 1909), excitement in Serbia became intense, and the wilder spirits clamoured for war against the Dual Monarchy. After a secret session of the Skupština, the Foreign Minister, Dr. Milovanović, undertook a mission to the courts of Europe and pressed Serbia's claim for the cession of a strip of territory linking up Serbia with Montenegro and with the Adriatic and securing the much needed independence for her commerce. Popular sentiment had never abandoned the hope of union with the Serbs of Bosnia, but the Government retained sufficient sanity to frame its demands within the limits of the possible. Austria-Hungary, however, though while annexing Bosnia she had simultaneously evacuated the Sanjak (partly to prevent Italy from claiming compensation under Clause 7 of her alliance) resolutely refused any territorial concession to Serbia, declining also to enter an international Congress until the Powers stood committed to endorse the annexation. Serbia received encouragement from Russia, one aspect of the crisis being the acute rivalry between the two Foreign Ministers, Aehrenthal and Izvolsky, who regarded himself as having been duped at their Buchlau meeting in September 1908. In January 1909 Milovanović declared in the Skupština that the Bosnian question was one of European interest, that Austria-Hungary's Balkan mission was ended and that she must not drive Serbia to despair. The war fever grew, Austria-Hungary mobilised and a very dangerous situation had arisen when Russia, yielding to a German ultimatum, recognised the annexation and advised Serbia to submit. On March 31, 1909, on the collective advice of the Triple Entente and Italy, she addressed a Note to Vienna, recognising "the fait accompli created in Bosnia" as "in no way affecting her rights." A few days earlier Crown Prince George, who had been the soul of the war party, abdicated his right of succession, owing to the report that he had mortally injured his valet in a fit of passion: his younger brother Alexander thus became Heir Apparent.

(R. W. S.-W.)

THE WAR ERA

The Balkan League.—The annexation of Bosnia marked a turning-point in Serbian history. Henceforth public opinion, supported by prominent statesmen in every party, was practically unanimous in regarding a conflict with Austria-Hungary as sooner or later inevitable. Aehrenthal's policy inevitably strengthened the tendencies towards the creation of a Balkan League, and these were accelerated by the political unrest evoked throughout the Balkan peninsula by the Young Turk revolution. At first the inclusion of Turkey in such a league was openly advocated by Russia, and favoured by Milovanović and Venizelos. But the increasing chauvinism of the Young Turks in Macedonia led Venizelos to discuss with Bulgaria measures of common defence against a possible Turkish attack. Negotiations followed between Sofia and Belgrade in the winter of 1912. Secret treaties of alliance were concluded on March 13, 1912, between Serbia and Bulgaria and on May 29 between Bulgaria and Greece. There was no actual treaty binding Serbia and Greece, while the Serbo-Montenegrin treaty, concluded in Sept. 1912, was less political than military, and provided for separate though parallel action.

By the first of these each State was bound to assist the other with all its forces in the event of an attack, and in particular in the event of any Great Power trying to annex any portion of Turkey's Balkan possessions. If internal troubles should arise in Turkey, either ally might initiate proposals for military action, and any point upon which agreement was not reached should then be referred to Russia for decision. Special provision was made for possible conquests, Serbia recognizing Bulgaria's rights over the territory lying east of the Rhodope mountains and the Struma river, and Bulgaria similarly recognizing Serbia's rights north and west of the Šar mountains. The districts lying between these limits, the Aegean and the Lake of Okhrida were to form "a distinct autonomous province," but should their partition prove inevitable, then Serbia undertook to make. no claim beyond a line drawn from the Lake of Okhrida to near Kriva Palanka on the old Turco-Bulgarian frontier and including Skoplje, but not Monastir, Prilep or Veles. In the event of a dispute the tsar was to act as arbitrator, and Bulgaria undertook to accept the more southerly line as its new frontier with Serbia if the tsar should decide in its favour. In the event of war Bulgaria undertook to place at least 200,000, Serbia at least 150,000 men in the field against Turkey. If either Turkey or Rumania attacked Bulgaria, Serbia was to send 100,000 men to her aid, while she on her part must provide 200,000 men in support of Serbia in the event of an attack by Austria-Hungary.

Internal disorder spread rapidly throughout Turkey-in-Europe after 1911; and the repressive policy adopted by the Committee of Union and Progress towards all non-Turks culminated in a reign of terror at the parliamentary elections of 1912, a recrudescence of Komitadji activities and a fresh Albanian rising. The premature death of Milovanović on July 1 both deprived Serbia of her ablest modern statesman, and removed one of the few restraining influences in any Balkan capital. On Sept. 12 Pašić, who placed almost unreserved reliance on Russian support, became premier at the head of a purely Old Radical cabinet.

Nothing could now have arrested the growing anarchy in Turkey. Public opinion in Belgrade and Sofia was roused by a massacre of Bulgarians at Kočana on Aug. 1. By the middle of the month Skoplje, and the entire district recognized by the secret treaty as Serbian, were in the hands of the insurgent Albanians. The proposals for reform put forward by Count Berchtold on Aug. 20 prompted the Balkan Allies to hasten their preparations, and before the Powers had taken any collective action, they mobilized almost simultaneously (Oct. 1). At the last moment the Porte announced its intention to enforce the Vilayet Law of 1880, which had from the first remained on paper. Soon after, the Powers addressed a conciliatory Note to Constantinople and simultaneously warned the Allies that even in the event of their victory no change in the territorial status quo would be tolerated. The four allies decided to precipitate events, and before any further Note could reach them, the King of Montenegro, by an act of undoubted collusion, declared war upon Turkey. On Oct. 13 the other three Balkan Governments presented to the Porte a series of far-reaching demands, culminating in racial autonomy for all the nationalities of the Ottoman Empire; and four days later the Turks, without even deigning to answer the note, declared war on Serbia and Bulgaria (see BALKAN WARS, 1912–13).

The First War.—The rapid and overwhelming success of the Allies transformed the situation. By the end of November Turkish rule in Europe was restricted to the Chatalja lines, the Gallipoli Peninsula and the three fortresses of Adrianople, Janina and Scutari. The Serbs in particular, after the victories of Kumanovo and Monastir, were in actual occupation of all Macedonia west of the Vardar and had reached the Adriatic at Durazzo and Medua.

Kumanovo was much more than an ordinary victory. It restored to Serbia that self-confidence which had been so gravely shaken by the rebuffs and scandals of the previous 30 years; and throughout the Yugoslav provinces of Austria-Hungary it was hailed as an atonement for Serbia's downfall on the field of Kosovo and as a pledge of her new mission as the Southern Slav Piedmont. Austria-Hungary at first adopted a waiting attitude, but as the Serbs approached the Adriatic she suddenly ordered a general mobilization, and suppressed all public expressions of feeling, while the official press of Vienna and Budapest adopted a menacing tone towards Serbia. Great prominence was given to the alleged insults offered to Prochaska, Austro-Hungarian Consul at Prizren, and for some weeks public opinion was allowed to believe that he had been shamefully mutilated by Serbian officers. It only transpired long after that Prochaska had been entirely unmolested by the invaders, but had received definite instructions from Vienna to create an "incident" such as might provide a pretext for action. The Austro-Hungarian Chief of Staff and War Minister, Generals Conrad and Auffenberg, are known to have favoured a radical solution of the Southern Slav question by immediate war with Serbia; and similar views were held by the leading Ballplatz officials, Macchio, Kanya and Forgács. But both the emperor and Francis Ferdinand were averse to war, and Germany, finding Italy restive as to any change in the Balkan *status quo*, exercised a moderating influence over Vienna in connection with the fourth renewal of the Triple Alliance (Dec. 7).

Meanwhile, the success of the Balkan Allies, and the general relief with which public opinion hailed the downfall of Turkish rule in Europe, led the Powers to accept the accomplished fact. The Turks, seeing themselves isolated in Europe, made overtures of peace as early as the 11th to King Ferdinand, who was not willing to consider them until his troops had been checked before Chatalja.

The Conference of London.—The armistice of Dec. 3 was followed by a peace conference in London on Dec. 16, at which Serbia was represented by Novakovit, Nikolić and Vesnit. After a month of fruitless negotiations, complicated by a revolution in Constantinople, the Balkan Delegates broke off the negotiations on Jan. 28. The Council of Ambassadors initiated by Sir Edward Grey continued to sit in London, and devoted especial attention to the Albanian problem and to the friction produced between Albanians and Serbs by the latter's presence on the Adriatic.

When war was resumed on Feb. 3 the brunt fell upon Bulgaria, and the Serbs, being complete masters of Macedonia, were free to contribute 47,000 men and a siege train of 38 guns to the operations against Adrianople, which held out until March 26. The dispute which arose as to whether Shiikri Pasha had surrendered to the Bulgarians or to the Serbs was in itself quite unprofitable but was a symptom of the friction which was daily increasing between the two allies. The final phase of the war concentrated round Scutari, which Montenegro and Serbia made desperate efforts to reduce. Even the announcement that the Council of Ambassadors had definitely assigned Scutari to the new Albanian state, only strengthened the resolve of King Nicholas to create a fresh *fait accompli.* But Austria-Hungary upheld her veto, and on March 20 addressed a severe note to Montenegro and dispatched a strong naval squadron to the Southern Adriatic. Realizing the danger of Austro-Hungarian intervention, the Powers on March 31 joined Vienna in ordering Montenegro to cease hostilities, and on her refusal established a naval blockade of her strip of coast. On April 23 Scutari surrendered to the Montenegrins, but the Powers, after a crisis of some weeks, eventually compelled the hfontenegrins to surrender it to Admiral Burney, as commander of the international fleet.

Negotiations were resumed in London on May 20. By the Treaty of London (hfay 30, 1913) Turkey ceded to the four allies conjointly the island of Crete and all territory lying to the west of the Enos-Midia line, while the settlement of Albania and the Aegean Islands was referred to the Great Powers.

The Second Balkan War.—The Balkan Allies were now faced by the thorny problem of dividing the spoils. Macedonian autonomy, which the treaty had laid down as the ideal solution, was from the first abandoned by all parties. Between Bulgaria and Greece there was no territorial bargain, and no obvious means of reaching one, while Serbia as early as Jan. 23 formally raised the question of a revision of the Serbo-Bulgarian treaty. She claimed compensation for four reasons: (1) that she had furnished her ally with military support far in excess of her bargain; (2) that she had absolved Bulgaria from her military obligations in Macedonia; (3) that she had loyally continued the war three months after her own work was done; and (4) that the acquisition of Adrianople by Bulgaria radically modified the basis upon which the bargain rested. But if her attitude can be justified, it must be on the broader ground that Austria's veto on her obtaining a port in Northern Albania had upset her whole basic calculation, leaving the Vardar valley her only possible alternative outlet; and this involved her retention of Veles, Prilep, Monastir and Okhrida as well as the "disputed zone."

While Russia strained every effort to avert a conflict, Bulgaria was encouraged by the openly Serbophobe tone of the official press in Vienna and Budapest; and King Ferdinand had already ordered General Savov to hasten the transference of the army from the Thracian to the Macedonian front, when on May 27, Pašić, under pressure from the Serbian Opposition, publicly committed his Government to the demand for treaty revision. This hastened the resignation of the pacific Gvešov. His successor Danev opposed the suggestion that the Premiers should meet at St. Petersburg, contended that Russia had already prejudged the case by even considering revision, and relied increasingly upon Austria-Hungary. Serbia and Greece, realizing the danger, concluded first a military convention, and then a definite treaty of alliance for ten years (June 1). While the first of these provided for mutual military support in case of a Bulgarian attack upon either ally, the second extended the *casus* foederis to an attack by a third Power. Both the wording and the events of the moment make it clear that the intention was to guard against an Austro-Hungarian attack upon Serbia.

The tsar's personal appeal to the kings of Serbia and Bulgaria in the name of "the Slav Cause," fell on deaf ears (June 8). On June 13 Bulgaria rejected the proposal of the Powers in favour of parallel demobilization, and her attitude stiffened still further after the speech of the new Hungarian premier, Count Tisza, who emphasized the right of the Balkan States to settle differences in their own way—even by war—and declared that Austria-Hungary could not allow any other Power to acquire special prerogatives in the Peninsula (June 19).

Danev rejected Russia's fresh proposals for a compromise and reiterated the demand for the joint occupation of Macedonia. With Sazonov's sharp reply bidding Bulgaria to expect nothing more from Russia, St. Petersburg's influence over Sofia ended. On the night of June 29, without previous declaration of war, the Bulgarian armies made an almost simultaneous attack upon the Serbs and Greeks in the hope of seizing and holding the coveted districts of Macedonia until the foreign intervention which King Ferdinand believed to be imminent settled the dispute on a basis of beati possidentes. This is borne out, not merely by captured dispatches, but by the fact that when Putnik's forces everywhere held their own, Savov on July 1 telegraphed the order to stop hostilities. But that very afternoon the Serbian counter-offensive opened, and after a desperate struggle of nine days on the Bregalnica front (July 1–9), the Bulgarians were obliged to abandon the whole Ovčepolje, the strategic key to central Macedonia.

The Treaty of Bucharest.—By July 17 the Serbs had forced back the Bulgarians at all points to the frontier of 1912, and could henceforth adopt a mainly defensive attitude, while Greeks, Rumanians and Turks continued to advance. The appeals of Sofia to the Powers to enforce upon Turkey respect for a treaty concluded under their auspices were disregarded; and Western public opinion was not inclined to save Bulgaria from the consequences of her own act. Meanwhile Austria-Hungary was held back from intervention by both her allies—Italy, who viewed with alarm the Balkan activities of any outside Power and was determined to insist upon compensation, and Germany, who feared the loss of Rumania for the Triple Alliance and the consequent derangement of the military balance in Europe. Italy indeed made it clear to Vienna that she would not recognize the casus foederis of the Triple Alliance as applicable to such a case; and the combined pressure of Rome and Berlin, coupled with the certainty of Russian aid to Serbia, again averted war at the last moment. Bulgaria was forced to sign an armistice on July 31 and to open peace negotiations at Bucharest with her four Christian neighbours.

By the Treaty of Bucharest (Aug. 10) Serbia acquired all Macedonia west of the Vardar, and to the east the districts of Štip (Istib) and Kočana: Bulgaria retained possession of a dangerous salient at Strumnica, which enabled her to threaten Serbia's only railway connection with the Aegean. The Treaty of Constantinople, which was concluded between Bulgaria and Turkey (Sept. 29) and deprived the former of the greater part of Thrace, did not directly concern Serbia; but the indifference shown by her and her new allies, and still more by Britain and Russia, to Turkey's violation of a treaty which was their joint work, and indeed was morally binding upon them, was to be dearly paid for by Bulgaria's attitude in the World War. The treaties marked a new orientation in the Near East. Slav co-operation was replaced by mutual hatred, which threw defeated Bulgaria into the arms of Turkey and predisposed both for alliance with Berlin; Rumania's ties with the Triple Alliance were sensibly loosened, while Greece was drawn in two directions by dynastic attractions and party rancours.

The Albanian Conflicts.—Austria-Hungary now concentrated her attention upon Albania, and thereby rendered still more acute the relations between Serbs and Albanians. The summons addressed to Belgrade by the Great Powers for the withdrawal of the Serbian troops (Aug. 19) was a signal for further trouble. Late in Sept. there was a formidable Albanian rising, and the insurgents seized Dibra and even Okhrida, and forced Serbia to remobilize. In October the Serbs, in response to a peremptory demand from Austria-Hungary, withdrew their troops, but sent an effective Note to the Great Powers, begging them to enjoin upon their Albanian protégés a respect for the frontiers created for their benefit.

By Christmas 1913 the situation in the new territory was rapidly becoming normal, but its administration left much to be desired, and the closing of Bulgarian schools, the expulsion of Exarchist clergy and occasional excesses against the Moslem population caused serious unrest and discontent. The Pašić administration became absorbed in defending itself against the increasingly violent onslaughts of the Opposition, which on March 4, 1914, withdrew from the Chamber as a protest against alleged unconstitutional action of the Government in budget matters. But though the tension was increased by the activities of a powerful military society known colloquially as "The Black Hand," and by the seizure of its club premises by the Minister of the Interior, Protić, the Government was still in office in the summer. The visit of Crown Prince Alexander and Pašić to St. Petersburg early in February had given rise to rumours of a new Balkan League under Russian auspices; but the return of Radoslavov to power in Sofia had really made any such plan impracticable.

Murder of the Archduke.—On June 24 King Peter, incapacitated by ill-health, appointed Prince Alexander as regent, and simultaneously dissolved parliament, Pašić having in April pledged himself to the elections for a "Great Skupština" for constitutional changes. Only four days later the assassination of the Archduke Francis Ferdinand and his wife at Sarajevo revived the latent Austro-Serbian conflict in an acuter form than ever. The authors of the crime, Princip and Cabrinović, belonged to a group of Bosnian Serb students, mostly under the age of 20, who gave terrorist expression to the universal discontent aroused by Austro-Hungarian repression throughout her Yugoslav provinces. The victories of Serbia during the Balkan Wars and the openly hostile policy pursued towards her by Vienna and Budapest had assured to her in the eyes of public opinion the position of a Yugoslav Piedmont. Though the initiative unquestionably rested with the Bosnians themselves, it was proved that the assassins had been in Belgrade and had been secretly smuggled across the Drina into Bosnia, after receiving hand grenades and revolvers from the Serbian Komitadjis Major Tankosić and Ciganović. On these facts the Ballplatz sought to establish the complicity, or at least the foreknowledge, of the Serbian Government, yet despite the compromising admissions of Ljuba Jovanović, the theory is improbable. The country itself was exhausted by two wars; the Albanian campaign in the previous autumn had shown the reluctance of the peasant soldiers to return to the colours, and it was now the eve of harvest. Military stocks were alarmingly low; the young Prince had only just assumed the reins of government: the position of the Cabinet was shaky, and a fierce electoral campaign was opening. Delicate negotiations with Montenegro for a customs and military union, and perhaps even a dynastic arrangement, were still pending. Serbia had every conceivable motive for avoiding aggressive action. After the tragedy, it is difficult to see what other course her Government could have pursued; its one grave omission was failure to offer a thorough inquiry, without waiting for any suggestion from Vienna.

Ultimatum to Serbia.—The secret of the ultimatum was jealously guarded, and the long delay created, as was intended, a false sense of security in some quarters. Its delivery at Belgrade, which took place at 6 P.M. on July 23, was carefully timed for the moment after President Poincaré's departure from St. Petersburg after his state visit, the object being to disorganize the diplomacy of the allies. The ultimatum, after reminding the Serbian Government of its formal undertakings of March 31, 1909, charged it with "culpable tolerance" of terrorist propaganda directed against Austria-Hungary, and accused Serbian officers and functionaries of planning the Sarajevo murders. It therefore demanded that the Narodna Odbrana and any similar society guilty of anti-Austrian propaganda should be dissolved, that objectionable passages should be expunged from Serbian educational works, that all officers or officials whom Austria-Hungary might name as guilty of propaganda should be dismissed, and that the Belgrade Government should not merely arrest certain specified persons charged with complicity, but should order the trial of others, allow Austro-Hungarian delegates to take part in the inquiry and accept the collaboration of Austro-Hungarian officials "in the suppression of the subversive movement."

The general impression produced by this document upon European opinion is best summarized in the words of Sir E. Grey, who telegraphed the next day to Sir M. de Bunsen that he "had never before seen one State address to another independent State a document of so formidable a character." The fifth demand in particular, that of collaboration, he pointed out, "would be hardly consistent with the maintenance of Serbia's independent sovereignty." None the less, Serbia in her reply actually consented to "such collaboration as agrees with the principle of international law, with criminal procedure and with good neighbourly relations." Only on one point did she reply definitely in the negative—the share of Austro-Hungarian officials in the actual inquiry would, it was argued, be a violation of the Constitution and the criminal code; but even this could be met by "communications in concrete cases." As a final proof of sincerity, Serbia offered to submit any outstanding points to the decision of The Hague Tribunal or even to the Great Powers which had imposed upon her the declaration of March 31, 1909. Thus Serbia for the third time in six years offered to submit herself to the verdict of The Hague (the two previous occasions being the Bosnian crisis and the Friedjung trial), and each time Austria-Hungary rejected the proposal.

Austria-Hungary had left a period of 48 hours for either reply or mediation. The official documents published in Berlin and Vienna since the war make it abundantly clear that the Ballplatz deliberately couched the note in such terms as to be unacceptable. They also reveal that even William II. (to judge from his marginal notes) was impressed by the moderation of the Serbs, regarded Vienna's essential wishes as fulfilled and expressed the view that Giesl ought to have remained in Belgrade. His ministers, however, had failed to support Sir E. Grey's proposal for a prolongation of the time limit, and were thus responsible for bringing Russia into action. On July 27 the tsar replied to a despairing appeal of the prince regent for assistance to Serbia by a telegram strongly urging him to "neglect no step which might lead to a settlement," but conveying the assurance that "Russia will in no case disinterest herself in the fate of Serbia." On July 28 Austria-Hungary formally declared war upon Serbia. Henceforward the Austro-Serbian quarrel is merged in the larger diplomatic conflict between Alliance and Entente; and the reader may be referred to the special articles dealing with that subject.

Opening of the World War.—When Baron Giesl presented the ultimatum, Pašić had been absent electioneering in the provinces; but he at once returned to Belgrade, and on July 25 mobilization was ordered, and the seat of government and the archives were hastily transferred to Niš. In view of so grave a crisis elections became impossible, and as parliamentary sanction was more than ever necessary, the Government was forced to ignore the fact of dissolution and to call the previous Skupština once more into existence. At its first meeting in Niš on Aug. 1, the entire Opposition endorsed the Government's action, and for the moment party life was in abeyance But after Serbia's early military successes, the enforced evacuation of Belgrade (Nov. 29) brought the latent political crisis to a head. On Dec. 13 the purely Radical cabinet was succeeded by a Coalition Government, in which Pašić remained Premier, but the leaders of all parties save the Liberals received portfolios. It was, however, in this blackest week that the Skupština unanimously endorsed the Government's declaration that its foremost war aim was "the liberation and union of all our Serb, Croat and Slovene brethren not yet set free." This was the first public step of Serbia in favour of Yugoslav unity.

The brilliant offensive initiated on Dec. 2 by General Mišić and the I. Army cleared Serbian soil for the third time from invaders, and an enormous booty was captured. But the enemy left deadly infection behind him, and by the early spring of 1915 exhausted Serbia was immobilized by a typhus epidemic which is estimated to have caused about 300,000 deaths among the civil population. Serbia's negative rôle during 1915 was due not only to exhaustion but to considerations of high policy. Meanwhile the Entente was eagerly working for the intervention of Italy and of Bulgaria, neither of whom could receive adequate satisfaction save at the expense of Serbian aspirations. During the winter pressure was repeatedly brought to bear upon Niš to make territorial concessions to Bulgaria in Macedonia; but the one and only condition upon which Serbia could safely have considered this—namely, that the Allies should guarantee Yugoslav unity in the event of victory—was precluded by their parallel negotiations with Italy, whose official policy it was to prevent, not to further Yugoslav unity, and to whom by the Treaty of London, concluded on April 26, 1915, no less than 700,000 Yugoslavs were assigned. The fact that the concealment of this treaty from Serbia was made an absolute condition by Rome did not tend to diminish the reserve of Belgrade, which almost immediately learned the essential facts through St. Petersburg. The Serbs were more conscious than ever of the value to them of the Vardar valley, which would form part of any serious concessions to Bulgaria, whom they also believed to be tied to Vienna and Berlin by a secret compact. They were further handicapped by the attitude of Greece, who in the autumn of 1914 exercised her right of veto, under the Serbo-Greek Treaty, upon any cession of territory to Bulgaria and was prepared to demand Monastir as compensation. After the Dardanelles failure Bulgaria leaned increasingly towards Germany, and the concrete proposals addressed to Sofia by the Entente on May 28, over Serbia's head, came two months too late.

The Conquest of Serbia.—On Sept. 6 Bulgaria concluded a secret alliance with the Central Powers. Meanwhile the Serbian Government was unduly optimistic as to Greek and Rumanian intervention, and its disbelief in a German invasion was encouraged by Allied military opinion, which clung obstinately to the illusion that Bulgaria might enter on the Entente side. and therefore vetoed the Serbian general staff's plan for an immediate attack upon Sofia before the Bulgarian army was ready (Sept. 27). Next day Sir Edward Grey in the House of Commons announced that in the event of Bulgaria's aggression, "our friends in the Balkans" would receive help "without reserve and without qualification." Relying on the fulfilment of this pledge, the Serbs devoted their main effort to checking the Austro-German advance and remained on the defensive towards Bulgaria. The danger was increased by King Constantine's repudiation of Greece's treaty obligations towards Serbia and the overthrow of Venizelos. That statesman, however, had inquired of the Allies as early as Sept. 23 whether, if Bulgaria declared war on Serbia, and if Greece asked Serbia to supply the 150,000 men stipulated by the Serbo-Greek Treaty for such a contingency, France and Britain would assume Serbia's obligation for her; and an affirmative answer was received within 48 hours.

On Oct. 6 the rupture with Bulgaria was complete. The fatal delays in sending the promised troops, coupled with Allied insistence that the Serbs should hold back Mackensen to the last moment, belong to military history; but their results were eminently political. At the critical moment of the Bulgarian menace to the Niš-Salonika railway there were at Salonika not 150,000 Allied troops ready for action, but 35,000 French and 13,000 British, the latter under strict injunctions from London not to cross the frontier into Serbia (see General Sarrail, Mon *Commandement en Orient*, p. 27). Niš was decorated to welcome Allies who never came. The whole Serbian plan of campaign collapsed, and the armies, losing control of the railway southwards, retired precipitately through the passes leading to the plain of Kosovo. General Sarrail, informed that he must not expect reinforcements, was forced to arrest his belated offensive northwards (Nov. 12) and soon to withdraw to the west of the Vardar. The Serbs were thus cut off from Allied help, lost Skoplje and only just escaped being cut off between the converging Austro-German and Bulgarian armies.

The final retreat of the Serbian Army and Government across the inhospitable snowy mountains of Albania and Montenegro stands out as one of the great tragedies of the war. After dreadful sufferings the fugitives were conveyed by Allied transports to Corfu, which for the remainder of the war became the seat of the Serbian Government and a base for the convalescence and reorganization of the army. Notable assistance was rendered by British voluntary units, and some idea of the generous response of the British public to Serbia's need may be gathered from the fact that the Serbian Relief Fund from first to last collected over £1,000,000, in money and material and employed over 700 workers in Serbia, Albania, Corfu, Salonika, Corsica, Biserta and France; while the Scottish Women's Hospitals, under Dr. Elsie Inglis, performed notable services for the Serbs both on the Balkan and the Russian fronts.

Conquered Serbia was divided for administrative purposes between Austria-Hungary and Bulgaria: all that remained to the Serbs was a fragment of territory south of Monastir. Bulgaria, officially declaring the Serbian State to have ceased to exist, enrolled all men of military age throughout the occupied territory, and in Feb. 1917 extended this to include the whole male population. It refused to recognize the Serbian Red Cross and seized the Serbian Legation in Sofia; all Serbian schools, law courts and inscriptions were Bulgarized, libraries and collections were either destroyed or removed to Bulgaria, the Serbian clergy were evicted or executed. A formidable rising in the mountains behind Kursumlje was brutally repressed, with over 2,000 executions (March 1917). The war aims now repeatedly avowed by Sofia were the annexation not only of Macedonia, but of Kosovo, Prizren and the whole upper Morava and Timok valleys; a common frontier with Hungary; and the prevention of Yugoslav unity. Radoslavov more thdn once proclaimed Bulgaria's resolve to keep all her conquests (see *Vossische Zeitung,* Oct 10, 1916), and his official organs declared that Serbia's reconstitution, "no matter under what form, would be a perpetual menace to Balkan peace." Austria-Hungary showed much greater reserve, airing from time to time various alternative schemes for a vassal Southern Slav State under the Habsburgs, keeping Prince Mirko of Montenegro as a possible candidate for its throne and employing agents in Switzerland to sow dissension among the exiles.

The Serbs in Exile.—Soon after the establishment of the Serbian Government at Corfu party rivalries began to revive. The deputies were scattered, an independent press was impossible and regular Allied subsidies made the Government virtually immune from serious democratic control. The supersession of the Voivode Putnik and almost all his staff caused great indignation; and though the whole Serbian Coalition must bear the responsibility, it was known to be the work of Pašić and his colleague Protid, then still out of office. In Aug 1916 an attempt is alleged to have been made upon the life of the prince regent at the front, and the Government proceeded in the winter—while the joint advance under Sarrail was crowned by the capture of Monastir from the Bulgarians—to order numerous arrests on a charge of conspiracy and murder. The conspiracy trial which opened in Salonika in Jan. 1917, and was conducted behind the shelter of a strict military censorship, resulted in a death sentence upon nine Serbian officers, and notably of Colonel Dimitrievié (*q.v.*), head of the "Black Hand" There is no doubt that Dimitrievié favoured a military coup *d'état* against his Radical enemies, and that he had his hand in the Sarajevo murder; but the evidence for a plot against Prince Alexander was clearly inadequate, and he was the victim of rival military and political cliques. This trial revived all the old party dissensions: the reactionaries had triumphed on the very eve of the collapse of their chief support, the Tsarist Government. Pašić found himself between two fires—the need for a more democratic restatement of foreign policy, and the demand of the Young Radical and Progressive parties for a revision of the Salonika trial. Refusal led to their withdrawal from the Cabinet, and its reconstruction on a purely Old Radical basis under Pašić and Protić.

The last occasion when all parties co-operated was on July 20, 1917, when the Declaration of Corfu, drawn up between Trumbić for the Yugoslav Committee and Pašić for the Serbian Government, met with unanimous approval. It affirms that the Serbs, Croats and Slovenes constitute a single nation, and demands complete national unity under the Karageorgević dynasty, a constitutional democratic and parliamentary monarchy and the reference of all details to a Constituent Assembiy after the war. Pašić, having strengthened his position abroad by a visit to Paris and London, declined to convoke parliament for four months after the legal period had expired. At last, as the result of a direct appeal of its president to the Crown, it met in Corfu on Feb. 12, 1918, and the Government resigned, but after weeks of fruitless negotiation for a Coalition Ministry was allowed to resume office. In April, the Opposition, which numbered 60 as against 64 Old Radicals, withdrew in a body from the Chamber, thus leaving the Government without the quorum of 84 required by the Serbian Constitution.

During the spring and summer of 1918 there was acute tension among the rival Serbian groups, and the real initiative in the Yugoslav question and in the political campaign against Austria-Hungary passed to Trumbid, Beneš, Lansing and the Allies and to the leaders of the movement inside the Dual Monarchy. On April 8, 1918, a "Congress of the Oppressed Nationalities of Austria-Hungary" was opened in Rome, bdsed on the agreement reached a month earlier in London between Trumbid, on behalf of the Yugoslav Committee, and Andrea Torre, representing an influential committee of Italian deputies and senators. The result was immediate in two directions. The propaganda organized on the Italian front by the various national committees led to wholesale defections from the Austro-Hungarian army, and contributed materially, according to the high command's own admission, to the failure of the last Piave offensive in June. Meanwhile the Roman Congress was deliberately imitated inside the Dual Monarchy by an imposing Congress at Prague: it was attended by Czech, Polish, Rumanian, Slovak and Yugoslav delegates—among the latter Radić and Pribičević—and adopted a pledge of mutual support in the cause of unity and independence,

During 1918 the initiative among the Yugoslavs of the Monarchy fell more and more into the hands of the Slovenes, led by Father Korošec. The official recognition accorded to the Pact of Rome by Lansing in the name of America (May 31) was a fresh encouragement; and KoroSec, after constituting a Yugoslav National Council for the furtherance of unity, convoked a new Slav Congress at Ljubljana on Aug. 18, at which the Catholic hierarchy and clergy took a prominent part. In the early autumn, at the Emperor Charles's instance, Count Tisza visited Zagreb, Sarajevo and Dalmatia with the object of promoting a Hungarian solution of the Southern Slav question, but met, everywhere with a blank refusal. After the surrender of Bulgaria (Sept. 30) the Czech and Yugoslav spokesmen in the Reichsrat were still less conciliatory and insisted on separate representation at the peace negotiations and the absolute right to decide their own future state allegiance.

The Collapse of Austria-Hungary.—Events now followed each other with lightning speed. On Oct. 4 Austria-Hungary in a note to America accepted President Wilson's speeches as a basis of discussion, and on the 8th Baron Hussarek admitted that the Monarchy's internal structure must be modified and "full-grown nations" determine their own future. This only precipitated the collapse, and while Count Tisza voiced Hungarian public opinion in declaring the basis of the Dual system to be shattered, the Yugoslav National Council was transplanted from Ljubljana to Zagreb and strengthened by the inclusion of representatives of all parties (Oct. 10). On the 16th the Hungarian Government declared in favour of Personal Union, and next day Hussarek published an Imperial Proclamation, dated Oct. 16. dividing Austria (not Austria-Hungary) into four federal units (German, Czech, Yugoslav and Ukrainian), and leaving the Poles to make their own decision. KoroSec, in the name of the Czech and Yugoslav Clubs unreservedly rejected this stillborn project and claimed that the future of both nations was an international problem which only the Peace Conference could solve.

Henceforth the Yugoslavs acted independently of both Vienna and Budapest; and when on Oct. 21 the news of President Wilson's answer to Count Buribn's final Peace Note (refusing to negotiate Save on the basis of a recognition of Czechoslovak and Yngoslav national claims) became generally known, the old régime vanished almost as if by magic. Extraordinary scenes took place in many towns, the troops tearing off their military badges with the Habsburg arms and trampling them underfoot. National councils were speedily formed in Dalmatia and Bosnia, which arranged for the disarmament of the troops pouring northwards from the broken Albanian and Macedonian fronts. As early as the 23rd a Croat regiment stationed in Fiume disarmed the Magyar militia and took possession of the town. On the 24th Count Andrbssy was appointed Joint Foreign Minister, but the machinery of State had ceased to work, and both the Austrian and Hungarian Cabinets were *in statu demissionis.*

On the 28th, the military command in Zagreb handed over its authority to the National Council, and next day the Diet proclaimed the independence of Croatia from Hungary and assumed control of Fiume. The arsenals of Pola and Cattaro were already in the hands of the insurgents; and the Emperor Charles, in the hope either of winning the favour of the new régime in Zagreb or throwing an apple of discord between it and the Entente, signed a decree on Oct. 31 making over the whole Austro-Hungarian fleet to the Yugoslav State—a step which was interpreted by the Italian Nationalists as a proof of collusion between Zagreb and Vienna.

On the other hand, the action of the Supreme Council in Paris in prescribing the frontier line of the Secret Treaty of London as the line of occupation under the Austro-Hungarian Armistice was keenly resented by the Yugoslavs as a breach with Wilsonian principles. The Allies very properly insisted that the fleet must be surrendered into their hands, but before this could take place a deplorable incident occurred in Pola harbour, the "Viribus Unitis" being blown up by an Italian mine, with a Yugoslav admiral and crew on board. In Italy Baron Sonnino's frankly anti-Slav attitude threw Signor Orlando and the Pact of Rome into the shade; and the Consulta worked hard to prevent Yugoslavia's recognition by the Allies.

Rival Programmes.—That this recognition had not already been accorded before the collapse of the Central Powers began was due to disunion among the Yugoslavs themselves. Pašić, free from the restraints of a coalition and from all parliamentary control, had reverted to his original Pan-Serb standpoint, and steadily declined to reconstruct his Cabinet on a wider Yugoslav basis. Trumbić on his part could not enter a purely Serbian Cabinet without prejudicing that freedom of choice of his compatriots in the Dual Monarchy upon which the moral case of the Yugoslavs depended. A series of incidents, such as Pašić's dismissal of the Serbian Ministers in London and Washington for their Yugoslav sentiment, proved the differenceof outlook to be not merely personal but fundamental. When on Aug. 9 Balfour officially recognized the Czechoslovak National Council as "trustees of the future Czechoslovak Government," he was ready to extend a similar recognition to the Yugoslav cause, but as a preliminary condition he very reasonably insisted upon unanimity between those who claimed to represent the rival groups of Yugoslavs. But every effort lo bring Pašić and Trumbid together was unavailing, and when in the last week of Oct. the rival statesmen moved from London to Paris, all hope of Yugoslav recognition before the Peace Conference had vanished, owing to the stiffening in the attitude of Italy.

To meet the impending danger, the Zagreb Government urgently invited the assisrance of the Serbian army, which during the final advance contained a large proportion of Yugoslav volunteers. The first Serbian troops entered Fiume on Nov. 18, and a most dangerous situation arose between them and the Italians in Istria and Dalmatia, which was only very partially mitigated by the dispatch of American military and naval forces to Trieste and Fiume. Much of the blame falls upon the Supreme Council, which shrank from the only effective means of allaying friction —immediate Allied occupation of the disputed zone, pending the decision of the Peace Conference.

The Union.—The equivocal attitude of the Entente towards the new State, and Italy's insistence upon a fulfilment of the Treaty of London, naturally hastened the process of union. On Nov. 23 the Zagreb National Council proclaimed the union of the territories under its control with the kingdoms of Serbia and Montenegro, and invited the prince regent of Serbia to assume the regency of the new State. This decision (passed with only one dissentient voice, but that, unhappily, Stephen Radid, the peasant leader) took formal effect on Dec. 1, when Prince Alexander, at the formal request of 24 delegates from Zagreb, proclaimed the union. Meanwhile on Nov. 26 a hurriedly convoked National Assembly at Podgoriča had proclaimed the deposition of King Nicholas and his dynasty and the union of Montenegro with Serbia in the new united State. The first Yugoslav Cabinet was constituted under Protid as Premier and Korošec as Vice-Premier; Trumbić became Foreign Minister; other portfolios were divided more or less equally between Serbia and the new territories. See also YUGOSLAVIA. (X.)

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SERBIAN CAMPAIGNS (1914–1915). The 1914 operations and the conquest of Serbia in 1915 are described below, while an account is given of the Allied operations in Macedonia, 1915–18, and of the reconquest of Serbia, under the heading SALONIKA CAMPAIGNS, 1915–18.

I 1914 CAMPAIGN

The Austro-Hungarian problem in starting a campaign against Serbia was complicated by the prospect of Russian intervention in Galicia; the Austrian staff had, accordingly, drawn up two plans of concentration.

Alternative **Austro-Hungarian** Plans.—The first plan, in case of war against Serbia and Montenegro, called Concentration

B (Balkan), involved the employment of seven corps. The second plan, in case of war with Russia and Serbia, called Concentration R (Russia), involved the'employment against Russia of nine corps; against Serbia and Montenegro of a minimum group of three corps and the formation of a reserve (four corps) which could be directed as required towards the Russian frontier or those of Serbia and Montenegro.

Convinced at first that they would have to deal only with the southern Slavs, Austria-Hungary ordered, on July 26, the partial mobilization required for Concentration B; but, owing to complications with Russia, general mobilization was proclaimed on July 31. To avoid confusion, the Austro-Hungarian staff decided to allow Concentration B to be completed before withdrawing the reserve provided for in plan R.

Serbian Mobilization. — The Serbian general mobilization, ordered on July 25, yielded 490,000 men at the outset, and some 43,000 more between August and September. Montenegro declared war on Austria-Hungary on Aug. 5, 1914. Her forces amounted to about 50,000 militia with very little artillery, and were of no direct assistance to Serbia, though they occupied the attention of three Austrian mountain brigades. Circumstances compelled Serbia to adopt a purely defensive strategy. Her army, commanded by the Crown Prince Alexander, with Voivode Putnik as chief of staff, was therefore concentrated in a central position enabling it to operate either towards the Sava and Danube or towards the Drina.

After the withdrawal according to Concentration R of the Austrian II. Army, the Serbs had a superiority not only in numbers but also in quality, 90% of them having fought in the 1912–13 wars, and three-quarters of their guns being better than the Austrians'. On the other hand, Austria's equipment and resources in ammunition were far superior.

Jadar Operations, and Cer Battle: **Aug.** 16–24.—North Serbia is a mountainous country, devoid of good communications, particularly in the northwest, whilst the actual frontier was formed on the north by the formidable obstacle of the Danube and Sava, on the west by the Drina, a river not very broad but swift and difficult to bridge. The plan for the invasion of Serbia, drawn up by Conrad von Hotzendorff and Moltke in consultation, involved a concentric advance from all fronts, but was vitiated by the withdrawal of the II. Army. Potiorek, however, who feared an advance of the Serbs over the Drina to excite insurrection among their kinsmen in Bosnia, launched, on his own responsibility, a preventive offensive.

On the night of Aug. 11–12, the Austrian V. Army (VIII. and XIII. Corps) and elements of IV. and IX. Corps from the II. Army began to cross on a wide front from Drenovac on the Sava to Ljubovija on the Middle Drina, successfully driving back the Serbian frontier detachments. The Serbians moved to oppose the enemy, and by the evening of the 15th their II. Army occupied positions on a line south of Sabac, across the Cer and Iverak ridges and the Jadar valley, connecting with their III. Army who had moved forward from Valjevo to Zavlaka and Krupanj. Their I. Army had taken over the whole northern front as far as Obrenovac.

On the 16th, after severe fighting, the Austrian XIII. Corps drove back the left and centre of the Serbian III. Army, capturing Krupanj and threatening the Valjevo-Osečina road behind the Serbian positions. On the right of the II. Army the Serbs were also forced to give way, but in the centre a local counter-attack secured for the Serbs the important position of Kosaningrad (Aug. 18). This enabled the II. Army Commander Stepanović, to launch on the 19th a counter-stroke along the Cer and Iverak ridges, which swept the Austrian VIII. Corps down in and over the Drina. The Austrian right wing (VI. Army), which had concentrated around Vingrad, less hard pressed, and better organized for mountain warfare, retired in good order, but by the 22nd the whole river front was again occupied by the Serbs. The Austrian II. Army fared no better, losing prisoners and guns in their retreat over the Sava.

By the 24th the first invasion of Serbia was ended, with a loss of about 50,000 men to the Austrians. The Austrian commander-in-chief had greatly underestimated the military value of the forces opposed to him, while, on the Serbian side, Putnik's management of his forces and his choice of the moment and place of counter-attack were masterly.

Syrmian Operation, and Drina Battle. — Meanwhile, no events had taken place on the northern front east of Obrenovac other than the evident withdrawal of the Austrian II. Army. Putnik decided to throw his I. Army across the Sava into Syrmia in order to secure the line Mitrovica-Fruška range — Danube to Semlin and Belgrade. This would enable the Serbs to invade Bosnia without fear of a sudden attack on their north flank and rear.

After making good crossings on the night of Sept. 5–6, the I. Army occupied Semlin and was progressing towards its objective when the situation on the Drina front caused its recall. For, on the Austrian side, Potiorek was reorganizing his forces for a new thrust across the Drina. His VIII., XIII., XV. and the major part of his XVI. Corps bordered the Drina from the Sava to Ljubovija.

Potiorek's second offensive opened on the night of Sept. 7–8. In the north the VIII. Corps only succeeded in securing a bridgehead at Parašnica, but in the south the IV. and the right of the XIII. Corps crossed in force between Zvornik and Ljubovija, driving back the Serbian left. By the 11th, the situation was serious enough to compel Serbian G.H.Q. to order the transfer of the I. Army from Syrmia to Valjevo-Pecka. On the 13th, the Austrian XIII. Corps threatened to cut the Serbian line in two, but, on Sept. 16, a strong counter-attack was launched by the I. Army against the Austrian right. Even so, the Serbs barely succeeded in holding up the invaders, whom they failed to drive back over the rivers. Meanwhile the Užice Army and the Montenegrins had successfully undertaken a series of operations designed to prepare the way for the offensive over the Drina, but, being forestalled by the Austrian attack, they had no practical results.

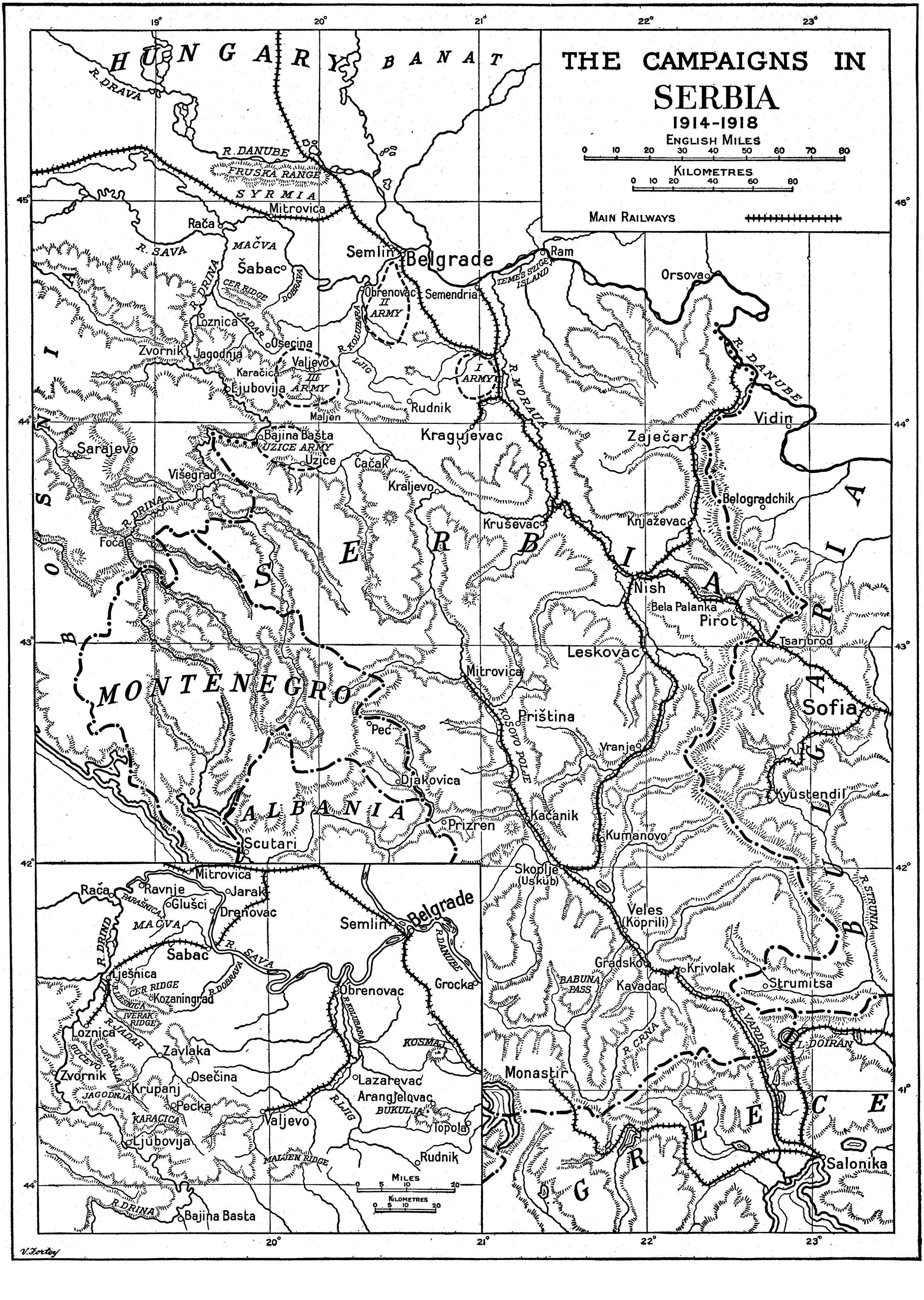
Kolubara and Rudnik Operations. — The Serbs suffered severely from the unfamiliar conditions of trench warfare and a shortage of ammunition, and Potiorek decided to make a third attack, although winter was near at hand. The new offensive opened with an attack in the Mačva, which drove back the Serbs to the line Dobrava-Cer ridge. The main Austrian attack, however, again took place in the Zvornik area, where the Serbian centre had to be withdrawn. Putnik, after attempting to cover Valjevo, decided to try and hold up the Austrian advance on the so-called "Kolubara line." The weather was terrible, but the Austrians, pushing along the Maljen ridge, attacked on the 17th, and drove the Serbs off that ridge. The Austrian left made good the passage of the Lower Kolubara by the 25th.

Putnik now resolved to give up Belgrade and to fight for time so as to last out until the arrival of ammunition enabled him to launch a counter-offensive. He therefore withdrew his forces during the night of Nov. 29–30 to a line with its flanks resting at Obrenovac and on the Lower Morava, its centre on the Rudnik Massif. The Austrians entered Belgrade on Dec. 1.

On the arrival of munitions Putnik undertook a counter-offensive; it opened on Dec. 3 with an attack of the I. Army under Mišic, which drove a deep wedge in the enemy lines. Further north the II. and III. Armies made little progress at first, the Serbian right being seriously threatened by a counter-attack (Dec. 6–9) effected by Krauss's and VIII. Corps. In the south, however, Mišic's Army swept the Austrians back towards Valjevo and Užice with such success that, on the 9th, Potiorek ordered a general retreat on Belgrade, Sabac and Loznica. All the Serbian armies then took up the pursuit, but mud and exhaustion prevented them from turning the Austrian retreat into a rout. By Dec. 16, Belgrade had been re-occupied, while Sabac, Loznica and Bajina Bašta had been retaken. Putnik's decisive victory gave Serbia peace for a few months, but her losses had been very heavy — 69,000 killed or died of sickness, 18,000 wounded and some 15,000 prisoners.

II. THE CONQUEST OF SERBIA, 1915

The third expedition having ended in failure, Potiorek was


THE CAMPAIGNS IN
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R. DRINA
CER RIDGE
DOBRAVA
JADAR
Loznica
Zvornik
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Valjevo
III ARMY
Karačica
Ljubovija
Maljen
Semlin
Belgrade
Obrenovac
II ARMY
Semendria
R. KOLUBARA
LJIG
Rudnik
I ARMY
R. MORAVA
Ram
TEMES SZIGET ISLAND
Orsova
R. DANUBE
Vidin
Zaječar
Belogradchik
Knjaževac
Kragujevac
Bajina Bašta
UZICE ARMY
Užice
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Kraljevo
Kruševac
Sarajevo
Višegrad
R. DRINA
Foča
BOSNIA
SERBIA
BULGARIA
Nish
Bela Palanka
Pirot
Tsaribrod
Leskovac
Mitrovica
MONTENEGRO
Priština
KOSOVO POLJE
Sofia
Vranje
Peć
Djakovica
Kyustendil
ALBANIA
Prizren
Kačanik
Kumanovo
Scutari
Skoplje (Uskub)
Veles (Köprili)
R. STRUMA
Gradsko
Krivolak
BABUNA PASS
Kavadar
Strumitsa
R. CRNA
R. VARDAR
L. DOIRAN
Monastir
GREECE
Salonika
Mitrovica
Rača
Ravnje
Jarak
PARAŠNICA
Glušci
Drenovac
MAČVA
R. DRINA
Šabac
R. SAVA
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Belgrade
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V. Forley

relieved of his command, a portion of his troops transferred to other fronts, and General Tersztianski left with a much weakened force. The latter, however, were incapable of taking the offensive, their sorely depleted ranks being further devastated by an epidemic of typhus. Meanwhile Falkenhayn (*q.v.*) had become convinced of the necessity of opening up direct railway communications with Turkey, and, the active support of Bulgaria having been secured, a new combined offensive was prepared for the autumn under a German commander, Marshal Mackensen.

His forces consisted of the Austrian III. Army (two Austrian, one German Corps), under Kovess, concentrated in Syrmia; the German XI. Army (three corps) under Gallwitz, in Banat; the Bulgarian I. Army (four double size divisions), under Bojadiev, between Vidin and Tsaribrod; and the Bulgarian II. Army, under Tokorov, between Kyustendil and Strumitsa.

The Serbian dispositions were influenced by the threat from the east which the Western Powers had forbidden Serbia to meet by a preventive offensive, and by the hope of assistance from Salonika. Serbian fighting strength was not more than 200,000; but the help of Greece was invoked under the 1913 treaty, and that of the Western Powers promised. Putnik deployed three-fifths of his forces facing north and guarded the route to Salonika with the rest.

Mackensen's Attack.—Mackensen assembled a mass of heavy artillery and modern appliances, and a heavy preliminary bombardment opened on Oct. 5, the 6th being fixed as the day of attack for Kijvess and Gallwitz and the 11th for the Bulgars. Kövess's main crossing, undertaken by two corps with the support of an intense bombardment, took place at Belgrade. After three days' fierce fighting, bridgeheads were secured and the Serbs forced to evacuate their capital (Oct. 9–10). His third corps, who crossed the Lower Drina and Sava, were held up in the Maćva. Simultaneously after a demonstration at Orsova and a Bulgarian threat towards Negotin, two of Gallwitz's corps secured crossings at Ram, and over Temessziget (Ostrovo) Island, but his third corps was held up near Semendria.

On the 11th Putnik began a steady policy of fighting successive delaying actions on the northern front, keeping back the Bulgars on the right and rear in order to gain time for the arrival of French and British aid, the first elements of which (British 10th, French 156th Div.) had started to land at Salonika on Oct. 3. Whilst heavy fighting was going on in the Morava valley and the mountains to the west, the Bulgarian advance began to threaten Pirot and the Salonika railway. Vranje was occupied on Oct. 16, whilst further south Todorov occupied Skoplje (Üsküb) on Oct. 21, thus cutting the Salonika line, and driving a deep wedge between the Serbs and the advancing Anglo-French force under Sarrail.

Until then the Austro-German armies from the north had made but slow progress, but the Bulgarian successes on his right forced Putnik to withdraw his left and centre concentrically towards Kraljevo-Kruševac. From Nov. 1 onwards a desperate effort was made by the Serbs to hold the arc Caćak-Kragujevac-Jagodnja-Nish-Leskovac. The Bulgars were held back at Bela Palanka, but the Germans and Austrians advanced steadily. Kragujevac fell with its arsenal on Nov. 1, and by the 9th Nish fell. The Orient railway, Falkenhayn's objective, was now clear from Germany to Constantinople.

Final Serbian Effort.—Making a further effort to envelop the Serbian right, the Bulgar II. Army moved out fanwise from Vranje on Priština and from Skoplje (Üsküb) on Kačanik and the Babuna pass, whilst its left was heavily engaged with considerable Anglo-French forces from Lake Doiran to Krivolak and Kavadar. In a last attempt to break through to the south Putnik assembled the remnants of five divisions round Priština and struck at the Bulgar II. Army on the 9th, driving back its right to Vranje and towards Kumanovo. But the arrival of part of the Bulgar I. Army from Leskovac on his left rear and the pressure of the Germans and Austrians from the north made it impossible for Putnik to persist; he then decided to escape through Albania with what could be saved of his army.

Between Nov. 20 and 25, the historic plain of Kosovo Polje witnessed another last effort of the Serbian people, then everything flowed away towards Peć, Djakovica and Prizren. The pursuit ceased in the first week of December. The Bulgar II Army then turned south and drove the Anglo-French force over the Serbian border. By Dec. 16 this force had withdrawn to Salonika (see SALONIKA CAMPAIGNS, 1915–18). Montenegro was completely occupied by the third week in Jan. 1916.

The end of the pursuit did not mean rest and reorganization for the remnant of the Serbian Army. A midwinter march through the Albanian mountains brought those whom its rigour left alive to the coast of the Adriatic. Thence they were transferred to Corfu, and later to Salonika, where the Western Powers provided food, clothing, equipment and stores, mitigating to that extent a disaster which might have been prevented by a more vigorous policy towards Bulgaria and Greece, and the earlier dispatch of the reinforcements which were ultimately sent.

See WORLD WAR I: *Bibliography.* (T. G. G. H.)

SERBO-BULGARIAN WAR (1885). The Berlin Congress of 1878, by its revision of the treaty of San Stefano, created two states in the Balkan Peninsula: the principality of Bulgaria, owning a nominal suzerainty to Turkey, and the autonomous province of Eastern Rumelia, presided over by a Turkish governor-general, and apparently intended to remain in close relations with the porte. This settlement ended when the movement for a united Bulgaria culminated (Sept. 1885) in a revolution in the Rumelian capital, Philippopolis. Prince Alexander of Bulgaria, recognizing that the movement was irresistible, placed himself at its head, and, proceeding to Philippopolis, formally accepted the government of the united Bulgarian states. As it was assumed that the sultan would reassert his claim by force of arms, the Bulgaro-Rumelian forces were concentrated as rapidly as possible near the Turkish frontier. Prince Alexander, however, had taken the step of acknowledging the sultan's suzerainty; and Turkey was not inclined to begin a war which would probably cause a revolt in Macedonia and might end by rendering Russian influence paramount in Bulgaria. But, while a conference of ambassadors was vainly discussing the situation at Constantinople, the Gordian knot was cut by the announcement that Serbia, seeking compensation for the aggrandizement of Bulgaria, had constituted herself the champion of the treaty of Berlin. King Milan had issued orders for the Serbian army mobilization on the very day of Prince Alexander's proclamation at Philippopolis, and large forces were concentrated (Oct. 1–12) on the Bulgarian frontier. On the 19th the prince ordered troops to the quarter thus threatened, but it seems certain that, whilst in eastern Rumelia every preparation had been made for war, Prince Alexander had so little expectation of, and wish for, a war with Serbia, that few measures were taken to supply the needs of a field army on that side.

Unlike the Serbian army, which contained few permanent units and consisted mainly of militiamen, the standing army of Bulgaria, trained and commanded by Russian officers since 1877–78, was organized on the German system of filling up relatively strong cadres to war strength and forming additional units. When fully mobilized the field army numbered about 55,000 men. The Rumelian forces (militia) consisted in all of about 35,000 men. Besides these, there was the "Bandit brigade" of Capt. Panitza, an irregular force some 3,000 strong. This force did good service as a flying right wing of the main army. In the Bulgarian army the whole of the staff and superior officers, as well as about half the regimental captains, were Russians. When the mobilization of the Bulgarian and Rumelian forces was decreed the Russian officers were at once withdrawn, and the heavy task of creating a staff and selecting young officers for all the superior commands had to be undertaken in face of the enemy. Moreover, when on Nov. 14, Milan declared war, the Bulgarian forces were mostly far away on the Turkish frontier. The Serbian main army (under King Milan), and the army of the Timok promptly crossed the frontier and soon came in contact with small forces of the enemy. On the Timok little or nothing of importance took place throughout the war, as the forces opposing the army of the Timok near Vidin effectually neutralized that force. In front of Dragoman and Trn the Bulgarians fell back, engaging in stubborn rearguard combats at every favourable place. The Serbian "Army of the Nishava" advanced but slowly and with hesitation, while the most strenuous exertions were made by Prince Alexander and his newly formed staff to collect their far-distant troops in the Slivnitza position. Every commander was given the simple order to march on Slivnitza. The civilian population was warned to be ready with supplies to meet the troops by the roadside, and under these peculiar conditions and extraordinary difficulties of country and weather, the Bulgarians marched on the decisive point at the highest possible speed of man and horse. Some remarkable marches are recorded: the 8th infantry, 4,500 strong, covered 59m. in 32 hours, leaving only 62 men behind; the troops that were sent up by rail were packed in open trucks, 60 men to a truck. The furious energy displayed had its reward on the field of battle. Before the last shot of the battle of Slivnitza was fired, nearly half of the entire forces of Bulgaria and Rumelia were in the lines, and 14,000 men more faced the army of the Timok at Vidin. With the main army—a striking display of what could be accomplished by patriotism and vigour—were 56 pieces of artillery, most of which had been dragged over the Balkan passes in mid-winter.

The position of Slivnitza, barring the high road between Nish and Sofia, had been extensively fortified, but when the Serbians opened their attack on Nov. 17, there were but few troops available to occupy the works. On the right of the Bulgarian line was the Meka Krud height; here fighting went on through the short winter day, which ended with a gallant, and for the time successful, counter-attack by six Bulgarian battalions led by Capt. Benderev. The prince, not yet ready for the offensive, withdrew these troops to their original position. In the centre, near the high road, a hot and, at one moment of the day, almost successful attack of the Serbs ended with their complete repulse. The latter had had 17,000 men against the Bulgarians' 11,000; yet they had, owing mainly to faults in the superior leading, been unsuccessful. Next day their chances of victory would be even less, for the defenders were hourly reinforced from Sofia, and on the 18th were actually somewhat superior in numbers. On this day the Serbs made a very heavy attack on the Bulgarian left wing, which was eventually repulsed, though not without great difficulty, by the newly arrived troops from Sofia. Later a half-hearted attack was made on the centre, and from his position on Meka Krud Benderev again attacked the Serbian "Danube" division. On this day a Serbian division pushed the Bulgarians out of Breznik, but made no farther advance either on Sofia or on the left flank of the Bulgarians at Slivnitza, in spite of orders to do so. On the 19th alarm and consternation at Sofia, caused by the presence of hostile forces at Breznik, were so great that Alexander left the command in the hands of his chief of staff, Major Guchev, and hurried back to the capital in order to organize the defence. The Serbian leader was, however, as inactive on the 19th as on the 18th, and when he at last moved forward towards Slivnitza it was only with a portion of his force; this was driven back, by a detachment from the left wing of the Bulgarian position, to Rakita. Meanwhile, the active Benderev had reopened his attack on the Danube division. Twice he was repulsed, but finally at about 3 P.M. his battalions carried the heights held by the Serbs. A little before this the Bulgarian centre likewise moved forward, and, though a final attack of the Serbs on the gap caused by the absence of the Bulgarian troops detached towards Breznik came near to success, the prince returned to the battlefield to find his troops everywhere victorious and driving the enemy before them. Two days later, reorganized and reinforced, the Bulgarians took the offensive and carried the Dragoman pass.

On the 25th Prince Alexander received at Tsaribrod proposals for an armistice from King Milan; these were not accepted, and the Bulgarian army, crossing the frontier, advanced in several columns upon Pirot, where the army of the Nishava took up a defensive position in the town and on the surrounding heights. A two-days' engagement followed (Nov. 26 and 27). On the 26th the Bulgarians were successful, but a heavy counter attack on the following day almost siiatched the victory out of their hands, and it was only after a severe contest lasting 11 hours that the Serbs finally gave way. The Bulgarians were not permitted to reap the fruits of their success. As they were preparing to pursue the defeated and now greatly demoralized enemy on the 28th, the Austrian minister at Belgrade arrived at headquarters and hostilities ceased. The intervention of Austria saved the Serbian army, which was greatly demoralized, and was now threatened by the united Bulgarian force of nearly 35,000 men. On the same day the army of the Timok was repulsed with heavy loss in an attack on Vidin.

Serbia escaped almost unpunished from her war of aggression The young Bulgarian army, with its improvised staff and newly-appointed field officers, displayed admirable marching power and fighting qualities, and the Rumelian militiamen proved themselves to be good soldiers. The Serbs had, however, fought with great bravery also, and the victory must be ascribed in the main to the personal influence, the strenuous exertions and the sound military judgment of Prince Alexander; and the brief but decisive campaign set the seal to Bulgarian unity.

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SERBO-CROATIAN LANGUAGE, a member of the southern group of the Slavonic languages (*q.v.*), is the principal language of Yugoslavia. It is native to the four republics of Serbia, Montenegro, Bosnia-Hercegovina, and Croatia, and serves as an important secondary language in Slovenia and Macedonia. The number of speakers of Serbocroatian in Yugoslavia in mid-20th century was over 12,000,000.

The Serbs and Croats are of the same racial stock and speak a single language, but because of nationalistic antagonisms deeply rooted in history they often exaggerate the minor regional differences in an attempt to prove that there are two languages. The Catholic Croats lived for centuries under Venetian or Austro-Hungarian rule, while the Orthodox Serbs enjoyed a brief period of independence within the sphere of Byzantium and then were subject to the Turks for five centuries. Consequently the Croat writes his language in Roman letters, calling it Croatian, whereas the Serb uses the Cyrillic alphabet and calls the language Serbian. The Croats speak a western type of dialect, but not all Serbs speak eastern dialects. In vocabulary it is possible to point out some words which are specifically Croatian and others which can be called Serbian. yet nearly always where lexical doublets exist, both forms are known and understood all over the country.

History. — The earliest surviving Serbo-Croatian texts date from the 12th century. In Serbia, the local variant of Church Slavonic was in use until Russian Church Slavonic books were adopted at the end of the 17th century. During the following decades the Serbs worked out a compromise style called Slavono-Serbian. In Croatia the chief written language was Latin, but nonetheless in some areas the Croats wrote their own language with Glagolitic letters, using their own style of Church Slavonic for literature and the local *ča*-dialects (see below) for records and legal documents. Dalmatian poets wrote in the fa-dialect in the 16th century. but the *što-(i)je* dialect of Dubrovnik soon became the literary language. Attempts in the 18th century to base a literary language on the kaj-dialects gave way to enthusiasm for an artificial "Illyrian" language which was to unite all south Slavs. At this time a Serb. Vuk Stefanović Karadžić (1787–1864) began to write in his native *što-(i)je* Hercegovinian dialect. He worked out an excellent phonemic orthography, adapting Cyrillic letters to make an alphabet truly suited to the language. Vuk's dialect was the one spoken by the largest number of people, it was central, in a sense a compromise among peripheral dialects, and moreover it was close to the language of Dubrovnik literature. After long controversy, a group of leading Croat and Serb writers formally accepted Vuk's language in 1850, but dissension about details continued. Since the end of the century, the e-dialects have been used in the Serbian east, while the rest of the country has retained Vuk's *(i)je* forms.

Classification. — Serbo-Croatian is joined to its South Slavonic neighbours by transitional dialects, in the east and south to Bulgarian and Macedonian, and in the northwest to Slovene. It is closer to Slovene, however, in that both have retained full nominal declensions and vocalic systems which distinguish long from short and rising from falling vowels, whereas Macedonian and Bulgarian have virtually lost the case system and have neither length nor intonation as distinctive features of the vowels.

The three major Serbo-Croatian dialects are named Sto, *ča,* and kaj, according to their respective interrogative pronouns for "what?"

The Sto dialect covers the largest area and is the basis for the standard language. The Ea dialect. formerly spoken widely in the west, is rapidly disappearing. It can still be heard on the Dalmatian islands, in much of Istria, and in a few spots on the mainland. It is important for historical linguistics because it has preserved with great fidelity the accent on the same syllable that bore it in Common Slavonic. The kaj dialect is spoken in most of northern Croatia, including all of the surroundings of Zagreb. It seems to have been once a part of Slovene, but during the last millenium its character was changed because of strong influence first from the Ea and then from the Sto dialects.

Sto-Serbo-Croatian is characterized by the development of Common Slavonic *ǫ* to *u*, *tj* and dj to the strongly affricated palatal stops *ć đ*, syllabic $l > u$, and, generally. post-vocalic $l >$ o, and both *ŭ* and *ĭ* > a. There is a strong tendency to avoid difficult consonantal clusters, either by inserting a vowel or by dropping one of the consonants. The aorist and imperfect tenses are regularly used in the east, but restricted to the written language in the west. In the east the infinitive is usually avoided, being replaced by *da* plus present tense.

The subdivisions of the Sto dialect are generally defined by a combination of criteria, chiefly the development of Common Slavonic *ě* and the degree of innovation in the accentual system. In the east *ě* > e (**dětę* "child" > *déte*, **děca* "children" > *dèca*), in the west i (dite, dica). and in the intermediate area ije if long and je if short (*dijète, djèca*). The original geographic division has been obscured by mass migrations of *(i)je*-speakers to the west. and in some areas (especially Bosnia) Catholics and Moslems use the i-forms. and members of all three religions the (i) je-forms. Isolated dialects have a mixed development (*ī*/je or *ē*/*je*) or have maintained a six-vowel system where *ě* has not fallen together with any other vowel. In accentuation, there is a general tendency to shift the stress one syllable toward the beginning of the word. Conservative dialects have admitted shifts rarely or not at all, but most dialects have carried the shift through in many or all possible cases. The standard language has the newer accentuation! and for *ě* either e (Serbia and the Vojvodina) or *(i)je* (Montenegro. Bosnia-Hercegovina. Croatia). The vocalic system here includes i e a o *u* and syllabic r, all of which may occur long or short, with rising or falling intonation. Rising intonation never occurs in a final syllable. There can be only one rising syllable in a word, and it automatically receives the stress, which is weak. If there is no rising intonation, the stress falls on the first syllable.

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SERBO-CROATIAN LITERATURE. Serbo-Croatian literature is considered to have had its origin in the 9th century, when the "Slav apostles" Cyril and Methodius, with their disciples, translated church books from Greek into a Slavonic dialect then spoken in southern Macedonia. Copyists and later translators in Serbia and Croatia gradually adapted these and other works to the requirements of their own language; the earliest extant monuments of their work are a stone inscription in a church on the island of Krk (c. 1100) and an illuminated manuscript of the 12th century, *Miroslavljevo jevandjelje* ("Miroslav's Gospel"). The early literature flourished principally among the Serbs, who had welcomed the Slavonic liturgy. The cultivation of the arts was encouraged by Serbian kings; Serbian monks were assiduous translators and copyists. Mediaeval Serbian literature (in the Cyrillic alphabet) was rich in translations of all branches of Byzantine literature, secular as well as ecclesiastical. These are also found in the Croatian literature (in the Glagolitic alphabet) of the 13th and 14th centuries. Of these translations hagiographies are of the chief importance in mediaeval Serbian literature, since they led to the composition of the first original works, the 13th-century biographies. Saint Sava (d. 1236), the son of the ruler Nemanja, is the earliest known original Serbian writer. His brief and simple account of the last years of his father's life was followed by a fuller biography of Nemanja by his other son Stefan. Two biographies of Saint Sava were composed later in the century; one of these, by a monk Teodosije, has qualities of style and composition which make it the outstanding Serbian literary work of the mediaeval period. Archbishop Danilo (d. 1346), who compiled Lives of Serbian Kings and Archbishops, is the only known biographer of the 14th century. Biographies of kings by Grigorije Camblak and Konstantin the Philosopher in the 15th century are principally of historical value; various chronicles of the period are of historical rather than literary interest.

Ragusan Literature. — For nearly two centuries, under Turkish subjugation. all forms of cultural activity in Serbia were now crushed. Croatian Glagolitic literature was at the same time repressed by Rome and Venice. But this bitter loss was far outweighed by the results of the influence and inspiration of the Italian Renaissance in Dubrovnik (Ragusa) and elsewhere on the Dalmatian coast and islands; for Dalmatia, by reason of its geographical position and political relations, did not suffer the fate of the inland provinces.

"Troubadour" lyric poetry was first imitated; Šiško Menčetić (d. 1527) and Djordje Držić (d. 1501) were prolific in its production. Of the imitations of Florentine carnival poetry, Jedjupka ("The Gipsy") by Andrije Čubranović (d. 1530?) is the most original and has the greatest poetic value, particularly because of the serious and sincere tone of its final section. The first epic of Serbo-Croatian literature is *Judita* ("Judith"), in which the poet Marko Marulić (d. 1524) treats a biblical subject. *Robinja* ("The Slave Girl"), by Hanibal Lucić (d. 1553) is one of the earliest European secular romantic dramas. Italian pastoral poetry was imitated, notably by Peter Zoranić, of Zadar (d. 1569); his Planine ("The Mountains"), composed in prose and verse, may be regarded as the first novel of Serbo-Croatian literature. Petar Hektorović (d. 1572) of Hvar shows an almost complete independence of Italian models in his narrative and philosophical idyll Ribanje *i* ribarsko *prigovaranje* ("Fishing and Fishermen's Talk"), describing a three-day fishing expedition. Mavro Vetranić, a Benedictine monk (d. 1576) was a prolific writer; his most original work is Remeta ("The Hermit"), in which his own retired existence is compared with the gay life of Dubrovnik. The witty and lively comedies of Marin Držić (d. 1567) were, and still are, popular. Some of his plots are original; he introduced Ragusan local colour to others borrowed from Plautus and Boccaccio. A reaction from Italian influence in favour of the Greek and Latin classics is seen later in the same century in the poetry of Dinko Ranjina (d. 1607) and Dominko Zlatarić (d. 1609). The greatest poet of Ragusan literature was Ivan Gundulić (1588–1638). His pastoral play Dubravka first performed in 1628, glorifies liberty and warns against social evils; his epic Osman, inspired by patriotic Slav ideals and by the Christian consciousness which is bound up with them, describes, with many digressions, events connected with a contemporary Polish triumph in war against the Turks. Gundulić's work represents the culmination of the "golden age" of Ragusan literature. He was succeeded by only two other notable Ragusan writers: a lyric poet, Ivan Bunić (d. 1658), and a writer of patriotic dramas, Junije Palmotić (d. 1657). A "history" in verse, written in the 18th century by a Dalmatian, **A.** Kačić Miošić (d. 1760), is of interest because the writer includes folk ballads in his work and shows consciousness of the national unity of the south Slavs.

The 18th Century. — By the beginning of the 18th century literature had slowly begun to revive in other parts of the country. In Bosnia and Croatia its development had been largely directed by Jesuits and Franciscans, following on the Counter-Reformation; among the Orthodox Serbs literary production was principally in the hands of monks during most of the 18th century and therefore mainly ecclesiastical in character. The first works of this period — the majority of which were in the artificial "literary" Serbo-Slavonic or Russo-Slavonic languages *(see* SERBO-CROATIAN LANGUAGE)—appeared among the Serbs and Croats under Habsburg rule. The Serb Jovan Rajić (1726–1801) wrote an epic poem in the vernacular, but his history of the Slavs (in which most attention is devoted to that of the South Slavs) is in Serbo-Slavonic. Toward the end of the century Serbian and Croatian writers began to adopt the principles of western European rationalism and to cater for the needs of the people. Social evils of life in Zagreb were exposed in the comedies of the Croat Tito Brezovački (1757–1805); Matija Reljković criticized the corrupt customs and sloth of his fellow Slavonians in his didactic poem *Satyr* (1762); and the Serb Zaharija Orfelin attempted the introduction of a literary and didactic periodical (*Magazin,* 1768) in the vernacular. The real founder of modern Serbian literature was Dositej (or Dimitrije) Obradović (1740–1811), who devoted his life to the task of raising the cultural level of his own unfortunate people to that of their contemporaries in western Europe and to introducing to them the progressive ideas of western European rationalism. Obradović was a monk who had early abandoned monastic life and travelled extensively; an account of his visit to London is given particular attention in his autobiography (Eng. trans., *The Life and Adventures of Dimitrije Obradović who as a Monk was Given the Name Dositej,* Berkeley, Calif., 1953). In this and in his other works *(Sovjeti zdravago razuma,* "Counsels of Sound Reason"; *Basne,* "Fables"; *Sobranije,* "Anthology"; *Etika,* "Ethics"; and *Mezimac,* "The Last-Born") he presents a variety of instruction in a variety of forms; much is translated or adapted from works in other languages, particularly English. The pseudoclassical lyric poetry of Lukijan Mušicki (d. 1837) continued the teaching of Obradović. Jovan Sterija Popović (1806–56), the "father of Serbian drama," whose satirical comedies were a vehicle for social criticism, is the most prominent Serbian didacticist following Obradović. The pseudohistorical novels of Milovan Vidakovit (1780–1841), which also carried on Obradović's moral instruction but had much in common with the literature of the romantic movement. did much to satisfy the demands of the new reading public and to encourage its growth.

The Romantic Movement. — A great impetus was given to literary production before the middle of the 19th century by the publication of the vast collections of Serbo-Croatian folk poetry made by the Serb Vuk Karadžić (1787–1864). This traditional poetry is of two kinds: lyric poems or "women's songs," sung at work or to accompany dancing, celebrations, or various customs and including love poems, elegies and hymns; and heroic narrative or epic ballads. which exist in thousands, the majority relating events from the country's past — legendary or semilegendary in the older ballads, more clearly authentic in later ones. Ballads of a 15- or 16-syllable line are believed to be of earlier origin than those, far more numerous. of the decasyllabic line. Those of the greatest interest and literary value relate events connected with the tragic defeat of the Serbs by the Turks at Kosovo in 1389, and the often superhuman exploits of a semilegendary figure. Marko Kraljević, the national hero. The heroic ballads are chanted by one man, accompanying himself on the national instrument, the one-stringed *gusle.* The attention paid by Goethe and other western European writers to this newly revealed wealth of Yagoslav traditional poetry increased the pride of the people in their own folk creations; and writers, particularly poets, sharing the interest of all romanticists in past history, tradition and folklore, drew abundant inspiration from it. Literary production was further promoted at this period by linguistic reforms, also largely the work of Vuk Karadžić, and by the agreement reached by the Croats in 1836 to adopt the language of the traditional ballads as the literary language, abandoning other dialects. This literary unification of Serbs and Croats was the principal achievement of the "Illyrian movement," centred in Zagreb and led by Ljudevit Gaj (1809–72).

The first and most truly romantic poet of this renascent literature was Sima Milutinović (1791–1847); his influence may be seen in the shorter works of Petar Petrović Njegoš (1813–51), prince-bishop of Montenegro, the greatest Serbian poet. But Njegoš was far too individual a thinker to be influenced to any extent by current literary trends. His intense patriotic emotion, his idealism, pessimism and scepticism are given expression in his profound philosophical poem *Luča mikrokozma* ("The Light of the Microcosm"; Eng. trans. *The Rays of Microcosm,* Munich, 1953), inspired to some extent by Milton's *Paradise Lost,* and in his epic in dramatic form, *Gorski Vijenac* (Eng. trans., *The Mountain Wreath,* London, 1930), a work that has no parallel. The subject of this poem is an event from Montenegro's troubled past. The poet introduces characters, dialogue and episodes which present a vivid and colourful picture of Montenegrin life and customs. This is the most powerful poetic work in the Serbian language.

The greatest Croatian poet of this period was Ivan Mažuranić (1814–90), whose work, strongly nationalist in spirit, shows, as does that of Njegoš, the inspiration of the heroic ballads. The theme of his dramatic and moving epic *Smrt Smail-Age Čengića* ("The Death of Smail-Aga Čengić") is an event that had taken place a few years previously in Montenegro. Turkish tyranny over the Yugoslavs is shown as symbolizing the oppression of the poor by the rich. This poem has also been translated into English.

Other prominent poets of the romantic movement in Croatia are Stanko Vraz (1810–51), by origin a Slovene, and Petar Preradović (1818–72), writers of patriotic poems and love lyrics. The lyric poetry of the Serb Branko Radičević (1824–53) expresses sincere emotion. Later lyricists of the romantic movement in Serbia are Jovan Jovanović Zmaj (1833–1904) and Djura Jakšić (1832–78), both poets of fertile inspiration.

The novel and drama were little cultivated by the romanticists. Historical plays were written for the Zagreb theatre by the Croat Dimitrije Demeter (1811–72); in Serbia a belated follower of the romantic movement, Laza Kostić (1841–1910), translated some of Shakespeare's plays and imitated them in his own historical dramas. A Serb, Bogoboj Atanacković (1826–58) wrote sentimental patriotic stories in the romantic tradition; but novels and short stories of literary value began to appear in Serbia only when the influences of romanticism began to yield to those of realism in literature.

The Development of the Novel. — The realist novel was introduced to Serbia by Jakov Ignjatović (1824–88). The best-known works of two Serbian writers of the 19th century, written with a light and humorous touch, belong to no particular school: these are accounts of travels by Ljubomir Nenadović (1826–95) and the satirical novels of Stevan Sreinac (1855–1906). Short stories of village life are a prominent feature of Serbian literature of the last decades of the 19th century; in those of Stjepan Mitrov Ljubiša (1824–78), Milovan Glišić (1847–1908) and Janko Veselinović (1862–1905) the subject is seen through the eyes of a romanticist although the treatment is realistic. This is true also of the short stories of the Serb Laza Lazarević (1851–go), who wrote little but excelled in this branch of literature.

Both romantic traditions and the nen realistic outlook influenced the work of the Croat August Šenoa (1838–81), a prolific writer—poet, critic and novelist — and a dominant personality in 19th-century Croatian literature. Šenoa's poetry was of the romantic school, but as a novelist he wrote as a realist and social reformer, influenced, as were subsequent Croatian novelists of the last decades of the 19th century, by the tendentious realist novels of France and Russia. The novels of Ante Kovačić (1854–89), Evgenij Kumičić (1850–1904), Yjenceslav Novak (1859–1905) and the Slavonian Josip Kozarac (1858–1906) are indictments of the evils brought about by the changing social conditions of their time. The same is true, though to a less extent, of the work of the writers of novels in the realist tradition in Serbia. Simo Matavulj (1852–1908) treats the problems of his time in his short stories of life in Belgrade and Dalmatia; his novel *Bakonja Fra-Brne,* which presents a picture of life in a Franciscan monastery. is of equal interest for its realism and for its studies of character and psychology. The Serb Svetolik Rankovid (1863–99) is principally concerned with the psychological analysis and development of his characters, though his novels still follow realist traditions. Local customs and local colour play an essential part in the psychological novel *Nečista krv* ("Tainted Blood"), a work of merciless realism, by Borisav Stanković (1876–1927), which has been translated into English under the title *Sophka.* Ivo Andrić (1892–), a native of Bosnia, was by the second quarter of the 20th century recognized as the most prominent Yugoslav novelist. His short stories written before World War II and his later novels. which include two on historical themes. *Na Drini ćuprija* ("The Bridge on the Drina") and *Travnic'ka hronika* ("The Chronicle of Travnik") show a restrained realism combined with psychological insight, a rich vocabulary and a style that, while clear and straightforward, is often of lyrical beauty.

L. Babić Gjalski (1854–1935), whose work has something of the atmosphere of that of Turgenev. is regarded as the founder of the realistic novel of psychological interest in Croatia. A further development of the concentration of interest on psychological studies in the Croatian novel is seen in the work of Vladimir Treščec (1870–1932) and still more in that of Janko Leskovar (1861–1952?) and Milutin Nehajev (1880–1931).

Later Poetry. — Poetry was generally but by no means entirely overshadowed by the novel or short story during the last decades of the 19th century. Silvije Strahimir Kranjčević (1865–1908), a Croatian symbolist of great originality and ruthless sincerity, gave vigorous expression in his poetry to the ideas treated by the realist writers of his time: as well as to other problems by which his mind was tormented. The most distinguished Serbian poet was Vojislav Ilić (1862–94), a disciple of Pushkin. There are many exquisite lyrics among the works of later Serbian poets. for example Aleksa Šantić, Jovan Dučić, and Milan Rakid; French influence is seen in the pessimism of the lyric poet Sima Pandurović; the poetic qualities of the lyrics of Milan Ćurčin (1880–) are all the more striking for their studied lack of sentiment.

Vladimir Nazor (1876–1949) is the most prominent of the Croatian "modern" school of poets; there is a spirit of optimism in most of his works. a great love of nature and a vigorous patriotic note. His short stories have many of the qualities and characteristics of his lyric poetry. Nazor's allegorical epic *Medvjed Brundo* (1915; "Brundo the Bear") is one of the best-known of his earlier works. In his diary *S Partizanima* ("With the Partisans'!) he recorded his experiences in World War II. Other prominent Croatian poets of the 20th century are: the philosophical neoclassicist Ante Tresić-Pavičić; two writers of contrasting temperament. Vladimir Vidrić and Dragutin Domjanić. the former a poet of optimism. the latter a so-called decadent; the melancholy and subjective Mihovil Xikolid; and Milan Begović, whose lyrics are notable for their polished form and style.

Drama. — Serbian dramatists have been successful principally as writers of comedies. Kosta Trifković (1843–75) followed Jovan Sterija Popović in this field, though his comedies of intrigue have no didactic purpose. The popularity of the satirical comedies of Branislav Nušić (1864–1938) is well-established.

The two outstanding Croatian dramatists of the modern period are Ivo Vojnović (1858–1929) and Miroslav Krleža (1893–), though others should be mentioned. particularly Srgjan Tucić and Milan Ogrizović. Yojnovid's *Dubrovačka trilogija* ("Trilogy of Dubrovnik") is an eloquent poetic chronicle. in dramatic form, of the decline of the old aristocracy of Dubrovnik during the 19th century. Krleža is a powerful and vigorous writer and a leading figure in many branches of contemporary Yugoslav literature.

The 1950s. — Interest in literature after World War II was concentrated mainly on the work of the modern writers already mentioned; on that of novelists and writers of short stories whose work had come more recently into prominence, such as Branimir Ćosić, Veljko Petrović, Jovan Popović, Čedomir Minderovid, Branko Ćopić and Oskar Davičo; and on the poems and short stories of Ivan Goran Kovačić.

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SERENA: *see* LA SERENA.

SERENADE, a musical composition which was originally a song of courtship, the name implying that it was heard in the evening. The serenade to Zerlina. "Deh! vieni alla finestra," in Mozart's *Don Giovanni,* is an outstanding example in opera. Losing its association of courtship. the term serenade was applied about 1770 to instrumental works for a small ensemble in several movements. similar in kind to works of the same period entitled cassation, divertimento and notturno. The sequence of movements. which was indefinite. included marches, minuets and sonata movements, and resembled that of the suite (*q.v.*). Mozart's *Haffner* serenade was one of the finest examples. Later, in works by many composers from Beethoven to Sir Edward Elgar, Richard Strauss and Arnold Schonberg, the term was loosely applied to works in several movements for small orchestra. a solo instrument. wind or string instruments.

SERENUS "of Antissa," Greek geometer, probably not of Antissa but of Xntinoeia or Antinoupolis, a city in Egypt founded by Hadrian, lived most probably in the 4th century. between Pappus and Theon of Alexandria. Two treatises of his have survived, viz.. *On the Section of the Cylinder* and *On the Section of the Cone,* the Greek text of which was first edited by Edmund Halley along with his Apollonius (Oxford, 1710), and is available in a definitive critical edition by J. L. Heiberg *(Sereni Antissensis Opuscula,* Leipzig, 1896). A Latin translation by Commandinus appeared at Bologna in 1566, and a German translation by E. Nizze in 1860–61 (Stralsund). Besides these works Serenus wrote commentaries on Apollonius. and in certain mss. of Theon of Smyrna there appears a proposition "of Serenus the philosopher, from the Lemmas" to the effect that, if a number of rectilineal angles be subtended. at a point on a diameter of a circle which is not the centre, by equal arcs of that circle, the angle nearer to the centre is less than the angle more remote.

The book *On the Section of the Cylinder* states as its primary object the correction of an error on the part of certain geometers of the time who supposed that the transverse sections of a cylinder were different from the elliptic sections of a cone. When this has been done. Serenus shows (Prop. 20) that "it is possible to exhibit a cone and a cylinder cutting one another in one and the same ellipse." Other propositions naturally deal with subcontrary and other circular sections of a scalene cylinder or cone.

The treatise *On the Section of the Cone,* though Serenus claims originality for it, is unimportant. (T. L. H.)

SERER, a vigorous, coarse-featured people of Senegal. They speak a language that is related to Wolof and Fulani. and were for long subject to the Wolof, but with a paramount chief for their own race in the Sine country. The upper land-owning class lends or hires land to the lower class, slavery being unknown. There is no artisan caste amongst the Serer, but there is a caste of musicians and singers. Descent is patrilineal. the paternal uncle being head of the family. Marriage is endogamous. The Serer are cultivators and cattle raisers. and their villages are subdivided into different quarters. The dead are buried outside the village and provided with arms and grave furniture. The bodies of *griots* are wrapped in cloth and placed in hollo baobab trunks. The people are animists, believe in sorcery, and practise the ordeal by redwood and red-hot irons.

See Bérenger-Feraud, *Les Peuplndes de la Sénégambie* (1879); A. Hovelacque, *Les Négres de l'Afrique Sus-Équatoriale* (1889); Dr. Lasnet, Une *mission au sénégal* (1900).

SÉRES, the chief town of the Séres province of Greek Macedonia, 43 mi. by rail N.E. of Salonika. Pop. (1928. last census before World War II) 29.640, almost wholly Greek immigrants settled after 1922. A few Bulgarians remained. In 1912 only 30% of the population was Greek. Séres is built in a district so fertile as to have borne among the Turks the name of Altin Ovassi, or Golden Plain. It is the seat of a Greek archbishop and patriarch. It consists of the old town, *Varosh,* situated at the foot and on the slope of the hill crowned by the old castle, and of the new town built in the European fashion on the plain, and forming the commercial centre. There is a large trade in rice and cereals, and the other exports include tobacco, cotton and hides.

Séres is the ancient *Sirrhae*, mentioned by Herodotus in connection with Xerxes's retreat, and by L i w as the place where Aemilius Paulus received a deputation from Perseus. In the 14th century. when Stephen Dushan of Serbia assumed the title emperor of Serbia, he chose Sirrhae as his capital; and it remained in the hands of the Serbians till its capture by Sultan Murad II (1421–1451). In 1913 the city was looted and largely burned by Bulgarian troops during the Greek advance up the Struma valley. It later fell into Greek territory but was occupied by the Bulgarian army in 1916 until Oct. 1918. It suffered severely from bombardment but was later largely rebuilt. In 1941 the town and province were occupied by Bulgaria, after the Germans' Balkan conquest.

SERFDOM. The notion of serfdom is distinct from those of freedom and of slavery. The serf is not his own master: to perform services for other persons is the essence of his status, but he is not given over to his lord to be owned as a thing or an animal—there are legal limits to the lord's power. Seridom is very often conceived as a perpetual adherence to the soil of an estate owned by a lord, but this praedial character is not a necessary feature of the condition. Hereditary serfdom may sometimes assume the shape of a personal relation between servant and master. Serfdom will be formed naturally in cases when one barbarous community conquers another, but is not able to destroy entirely the latter or to treat its members as mere chattels, but this mitigated form may be brought about as well by the paucity or comparative weakness of the victors as by the difficulty for them to draw income from pure slaves. In a state of backward agriculture and natural economy it will sometimes be more profitable for the conquerors as well as for the conquered to leave the dependent population in their own households and on their own plots, at the same time taxing them heavily in the way of tribute and services. Such an arrangement clearly obtained in several of the agricultural states of ancient Greece. The Penestae of Thessaly appear as a remnant of a distinct tribe settled on the confines of Macedonia and at the same time as a class of tributary peasants serving Thessalian aristocrats. The Mnoitae, Klarotae and Aphamiotae of Crete were more or less in the same position. Even in the case of the Helots of Sparta, who were made to perform services to any Spartiate who might require them to do so, features of a similar tributary condition are apparent. The chief work of the Helots was to provide a certain quantity of corn, wine and oil for the lords of the shares on which they were settled; personal services to other Spartiates were exceptional. Pollux in his account of the Helots places them distinctly in an intermediate position between free men and slaves. The fact that in these instances governments had a good deal to say in the regulation of the status of such serfs is well worth noting: it explains to a great extent the legal limitations of the power of the lords. Even downright slaves belonging to the state or to some great temple corporation were treated better than private slaves by the Greeks.

We shall not be astonished to find, therefore, in the Hellenistic states of Asia a population of peasants who seem to have been in a condition of hereditary subjection and adherent to the glebe on the great estates of the Seleucid kings. They were certainly not slaves, but their condition was closely bound up with the cultivation of the estates where they lived. The regulation by the state of the duties and customary status of peasants on government domains turns out to be one of the roots of serfdom in the Roman world. which in this respect as in many others follows on the lines laid down by Hellenistic culture. It is important for our purpose to notice that the condition of *coloni* was developed as a result of historic necessity by the working of economic and social agencies in the first centuries of the Roman empire and was made the subject of regular legislation in the 4th and 5th centuries. In the enactments of Justinian, summing up the whole course of development (C.J. xi., 48, 23), two classes of coloni are distinguished—the *ndscripticii,* representing a more complete state of serfdom, and the free coloni, with property of their own. But the whole class, apart from minor variations, was characterized by the idea that the peasants in question were serfs of the soil on which they were settled, though protected by the laws in their personal and even in their praedial status. Thus the ascription to the soil, although originally a consequence of ascription to the tributes (*adscriptio censibus*), became the mark of the legal status of serfdom. The emperors actually tried in their legislation to prevent the landowners from evicting their coloni and from raising their rents. In this way fixity of tenure and service was aimed at and to a certain degree enforced by the state.

With the break-up of the Roman empire, the weak governments which took the place of imperial authority were not able to maintain the discipline and judicial power which would have been necessary to guarantee the tenure and status of the serfs. And yet serfdom became the prevailing condition for the lower orders during the middle ages, custom and economic requirements producing checks on the sway of masters. The direction of events towards the formation of serfdom is already clearly noticeable in Celtic communities. In Wales and Ireland the greater part of the rural working classes was reduced not to a state of slavery, but to serfdom. The male slave (W. *caeth)* does not play an important part in Celtic economic arrangements: there is not much room for his activity as a completely dependent tool of the master The female slave (*cumal*) was evidently much more prominent in the household. Prices are reckoned out in numbers of such slaves and there must have been a constant call for them both as concubines and as household servants. As for male workmen, they are chiefly *taeogs* in Wales, that is half-free bondmen with a certain though base standing in law. Even these, however, could not be said to form the social basis for the existence of an upper free class. The latter was numerous, not wealthy as a rule, and had to undertake directly a great part of the common work, as may be seen from the extent of the free and servile tenures on the estates carved out for English conquerors in Wales and Ireland. Anyhow, the taeog class of half-free peasants stands by the side of the smaller tribesmen as subjected to heavier burdens in the may of taxation and services in kind. In Wales they are distributed into *gavells* and *gwelys,* like the free tribesmen themselves and thus concected with the land, but there is nothing to show that this connection was deemed a servitude of the glebe. The tie with the lord is after all a personal one.

The Germanic tribes moved on similar lines. The slaves had their separate households, while the masters exacted tribute from them in the shape of corn, cattle or clothes, and the serfs had to obey to the extent of rendering such tribute (Tacitus, *Germania,* 21). This means, of course, that it was in the interest of the master to levy tribute and not to organize slave labour. After the conquest of the provinces by the Germanic invaders the Roman stock of coloni naturally combined with German tributary peasants to form mediaeval serfdom. A half-free group is marked off in the early laws under the designation of Ziti, *lazzi, aldiones*. But in process of time this gronp was merged with freedmen, settled slaves (*servi casati)* and small freedmen into the numerous class of serfs (*servi, rustici, villani*) which appears under different names in all western European countries. The customary regulations of the duries of an important group of this class in regard to their lords are clearly expressed in the Bavarian law (7th century): serfs settled on the estates of the church have to work, as a rule, three days in the week for their masters and are subject to divers rents and payments in kind. The regulations in question, although entered in a legal text, are not a legislative enactment but the result of a slow process of adjustment of claims between the ecclesiastical landowners and masters on one side and their rural dependents on the other. There can be no doubt that they were largely representative of the conditions prevailing on Bavarian estates belonging not only to the church but also to the duke and to lay lords. The old English Rectitudines *singularum personarum* (11th century) present other variations of the same customary arrangements. The rustic class appears in them to be differentiated into several subdivisions—the geneats performing riding duties and occasional services, the *gebúrs* burdened with week work and the *cotsets* holding cottages and performing light work in the shape of one day in the week and services to match (see VILLEINAGE). Of these various groups that of the gebúrs corresponds more closely to the continental serfs (*coloni, Hörige, unfreie Hintersassen*).

The dualism characteristic of mediaeval serfdom, its formation out of debased freedom and rising servitude, may be traced all through the history of the middle ages. French jurists of the 13th century, *e.g.*, lay stress on a fundamental difference in law between the complete serf whose very body belongs to his lord (cf. the German *Leibeigenschaft*) and the villein or *roturier*, who is only bound to perform certain duties and ought not to be further oppressed by the landowners on whose soil he is settled (Beaumanoir, *Coutume* de *Beauvaisis*). But the same texts which draw the line between the two classes make it clear that there were no other guarantees to the maintenance of the rights of the superior rustics than the moral sense and the self-interest of their masters. It must be added, however, that even in the darkest times, economic forces provided some protection for the peasants who had lost the means of appealing to legal remedies. Lords who did not wish to see their estates deserted had to submit to the rule of custom in respect of exactions. And the screen of rural custom proved sufficient to allow of the growth of some property in the hands of the toiling class, a result which in itself rendered possible further emancipation.

A very instructive example of the formation of serfdom is presented by the history of Russia. Personal slavery in the sense in which it existed in the West was practised in ancient Russia (kholopi) and arose chiefly from conquest, but also from voluntary subjection in cases of great hardship and from the redemption of fines and debts (cf. the O. Eng. *wite-theow*). The great mass of the peasantry was originally free. Even when landownership was appropriated by the crown, the ecclesiastical corporations and the nobles, the fillers of the land retained their personal freedom and were considered to be farmers holding their plots under contracts. They were free to leave their farms provided they were able to effect a settlement in regard to all outstanding rent arrears and debts. The custom of the country gradually took the shape of a simultaneous resettlement of all conditions of rural occupation about St. George's day (Nov. 24), that is after the gathering of the harvest and the practical winding up of rural work.

Such was the legal state of affairs up to the end of the 16th century. A great change supervened, however, through the slow working of economic and political causes. The peasants settled under the sway of nobles and churches could very seldom produce a clean hill in regard to their money relations with the landlords. Thus. they gradually lapsed into a state of perpetual subjection from which they could not emancipate themselves by legal means. On the other hand, the growth of the Muscovite state with its fiscal governmental requirements involved a watchful repartition of burdens among the population and led ultimately to a system of collective liability in which the farms were considered chiefly as the sources of taxable income. The government was directly interested in maintaining their efficiency and in preventing migrations and desertions which led to a weakening of the taxpaying communities. A third aspect of the question must also not be disregarded, namely, the keen competition between landowners trying to attract settlers to their estates at the expense of their needy or less powerful neighbours. The first legislative measures of the Moscow rulers directed towards the establishment of a servile class similar to the Roman coloni fall into the first years of the 17th century (A.D. 1601, 1606) and consist in enactments against landowners depriving their neighbours of the tillers of their estates. But matters were clearly ripe for a wider application of the view that the peasant ought to stick to the soil, and the restoration of the Muscovite empire under the Romanovs brought with it the consolidation of all rural arrangements around this principle. Peter the Great regularized and completed this evolution by effecting a comprehensive cadastre and census of the rural population. The ultimate result was, however, not only the fixity of peasant tenures, but the subjection of the entire peasant population as a separate class (*Krepostrie*) to the personal sway of the landowners. The state insisted to a certain extent on the public character of this subjection and drew distinctions between personal slavery and serfdom. In the midst of the peasants themselves there lived a consciousness of their special claims as to tenant right. But, in fact, serfdom naturally took the form of an ugly ownership of live chattels on the part of a privileged class. Emancipation was brought about in the 19th century by economic causes as well as by humanitarian considerations. Private enterprise and the free application of capital and labour were hindered in every way by the bondage of the peasant class. Even such a necessary measure as that of moving cultivators to the rich soil of the south was thwarted by the adherence of the northern peasantry to the glebe. After several half-hearted attempts directed in the course of Nicholas I.'s reign to face the question while safeguarding at the same time the rights and privileges of the old aristocracy, the moral collapse of the ancien *régime* during the Crimean war brought about the Emancipation Act of Feb. 19, 1861, by which some 15 millions of serfs were freed from bondage. The most characteristic feature of this act was that the peasants, as distinct from household servants, received not only personal freedom but allotments in land in certain proportions to their former holdings. The state indemnified the former landowners, and the peasants had to redeem the loan by yearly payments extending over a number of years.

If we turn back from this course of development to the history of serfdom in the West striking contrasts appear. As we have already noticed, mediaeval serfdom in the West was the result of a process of customary feudal growth hardly interfered with by central governments. The loosening of bondage is also, to a great extent, prepared by the working of local economic agencies. Villeins and serfs in France rise gradually in the social scale, redeem many of the onerous services of feudalism and practically acquire tenant-right on most of the plots occupied by them. Tocqueville has pointed out that already before the revolution of 1789 the greater part. of the territory of France was in the hands of small peasant owners, and modern researches have confirmed Tocqueville's estimate. Thus feudal overlordship in France had resolved itself into a superficial dominion undermined in all directions by economic realities. The fact that there still existed all kinds of survivals of harsh forms of dependence, *e.g.* the bondage of the serfs in the Jura Mountains, only rendered the contrast between legal conditions and social realities more pointed. The night of Aug. 4, 1789 put an end to this contrast at one stroke and the further history of rural population came to depend entirely on the play of free competition and free contract.

In the evolution of serfdom in Germany the regulating influence of government made itself felt to a greater extent, especially in the east. The colonization of the eastern provinces and the struggle against the Slavs necessitated a stronger concentration of aristocratic power, and the reception of Roman law during the 15th and 16th centuries hardened the forms of subjection originated by customary conditions. It may be said in a general way that Germany occupied in this respect, as in many others, an intermediate position between the west of Europe and Russia. Emancipation followed also a middle course, being brought about chiefly by governmental measures, although the ground was to a great extent prepared by social evolution. The reforms of Stein and Hardenberg in Prussia, of the French and of their clients in South

Germany, opened the way for a gradual redemption of the peasantry. Personal serfdom (Leibeigenschaft) was abolished first, hereditary subjection (Erbunterthanigkeit) followed next. Emancipation in this case was not connected with a recognition of the full tenant-right of the peasants; they had to part with a good deal of their land. To the last the landowners were not disturbed in their economic predominance. and succeeded very well in working their estates by the help of agricultural labourers and farmers. In the west the small peasant proprietorship had a better chance, but it arose in the course of economic competition rather than through any general recognition of tenant-right. On the whole serfdom appears as a characteristic corollary of feudalism. It grew up as a consequence of customary subjection and natural husbandry; it melted away with the coming in of an industrial and commercial age. (P. Vi.; X.)

SERGE. A general term denoting several varieties of worsted twill fabrics, but more particularly that employed for men's suitings and women's costume, dress and coating fabrics. Serge fabrics are produced with a distinct twill weave and are of a coarser and somewhat rougher texture than the lighter grades of worsted fabrics. They are usually based on the even-sided regular twill weaves, as the four-end two-and-two ($\frac{2}{2}$) twill, and the six-end three-and-three ($) twill weave, according to the character of texture required and the purpose for which it is intended.

Thus, serge of lighter and medium textures suitable for women's wear is usually based on the two-and-two twill weave, while the three-and-three twill weave is better suited for serge of heavier, closer and stronger textures, as this weave, by permitting a relatively freer interlacement of the warp and weft threads, thereby allows the employment either of coarser and stronger yarn or else of a greater number both of warp and weft threads per inch being inserted in the fabric produced.

Serge fabrics are usually woven from Botany worsted yarns of counts ranging from 2/30s down to 2/18s, and with the number of warp threads and picks per inch varying according to the counts of yarn employed, and the weight and character of texture required, of which there are innumerable grades and qualities ranging between extreme limits chiefly according to the particular use for which they are intended. Worsted yarn for the warp and woolen yarn for the weft, or else all worsted yarn both for warp and weft of the better grades of wool, are employed in the superior qualities of serge fabrics. So-called silk serges are used for women's dress and coating fabrics, while iighter grades of silk serge are used for coat and dress linings and also for umbrella covers. The description of "serge" is also applied to many other varieties of fabrics having the general textural features and other characteristics of serge fabrics. (H. N.)

SERGEANT, JOHN (1622–1710), English Roman Catholic controversialist, especially well known for his criticism of Locke, was born in 1622 at Barrow-upon-Humber, Eng. He was educated privately and at St. John's college, Cambridge, and then became secretary to Thomas Morton, bishop of Durham. The result of his researches into early church history was his conversion to Roman Catholicism. After a period of theological study at the English college at Lisbon, he was ordained and was sent on the English mission in 1652 to defend the Catholic cause. In 1675 he was in France, where he lived for a time with Bossuet. Most of his life was spent in animated theological and philosophical controversy, for which he had an outstanding, if unrestrained, talent. Hardly any Anglican writer of note escaped his argumentative pen, Bishop Stillingfleet, Jeremy Taylor and Bishop Tillotson being among his more celebrated adversaries. Sergeant was also one of the many critics of Locke, whom he attacked in his Solid Philosophy Asserted Against the Fancies of the *Ideists* (1697). In all he published 34 works, most of which were pamphlets. He was said to have died "with a pen in his hand."

Sergeant holds that we can extend and explain our knowledge of the world by the application of metaphysical principles and of the general principles of reason or "maxims," and that where empirical investigations themselves yield no new knowledge, we must resort to these principles. He therefore criticized Locke, who denied the importance of these principles in extending our knowledge, though he did not rule them out entirely. See LOCKE, JOHN.

See for Sergeant's criticism of Locke, J. W. Yolton, ***John Locke*** and ***the Way*** of *Ideas* (1956).

SERGEANT, the title of a noncommissioned officer in the army, air force or marine corps, and of a subordinate officer of police. The term derives from the Latin servire, "to serve." In Europe in the 13th century it referred to any foot soldier, but gradually came to be applied to the chief tenant of a knight's military retinue. A serviens was also a military servant or esquire.

With the decline in the 16th and 17th centuries of armies organized on feudal lines, the sergeant, a noncommissioned officer, became the principal assistant to the commanding officer of a company, a position he has continued to hold. The commissioned ranks of sergeant major and sergeant major general, as the staff officer or second in command of the regiment and army respectively, were also introduced about this time, and later devolved into the major and major general. The modern sergeant major is the senior noncommissioned officer of the battalion or regiment, with an important administrative, training and command role.

In the British army, sergeant is the noncommissioned officer rank immediately above corporal. A lance sergeant is a corporal holding a temporary appointment between the ranks of corporal and sergeant. Following the practice of indicating in a noncommissioned officer's title the practical duties he performs, the word sergeant forms part of numerous titles, such as orderly room sergeant, band sergeant, signal sergeant and so forth.

Until the end of World War I, this practice was followed in slightly different form in the U.S. army, where such designations as ordnance sergeant and quartermaster sergeant existed; the rank of musician was usually also equivalent to that of a sergeant. From 1920 through World War II, there were several grades of sergeant, designating both subordinate commanders and technical specialists. The company commander's first assistant held the rank of first sergeant; there were also master sergeants, technical sergeants, staff sergeants and sergeants. In a postwar reorganization of the U.S. armed forces, these grades were cut to three, but later re-expanded to include sergeant major, first sergeant, master sergeant, platoon sergeant, staff sergeant and sergeant, the latter ranking just above corporal. In the army, technical specialists hold equivalent grades, but are not called sergeants and exercise no command function. In the air force and marine corps, sergeant is used to designate technicians as well as subordinate commanders. In the U.S. navy the various grades of petty officer correspond to the sergeant grades.

(See also INSIGNIA, MILITARY.)

In Great Britain and the United States, a subordinate police officer, usually holding a position just below that of lieutenant, is also called sergeant. (S. L. FK.)

SERGEANT AT ARMS. In early usage in England a sergeant at arms was generally an armed officer of a lord, often one of a special body required to be in immediate attendance on the king's person, to arrest traitors and other offenders. Thus the title now denotes certain court, parliamentary and city officials with ceremonial (and ostensibly disciplinary) functions. It is perhaps most readily associated in modem times with an officer in each house of the British parliament (where the word "sergeant" is spelled with a "j"), paralleled by two officers in the United States congress. In the British house of commons, the serjeant at arms is appointed by the sovereign, but thereupon becomes the servant of the house. His duties include attendance on the speaker, with the mace, and maintenance of order in the house and its precincts. In the house of lords, though similarly appointed by the crown, he remains the officer of the lord chancellor (whom he attends with the mace) rather than of the house. The sergeants at arms in the United States congress, on the other hand, are elected officers. The sergeant at arms of the house of representatives has similar duties with the mace and also exercises certain police functions about the legislative buildings. (E. C. TN.)

SERGIPE, (originally SERGIPE D'EL REI), a state in northeastern Brazil bounded east by the Atlantic, south and west by the state of Bahia, and north by Alagôas, from which it is separated by the São Francisco river. It is the smallest of Brazilian states, with an area of 8,505 sq.mi. Its population (1950) 644.361, is about three-fourths of mixed racial origin and Negroes. The northern part of the state slopes downward to the São Francisco river. while the southern part drains into the Atlantic. Sergipe is traversed by a number of small rivers which are frequently dry in their upper reaches. The largest of these are the Vasa Barris. the Real and the Cotinguiba, which are not navigable to ocean shipping. From east to west the state is divided into two major geographic regions, with a narrow, heavily forested coastal strip giving way to a higher zone of rough open country. The interior is devoted primarily to livestock raising. The lower, fertile lands are cultivated and produce sugar, coconuts, cotton, maize. tobacco, rice, beans and cassava. Sergipe is Brazil's leading producer of coconuts, although sugar is its principal money crop. The only manufacturing industries of importance are cotton mills, sugar factories and distilleries. One of the largest sugar *usinas* in Brazil is located at Riachuelo near Laranjeiras. However, a considerable expansion of vegetable and mineral processing industries is anticipated, since Sergipe has a surplus of electric power available from the Paulo Afonso hydroelectric project.

The capital of the state is Aracajú (*q.v.*), on the estuary of the Cotinguiba river, near the coast. It is connected by rail with the town of Propiá on the São Francisco river and with Bahia to the south. Highways link Aracajú with interior towns in Sergipe and nith Bahia and southern Brazil. Domestic airlines provide regular service between Aracajú and all major Brazilian cities. Other important towns in Sergipe are Estância, Laranjeiras, Capela, São Cristóvão, formerly the capital, and Lagarto. Sergipe mas settled in the 16th century by cattlemen and sugar planters from Bahia and it remained an administrative district of Bahia until 1821, when it became an independent captaincy. During the period of the Dutch conquest (1624–54) Sergipe was a focal point of the Brazilian resistance. It became a province of the empire in 1824 and a state in the republic in 1889. (R. E. P.)

SERGIUS, SAINT, OF RADONEZH (in Russian SERGII RADONEZHSKI; baptismal name VARFOLOMEI KIRILLOVICH) (c. 1315–1392), Russian spiritual leader to whom the monastery of Troitse-Sergiyevo owed its lasting fame as a centre of the religious and social life of the nation. He was born in the city of Rostov, probably in 1315, of noble parents who soon after became impoverished and moved to the village of Radonezh, north of Moscow. At this time Tatar political oppression and social, economic and moral decline within Russian society made "worldly" life tedious and distressing for high-minded men, so that after his parents' death the young Varfolomei Kirillovich withdrew into a wild forest and for several years lived as a hermit in a log cabin, Taking monastic vows in 1337, with the name Sergius, he became the abbot of the new monastery at Troitse (named Sergiyevo after him, but renamed Zagorsk in 1930).

Even when Sergius had won fame for his sanctity, he remained the poorest, humblest and most hard-working member of the community and firmly refused the metropolitan Alexis' invitation to be his successor. In the second half of the 14th century great numbers of Russians, princes and poor peasants alike, began to make pilgrimages to the monastery. In 1380 the grand prince Dimitri (Donskoi), when he was preparing his fateful struggle against the Tatars, turned for advice and blessing to Sergius, whose message helped to inspire the Russian warriors before their victory at Kulikovo. Sergius died in 1392, revered throughout Russia. His feast day is Sept. 25.

See N Zernov, ***St. Sergius, Builder of Russia (1939).*** (S. G. Pu.)

SERGIUS, the name of four popes.

SERGIUS I, SAINT, pope from 687 to 701, came of an Antiochene family which had settled at Palermo. He was elected successor to Conon after a fierce struggle between two other candidates, Paschal and Theodore, and was consecrated on Dec. 15, 687. In 689 he baptized King Ceadwalla of Wessex in Rome. For rejecting certain canons of the Trullan council of 692, Justinian II commanded his arrest and transportation to Constantinople, but the militia of Ravenna and the Pentapolis forced the imperial officer to abandon the attempt. Sergius died c. Sept. 8, 701.

SERGIUS II. SAINT, pope from 844 to 847, a Roman of noble birth, elected by the clergy and people to succeed Gregory IV in Jan. 844, was forthwith consecrated without waiting for the sanction of the emperor Lothair I, who accordingly sent his son Louis with an army to punish the breach of the Roman constitution of 824. A pacific arrangement was ultimately made, and Louis was crowned king of the Lombards by Sergius. In this pontificate Rome was ravaged and the churches of St. Peter and St. Paul robbed by Saracens (Aug. 846). Sergius died on Jan. 27, 847.

SERGIUS III, elected pope by one of the factions in Rome in 898, simultaneously with John IX, was expelled from the city by his adversaries. He reappeared early in 904, seized the two claimants. Leo V and Christophorus, who were disputing the succession of Benedict IV, and had them strangled, being himself consecrated on Jan. 29. His adherents, rallied round the master of the wardrobe Theophylact and his wife Theodora. Sergius is reputed to have been the lover of Theodora's daughter Marozia and the father of her son, the future Pope John XI. Sergius was very hostile to the memory of Pope Formosus and refused to recognize any of the ordinations celebrated by him, thus causing grave disorders. He also affected to consider as antipopes not only John IX but also Benedict IV and Leo V as well as Christophorus. He restored the Lateran basilica, which had fallen down in 897. He died in the second quarter of the year 911.

SERGIUS IV, pope from 1009 to 1012, had been known as "Pigmouth" before he was consecrated successor to John XVIII in July 1009. He was powerless in the hands of John Crescentius and the Roman nobles. He died in May 1012.

SERGIUS AND BACCHUS, SAINTS, two 4th-century martyrs, according to legend, officers of the Roman army on the Syrian frontier. On their refusal to sacrifice to Jupiter, they were sent to Rosafa in Mesopotamia, where they were scourged so severely that Bacchus died. Sergius later was beheaded. The church over Sergius' grave was restored in 431, and shortly afterward Rosafa became the seat of a bishopric; it was renamed Sergiopolis. Sergius and Bacchus became protectors of the Byzantine army. Their feast day is Oct. 7.

See H. Thurston and D. Attwater (eds.), ***Butler's Lives of the Saints,*** vol. iv, p. 50 (1956).

SERGIYEVO (now ZAGORSK), a town of the Russian Soviet Federated Socialist Republic, U.S.S.R., in the Moscow *oblast,* in 56° 23′ N., 38° 5′ E. It grew up around the monastery or *lavra* of Troitsko-Sergiyevskaya, one of the most important architectural and historic relics of Russia's middle ages. It was formerly venerated in Russia and visited by thousands of pilgrims; the inhabitants were renowned for their carved and painted icons and wooden souvenirs sold to the visitors. After the 1917 Revolution it was converted into a museum. The electrotechnical academy of the Red army was located in the town and a textile artel formed. Pop. (1959) 73,000. A small wooden church erected by the monk Sergius was burned by the Tatars in 1391; the cathedral of the Trinity (Troitsk) was built on the site in the Vladimir Suzdal style in 1422. The Uspensky (Assumption) cathedral was erected in 1585 and in the southern part of the monastery the church of Sergius was established, beneath which were built the spacious rooms where in pre-Revolution times dinners were distributed gratis to pilgrims. Several monasteries of lesser importance existed in the neighbourhood. The monastery acquired so much wealth that walls 25 to 50 ft. in height and fortified by nine towers were erected in 1513 and within them were the two cathedrals, several churches, buildings for the monks and pilgrims, including a hospital, and a theological academy. Ivan the Terrible made the Sergiyevo monastery the centre of the ecclesiastical province of Moscow in 1561.

SERI, a tribe of Tiburon Island and adjacent parts of Sonora, reputed one of the most primitive in America. Alone among all their neighbours they are nonagricultural, subsisting on shellfish, turtles, pelicans and cactus fruit. They make pottery and navigate boat-shaped rush rafts. Although sometimes reckoned an independent stock, they form part of the larger Hokan (*q.v.*) group and seem to be specially related to the Yuman (*q.v.*) peoples.

SERIEMA (CARIAMA) South American birds belonging to the family Cariamidae, allied to the cranes (*q.v.*) and trumpeters. There are two species. Carianza cristata, because of its long legs and neck, stands about two feet high. The beak and legs are red, the plumage gray dbove and dull white beneath with bluish skin around the eyes. It inhabits the campos of Brazil inland as far as Matto Grosso, living in high grass, where it runs swiftly. The nest is built in bushes or trees and contains two eggs. The young are hatched covered with gray down. The seriema feeds on insects, snails, reptiles and berries.

Chunga burmeisteri, the gray seriema, which inhabits northern Argentina, is darker and has shorter legs.

SERIES. In mathematics, the notion of a series has close connection with that of a sequence. (See NUMBER SEQUENCES.) The simplest example of a sequence is that of positive integers 1, 2, 3, . . . , n, . . . ; this particular example is important for the general definition. An infinite sequence of numbers exists if every positive integer 1, 2, 3, . . . , n, . . is assigned a number; in what follows the expression "sequence" stands for "an infinite sequence of numbers." Some examples of sequences are as follows:

$$1^2, 2^2, 3^2, \ldots, n^2, \ldots \qquad (1)$$
$$1, 0, 1, 0, 1, \ldots \qquad (2)$$
$$1, -2, 3, -4, 5, -6, \ldots \qquad (3)$$
$$1, \tfrac{1}{2}, \tfrac{1}{3}, \cdots, \frac{1}{n}, \cdots \qquad (4)$$

The numbers constituting a sequence are called the terms of the sequence (such as the first, the second, . . , the nth . .). It is customary to denote a sequence by a single letter with a subscript (index) indicating the position of the term in the sequence; for example, $a_1, a_2, a_3, \ldots$, a,, . ·, or $b_1, b_2, b_3, \ldots$, b, . . · . The abbreviated notation {a,) for a_1, a_2, a_3, . . , a,, . . . and, similarly with other letters, also is used. It will be assumed that the terms of a sequence are real numbers (see NUMBER: The Real *Number System*); the case of sequences of complex numbers is considered below.

If the terms of a sequence $\{a_n\}$ have the property that $a_n \leq a_{n+1}$ for each n, the sequence is said to be increasing (or, sometimes, nondecreasing); if $a_n < a_{n+1}$ for each n, the sequence is strictly increasing. If $a_n \geq a_{n+1}$ for each n, the sequence is decreasing (or nonincreasing); if a, $> a_{n+1}$, it is strictly decreasing. Sequences that are either increasing or decreasing are called monotone (monotonically increasing or monotonically decreasing, as the case may be). Sequences (1) and (4) above are monotone, while (2) and (3) are not. If all the terms of the sequence {a,} are less than a certain number (in symbols, a, $< M$ for some M and all n), the sequence is said to be bounded above. If all a, exceed a certain number, {a,) is said to be bounded below. Sequences bounded both above and below are simply called bounded. For example, sequence (1; see above) is bounded below but not above, (2) is bounded and (3) is not bounded either above or below.

A sequence $\{a_n\}$ is said to converge (or tend) to the limit a if the terms a, approach a indefinitely as n increases; in symbols,

$$\lim_{n \to \infty} a_n = a, \text{ or, } a_n \to a$$

A precise definition is as follows: a, tends to the limit a if given any positive number ϵ (no matter how small) so that $|a_n - a| < \epsilon$ for all n large enough. If {a,) tends to a limit, the sequence is said to be convergent; otherwise it is divergent. The following type of divergence is important: {a,} is said to diverge to $+\infty$ or, in symbols,

$$\lim_{n \to \infty} a_n = +\infty, \text{ or, } a_n \to +\infty$$

if for any number M (no matter how large) a, is greater than M for all n large enough; divergence of a sequence to $-\infty$ is defined correspondingly. Of the sequences mentioned above, (4) converges to the limit 0; (1) and (2) diverge (the former to + m). Whether a given sequence converges and, if so, toward what limit, is not always easy to decide. The following facts can be helpful here.

1. If a, $\to$ a and b, $\to$ b, then

$$a_n + b_n \to a + b,\ a_nb_n \to ab,\ a_n/b_n \to a/b,$$

the last relation requiring, however, the additional assumption that $b \neq 0$.

2. Every convergent sequence is necessarily bounded (example (2) shows that the converse is not true: a bounded sequence need not converge).

3. If a sequence is increasing and bounded above, or decreasing and bounded belom, it converges.

4. If a sequence converges, then its terms, coming arbitrarily close to the limit, must also come arbitrarily close to each other, provided the indices are large enough. The converse of this is also true, though less easy to prove, and the result is the following important Theorem of *Cauchy*: a sequence (a,) converges if and only if it has the following property: given any positive number ϵ. Then la, $- a_n| < \epsilon$ for all m and n large enough.

Starting with a sequence $a_1, a_2, \cdots, a_n, \cdots$ a new sequence $s_1, s_2, \cdots, s_n, \cdots$ is formed by the following rule:

$$s_1 = a_1,\ s_2 = a_1 + a_2,\ s_3 = a_1 + a_2 + a_3, \ldots$$
$$s_n = a_1 + a_2 + \cdots + a_n, \cdots$$

If $\{s_n\}$ converges to limit s, then it is said that the infinite series

$$a_1 + a_2 + a_3 + \cdots + a_n + \cdots$$

converges to sum s. Instead of $a_1 + a_2 + \cdots + a_n + \ldots$ it is customary to write $\sum_{n=1}^{\infty} a_n$ or, simply, Σa_n; the Greek letter sigma is a symbol for summation. The numbers s_n are called the partial sums of the series Σa_n, and the relation $s_n \to s$ is also written $\Sigma a_n = s$. The numbers a_n are the terms of the series Σa_n.

Given any sequence $b_1, b_2, \cdots, b_n, \cdots$, there is always a series, namely

$$b_1 + (b_2 - b_1) + (b_3 - b_2) + \ldots + (b_n - b_{n-1}) + \ldots$$

whose partial sums are $b_1, b_2, b_3, \cdots, b_n, \cdots$. Hence every series is represented by a sequence (that of its partial sums) and, conversely, every sequence by a series. It follows that every statement about series can be given in a form bearing on sequences, and conversely (but usually, in individual cases, one form may be preferable to the other). For example, Cauchy's theorem stated above and pertaining to sequences assumes in the case of series the following form:

5. A series Σa_n converges if, and only if, given any positive number ϵ, la, $_{+1}$ + a, $_{+2}$ + . . + $a_n| < \epsilon$ for all m large enough and any ngreater than m. In particular (takingn = m + 1), the terms of a convergent series must necessarily tend to 0.

Examples. — If a is any number and q is any number of absolute value less than 1, the series a + aq $+ aq^2 + \ldots + aq^{n-1} + \ldots = \Sigma aq^{n-1}$, (called a geometric series) converges, and its sum is $a/(1-q)$.

The series $\Sigma 1/n = 1 + \frac{1}{2} + \frac{1}{3} + \ldots$, called the harmonic series, diverges.

If the terms of a series are positive numbers, the series is called positive. The partial sums of a positive series form a strictly increasing sequence and, in view of proposition (3), a positive series converges if its partial sums are bounded above. If the partial sums of a positive series are not bounded above, the series diverges to + m. Proposition (3) also shows that:

6. If Σa_n and Σb_n are positive series, and if $a, \geq b_n$ for all n, then the convergence of Σa_n implies convergence of Σb_n and, equivalently, the divergence of Σb_n implies that of Σa_n. This result, usually called the comparison test, is very useful since the knowledge of convergence or divergence of some positive series can be utilized to obtain information about other series. For example, from the fact that the geometric series Σaq^{n-1} converges if a is positive and q is positive and less than 1, it is possible to deduce the following corollaries: for positive series:

7. Suppose that a, $_{+1}/a_n \to l$. Then, if 1 < 1 the series Σa_n converges; if $l > 1$ the series diverges (ratio test).

8. Suppose that $\sqrt[n]{a_n} \to l$. If $l < 1$, the series Σa_n converges; if $l > 1$, the series diverges (root test).

If the limit 1 in (7) or (8) exists but is equal to 1, the test fails (the case $l = 1$ can occur both for convergent and divergent series) and one must look for other tests. There are many of them but the most useful is the following one based on the notion of the integral:

9. If $f(x)$ is a function defined for x positive, itself positive and steadily decreasing to 0 as x increases indefinitely, then the series $\Sigma f(n) = f(1) + f(2) + f(3) + \cdots$ converges or diverges according as the integral $\int_1^\infty f(x)dx$ is finite or not (the integral test).

When applied to the function $f(x) = x^{-k}$, where k is a fixed positive constant, the test shows that the series

$$1^{-k} + 2^{-k} + 3^{-k} + \cdots + n^{-k} + \cdots = \sum_{n=1}^{m} n^{-k}$$

converges if $k > 1$ and diverges in all other cases. The result is not deducible from either the ratio or root test, since for the series $\sum_{n=1}^{\infty} n^{-k}$, l is equal to 1 both in (7) and (8).

Of interest among series that are not positive are alternating series; this name is given to series $a_1 - a_2 + a_3 - a_4 + \cdots$ where the numbers a_n themselves are of constant sign. It can be shown that such a series converges if $\{a_n\}$ decreases monotonically to 0. For example, the series $1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \cdots$ converges.

A series Σa_n is said to converge absolutely if $\Sigma|a_k|$ converges. Cauchy's theorem for series shows that if a series converges absolutely, then it converges in the ordinary sense; but the example of the convergent alternating series $1 - \frac{1}{2} + \frac{1}{3} - \cdots$ shows that a series may converge without converging absolutely. It follows that absolutely convergent series form a special class among all convergent series. Since series $\Sigma|a_k|$ have positive or zero terms, the problem of whether a given series converges absolutely can be solved by applying one of the tests for the convergence of positive series. In many cases the simplest way of proving that a certain series converges is by showing that the series converges absolutely, and this shows the importance of positive series for the general theory of series. Absolutely convergent series have many properties which are not shared by all convergent series. The most important of them is the fact that if a series converges absolutely, then arbitrary changes in the order of the terms of the series affect neither the convergence nor the sum of the series. The situation is completely different for series that converge but do not do so absolutely (such series are called conditionally convergent): by a suitable change of the order of the terms such a series can be made to converge to any prescribed sum, or can even be made divergent (theorem of Riemann). Hence, unlike the case of absolutely convergent series, a conditionally convergent series has no intrinsic sum and everything depends on the order of the terms.

The number of important series that occurs in mathematics is enormous. A few basic convergent series are listed below:

$$1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \frac{1}{5} - \cdots = \text{log nat } 2$$

$$1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \cdots = \frac{1}{4}\pi \text{ (Leibniz' series)}$$

$$1 + \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} + \frac{1}{5^2} + \cdots = \frac{1}{6}\pi^2$$

$$1 + \frac{1}{3^2} + \frac{1}{5^2} + \frac{1}{7^2} + \frac{1}{9^2} + \cdots = \frac{1}{8}\pi^2$$

$$1 + \frac{1}{1} + \frac{1}{1\times2} + \frac{1}{1\times2\times3} + \frac{1}{1\times2\times3\times4} + \cdots = e = 2.7182818.$$

Series With Complex Terms.—The convergence of complex sequences and series, *i.e.*, sequences and series whose terms are complex numbers, is formally defined exactly in the same way as in the case of real numbers, the absolute value $|z|$ of a complex number $z = x + iy$ $(i = \sqrt{(-1)})$ being now $\sqrt{(x^2 + y^2)}$. This definition leads to the following important conclusion: if $c_n = a_n + ib_n$, the convergence of Σc_n is equivalent to the simultaneous convergence of Σa_n and Σb_n; and if $\Sigma a_n = s$, $\Sigma b_n = t$, then $\Sigma c_n = s + it$. Hence, the study of complex series reduces to that of real series. As in the case of real series, the absolute convergence of Σc_n is defined as the convergence of $\Sigma|c_n| = \Sigma\sqrt{(a_n^2 + b_n^2)}$. Since the convergence of $\Sigma\sqrt{(a_n^2 + b_n^2)}$ means the same thing as the simultaneous convergence of $\Sigma|a_n|$ and $\Sigma|b_n|$, the absolute convergence of $\Sigma(a_n + ib_n)$ is equivalent to the absolute convergence of both $\Sigma|a_n|$ and $\Sigma|b_n|$; it therefore implies the ordinary convergence of Σa_n and Σb_n, and so also of $\Sigma(a_n + ib_n)$. Among complex series, absolutely convergent series play the same important role as among real series; in particular, the convergence and the sum of an absolutely convergent complex series are independent of the order of the terms.

Double Sequences **and** Series.—A double sequence is defined by assigning to every pair m,n of positive integers a number $\{s_{m,n}\}$. A double sequence can thus be written as a double array of numbers:

$$\begin{array}{l} s_{1,1},\ s_{1,2},\ \cdots,\ s_{1,n},\ \cdots \\ s_{2,1},\ s_{2,2},\ \cdots,\ s_{2,n},\ \cdots \\ \cdots\ \cdots\ \cdots\ \cdots\ \cdots \\ s_{m,1},\ s_{m,2},\ \cdots,\ s_{m,n},\ \cdots \\ \cdots\ \cdots\ \cdots\ \cdots\ \cdots \end{array}$$

The indices m,n of a term can be interpreted as the co-ordinates of a point in a plane. The notion of convergence of a double sequence is complex and can be introduced in many ways (which are not equivalent). The following definition is most commonly used: $\{s_{m,n}\}$ is said to converge to limit l if for any positive ϵ we have $|s_{m,n} - l| < \epsilon$ provided both m and n are large enough. With this definition, changing the terms in any finite number of rows and columns in the table above (the number of changes may be infinite) does not affect the convergence or limit of $\{s_{m,n}\}$.

The definition of convergence of a double series

$$\begin{array}{l} a_{1,1} + a_{1,2} + \cdots + a_{1,n} + \cdots \\ a_{2,1} + a_{2,2} + \cdots + a_{2,n} + \cdots \\ \cdots\ \cdots\ \cdots\ \cdots\ \cdots \\ a_{m,1} + a_{m,2} + \cdots + a_{m,n} + \cdots \\ \cdots\ \cdots\ \cdots\ \cdots\ \cdots \end{array}$$

can also be introduced in various ways; the series itself will be written as $\sum_{m=1}^{m}\sum_{n=1}^{m} a_{m,n}$ or simply $\Sigma\Sigma a_{m,n}$. Three definitions follow, only the first of which has close connection with the just defined notion of convergence of double sequences (at any rate, connection between double series and sequences is less intimate than in the case of single series and sequences):

(a) $\Sigma\Sigma a_{m,n}$ is said to converge to sum s, if the double sequence $\{s_{m,n}\}$ tends to s, in the sense just described, where $s_{m,n}$ denotes the sum of the terms $a_{j,k}$ with $j \leq m$, $k \leq n$; such terms $a_{j,k}$ fill a rectangle in the upper-left corner of the double series table above and the sums $s_{m,n}$ are correspondingly called rectangular partial sums of the series; the kind of the convergence just introduced is called the rectangular convergence of the series,

(b) the series $\Sigma\Sigma a_{m,n}$ is said to converge to sum s, if S_R tends to s as R tends to $+\infty$, where S_R is the sum of the terms $a_{m,n}$ with $m^2 + n^2 \leq R^2$; indices m,n satisfying this inequality are co-ordinates of points situated in the circle with the centre at the origin and radius R, so that it is natural to call the S_R the circular partial sums, and the kind of convergence they generate circular convergence;

(c) $\Sigma\Sigma a_{m,n}$ is said to converge to sum s if the terms in each column of the table form convergent series and if $A_1 + A_2 + \cdots + A_n + \cdots = s$, where A_n is the sum of terms in the nth column of the table; this kind of summation is called summation by columns, and by interchanging the roles of columns and rows leads to a parallel notion of convergence by rows

These definitions of convergence are not equivalent and a series can converge according to one definition and not according to another. The problem of additional conditions under which the definitions are equivalent is not very difficult but the conditions themselves are not of a simple nature and most (though not all) important series $\Sigma\Sigma a_{m,n}$ in analysis are absolutely convergent (that is $\Sigma\Sigma|a_{m,n}|$ converges). For such series all reasonable definitions of convergence are equivalent and the sum of the series is independent of the definition. Definitions and results can be extended to triple, quadruple, etc. series.

Series of Functions.—Let $\Sigma u_n(x)$ be a series whose terms $u_1(x)$, $u_2(x)$, $\cdots$, $u_n(x)$ are functions defined in an interval of the real variable x. If $\Sigma u_n(x)$ converges at each point of the interval the series is said to converge pointmise in the interval. Denote by $f(x)$ the sum and by $s_n(x)$ the partial sums of the series. Pointwise convergence means that, for any positive ϵ, there is an index n_0, depending in general on ϵ and x [in symbols, $n_0 = n_0(\epsilon,x)$] such that $|f(x) - s_n(x)| < \epsilon$ for $n > n_0$. If for each $\epsilon > 0$, an n_0 can be found independent of x, the series is said to converge uniformly in the interval considered; geometrically this means that for each $n > n_0$ the graph of the curve $y = s_n(x)$ and that of the curve $y = f(x)$ differ by less than ϵ in the whole interval under consideration. Pointwise convergence in general does not preserve properties of the terms of the series. For example, if the $u_n(x)$ are continuous and $\Sigma u_n(x)$ converges pointwise, the sum of $\Sigma u_n(x)$ need not be continuous. A simple example is provided by the series $(1 - x) + x(1 - x) + x^2(1 - x) + \ldots$, which converges at each point of the interval $0 \leq x \leq 1$ and whose sum is equal to 0 for $x = 1$ and equal to 1 at the remaining points of the interval. Similarly, if the $u_n(x)$ are integrable over an interval and the series $\Sigma u_n(x)$ converges pointwise, the sum of $\Sigma u_n(x)$ need not be integrable. The significance of the notion of uniform convergence is that the sum of a uniformly convergent series of functions inherits many important properties of the terms, and in particular continuity and integrability. Not all properties, however, are preserved by uniform convergence; for example, the sum of a uniformly convergent series of differentiable functions need not be differentiable (as a matter of fact, examples of continuous and nowhere differentiable functions are usually given as sums of uniformly convergent series of differentiable functions). The following three theorems about uniformly convergent series are particularly useful.

10. If the functions $u_n(x)$ are continuous in an interval, and the series $\Sigma u_n(x)$ converges uniformly in the interval, the sum of the series is continuous in the interval.

11. If the $u_n(x)$ are integrable over a finite interval (a,b), and $\Sigma u_n(x)$ converges uniformly in (a,b), then the sum $f(x)$ of $\Sigma u_n(x)$ is integrable over (a,b) and

$$\int_a^b f(x)dx = \Sigma \int_a^b u_n(x)dx$$

12. If each term of the series $\Sigma u_n(x)$ has a continuous derivative in a finite interval (a,b), and if the series $\Sigma u_n'(x)$ of derivatives converges uniformly in (a,b), then the series $\Sigma u_n(x)$ also converges uniformly in (a,b), its sum $f(x)$ is differentiable and $f'(x) = \Sigma u_n'(x)$.

There are no special tests for the pointwise convergence of series since pointwise convergence simply means ordinary convergence at each point x separately. There are tests for the uniform convergence of a series of functions, among which the following, usually called Weierstrass' M-test, is particularly useful:

13. If there are positive constants $M_1, M_2, \cdots, M_n, \ldots$ such that the series ΣM_n converges and $|u_n(x)| \leq M_n$ for each n and all x of an interval then the series $\Sigma u_n(x)$ converges uniformly in the interval.

Only the uniform convergence of series has been considered. There are parallel definitions and results for the uniform convergence of sequences. One can also consider the uniform convergence of double series and sequences. Special types of series of functions are particularly important for various branches of analysis (see, for example, FOURIER SERIES). The convergence of series $\Sigma u_n(z)$ whose terms depend on a complex variable $z = x + iy$ may be considered. The most important among them is the case of power series.

Power Series.—Power series are of the form

$$a_0 + a_1z + a_2z^2 + \cdots + a_nz^n + \ldots = \Sigma a_nz^n$$

where the a_n are constants (in general, complex) and $z = x + iy$ is a complex variable; in the symbol Σa_nz^n the index n ranges through the values $0, 1, 2, \cdots, n, \ldots$. Each power series has a circle of convergence; this is a circle (disk) with the centre at the point $z = 0$ and the following properties: the series converges at each point interior to the circle and diverges at each point exterior to the circle. As to the behaviour on the circumference of the circle of convergence, Σa_nz^n may converge at some points, diverge at others. The intersection of the circle of convergence with the real axis is an interval $(-R,R)$ and the series Σa_nx^n, a power series of the real variable x, converges in the interior of this interval, and diverges in the exterior. The radius R of the circle of convergence is called the radius of convergence of the power series. The circle of convergence can degenerate to a point; each power series Σa_nz^n necessarily converges at the point $z = 0$ but may converge at no other point: the series $\Sigma n!z^n$ is an example for this. The circle of convergence may also cover the whole complex plane, as in the case of the series $\Sigma z^n/n!$ Finally the radius of convergence may have any prescribed positive value R since the radius of convergence of the geometric series $\Sigma(z/R)^n$ is precisely R.

At each point interior to the circle of convergence the power series not only converges but converges absolutely. What is very important is that in each circle concentric with the circle of convergence but of smaller radius the power series converges uniformly. Series of the form $a_0 + a_1(z - b) + a_2(z - b)^2 + \ldots = \Sigma a_n(z - b)^n$, where b is a fixed complex number are called power series with centre b. Their study does not require the introduction of new concepts since by replacing $z - b$ with a new variable Z we reduce the series to the previously discussed case Σa_nZ^n. It follows that $\Sigma a_n(z - b)^n$ has also its circle of convergence, but this time the circle has its centre at the point b. Functions representable by power series have very important properties. Listed below are a few basic power series, considering for simplicity only real values of z.

$(1+x)^\alpha = 1 + \alpha x + \frac{\alpha(\alpha-1)}{1 \times 2}x^2 + \frac{\alpha(\alpha-1)(\alpha-2)}{1 \times 2 \times 3}x^3 + \ldots$ (Newton's binomial series; $R = 1$)

$\ln(1 + x) = x - \frac{1}{2}x^2 + \frac{1}{3}x^3 - \cdots (R = 1)$

$\arctan x = x - \frac{1}{3}x^3 + \frac{1}{5}x^5 - \ldots (R = 1)$

$e^x = 1 + \frac{x}{1} + \frac{x^2}{1 \times 2} + \frac{x^3}{1 \times 2 \times 3} + \cdots (R = \infty)$

$\cos x = 1 - \frac{x^2}{1 \times 2} + \frac{x^4}{1 \times 2 \times 3 \times 4} - \frac{x^6}{1 \times 2 \times 3 \times 4 \times 5 \times 6} + \cdots$ $(R = \infty)$

$\sin x = x - \frac{x^3}{1 \times 2 \times 3} + \frac{x^5}{1 \times 2 \times 3 \times 4 \times 5} - \cdots (R = \infty)$

Divergent Series.—Consider the series $1 - 1 + 1 - 1 + \cdots$. Its partial sums 1, 0, 1, 0, ... do not tend to any limit; therefore, according to the definition, the series is divergent. On the other hand, the average value of the partial sums 1, 0, 1, 0, ... is $\frac{1}{2}$, which made some mathematicians as early as the 17th century adopt the point of view that though the series, strictly speaking, is divergent it somehow has the sum $\frac{1}{2}$. Such ideas, though for a long time unclear and confused, were finally clarified and led to a logically coherent and fruitful theory of divergent series and sequences. A few facts are here presented. The theories of divergent series and sequences being parallel, sequences are considered first.

Consider a sequence $\{s_n\} = s_0, s_1, \ldots, s_n, \ldots$ (in this context it will be convenient to include 0 as an index). A definition of convergence of $\{s_n\}$ already has been formulated. This definition, which may be called classical, is not the only one possible; alternate definitions could be adopted. The following one is very intuitive. Consider the averages of the successive terms of $\{s_n\}$; these averages will be denoted by $\sigma_0, \sigma_1, \sigma_2, \ldots, \sigma_n, \ldots$ so that

$$\sigma_0 = \frac{s_0}{1}, \sigma_1 = \frac{s_0 + s_1}{2}, \sigma_2 = \frac{s_0 + s_1 + s_2}{3}, \cdots, \sigma_n = \frac{s_0 + s_1 + \cdots + s_n}{n+1}, \ldots$$

It may be said that $\{s_n\}$ converges on the average to limit s if the sequence $\{\sigma_n\}$ converges to limit s in the classical sense. It can be shown that any sequence $\{s_n\}$ which converges in the classical sense also converges on the average, and that the limits are the same in both cases. There are sequences that do not converge in the classical sense but converge on the average (the sequence $\{s_n\} = 1, 0, 1, 0, \ldots$ is an instance in point, since here $\{\sigma_n\} = 1, \frac{1}{2}, \frac{2}{3}, \frac{1}{2}, \frac{3}{5}, \frac{1}{2}, \ldots$ tends to $\frac{1}{2}$). Hence, in adopting convergence on the average as a definition of convergence of a sequence, conflict with the old definition is avoided on the one hand and, on the other, sequences previously considered divergent (and useless) are made convergent. Instead of saying that $\{s_n\}$ converges "on the average" it is now customary to say that $\{s_n\}$ is summable by the method of the first arithmetic mean. Not every sequence is thus summable. For example, if $s_n = 1, -2, +3, -4, +5, \cdots$, then σ_n does not converge in the classical sense; but it is easy to prove that σ_n is summable by the method of the first arithmetic mean to the limit 0, so that we may say that $\{s_n\}$ is summable to limit 0 by the method of the second arithmetic mean. We could similarly introduce the third, fourth, etc., arithmetic means. It is, however, preferable to adopt a more general point of view.

The averages considered in the definition of $\{\sigma_n\}$ are not the only conceivable ones, since "weighted" averages may be introduced. The general scheme is as follows. Consider a fixed matrix (double array) of numbers denoted by M:

$$\begin{array}{l} a_{0,0},\ a_{0,1},\ a_{0,2},\ \ldots.\ a_{0,n},\ \ldots \\ a_{1,0},\ a_{1,1},\ a_{1,2},\ \cdots,\ a_{1,n},\ \cdots \\ a_{2,0},\ a_{2,1},\ a_{2,2},\ \cdots,\ a_{2,n},\ \cdots \\ \cdots\cdots\cdots\cdots\cdots\cdots \\ a_{m,0}, a_{m,1}, a_{m,2}, \cdots, a_{m,n}, \cdots \\ \cdots\cdots\cdots\cdots\cdots\cdots \end{array}$$

Given any sequence $\{s_n\}$ a new sequence σ_m may be introduced defined by the formulas

$$\sigma_m = a_{m,0}s_0 + a_{m,1}s_1 + a_{m,2}s_2 + \cdots + a_{m,n}s_n + \cdots$$

(in which $m = 0, 1, 2, \ldots$).

Then σ_m may be considered as a weighted average of the numbers s_0, s_1, $\cdots$ formed with weights situated in the mth row of the matrix. If (a,) converges in the classical sense to limit s, it may be said that {s,} is summable by the matrix M, or simply summable M, to limit s; s is then the generalized limit of $\{s_n\}$, associated with the matrix M. It is easily seen that the method of the first arithmetic mean is given by the matrix

$$\begin{array}{llll} 1, & 0, & 0, & 0, \ \cdots \\ \frac{1}{2}, & \frac{1}{2}, & 0, & 0, \ \cdots \\ \frac{1}{3}, & \frac{1}{3}, & \frac{1}{3}, & 0, \ \cdots \\ \cdots & \cdots & \cdots & \cdots \end{array}$$

Classical convergence corresponds to the matrix whose terms on the main diagonal are all $1 (a_{n,n} = 1$ for all $n)$ and the remaining terms are 0, since then a, = s, for all n.

This definition of summability of a sequence was introduced by the German mathematician Otto Toeplitz. It is extremely general, though it could be generalized still further, and raises a very large number of problems which are the subject of the general theory. A few such problems are considered below.

The first question concerns the conditions under which this definition is a genuine generalization of the classical convergence. The answer is that a necessary and sufficient condition that every convergent sequence should also be summable M, and to the same limit, is that (1) the terms of M should tend to 0 in each column separately; (2) the sum of the absolute values of the terms in each row should stay below some constant; (3) the algebraic sum of elements in each row should tend to 1 as the index of the row increases. Many results about summable sequences are corollaries of this theorem. In the special case when the elements of the matrix are nonnegative, condition (2) is essentially a consequence of (3) and can be dropped.

It is said that a method M' is stronger than M if every sequence summable M is summable M', but not conversely, and if the limits in both cases are the same. It rnay then be asked when a given method M' is stronger than M. Theorems answering this question are called abelian, after Niels Henrik Abel. If M' is stronger than M we may ask under what additional conditions, for the sequence summability by M' implies summability by M; results of this type are called tauberian theorems, after the Austrian mathematician Alfred Tauber. The most interesting theorems of abelian and tauberian character pertain to specific and important methods of summability.

Given a series $a_0 + a_1 + \cdots +$ a, $+ \cdots$ it may be said that it is summable M to sum s if the sequence of the partial sums of the series is summable M to limit s. To distinguish between series and sequences some writers say that a series is summable while a sequence is limitable, but no confusion arises if the word summable is used in both cases. However, certain forms of summability are more adapted to series than sequences, and vice versa. This situation in particular applies to Abel's method of sutnmation, which defines the sum of Σa_n as the limit of $\Sigma a_n r^n$ for r tending to 1 through values less than 1. Abel's method is stronger than convergence, and even stronger than the method of the first arithmetic mean (abelian theorems). A series that is Xbel summable need not converge; for example, the divergent series $1 - 1 + 1 - \cdots$ is Abel summable to sum $\frac{1}{2}$ since $1 - r + r^2 - r^3 + \cdots = 1/(1 + r)$ tends to $\frac{1}{2}$ as $r \to 1$. If, however, a, $\leq 1/n$ for all n, and Σa_n is Abel summable, then Σa_n converges (a tauberian theorem).

The method of the first arithmetic mean and that of Abel are among the most important ones. Their main applications are to the study of the behaviour of power series on the circumference of its circle of convergence and to the theory of Fourier series. There is a great variety of methods of considerable intrinsic interest and importance in applications. The method of arithmetic means of various orders (hinted at sbove) has developed into a wide and elegant theory with far-reaching applications. The method of Borel assigns to a sequence $s_0, s_1, \cdots, s_n, \cdots$ the sum

$$\lim_{x \to +\infty} \left\{ e^{-x} \sum_{n=0}^{\infty} \frac{s_n}{n!} x^n \right\}$$

and can sum power series outside their circles of convergence. There is also an extension of the theory to divergent integrals. The importance of the theory of divergent series lies, however, not only in individual results but in the general point of view upon the notion of convergence, a point of view which has had a great impact upon the development of mathematical analysis.

History of Series.—The origin of the modern theory of series precedes that of the calculus and can be associated in the 17th century with the names of Bonaventura Cavalieri. John Wallis, James Gregory and others. In the same century. the discovery of the calculus by Leibniz and Newton gave a very strong impulse to the theory; and the 18th century witnessed considerable progress in the work of Jakob and Daniel Bernoulli, D'Alembert, Leonhard Euler and others. Much of this work was of purely formal character, and mathematical rigour was not the primary concern of the investigators. Though Newton and Leibniz avoided divergent series, formal and uninhibited use of the latter was bringing such mathematical rewards that the temptation was too much to withstand, and divergent series became—mostly through the work of Euler—an accepted tool of investigation. Mathematical instinct of the great mathematicians of the 18th century prevented them, however, from making mistakes and their results, properly interpreted, can now be proved rigorously. Rigorous foundations ior the theory of infinite series were laid in the first half of the 19th century by Augustin Louis Cauchy and Niels Henrik Abel; definitions they gave and results they proved can be found in all textbooks of calculus. Their attitude toward divergent series was purely negative, however. (Abel wrote in 1828: "Divergent series are the invention of the devil, and it is shameful to base on them any demonstration whatsoever.") The respect commanded by the work of Cauchy and Abel banished divergent series from mathematics for half a century. Their work on the foundations of the theory of series was continued by others in the 19th century, in particular by Peter Gustav Lejeune-Dirichlet, Georg Friedrich Riemann and Karl Weierstrass. By the last decade of the 19th century the effects of Abel's anathema began to disappear. and the work of Ernesto Cesaro, Emil Borel, Leopold Fejer and others showed that the theory of divergent series can be put on a rigorous basis and is a source of great progress in mathematics. In the 20th century the work of G. H. Hardy and J. E. Littlewood brought major breakthroughs and extended the field in depth. Important progress in tauberian theorems was made by Norbert Wiener.

BIBLIOGRAPHY.—Elements of the theory of convergent series will be found in any book of calculus; a good source is G. H. Hardy, *A Course of Pure Mathematics* (many editions). On a more advanced level are T. Fort, *Infinite Series* (19.10); T. J. I' A. Bromwich, *An Introduction to the Theory oj Infinite Series,* 2nd ed. (1926); K. Knopp, *Theory and Application oj Infinite Series,* Ger. trans., elegantly written and containing a wealth of material. *See* also G. H. Hardy, *Divergent Series* (1949); H. R. Pitt, *Tauberian Theorems* (1958); K. Zeller, *Theorie der Limitierungsverfahren* (1958); and, for summability of integrals and related topics, K. Chandrasekharan and S. Minakshisundaram, *Typical Means* (1952). (A. ZD.)

SERJEANTS-AT-LAW or SERVIENTES AD LEGEM constituted the highest order of counsel at the English and Irish bar. The title is said by Sir Edward Coke to have been introduced into England by William the Conqueror with other titles of serjeanty (*q.v.*). However this may be. Henry de Bracton, writing *c.* 1250–58, says that the king had his serjeants-at-law in every county, and that until 19 Stephen he had no other chief officer in the city of Norwich but his serjeant, who presided in the courts there.

After the Conquest the sheriffs are officers of the crown, and we know from other sources that they were usually serjeants-at-law. They were therefore styled *servientes* Regis ad *legem* who as stewards of courts baron served the lords of the manor in a similar capacity. or who as counsel — conteurs or *narratores*—appeared for suitors in the courts. These men were styled common serjeants, a title which survives in the common serjeant of the city of London. and (a second class) king's serjeants. As it happened, both were selected from the utter barristers. The serjeants (except king's serjeants) were created by writ of summons under the great seal, and wore a gown and scarlet hood. They had social precedence after knights bachelors and before companions of the Bath and other orders. In this they differed from king's counsel, who had simply professional as distinguished from social rank.

The serjeants at the Irish bar had precedence next after law officers of the crown. Till past the middle of the 19th century a limited number of the serjeants were called "king's (queen's) serjeants." They were appointed by patent and summoned to parliament. Until 1814 the two senior king's serjeants had precedence of the attorney general and solicitor general. It was the custom for serjeants, on their appointment, to give gold rings inscribed with mottoes to their colleagues. Down to 184j the order enjoyed a very valuable monopoly of practice. Certainly for at least 600 years the judges of the king's bench and common pleas were always serjeants, but by the Judicature act, 1873, this qualification was abolished. The serjeants had their own inns. one in Fleet street and one in Chancery lane. In 1758 the members of the former joined the latter. In 1877 the society was dissolved, the inn sold to one of the members, and the proceeds divided among the existing serjeants. The order is now extinct.

SERJEANTY. Tenure by serjeanty was a form of land holding under the feudal system, intermediate between tenure by knight-service (*q.v.*) and tenure in socage. It originated in the assignation of an estate in land on condition of the performance of a certain duty, which can hardly be described more exactly than as not being that of knight-service. Its essence, according to Sir Frederick Pollock and Sir Richard Maitland, might be described as "servantship," the discharge of duties in the household of king or noble; but it ranged from service in the king's host, distinguished only by equipment from that of the knight, to petty renders scarcely distinguishable from those of the rent-paying tenant or socager. The varieties of serjeanty were afterward increased by lawyers classing for convenience under this head such duties as those of escort service to the abbess of Barking, or of military service on the Welsh border by the men of Archenfield.

Serjeants (servientes) are already entered as a distinct class in Domesday Book (1086), though not in all cases differentiated from the barons, who held by knight-service. Sometimes, as in the case of three Hampshire serjeanties — those of acting as king's marshal, of finding an archer for his service, and of keeping the jail in Winchester castle — the tenure can be definitely traced as far back as Domesday. It is probable, however. that many supposed tenures by serjeanty were not really such. although so described in returns. in inquests after death. and other records. The simplest legal test of the tenure was that serjeants, though liable to the feudal exactions of wardship, etc., were not liable to scutage; they made in place of this exaction special composition with the crown.

The germ of the later distinction between "grand" and "petty" serjeanty is found on the Great Charter (1215), the king there renouncing the right of prerogative wardship in the case of those who held of him by the render of small articles. The legal doctrine that serjeanties were (1) inalienable, (2) impartible, led to the "arrentation," under Henry III, of serjeanties the lands of which had been partly alienated, and which were converted into socage tenures, or, in some cases, tenures by knight-service. Gradually the gulf widened, and "petty!' serjeanties, consisting of renders (usually a bow, sword, dagger or other small thing belonging to war), together with serjeanties held of mesne lords, sank into socage, while "grand" serjeanties, the holders of which performed their service in person, became alone liable to wardship and marriage.

When the military tenure of knight-service was abolished at the Restoration, that of grand serjeanty was retained, it being then limited in practice to the performance of certain duties at coronations, the discharge of which as a right has always been coveted. The most conspicuous are those of champion, appurtenant to the Dymokes' manor of Scrivelsby, and of supporting the king's right arm, appurtenant to that of Worksop.

The title of serjeant as a household officer is still preserved in the king's serjeants at arms, etc.

The best summary of tenure by serjeanty is in F. Pollock and R. Maitland, *Hist. Eng. Law;* McKechnie, *Magna Carta* (1905), should also he consulted; and for Domesday the *Victoria History of Hampshire,* vol. i. The best list of serjeanties is in the *Red Book of the Exchequer* ("Rolls Series"). (J. H. R.)

SERLIO, SEBASTIANO (1475–1554), Italian architect and theorist, the founder of the classical school of architecture in France. was born at Bologna on Sept. 6, 1475. He worked in Rome with Baldassare Peruzzi from 1514 until the sack of the city in 1527, when he fled to Venice. Peruzzi bequeathed him all his own drawings, and these were put to good use by Serlio in his Treatise, his greatest achievement. The first part of it. published in 1537, was really Book iv of the complete Treatise but was soon reprinted and translated as an independent work (Eng. trans., 1611). Book iii followed in 1540, and in 1541 Serlio moved to France, where he was supported for six years by Francis I. Books i and ii came out in 1545, Book v in 1547, Book vi exists only in manuscript, Book vii was published posthumously in 1575, but there is a manuscript of (apparently) an eighth book in Munich. Most important of all, Serlio published an Extraordinario Libro in 1551 which contains 50 fanciful designs for doorways. These were much copied in northern Europe.

Serlio's Treatise as a whole was very influential because it was essentially a practical handbook of the antique style and presented a number of models for copying; it was fundamentally a set of illustrations linked by commentary rather than an essay on archaeology or aesthetics. The only surviving buildings which can be connected with Serlio are one doorway at Fontainebleau and the château of Ancy-le-Franc in Burgundy. He died at Fontainebleau in 1554.

See W. B. Dinsmoor in *Art Bulletin,* xxiv (1942), and A. F. Blunt, *Art and Architecture in France, 1500 to 1700* (1953). (P. J. MY.)

SERMON, an oration delivered from a pulpit with fullness and rhetorical effect. Blaise Pascal defines a sermon as a religious address, in which the word of God is stated and explained, and in which an audience is excited to the practice of virtue.

Among the earliest examples of pulpit oratory which have been preserved in English literature, the discourses of John Wycliffe and his disciples may be passed by. to arrive at the English sermons of John Fisher (1469?–1535), which have a distinct literary value. But Hugh Latimer (1485?–1555) is the first great English preacher, and the wit and power of his sermons give them prominence in literature. One of the expository discourses of John Knox

(c. 1505–72), we are told, was of more power to awaken his hearers than a blast from "five hundred trumpets." When we come to Elizabethan times, we possess a few examples of the sermons of the "judicious" Richard Hooker; Henry Smith was styled "the prime preacher of the nation"; and Lancelot Andrewes, "the star of preachers," dazzled his contemporaries by the brilliancy of his euphemism. In the middle of the 17th century the sermon became one of the most highly cultivated forms of intellectual entertainment in Great Britain, and when the theatres were closed at the Commonwealth it grew to be the only public form of eloquence. It is impossible to name all the eminent preachers of this time, but among them were John Hales, Edmund Calamy, Benjamin Whichcote, Richard Baxter, John Owen, Ralph Cudworth and Archbishop Robert Leighton. Outshining them all was Jeremy Taylor, the most illustrious British writer of sermons. The fault of the 17th-century sermon mas a tendency to dazzle the audience by a display of false learning and by a violence in imagery; the great merit of its literary form was the fullness of its vocabulary and its richness and melody of style.

The great names of the Restoration period were those of Isaac Barrow, Robert South, John Tillotson and Edward Stillingfleet. These preachers were controversialists, keen, moderate and unenthusiastic.

These qualities were accentuated in the 18th century, when for a while religious oratory ceased to have any literary value. The sermons of Benjamin Hoadly have a place in history, and those of Joseph Butler have great philosophical importance. Thomas Boston's memory has been revived by the praise of Stevenson, but his zeal was far exceeded by that of John Wesley, who preached 40,000 sermons, and by that of George Whitefield.

Of all countries, however, France is the one which has shone most brightly in the cultivation of the sermon. In the 14th century John Gerson seems to have been the earliest minister who composed and preached in French, but his example was not followed by any man of equal genius. It was the popular movement of the Reformation which made the sermon a piece of literature on the lips of John Calvin, Pierre Viret and Théodore Beza. With these stern Protestant discourses may be contrasted the beautiful, but somewhat euphuistical, sermons of St. Francis of Sales, full of mystical imagery.

Father Claude de Lingendes (1591–1660) has been looked upon as the father of the classic French sermon, although his own *conciones* were invariably written in Latin, but his methods were adopted in French, by the school of Louis Bourdaloue and Jacques B. Bossuet. In the great body of noble religious eloquence delivered from French pulpits during the 17th century, the first place is certainly held by the sermons of J. B. Bossuet, who remains perhaps the greatest preacher the world has ever seen. Bossuet's six Oraisons *Funèbres* (the latest delivered in 1687) form the most majestic existing type of this species of literature.

Around that of Bossuet were collected other noble names: Louis Bourdaloue, whom his contemporaries preferred to Bossuet himself; Esprit Fléchier, the politest preacher who ever occupied a Parisian pulpit; and Jules Mascaron, in whom all forms of eloquence were united. A generation later appeared Jean Baptiste Massillon, who was to Bossuet as Jean Racine to Pierre Corneille; and Jacques Saurin, whose evangelical sermons were delivered at The Hague, Holland. These are the great classic preachers whose discourses continue to be read, and to form an inherent part of the body of French literature. Since the end of the 18th century the sermon has, in general, been greatly shortened, and the ordinary sermon of today is no longer an elaborate piece of carefully balanced and ornamental literary architecture, but a very simple and brief homily.

SERMON ON THE MOUNT, the popular name for Matt. v–vii, the longest discourse of Jesus in the Synoptics. In it are concentrated the most familiar ethical teachings of Jesus; however, they are so thoroughly founded upon the insuperable demand of God as to be sharply distinct from any merely humanistic ethic. In brief outline the sermon contains: (1) nine blessings, v, 3–12; (2) salt and light, v, 13–16; (3) validity of the Law, v, 17–20; (4) ". . . but I say to you . . . ," interpretations of six demands of the Law, v, 21–48; (5) three acts of piety (almsgiving, prayer, fasting) with (6) the Lord's Prayer appended to the second, vi, 1–18; (7) true and false treasure, vi, 19–34; (8) miscellaneous ending, mostly warnings (against self-righteous judgment, against profaning the holy, God's response to prayer, the Golden Rule, against any easy way to Life, against false prophets, against serving God by word only), vii, 1–23, illustrated by the simile of a house with and without foundation, vii, 24–27, and an editorial conclusion, vii, 28 ff.

Most of these sayings have parallels in Luke, of which about half occur in Luke's much shorter Sermon on the Plain (vi, 20–49, named from Luke, vi, 17) and in nearly the same order; Luke's remaining parallels are scattered through his chapters xi–xvi. This parallelism suggests either that the author of Luke (see LUKE, GOSPEL OF) dispersed what had come down to him as a sermon or that the author of Matthew (see MATTHEW, GOSPEL OF ST.) editorially composed a sermon out of mostly scattered sayings offered him by tradition. From the clearly discernible literary habit of the Gospel of Matthew to organize the words of Jesus into connected complexes concluding with "And when Jesus had finished these sayings . . . ," the latter possibility is the probable one. The plan and some basic material of the sermon were furnished by what is common to the Sermon on the Mount and the Sermon on the Plain; *i.e.,* by a definite section of the lost source common to Matthew and Luke, whether this was a written document or only crystallized and memorized tradition.

Neither the "mount" nor the "plain" is given a name and it is idle to attempt to identify either. The source evidently did not localize the discourse, but apparently did suggest that it was of one piece. Whether the latter is true is neither determinable nor centrally important. What is important is that the sermon contains some of the most certain and characteristic utterances of the historical Jesus.

See M. Dibelius, The Sermon on the Mount (1940). (KE. G.)

SEROW or SARAU (*Capricornis* sumatraensis), found from the Himalayas to Sumatra, a goatlike antelope of the size of a donkey, nearly allied to the goral (*q.v.*) but larger, and with small face glands. The name serow may be extended to embrace all species belonging to the genus, the range of which extends from the Himalayas to Burma, the Malay peninsula and Sumatra in one direction, and to Tibet, China, Japan and Formosa in another. Serows inhabit scrub-clad mountains, at no great elevation.

SEROWE, town in the British protectorate of Bechuanaland, 1902 principal settlement of the Bamangwato and headquarters of the tribal administration. It is 30 mi. W.N.W. of Palapye on the Cape Town-Bulawayo railway and about 230 mi. N.N.E. of Mafeking. The population in 1946 was 15,935, the great majority Africans, but including some European officials and traders. Serowe has a church, several African schools, a hospital, a small airport and postal communications, including telephone and telegraph. On the hill behind the kgotla (place of assembly) stands the statue of a duiker, emblem of the tribe, in memory of Kgama III, chief of the Bamangwato from 1875 to 1923. (AY. SY.)

SERPA PINTO, ALEXANDRE ALBERTO DE LA ROCHA (1846–1900), Portuguese explorer in Africa, was born at the castle of Polchras, on the Douro, on April 10, 1846. Entering the army in 1864, he served in Mozambique, and in 1869 took part in an expedition against tribes in revolt on the lower Zambezi. In 1877 he and Captains Capello and Ivens of the Portuguese navy were sent on an expedition to south central Africa. They left Benguella in Nov. 1877 for the interior, but Serpa Pinto soon parted from his colleagues and went east. He crossed the Kwando in June 1878, and in August reached Lialui, the Barotse capital on the Zambezi, continued his journey down the river to the Victoria falls, where he turned south, arriving at Pretoria on Feb. 12, 1879. He was the fourth explorer to traverse Africa from west to east, and was the first to lay down the route between Bihe and Lialui. He received the founder's medal of the Royal Geographical Society of London. The account of his travels appeared in English under the title How I Crossed Africa (2 vols., 1881). In 1884 he attempted, with less success, the exploration of regions between Mozambique and Lake Nyasa. Appointed governor of Mozambique in 1889, he organized an expedition to obtain for Portugal the Shiré highlands and neighbouring regions, but the vigorous action of the British agents (John Buchanan and H. H. Johnston) frustrated this design. (*See* AFRICA: *History*.) Shortly afterwards Serpa Pinto returned to Lisbon and was promoted to the rank of colonel. He died on Dec. 28, 1900.

SERPENT, a synonym for snake (*see* SNAKES), now generally used of dangerous varieties or metaphorically. *See* also SERPENT CULTS below.

In music the serpent was a bass wind instrument in use from about the 16th to the 19th century. Derived from the old wooden cornetts, it was composed of two pieces of wood, hollowed out and cut to the desired serpentine shape. When joined they formed a conical tube about eight feet long whose diameter varied from about half an inch at the crook to about four inches at the wider end. The upper extremity ended with a bent brass tube or crook to which the cup-shaped mouthpiece was attached; the lower end did not expand to form a bell, a peculiarity the serpent shared with the cornetts. The tube was pierced laterally with six holes, the first three of which were covered with the fingers of the right hand and the others with those of the left. The instrument had a range of about three octaves from its lowest note, B-flat below the bass staff. Called the snake tube in Germany and "black pudding" in the north of England, the serpent took two forms. The first of these, popular in France, was for use in church; the second version was used by numerous military bands including that of George III. Handel, Mendelssohn and Wagner were among those who scored compositions for the serpent. In the 19th century the serpent was replaced by the now obsolete ophicleide, which was basically a keyed version of the serpent.

SERPENT CULTS. Common belief associated serpents, dragons and other monsters with the guardianship of treasure or wealth; comp., *e.g.*, the golden apples of the Hesperides, and the Egyptian Osiris, and the Indian Krishna and Indra. Serpents adorned with necklaces of jewels or with crowns were familiar in old superstition, and the serpent with a ruby in its mouth was a favourite love-token. Many stories tell of the grateful reptile which brought valuable gifts to a benefactor. According to a common Indian belief a wealthy man who dies without an heir returns to guard his wealth in the form of a serpent, and it was an Italian superstition that a serpent's skin brought luck. The serpent is often associated with metallurgy, and to serpent deities have been ascribed the working of metals, gem-cutting and indeed culture in general. The Ophites (*q.v.*) actually identified the serpent with Sophia ("Wisdom"); the old sage Garga, one of the fathers of Indian astronomy, owed his learning to the serpent-god Sesha Nāga; and the Phoenician γέρων 'Οφίων wrote the seven tablets of fate which were guarded by Harmonia (Baudissin, *Stud. z. Rel. Gesch.*, i. 255–292 [on Semitic serpent cults]). The Aztec Quetzalcoatl taught metallurgy and agriculture, gave abundance of maize, also wisdom and freedom from disease. The Babylonian Ea, who sometimes has serpent attributes, introduced—like the American serpent Votan—knowledge and culture. The half-serpent Cadmus brought knowledge of mines, agriculture, and the "Cadmean" letters, while Cecrops inculcated laws and ways of life and was the first to establish monogamy. Although the reptile is not particularly intelligent, it has become famed for shrewdness and wisdom, whether in the Garden of Eden (Gen. iii. 1; 2 Cor. xi. 3) or generally (*cf.* Matt. x. 16): "Be ye therefore wise as serpents, and harmless as doves."

Serpents in Healing.—In one form or another the healing powers of the serpent are very familiar in legend and custom. Siegfried bathed in the blood of the dragon he slew and thus became invulnerable; the blind emperor Theodosius recovered his sight when a grateful serpent laid a precious stone upon his eyes; Cadmus and his wife were turned into serpents to cure human ills. In 1899 a court in Larnaca, Cyprus, awarded £80 (Turkish) as damages for the loss of a snake's horn which had been lent to cure a certain disease. It was popularly believed that medical skill could be gained by eating some part of a serpent; the idea that its valuable qualities would thus be assimilated belongs to one of the fundamental dogmas of primitive mankind (*cf.* Porphyry, *De abst.* ii. 48). Serpents were tended in the sanctuaries of the Greek Aesculapius (Asklēpios), the famous god of healing. (*See* ASCLEPIUS.)

At Emesa in Syria, watered by the Orontes, an image, the lower part of which was a scorpion, cured the sting of scorpions and freed the city from snakes. Constantinople was similarly protected by the serpent-trophy of Delphi which Constantine removed thither; an emperor was said to have performed an enchantment over the monument well known in Greek history. In modern India a walking-stick from a species of cane in the neighbourhood of a certain serpent-shrine protects against snakebite. At Fernando Po, when there was an epidemic among children, they were brought to touch a serpent's skin which hung on a pole. The same ideas underlie the story of the Brazen Serpent which cured the Israelites of the bites of the serpents in the Wilderness (Num. xxi. 6–9). The object, however, was no temporary device; centuries later, long after the founding of the temple of Jerusalem, the Brazen Serpent was at last regarded as unorthodox by the reforming king Hezekiah, and the historian who relates its overthrow ascribes its origin to the founder of Israelite national religion (2 Kings xviii. 4).

In Wells and Lakes.—According to primitive thought, rivers, lakes, springs and wells are commonly inhabited by spirits which readily assume human or animal form. Here the serpent and its kind are frequently encountered (Frazer's notes on *Pausanias*, vol. v. pp. 44 *sqq.*). In India the serpent-godlings are very often associated with water, and, even at the digging of a well, worship is paid to the "world serpent," and the Sālagrāma (spiral ammonite), sacred to Vishnu, is solemnly wedded to the Tulasī or basil plant, representative of the garden which the pool will fertilize. It is often supposed that the Nāga (serpent) chiefs rule countries in or under the water, and in Kashmir a submarine serpent-king became a convert and built churches. Especially common are the popular stories connecting serpents with submarine palaces and treasures (Crooke i. 45); and one submarine realm in the Ganges was reputed to possess "the water of strength." In Palestine and Syria, where demoniacal beings are frequently associated with water, local opinion is sometimes uncertain whether the water is under the care of a *jinn* or of a patron-saint. Several springs are named after the serpent, and the sacred fountain of Ephca at Palmyra, whose guardian in the early Christian era was appointed by the god Yarhibol, is still tenanted by a female serpent-demon which can impede its flow. Jerusalem had the stone Zōheleth (possibly "serpent," 1 Kings i. 9) and also its Dragon Well (Neh. ii. 13); and in modern times the curative Virgin's Spring or St. Mary's Well has its dragon which, when awake, swallows the intermittent flow of the water.

The Cosmic Serpent.—The serpent of the water is also the serpent of the great sea upon which the earth rested. Sometimes the reptile lives in submarine infernal regions, and as the demon of the underworld it is sometimes the earth-shaker. The Greek demon or snake Poseidon, god of sea and springs, was an earthquake god. To the great half-serpent monster Typhon were ascribed numerous springs; he was also the cause of earthquakes, and when he buried himself in the earth he formed the bed of the Syrian Orontes. This river, which was otherwise called Drakōn, Typhōn or Ophites, is known at the present day as the "river of the rebel" (*Nahr El-'Aṣi*). The waterspout, sometimes taken for a long-tailed dragon, is a huge sea-serpent, according to the Wanika of East Africa (Tylor, *Primitive Culture*, i. 292 *seq.*). In ancient Persia the rainbow was the celestial serpent; and among some African tribes it is the subterranean wealth-conferring serpent, stretching its head to the clouds, and spilling the rain in its greedy thirst. An early Indian name of the Milky Way is "the path of the serpent" (Crooke i. 25), and a great dragon or serpent is often the cause of eclipses, so that in India, on the occasion of an eclipse, its attention can be attracted by bathing in a sacred stream, or by a ritual which includes the worship of the image of the snake-god (i. 22 *sqq.*).

Serpent and Parentage.— The folk-lore of the Old and New World contains many examples of supernatural conception, an idea which is supplemented by the actual living belief in the East that supernatural beings can be fathers (E. S. Hartland, Primitive Paternity; cf. his Legend of Perseus i. 121, etc). In Annam where water spirits may take the form of serpents or of human beings, two deified heroes were said to have been serpents born of a childless woman, who drank from a bowl of water into which a star had fallen. It was a mediaeval belief that the household snake, if not propitiated, could prevent conception, and in Bombay barrenness is sometimes attributed to a serpent which has been killed by the man or his wife in a former state of their existence. Hence the demon is laid to rest by burning the serpent-image with due funereal rites. In the sanctuary of Aesculapius at Epidaurus women were visited in their dreams by a serpent—the reputed father of the child that was born, and elsewhere Sicyon who had such a progenitor was regarded as the son of the divine healer. Similar also was the origin of Augustus in a temple of Apollo, the god who had his tame serpents in the grove on Epirus. Further, as the serpent-father of Alexander the Great came with a healing-root to cure his general Pompey (Cicero, De div. ii. 66), so in an Indian story the son of a king of serpents and of a virgin (or, in a variant form, a widow) was succoured in warfare by his sire (Fergusson, p. 266). In India, China and Greece the serpent origin of kings and rulers is well-known.

Relations with Clans.—There are many instances of tribes or clans named after the serpent. These are not necessarily examples of nicknames, since a relationship between the two often shows itself in custom or belief. This feature sometimes applies, also, to cases where the clan does not bear the serpent name. In accordance with universal ideas of the reality of the "name," there are tribes who will refrain from mentioning the serpent. Also there are clans like the American Apaches and Navahos who will neither kill nor eat rattlesnakes. Where the reptile is venerated or feared it is usually inviolable, and among the Brassmen of the Niger the dangerous and destructive cobra was especially protected by an article in the diplomatic treaty of 1856 for the Bight of Biafra (J. F. Maclennan, Studies, ii. 524). The North American Indians fear lest their venerated rattlesnake should incite its kinsfolk to avenge any injury done to it, and when the Seminole Indians begged an English traveller to rid them of one of these troublesome intruders, they scratched him—as a matter of form—in order to appease the spirit of the dead snake. The snake-tribes of the Punjab clothe and bury a dead serpent; and elsewhere in India when one is killed in the village a copper coin is placed in its mouth and the body ceremonially burned to avert evil. These snake-tribes claim to be free from snake-bite, as also the ancient Psylli of Africa and the Ophiogenes ("serpent born") of Cyprus who were supposed to be able to cure others. This power was claimed likewise by the Marsians of ancient Italy, and is still possessed by the snake-clan of Senegambia. In Kashmir the serpent-tribes became famous for medical skill in general, and they attributed this to the health-giving serpent (J. Fergusson, Tree and Serpent Worship [1873], p. 260). Moreover, the Psylli would test the legitimacy of their new-born by exposing them to serpents which would not harm those of pure birth, and a similar ordeal among the Ophiogenes of Asia Minor showed whether a man was really of their kin (Strabo, xiii. 1, 14). This peculiar kinship between serpent-clans and serpents can be illustrated from Senegambia, where a python is supposed to visit every child of the python-clan within eight days of birth, apparently as a sign of recognition.

Relations with Families.—A kindred belief is that which regards the household snake an agreeable guest, if not a guardian spirit. In Sweden, even in the 16th century, such snakes were virtually household gods and to hurt them was a deadly sin. Among the old Prussians they were invited to share an annual sacrificial meal, and their refusal was a bad sign. Mohammed is said to have declared that the house-dwelling snakes were a kind of jinn; and, certainly, the heathen Arabs regarded them as malevolent or benevolent demoniacal beings (Nöldeke, on Arab serpent-lore, Zeit. f. *Völkerpsych* i. 412 sqq.) Among the Romans every place had its genius, also in the form of a serpent—cf. the doubt of Aeneas (Virgil Aen. v. 84 *sqq.*)—and household snakes were lodged and fed in vast numbers. They were the guardian-spirits of men and families, and stories are told of the way in which human life depended upon the safety of the reptile. As a chthonic animal the serpent has often been regarded as an embodiment of the soul of the dead. Grimm's story of king Gunthram tells how, while he slept, his soul in serpent-form visited a mountain full of gold (Paulus *Diac.* iii. 34), and Porphyry relates that a snake crawled from beneath the bed of Plotinus at the moment of the philosopher's death. In Bali near Java, where the Nags-cult flourishes, a serpent is carried at the funeral ceremonies of the Kshatriya caste and burned with the corpse. Among many African tribes the house-haunting serpents are the dead, who are therefore treated with respect and often fed with milk.

As Heroes and Local Guardians.— In Greece, however, the dead man became a chthonic daemon, potent for good or evil; his natural symbol as such, often figured on tombs, was the snake. "The men of old time," as Plutarch observed, "associated the snake most of all beasts with heroes," and in Photius the term "speckled hero" thus finds an explanation. At the battle of Salamis the serpent which appeared among the ships was taken to be the hero Cychreus. These heroes might become objects of cult and local divinities of healing; people would pass their tombs in awe, or resort thither for divination or for taking oaths (Jane Harrison, Journ. of Hell. Studies xix. 204 sqq.). In Egypt not only are there serpents of the houses, but each quarter in Cairo had a serpent-guardian. This is said also of the villages and districts of Armenia, and Buddhist legends affirm it for India. The Sati (Suttee) wife immolated to accompany her deceased husband often became the guardian of the village, and on the Sati shrine a snake may be represented in the act of rising out of the masonry (Crooke, i. 187 seq.). Athene ("the Athenian one") was primarily the guardian spirit of Athens, and at the Erechtheum her sacred serpent (apparently known to the 3rd century A.D.), was fed monthly with honey-cakes; when, during the Persian War, it left the food untouched it was taken as a sign that the protectors had forsaken the city. At Lebadeia in the shrine of Trophonios and elsewhere serpents gave oracles.

Human Sacrifice.—The control of the weather was ascribed to the nāga derni-gods and rajahs of India and to the "king of snakes" among North American Indians. It is significant that in India the widely-distributed Nagapančami-festival occurs in the rainy season. There are popular stories of springs and waters which could only be used in return for regular human sacrifices. A very rich dynasty in the Upper Niger was supposed to owe its wealth to a serpent in a well which received yearly a maiden attired as a bride; the cessation of the practice brought drought and sickness (Hartland iii. 57 seq.). In Mexico the half-serpent Ahuizotl dragged into its pool hapless passers-by; however, their souls were supposed to go to the terrestrial paradise, and the relatives became rich through the unhappy accident. But in India human sacrifice was actually made in the expectation of gaining hidden treasure, and doubtless we have a survival of this when snake-charmers, for a drop of blood from the finger of a first-born, will track the snakes which are guardians of treasure (Crooke ii. 135, 170 seq.). Indian traditions tell how reformers have persuaded the people in the past to stop their human sacrifices to serpent-spirits.

The Famous **Dahomey** Cult.—Conspicuous in serpent cults is the prominence of women. In India, in Behār, during August, there is a colourless festival in which. women, "wives of the snake," go round begging on behalf of the Brahmans and the villages. Among the Nāyars of Malabar at the ceremonies of the Pambantullel, the household serpent-deities show their benevolence by inspiring with oracles certain women who must be of perfect purity. In Travancore a serpent-god is the property of a family, the priests of a temple; the eldest female carries the image at the festal processions and must lead a celibate life. The cult of the Python in Dahomey became the most remarkable example of a thoroughly organic serpent cult. The python-deity is god of wisdom and earthly bliss and the benefactor of man; he opened the eyes of the first human pair who were born blind. He is specially invoked on behalf of the king (the nominal head of the priesthood) and the crops, and a very close connection was supposed to exist between the god's agency and all agricultural life.

Various Developments **of** Cults.—In the gloomy rites of the Diasia, the Olympian Zeus, as Zeus Meilichios god of wealth, has been imposed upon a chthonic snake-deity who is propitiated by holocausts of pigs and by a ritual of purgation.

In the Thesmophoria (*q.v.*), a sowing festival of immemorial antiquity performed by women, cakes and pigs were thrown to serpents kept in caves and sacred to the corn goddess Demeter, who, like the Bona Dea, was representative of the fertility of nature.

The Maenads ("mad ones") or Bacchae, the women attendants of Dionysus, with their snake accompaniments, mere only one of the various snake features associated with the cult of a deity who mas also a god of healing. The symbol of the Bacchic orgies was a consecrated serpent, and the snakes kept in the sacred cistae of the cult of Dionysus find a parallel among the sect of the Ophites where, at the sacramental rites, bread mas offered to the living serpent and afterward distributed among the worshipers.

Other developments may be illustrated from the cult of Aesculapius, who seems to have been merely a deified ancestor, or the interesting Indian healer Sokha Bāba (see ASCLEPIUS; DRAGON).

Contests with Serpents.—For the retention of older cults under a new name. Islam supplies several examples, as when a forest-serpent of India receives a Moslem name. But sometimes there is a contest between the new cult and the old. It has been observed that where Apollo prevailed in Greek religion the serpent became a monster to be slain.

At Thebes Xpollo took the place of Cadmus, who, after killing the dragon which guarded a well and freeing the district, had ended by being turned into a serpent. Hercules had contests with serpents and dragons, became the patron of medicinal springs and, by marrying the serpent Echidna, the ancestor of the snake-worshiping Scythians. Phorbas killed the serpent Ophiusa, freed Rhodes of snakes and obtained supremacy, and Cychreus slew the dragon of Salamis and took the kingdom. From southeast Asia comes the story of the colonization of Cambodia, where the newcomer marries the dragon-king's daughter. A story told by Herodotus admirably shows how the serpent as a child of earth was a type of indigenous peoples.

In Christianity.—At Axum in Ethiopia, where worship was divided between the serpent and the Mosaic law, it is said that the great dragon was burst asunder by the prayers of Christian saints (c. A.D. 340). At the Phrygian Hierapolis the serpent Echidna was expelled by the Apostles Philip and John. France had traditions of the destruction of serpents by missionaries and memory possibly survived in the Pyrenees, where the clergy and people supposedly celebrated the eve of St. John by burning live serpents. Christian saints have also stepped into the shoes of earlier serpent-slayers; while, in stories of the "St. George and the Dragon" type, the victory of the pious over the enemy of mankind has often been treated as a literal conflict with dragons, thus introducing a new and confusing element into the subject. At Rouen the celebration of St. Romain seems to preserve a recollection of human sacrifice to a serpent-demon which was primarily suppressed by a pagan hero, and at Metz, where St. Clement is celebrated as the conqueror of a dragon, its image (formerly kept in the cathedral) was taken through the streets at the annual festival and received offerings of food. Most remarkable of all, at Cocullo in the Abruzzi mountains on the border of the old territory of the Marsi snake-men. the serpent-deity has a lineal descendant in the shape of St. Domenico of Foligno (A.D. 950–1031). The shrine is famous for its cures, and when the saint has his serpent-festival on the first Thursday in May, Serpari or serpent-men carry coils of live reptiles in procession before his image, which in turn is hung with serpents of all sizes. The rites are a valuable testimony to the persistence of the cult among people who still claim power over serpents and immunity from their bite, and who live near the home of the ancient tribe which ascribed its origin to the son of Circe. One may recall the old cult of Sabazios where men waved great red snakes over their heads as they marched in procession. Moreover, we find at Madagascar the procession of the god of fertility and healing, the patron of serpents who are the ministers of his vengeance. In a Bengal festival the men march entwined with serpents, while the chief man has a rock-boa or python around his neck and is carried or rides on a buffalo. (S. A. C.; X.)

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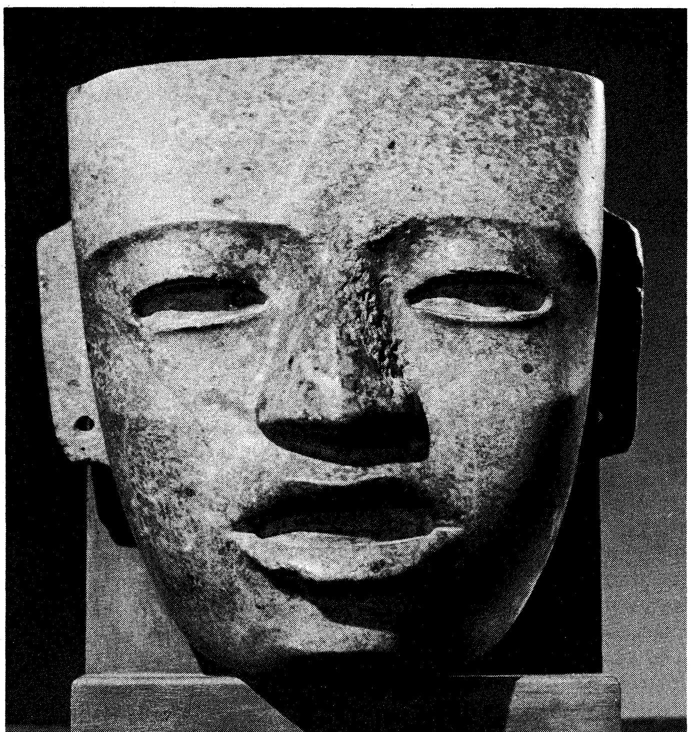
SERPENTINE, a group of hydrous magnesium silicates with iron. nickel and manganese commonly substituting for magnesium. The iron gives it a variety of green (although sometimes yellowish and brownish) colours; the pure material is grayish to white. When mottled with red the colour is due to a physical mixture of excess iron oxide. The usually massive serpentine rock may be composed of a mixture. the fine fibrous variety known as chrysotile



BY COURTESY OF NATIONAL GALLERY OF ART, WASHINGTON, D.C.

MASK OF GREEN SERPENTINE, STYLE OF TEOTIHUACAN. MEXICO. IN THE ROBERT WOODS BLISS COLLECTION, ON LOAN TO THE NATIONAL GALLERY OF ART. WASHINGTON. D.C.

and antigorite, both of the same composition but differing in crystal structure. Other varieties are identified by X-ray diffraction techniques.

Chrysotile serpentine, when found unmixed with antigorite and with long fibres, is used for most of the asbestos (*q.v.*) of commerce although some asbestos does come from the amphibole group of minerals. It develops with the fibres normal to fissure walls when the host rock is shattered as it is in Quebec, Can.

Serpentine is a secondary mineral generally formed by the hydration of the magnesium silicates in peridotite, an olivine, and pyroxene (*q.v.*) rich rock. The composition of serpentine is $Mg_3Si_2O_5(OH)_4$, so commonly both H_2O and SiO_2 must be added to an existing composition to form serpentine, especially in the magnesium carbonate rocks. This is a process that generates heat and requires an increase in volume for a large mass to develop. However, occasional distinct crystals show the form of olivine, pyroxene or amphibole that has been replaced forming a pseudomorph which may grow by some leaching process. The density of serpentine is about 2.j to 3.0. It cleaves easily parallel to the plates in the variety antigorite or to the fibres in the variety chrysotile. It has a waxy feel and appearance and takes a high polish after carving or cutting as a gem or ornamental stone. (See also MARBLE ; STONE.)

Serpentine occurrence is extremely widespread. It is characteristically found along the crests and axes, the low-pressure areas, of great folds whether island arcs or alpine mountain chains. These massive serpentines are commonly produced by metamorphism (*q.v.*) of peridotite, and indicate a development in these major structures of the earth's crust that progressed simultaneously with the growth of the fold system and may have continued after the mountain building ceased.

The serpentines along island arcs outcrop over areas covering from hundreds to thousands of square miles, as in New Caledonia and Cuba, and may be exposed by erosion or perhaps a solid extrusion. (K. O B.)

SERPENT MOUND, GREAT. A prehistoric earthwork on a narrow spur between Brush creek and East creek, Adams county, Ohio. It is the feature attraction of Serpent Mound State park. The effigy earthwork, 1,330 ft. long with seven serpentine convolutions, is 15 to 20 ft. wide in the body and 3 to 5 ft. high. The tail section has three coils, while the head is reconstructed as a serpent's open mouth. An oval embankment, 125 ft. long and 60 ft. wide, protrudes from the open mouth. Carefully excavated sections of the body and the oval disclosed a foundation of stone, ashes and clay.

There has been much speculation but no definite information as to the meaning of this effigy. It is obvious that it had considerable importance in the lives of the people who built it as a symbol of some of their religious beliefs.

Serpents have had a prominent place in the mythology and folklore of many peoples, including the historic Indians of the Mississippi and Ohio valleys. Materials excavated from conical mounds and a village site to the south of the serpent indicate the effigy was constructed by Indians of the Ohio valley Xdena culture 1,500 to 2,000 years ago. (J. B. GN.)

SERPUKHOV, a town of the Russian Soviet Federated Socialist Republic, U.S.S.R., in the Moscow oblast, in 54° j6' N., 37° 28' E. Built on high cliffs on both banks of the Nara river, three miles above its confluence with the Oka, Serpukhov is an important manufacturing and commercial town. Pop. (1956 est.) 102,000.

It has important textile and dyeing industries, and its chintz is famous. There are also iron and copper foundries. Grain, hemp and timber, brought from the east down the Oka, are discharged at Serpukhov and sent on to Moscow and Leningrad. The cathedral (1380) was rebuilt in the 18th century; the old fortress has almost entirely disappeared.

Serpukhov is one of the oldest towns of the principality of Moscow; in 1328 it was a nearly independent principality under the protectorate of Moscow. Its fortress protected Moscow on the south and was often attacked by the Tatars; the Mongol prince Toktamish plundered it in 1382, and the Lithuanians in 1410. In 1556 the town was strongly fortified, so that fifteen years later it was able to resist the Mongols.

SERRA, JUNÍPERO (1713–1784), Spanish missionary in America, was born in the island of Majorca, on Nov. 24, 1713, entered the Franciscan order in 1729, and in 1750 arrived at Mexico City to devote his life to missionary work among the Indians. From 1750 to 1769 he laboured among the Indians of the Sierra Gorda region. In 1769 he accompanied the Galvez expedition to the northwest and at San Diego founded the first mission in the present state of California. In 1770 he founded the mission of San Carlos at Monierey, and in 1771 the missions of San Antonio and San Gabriel, the latter near Los Angeles. He began the mission of San Francisco in 1776 and that at Santa Clara in 1777. Many lesser missions were founded by Father Junipero or his band of 16 followers, and these became the first settlements in California. He made Monterey his headquarters, from which he frequently visited all his missions, always covering the distance between them on foot. His farewell visit was in 1783, his health rapidly declining after his return to Monterey, where he died on Aug. 28, 1784.

See Francisco Palou's *Life and Apostolic Labors of the Venerable Father Junipero Serra,* trans. *by* C. W. Williamson (1913); A. H. Fitch, *Junipero Serra: The Man and his Work* (1914); C. E. Chapman, *The Founding of Spanish California* (1916).

SERRANO, FRANCISCO, DUKE DE LA TORRE AND COUNT OF SAN ANTONIO (1810–1885), Spanish marshal and statesman, born in the island of Leon, Cadiz, on Dec. 17, 1810. A cadet in 1822, he was promoted from captain to brigadier-general in the Carlist War (1834–1839). Member of the Cortes for Malaga in 1839, general of division and commander of the district of Valencia in 1840, he helped, in 1841, Espartero to overthrow the regency of Queen Cristina. He was minister of war in the Lopez and Olozaga cabinets, senator in 1845 and captain-general of Granada in 1848. He was made marshal in 1856, and captain-general of Cuba (1859–62). On his return to Spain he was made duke de la Torre, grandee of the first class and minister of foreign affairs by O'Donnell. Serrano helped O'Donnell quell the formidable insurrection of June 22, 1866, at Madrid and was rewarded with the Golden Fleece. At the death of O'Donnell, as president of the senate, he helped Rios Rosas to draw up a petition to Queen Isabella against her Moderado ministers. Exiled, he was transported to the Canary Islands (July 7, 1868). On Sept. 18, Admiral Topete sent a steamer to bring him to Cadiz. On landing, he took command of the revolutionary army and routed Isabella's troops at Alcolea.

The queen fled to France; Serrano entered Madrid, convoked the Cortes Constituyentes (Feb. 1869) and was appointed regent. He twice attempted to form a coalition cabinet under King Amadeus, and after his abdication (Feb. 11, 1873), he conspired against the republic (April 23, 1873), failed and went to France until General Pavia recalled him on the eve of his coup *d'état* (Jan. 3, 1874). President of the executive again, Serrano tried first a coalition cabinet, in which Martos and Sagasta soon quarrelled, then formed a cabinet presided over by Sagasta, which, however, proved unable to cope with the military and political agitation that ended in the restoration of the Bourbons. After the Restoration, he spent some time in France, returning to Madrid in 1876; he died there on Nov. 26, 1885. (A. E. HO; X.)

SERRES, OLIVIA (1772–1834), an English impostor, who claimed the title of Princess Olive of Cumberland, was born at Warwick on April 3, 1772. She was the daughter of Robert Wilmot, a house painter in that town, who subsequently moved to London. In 1791 she married her drawing-master, John Thomas Serres (1759–1825), marine painter to George III, but in 1804 separated from him. She claimed in 1817 to be the natural daughter of Henry Frederick, duke of Cumberland. brother of George III, and in 1820 claimed to be his legitimate daughter. Her story was that her mother had secretly married the duke in 1767, and that she had been substituted as an infant for the still-born child of Robert Wilmot. In 1823 Sir Robert Peel, then home secretary, speaking in parliament, declared her claims unfounded, and her husband expressly denied his belief in them in his will. Mrs. Serres died on Nov. 21, 1834, leaving two daughters. The eldest, who married Antony Ryves, a portrait painter, upheld her mother's claims and styled herself Princess Lavinia of Cumberland. In 1866 she took her case into court, but the jury declared the signatures to the documents produced to be forgeries.

See W. J. Thoms, *Hannah Lightfoot, and Dr. Wilmot's Polish Princess* (London, 1867); *Princess of Cumberland's Statement to the English Nation; Annual Register* (1866), Case **of** *Ryves* **v.** *the Attorney-General,*

SERRI, a village in central Sardinia. To the west of it is a plateau, surrounded by rocky cliffs, which was of great importance in prehistoric times. A group of sacred buildings has been found here, notably a sanctuary containing a sacred well, of a type not infrequent in Sardinia. Two other buildings which served the purposes of worship contained numerous votive offerings in bronze; a group of three altars was also found. There were also massive fortifications forming a complicated defensive system, and the whole group, which was in use down to Roman times, is the finest example we have of an early Sardinian cult centre, especially interesting now that it is known that the cult of the double axe was practised here. Pop. (1936) 902.

See Taramelli in *Monumenti dei Lincei*, xxiii. (1915–16) 313–436; *Year's Work in Classical Studies*, 1922–23, 114; 1923–24, 117.

SERTORIUS, QUINTUS (d. 72 B.C.) Roman statesman and general, was a native of Nursia in Sabine territory. After acquiring some reputation in Rome as a jurist and orator, he entered upon a military career. He served under Marius in 102 B.C. at Aquae Sextiae (mod. Aix). In 97 he was serving in Spain. In 91 he was quaestor in Cisalpine Gaul, and on his return to Rome he would have been elected to the tribuneship but for the opposition of Sulla. He now declared for Marius and the democratic party. On Sulla's return from the East in 83, Sertorius went to Spain, where he represented the Marian or democratic party, but without receiving any definite commission or appointment. Having been obliged to withdraw to Africa in consequence of the advance of the forces of Sulla over the Pyrenees, he carried on a campaign in Mauretania, in which he defeated one of Sulla's generals and captured Tingis (Tangier). The Lusitanian tribes then invited him (80) to head a rising. Brave and kindly, and gifted with a rough telling eloquence, Sertorius was just the man to impress them favourably, and the native militia, which he organized, spoke of him as the "new Hannibal." Many Roman refugees and deserters joined him, and with these and his Spanish volunteers he completely defeated one of Sulla's generals and drove Q. Caecilius Metellus Pius, who had been specially sent against him from Rome, out of Lusitania.

Sertorius owed much of his success to his statesmanlike ability. His object was to build up a stable government in the country with the consent and co-operation of the people, whom he wished to civilize after the Roman model. He established a senate of 300 members, drawn from Roman emigrants, with probably a sprinkling of the best Spaniards, and surrounded himself with a Spanish bodyguard. For the children of the chief native families he provided a school at Osca (Huesca), where they received a Roman education and even adopted the dress of Roman youths. Strict and severe as he was with his soldiers, he was particularly considerate to the people generally, and made their burdens as light as possible. It seems clear that he had a peculiar gift for evoking the enthusiasm of rude tribes, and we can well understand how the famous white fawn, a present from one of the natives, which was his constant companion and was supposed to communicate to him the advice of the goddess Diana, promoted his popularity.

For six years Sertorius may be said to have really ruled Spain. In 77 he was joined by M. Perperna (or Perpenna) Vento from Rome, with a following of Roman nobles, and in the same year the great Pompey (*q.v.*) was sent to conquer him. Sertorius proved himself more than a match for his adversaries, utterly defeating their united forces on one occasion near Saguntum. Pompey wrote to Rome for reinforcements, without which, he said, he and Metellus would be driven out of Spain. Sertorius was in league with the pirates in the Mediterranean, was negotiating with the formidable Mithridates, and was in communication with the insurgent slaves in Italy. But the arrival of Perperna formed a centre of disaffection, and his influence over the native tribes slipped away from him, though he won victories to the last. In 72 he was assassinated at a banquet, Perperna, it seems, being the chief instigator of the deed.

See Plutarch's lives of *Sertorius* and *Pompey*; Appian, Bell. *civ.* and *Hispanica*; the fragments of Sallust; Dio Cassius xxxvi. 25, 27, 28, xliv. 47; Vell. Pat. ii. 25, 29, 30, 90.

SERUM THERAPY. Serum, the liquid cell-free fraction of the blood, contains among other chemicals several varieties of proteins, chief of which are albumin and the globulins. The albumin is important in retaining fluid in the blood stream. Linked to the globulins are antibodies, a chemical fraction, elaborated by the body in response to the presence of a toxic substance, whose purpose is to neutralize agents harmful to the organism. Serum therapy, broadly defined, is the administration of serum to a sick person or animal to provide one or more needed fractions in the serum; the limited, classical definition is the injection of serum for the beneficial effect of the antibodies on infection in the patient.

Paul Ehrlich, one of the earliest immunologists, developed a concept that a noxious substance when injected into the body stimulates the body to form antibodies, which would combine with and neutralize the harmful material. The chemical structure of any toxic material is well defined and the corresponding antibody produced by the organism is highly specific, chemically exact and limited in its action to the substance against which it is formed.

One of the greatest advances in medicine took place in 1890 when E. von Behring applied this basic principle of immunology to prepare diphtheria antitoxin. This was done by repeated injections of diphtheria toxin (a poison elaborated by the diphtheria organism) into horses. The vaccination provoked formation of antibodies against the diphtheria toxin. Vaccinated horses were then bled and serum was prepared. Von Behring's theory that the administration of antibodies in the serum should neutralize the toxin in the tissues of patients sick with diphtheria mas quickly confirmed by the results. Treatment with the antitoxin had a dramatic effect on this severe disease; it reduced mortality from more than 33% to less than 5%.

The antitoxic serum was put to another use. Children exposed to diphtheria infection but treated with serum escaped the disease. The serum thus proved to be of value as a prophylactic measure, although the protection thus conferred was only of a temporary nature and each separate exposure required an injection.

The success of diphtheria antitoxin served as a great impetus for scientific workers to attempt to produce similar antiserums against other diseases. Unfortunately, most of the efforts ended in failure. Only a limited number of serums were produced that appeared to have benefit; but none was as successful as diphtheria antitoxin. Nevertheless, over the ensuing years, some antiserums were developed and used with moderate success in treating a variety of illnesses such as tetanus, epidemic meningitis, gas gangrene, streptococcus infections including scarlet fever, pneumonia, botulinus poisoning and especially poisoning from snakes and insects. Some serums, prior to the development and extensive use of good vaccines, were widely used for prophylaxis. This was especially true of diphtheria and tetanus antitoxin. In general, antiserums against bacterial toxins (antitoxic serums) were the most effective, whereas antiserums designed to combat bacteria themselves (antibacterial serums) were relatively ineffective. It was commonly experienced that an illness resulting from invasion by toxin-producing bacteria would be influenced by the administration of serum only to the extent of diminution of the toxic condition, while the bacterial infection was relatively uninfluenced.

There are two major sources of serum; that prepared from human blood and that prepared from blood of animals. Serum prepared from healthy adults is called normal human serum and is used principally in shock, or states of protein deficiency. Serum is also prepared from blood of people lately recovered from certain acute infections such as scarlet fever, measles, mumps and poliomyelitis. This is called human convalescent serum and is used to a variable extent for prophylaxis or treatment of the specific disease. The effectiveness of human convalescent serum depends on the fact that antibodies resulting from infection are at a peak level in the circulation soon after recovery from the illness. Serum is also prepared from adults who have been intensively treated with vaccines for the purpose of stimulating a high concentration of antibodies. This human hyperimmune serum finds principal use in the prophylaxis and treatment of pertussis (whooping cough) and mumps. Human serums are generally preferred to animal serums because their injection into patients is free from any undesirable reactions, as is encountered with the use of animal serums. However, for obvious reasons, supplies of human serum are definitely limited, and in the case of convalescent or hyperimmune serums the quantities are so limited that they can be used only in a restricted fashion. One of the fortuitous developments with the use of human serum was a method, evolved by Edwin J. Cohn, of fractionating the blood proteins in pure, concentrated and stable form. One of the protein fractions, gamma globulin, found valuable use as a preventive measure in measles, in the same manner as measles convalescent serum. Since the supply of human gamma globulin is much greater than that of convalescent serum, it is widely used to prevent the disease or modify its severity.

Animal serums, prepared from the blood of horses or rabbits, are of the hyperimmune variety. The animals are treated with an intensive and repeated course of vaccination of the specific agent such as diphtheria toxin, tetanus toxin. cobra venom, etc. When laboratory tests indicate that a satisfactory level of antibodies has been elaborated, blood is collected, from which serum is prepared. Such serum is further chemically processed, concentrated to make it more effective and purified to reduce those alien substances in the animal serum which cause undesirable reactions known as serum sickness.

Paul Ehrlich, who first advanced the concept of antibodies on which all the efforts to produce antiserums were based, also developed a chemical, arsphenamine, for the treatment of syphilis. An extension of chemotherapy, the sulfa drugs constituted one of the great advances in combating bacterial infections. Chemotherapy, implemented by the antibiotics such as penicillin, streptomycin, aureomycin, etc. (substances elaborated by microorganisms that have the ability to inhibit growth of other species of bacteria), succeeded where the therapeutic antiserums failed or were only partially effective.

Effective vaccines have served also to reduce the need for therapeutic or prophylactic antiserums. Widespread immunization against diphtheria, tetanus and pertussis so greatly reduced the incidence of these diseases that the need for serum therapy became very limited. For example, even the effective and historic diphtheria antitoxin is required only occasionally.

A broader use of serum as an agent in combating shock from haemorrhage, trauma, burns, etc.. was developed in 1940. Human serum and plasma (serum being the liquid fraction of clotted blood while plasma is the liquid fraction from unclotted blood and contains the clotting elements, prothrobin and fibrinogin) found extensive use for this purpose and was considered one of the three or four great medical weapons of World War II. The value of serum or plasma in shock or haemorrhage is that it provides the fluid and proteins to the circulation so that the vital tissues can be adequately oxygenated by the oxygen-bearing red blood cells. Illnesses accompanied by or resulting in a deficiency of circulating blood protein are also treated with human serum or plasma.

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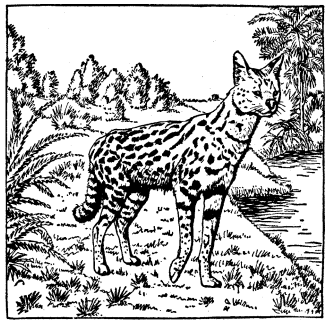
SERURIER, JEAN-MATHIEU-PHILIBERT, COMTE (1742–1819), French soldier, was born at Laon, Fr. He served in the royal army in campaigns in Hanover (1759), Portugal (1762) and Corsica and in 179j became general of division. He fought under Bonaparte in Italy and became governor of Venice (1797) and Lucca (1798). He was made senator, count, marshal and governor oi the palace of the Invalides. In 1814 he voted for the downfall of Napoleon, and under the Restoration was made a peer. He was dismissed from his posts for joining Napoleon during the Hundred Days.

SERVAL (*Felis serval*), an African wild cat, ranging from Algeria to the Cape. It is of medium size, with long limbs, short tail, and tawny fur spotted with black. It may measure 56 in., including the tail. The serval is fairly common in Central Africa, frequenting thick bush near rivers and preying on the smaller antelopes, guinea-fowls, and francolins. The mantles made from its skin are often seen in African villages.



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THE SERVAL, A WILDCAT OF AFRICA

SERVETUS, MICHAEL [MIGUEL SERVETO] (1511?–1553), Spanish physician and polemic, was probably born in 1511 at Tudela in Navarre, the son of Hernando Villanueva, a notary of good family in Aragon. His surname is given by himself as "Serveto" in his early works, "per Michaelem Serueto, alias Reues." Later he Latinized it "Servetus"; when writing French (1553) he signs "Michel Seruetus." The surname, Villanovanus or de Villeneufve, is derived from the home of the family, Villanueva. Servetus studied law at Toulouse, where he first became acquainted with the Bible (1528). From 1525 he had found a patron in Juan de Quintana (d. 1534), a Franciscan promoted in 1530 to be confessor to Charles V. In the train of Quintana he witnessed at Bologna the double coronation of Charles in Feb. 1530, visited Augsburg, and perhaps saw Luther at Coburg. The spectacle of the adoration of the pope at Bologna impressed him strongly in an anti-papal direction. He left Quintana, visited Lyons and Geneva, repaired to Oecolampadius at Basle, and pushed on to Bucer and Capito at Strnsbourg. His first publication, *De Trinitatis erroribus* (1531, printed by John Setzer at Hagenau) is crude, but original and earnest, and shows a wide range of reading. The essay was followed in 1532 by a revised presentation of his views in dialogue form. We next find him at Lyons (1535) editing scientific works for the Trechsel firm, adopting the "Villanovanus" surname, which he constantly used till the year of his death. At Lyons he found a new patron in Dr. Symphorien Champier (Campegius) (1472–1539), and he then went (1536) to Paris to study medicine under Johann Gunther, Jacques Dubois and Jean Fernel. In 1536 Calvin saw Servetus in Paris, and as he himself says, proposed to set him right on theological points. Servetus succeeded Vesalius as assistant to Gunther, who extols his general culture, and notes his skill in dissection, and ranks him *vix ulli secundus* in knowledge of Galen. He graduated in arts, and claims to have graduated in medicine, published six lectures on "syrups" (the most popular of his works), lectured on geometry and "astrology" (from a medical point of view) and defended by counsel a suit brought against him (March 1538) by the medical faculty on the ground of his astrological lectures. Shortly afterwards, on the death of his master, he left Paris for Louvain, where he studied theology and Hebrew. He then practised medicine for a short time at Avignon, and for a longer period at Charlieu. In September 1540 he entered the medical school at Montpellier.

Pierre Paulmier, since 1528 archbishop of Vienne, who had attended his lectures in Paris, now invited Servetus to Vienne as his confidential physician. At Vienne he remained for 12 years (1541–53), making money by his practice, and also by renewed editorial work for the Lyons publishers. Outwardly he was a conforming Catholic; privately he pursued his theological speculations. It is probable that in 1541 he had been rebaptized (he maintained the duty of adult baptism at the age of 30). Late in 1545, or very early in 1546, he opened a fatal correspondence with Calvin, forwarding the ms. of a much-enlarged revision of his theological tracts and expressing a wish to visit Geneva. Calvin replied (Feb. 13, 1546) in a letter now lost, in which, he says, he expressed himself "plus durement que ma coustume ne porte." On the same day he wrote to Guillaume Farel, "si venerit, modo valeat mea autoritas, vivum exire nunquam patiar,!' and to Pierre Viret in the same terms. Evidently Servetus had warning that if he went to Geneva it was at his peril. Writing to Abel Pouppin (in or about 1547) he complains that Calvin would not return his ms., and adds, "mihi ob eam rem moriendum esse certo scio." The volume of theological tracts, again recast, was declined by two Basle publishers, Jean Frellon (at Calvin's instance) and Marrinus, but an edition of 1,000 copies was secretly printed at Vienna by Balthasar Arnollet. Ready by Jan. 3, 1553, the bulk of the impression was privately consigned to Lyons and Frankfort for the Easter market.

On Feb. 26, a letter, enclosing a sheet of the printed book, and revealing the secret of its authorship, was written from Geneva by Guillaume de Trye, formerly *échevin* of Lyons, to his cousin Antoine Arneys in that city. The letter bears no sign of dictation by Calvin (who must, however, have furnished the enclosed sheet). For a subsequent letter Calvin furnished (reluctantly, according to de Trye) samples of Servetus's handwriting, expressly to secure his conviction. The inquisitor-general at Lyons, Matthieu Ory (the "Doribus" of Rabelais) took up the case on March 12; Servetus was interrogated on March 16, arrested on April 4, and examined on the two following days. His defence was that, in correspondence with Calvin, he had assumed the character of Servetus for purposes of discussion. At 4 A.M. on April 7 he escaped from his prison, evidently by connivance. How he spent the next four months is not known. On Saturday, Aug. 6, he rode into Louyset, a village on the French side of Geneva. Next morning he walked into Geneva, put up at "the Rose," and asked for a boat to take him towards Ziirich on his way to Naples. Finding he could not get the boat till next day (Monday) he attended afternoon service (he would probably have got into trouble if he had not done so), was recognized at church *par quelques frères,* and immediately arrested.

The process against Servetus (Nicholas de la Fontaine being in the first instance the nominal prosecutor) lasted from Aug. 14 to Oct. 26, when sentence to be burned alive was passed, and carried out next day at Champel (Oct. 27, 1553). Calvin would have had him beheaded. Meanwhile the civil tribunal at Vienne had ordered (June 17) that he be fined and burned alive; the sentence of the ecclesiastical tribunal at Vienne was delayed till Dec. 23. Jacques Charmier, a priest in Servetus's confidence, was condemned to three years' imprisonment in Vienne. The only likeness of Servetus is a small copperplate by C. Sichem, 1607 (often reproduced); the original is not known and the authenticity is uncertain. In 1876 a statue of Servetus was erected by Don Pedro Gonsalez de Velasco in front of his Instituto Antropologico at Madrid; in 1903 an expiatory block was erected at Champel; in 1907 a statue was erected in Paris (Place de la Mairie du XIV^{e} Arrondissement); another is at Aramnese; another was prepared (1910) for erection at Vienne.

The denial by Servetus of the tripersonality of the Godhead and the eternity of the Son. along with his anabaptism, made his system abhorrent to Catholics and Protestants alike, in spite of his intense Biblicism, his passionate devotion to the person of Christ, and his Christbcentric scheme of the universe. His earliest theological writings, in which he approximates to the views of F. Socinus, are better known than his riper work. He has been classed with Arians, but he endorses in his own way the homoousian formula, and denounces Arius as "Christi gloriae incapacissimus." He has had many critics, some apologists (*e.g.,* Postel and Lınçurius), few followers. The 15 condemnatory clauses, prefacing the sentence at Geneva, set forth in detail that he was guilty of heresies, blasphemously expressed, against the foundation of the Christian religion. An instance of his injurious language was found in his use of the term "trinitaires" to denote "ceux qui croyent en la Trinité." No law, current in Geneva, has ever been adduced as enacting the capital sentence. Claude Rigot, the procureur-général, put it to Servetus that his legal education must have warned him of the provisions of the code of Justinian to this effect; but in 1j35 all the old laws on the subject of religion had been set aside at Geneva; the only civil penalty recognized by the edicts of 1543 being banishment. The Swiss churches, while agreeing to condemn Servetus, say nothing of capital punishment in their letters of advice. The extinct law seems to have been revived for the occasion. A controversy followed on the question of executing heretics, in which Beza (for), Mino Selsi (against), and several caustic anonymous writers (especially Castellio) took part.

His Works.—The following is a list of the writings of Servetus:

1. *De Trinitatis erroribus libri septem* (Hagenau, 1531).

2. *Dialogorum de Trinitate libri duo* (Hagenau, 1532); two reprints of 1 and 2, to pass for originals; No. 1 in Dutch version (1620), by Regnier Telle.

3. *Claudii Ptolomaei Alexandrini geographicae enarrationis libri octo; ex Bilibaldi Pirckheymeri translatione, sed ad Graeca et prisca exemplaria a Michaele Villanovano jam primum recogniti. Adjecta insuper ab eodem scholia,* etc., Lyons, Melchior and Gaspar Trechsel (1535; 2nd ed., Lyons, Hugo & Porta, 1542 *seq.;* printed by Caspar Trechsel at Vienne); on this work Tollin founds his high estimate of Servetus as a comparative geographer; the passage incriminated on his trial as attacking the verity of Moses is from Lorenz Friese; the accounts of the language and character of modern nations show original observation.

4. *In Leonardum Fuchsium apologia. Autore Michaele Villanovano* (1536, reproduced by photography, 1909).

5. *Syruporum universa ratio,* etc. (Paris, 1537); four subsequent editions; latest, Venice, 1548 (six lectures on digestion; syrups treated in fifth lecture).

6. *Michaelis Villanovani in quendam medicum apologetica disceptatio pro astrologia* (Paris, 1538; reprinted, Berlin, 1880); the medicus is Jean Tagault, who interrupted Servetus's lectures on astronomy, including meteorology.

7. *Biblia Sacra ex Santis Pagini tralatione . . . recognita et scholiis illustrata,* etc. (Lyons, Hugo à Porta, 1542, *seq.),* remarkable for its theory of prophecy, explained in the preface and illustrated in the notes.

8. D'Artigny says Servetus *fit les argumens* to a Spanish version of the *Summa* of Aquinas; this, and *divers traités de grammaire* from Latin into Spanish have not been identified.

9. *Christianismi rcstitutio* (1553; perfect copies in Vienna and Paris); a copy in Edinburgh university library is complete except that the missing first 16 pages are replaced by a transcript from the original draft, containing matter not in the print (this supplementary ms. was reproduced by photography, 1909); a transcript of other portions of the draft is in the Bibl. Nat., Paris; partly reprinted (London, 1723) (copies in London and Paris); reprinted (page for page) from the Vienna copy (Kuremberg, Rau, 1790); German version, by B. Spiess (Wiesbaden, 1892–95); the last section *Apologia* to Melanchthon, is given in the original Latin. The book is not strictly anonymous; the initials M.S V. are given at the end; the name Seruetus on p. 199. The often-cited description of the pulmonary circulation (which occurs in the 1546 draft) begins p. 169; it has escaped even Sigmond that Servetus had an idea of the composition of water and of air; the hint for his researches was the dual form of the Hebrew words for blood, water.' etc. Two treatises, *Desiderius (ante* 1542) and *De fribus impostoribus* (1598) have been wrongly ascribed to Servetus. Most of his few remaining letters are printed by Mosheim; his letter from Louvain was despatched in duplicate (to evade capture), but both were seized; one is in the Record Office (U. 140), the other in the British Museum (Cotton mss., Galba B. x.).

The literature relating to Servetus is very large; a bibliography is in A. v. d. Linde, *Michael Servet* (1891); the following are among the important pieces. Calvin's *Defensio ortlzodoxae fidei* (1554) (in French, *Déclaration pour maintenir,* etc., 1554), is the source of prevalent misconceptions as to Servetus's opinions, and attitude on his trial. De la Roche's *Historical Account* in *Mem. of Lit.* (1711–12) (in French, *Biblioth. Ang.* Amsterdam, 1717) was followed by *An Impartial History,* etc., 1724 (said to be by Sir Benjamin or Nathaniel Hodges). Allwoerden's *Historia,* etc. (1728) (materials furnished by Mosheim) is superseded by Mosheim's *Anderweitiger Versuch* (1748, with appendix, *Neue Nachrichten,* etc., 1750), reproducing the records of the Vienne examination (since lost) first printed by D'Artigny. *Nouveaux Mémoires d'hist.,* etc., vol. ii. (1749). Chauffepié's valuable article, *Nouv. Dict. historique,* iv. (1756) (in English, by Rev. James Yair, 1771) makes no use of Mosheim's later researches. Trechsel's *Die Prot. Antitrinitaires vor F. Socin, bk.* i. (1839), uses all available material up to date. The investigations of H. Tollin (40 separate articles in various journals, 1874 to 1885) have thrown much light, mixed with some con-

jecture. The records of the Geneva trial, first published by De la Roche, reproduced in Rilliet's *Relation* etc. (1844), and elsewhere, are best given in vol. viii. (1870) of the *Corpus reformatorum* edition of Calvin's works; Roget's *Hist. du peuple de Genève,* vol. iv. (1877), has a good account of both trials. The passage on the pulmonary circulation, first noticed by W. Wotton, *Reflections upon Anc. and Mod. Learning* (1694), has given rise to a literature of its own; *see,* especially, Tollin, *Die Entdeckung des Blutkreislaufs,* etc. (1876); Huxley, in *Fortnightly Rev.* (Feb. 1878); Tollin, *Kritische Bemerkungen über Harvey und seine Vorgänger* (1882). Other physiological speculations of Servetus are noted by G. Sigmond, *Unnoticed Tlteories of Servetus* (1826). The best study of Servetus as a theologian is Tollin's *Lehrsystem M. Servets* (3 vols., 1876–78); Piinyer's *De M. Serveti doctrina* (1876) is useful. From a Unitarian point of view, Servetus is treated by R. Wright, *Apology* (1807); W. H. Drummond (1848); R. Wallace, *Antitrin. Biog.* (1850); J. S. Porter, *Servetus and Calvin* (1854). E. Saisset, *Rev. des deux Mondes* (1848), treats Servetus as a pantheist; he is followed by Menendez Pelayo, *Los Heterodoxos españoles* (1880, vol. ii.), and by R. Willis, *Servetus and Calvin* (1877, *cf.* A. Gordon, *Theol. Rev.,* April and July 1878). Oi Servetus's personal character the best vindication is Tollin's *Characterbild M. Servets* (1876); *see* also A. Dide, *M. Servet et Calvin* (1907); W. Osler, *Michael Servetus* (N.Y., 1909); J. van der Erde, *M. Servet* (Amsterdam, 1909); A. Gordon, *The Personality of M. Servetus* (1910), and *Servetus and the Spanish Inquisition* (1925). His story has been dramatized by Max Ring, *Die Genfer* (1850), by José Echegaray, *La Muerte en los Labios* (1880), by Albert Hamann, *Servet* (1881), and by Prof. Shields, *The Reformer of Geneva* (1897). (A. Go.; X.)

SERVICE, ROBERT WILLIAM (1874–1958), Canadian poet and novelist, n-as born at Preston. Eng.. on Jan. 16. 1874, and educated at Hillhead public school. Glasgow. He went in 1894 to Canada and settled for a short time on Vancouver Island. He entered the Canadian Bank of Commerce in Victoria. B.C., and was afterward transferred first to White Horse in the Yukon and then to Dawson. In all he spent eight years in the Yukon and travelled widely. During his last years with the bank. he wrote verse describing life in the north. notably *Songs of a Sourdough* (190;) and *Ballads of a Cheechako* (1909). In 1910 appeared a novel, *The Trail of '98,* giving a vivid description of men and conditions in the Klondike. During the Balkan War of 1912–13, Service was war correspondent to the *Toronto Star.* He served this paper in the same capacity during World War I, in which he spent two years as an ambulance driver in the Canadian army medical corps. He described his war experiences in *Rhymes of a Red Cross Man* (1916). He remained in Europe until 1940, when he returned to Victoria. His other works include *Rhymes of a Rolling Stone* (1912): *Ballads of a Bohemian* (1920); and *The Roughneck* (1923).

Service died at Lancieux. France on Sept. 11, 1958.

SERVICE TREE (*Sorbus domestica*), a native of the Mediterranean region, not infrequently planted in southern Europe for its fruit. It has been regarded as a native of England on the evidence of a single specimen. which probably was planted, now existing in the forest of Wyre. The tree is seldom productive until it has arrived at a goodly size and age. The fruit has a peculiar acid flavour and, like the medlar. is fit for use only when kept until "bletted," *i.e.,* partially rotten. There is a pear-shaped variety. *pyrifera,* and also an apple-shaped variety. *pomifera,* both of which may be propagated by layers and. better. by grafting on seedling plants of their own kind. The fruit is sometimes brought to market in winter. The service is nearly allied to the mountain ash. *Sorbus aucuparia,* which it resembles in having regularly pinnate leaves. *S. torminalis* is the wild service, a small tree occurring in woods and hedges from Lancashire southwards; the fruit is sold in the country markets.

SERVITES or **"SERVANTS OF MARY,"** an order under the rule of St. Augustine, founded in 1233. In this year seven merchants of Florence. recently canonized as "the seven holy Founders." gave up their wealth and position. and with the bishop's sanction established themselves as a religious community on Monte Senario near Florence. They lived an austere life of penance and prayer. and being joined by others. they were in 1240 formed into an order following the Augustinian rule supplemented by constitutions borrowed from the Dominicans. Soon they were able to establish houses in various parts of Italy. France. Germany and Spain. The most illustrious member of the order and its chief propagator and organizer was St. Filippo Benizzi, the fifth general, who died in 1285. The order received papal approbation in 1255; in 1424 it was recognized as a Mendicant order, and in 1567 it was ranked with the four great orders of Mendicant friars.

BIBLIOGRAPHY.—The chief work on the Servites is the *Monumenta* by Morini and Soulier, 1897, etc. Max Heimbucher, *Orden u. Kongregationen* (1907), ii. § 73; Wetzer u. Welte, *Kirchenlexicon* (2nd ed.); the *Catholic Encyclopaedia;* Herzog-Hauck, *Realencyklopadie* (3rd ed.). The most interesting part of Servite history is told by P. Soulier, *Vie de S. Philippe Benizi* (1886). (E. C. B.)

SERVITUDE, a right over the property of another. In Roman law, servitudes were classified into (1) personal and (2) praedial. (*See* ROMAN LAW.)

The term "servitude" is in use in Scots law and in other systems which have been much influenced by Roman law. For the English law, *see* EASEMENT.

SERVIUS (fl. *c.* A.D. 400), whose other names sometimes appear in manuscripts as Marius or Maurus and Honoratus, was a Latin grammarian, commentator and teacher and author of a valuable commentary on Virgil. As an *adulescens* he was one of the speakers in the *Saturnalia* of Macrobius (*q.v.*) and at least the greater part of his life was spent in Rome.

His commentary on Virgil is extant in two versions, a longer and a shorter. The longer and anonymous version, first printed in 1600 in an edition by Pierre Daniel, consists of Servius' own work —somewhat altered—in which he sought to meet the needs of schools and paid special, but not exclusive, attention to grammatical and stylistic points. With it are incorporated some valuable additions, in the main from a commentary—perhaps those parts of the commentary by Aelius Donatus which were not used by Servius —which mostly concern Virgil's rhetoric, mythology and subject matter. These are a precious source of knowledge about Roman antiquities. They presuppose that Virgil had an exact knowledge of ancient Roman customs and institutions.

Servius was a pagan, convinced that Virgil represented the highest truth. He was a learned man and a capable verbal expositor; but he was not a literary critic. His work is interesting as an example of 4th-century exegesis for schools.

An *explanatio in artem Donati* and three unimportant works— *De centum metris, De finalibus* and *De metris Horatii*—also go under Servius' name.

BIBLIOGRAPHY.—Modern editions of the Virgilian commentary by G. Thilo (1881–1887); E. K. Rand *et al.,* vol. 2 (1946). For minor works *see* H. Keil, *Grammatici Latini,* vol. iv (1864). *See* also E. Thomas, *Essai sur Servius et son commentaire sur Virgile* (1880); Pauly-Wissowa, *Real-Encyclopadie der classischen Altertumswissenschaft,* ii, 2, col. 1834–1848 (1923). (G. B. A. F.)

SERVIUS TULLIUS, sixth legendary king of Rome (578–534 B.C.). According to one account he was the son of the household genius (Lar) and a slave named Ocrisia, of the household of Tarquinius Priscus. He married a daughter of Tarquinius and succeeded to the throne by the contrivance of his mother-in-law, Tanaquil, who was skilled in divination and foresaw his greatness. Another legend, alluded to in a speech by the emperor Claudius (fragments of which were discovered on a bronze tablet dug up at Lyons in 1524), represented him as an Etruscan soldier of fortune named Mastarna, who attached himself to Caeles Vibenna (Caelius Vivenna), the founder of an Etruscan city on the Caelian Hill (*see* also Tacitus, *Annals,* iv. 65). An important event of his reign was the conclusion of an alliance with the Latins, whereby Rome and the cities of Latium became members of one great league. His reign of forty-four years was ended by a conspiracy headed by his son-in-law, Tarquinius Superbus.

Servius was regarded as the originator of a new classification of the people, which laid the foundation of the gradual political enfranchisement of the plebeians (for the constitutional alterations with which his name is associated, *see* ROME: *Ancient History*).

For a critical examination of the story *see* Schwegler, *Römische Geschichte,* bks. xvi., xvii.; Sir G. Cornewall Lewis, *Credibility of early Roman History,* ch. xi.; W. Ihne, *History of Rome,* i.; E. Pais, *Storia di Roma,* i. (1898); and *Ancient Legends of Roman History* (Eng. trans., 1906); C. Pascal, *Fatti e legende di Roma antica* (Florence, 1903); also O. Gilbert, *Geschichte und Topographie der Stadt Rom im Altertum* (1883–85), and J. B. Carter, *The Religion of Numa* (1906), on the reorganization of Servius.

SERVOMECHANISM, a device which tends to position an object in accordance with the command given by an arbitrarily varying position indicator capable of supplying only a small amount of power. The operation of a servomechanism is dependent upon the difference between the actual position of the object and the desired position. The servomechanism acts to reduce this difference, called the error, despite disturbing influences. A common example is the automatic pilot in which a signal indicating the actual direction and height of the aircraft is compared with a signal indicating the desired direction and height; any difference actuates ailerons and rudder to position the aircraft onto the desired course.

Most servomechanisms do not rely on human beings to carry out their function. A simple servomechanism in which a human being is involved, however, serves to illustrate all the essential elements. When an operator drives a car he becomes part of a servomechanism whose object is to keep the actual path of the automobile following the desired path, the road. As the road changes direction and the desired path of the car changes, the operator senses any difference between the actual path of the car and the desired path. His eyes detect any existing errors, his brain signals his muscles to act and by means of the steering mechanism of the automobile he corrects the actual path to coincide with the desired path. He is able to do this despite disturbing influences in the form of wind or ruts that might try to force the car's direction from the desired path. Even this simple system does not always respond in the same way. For example, drivers have different reaction rates in the detection of errors and apply different magnitudes of correction for the same deviation from the desired path. Automobiles differ in their responses, too, depending upon the steering ratio and size of the load in the car. Actual malfunction of the apparatus, such as that caused by backlash in the steering mechanism or by soft tires, influences the accuracy with which the path is maintained. These analogies also find their counterparts in completely automatic systems.

The need for servomechanisms arises because man is limited in his ability to perceive errors swiftly and precisely enough, to use his muscles to correct them fast enough and to exert enough power to control the enormous masses often involved. Servomechanisms are also used to relieve man of the drudgery of many tasks; they operate tirelessly and, when functioning properly: with great accuracy and smoothness. They are capable of amplifying signals of no more power than the light from a star to the hundreds of horsepower necessary to control large masses.

Applications. — There are many practical applications of servomechanisms: one is the automatic pilot mentioned earlier, another is in the field of machine tools, particularly those used to duplicate the contours of a piece with rounded surfaces of different radii, such as an aircraft propeller. In this application, the master pattern is clamped beside the piece of raw metal from which a replica is to be made. The servomechanism positions a metal-cutting tool in accordance with the movement of a stylus that is passed over every part of the surface of the master pattern while the tool cuts away unnecessary metal. The master pattern can be made of some material more easily worked by hand tools than the metal from which the final replica is made.

Many applications of servomechanisms involve military devices. Numerous interconnected servomechanisms are utilized in tracking and firing on an enemy airplane that is invisible to observers at a missile emplacement below. A radar antenna is pointed toward the airplane guided by servomechanisms that detect any slight angular difference between the direction the antenna is pointing and the location of the airplane. Given the location and rate of travel of the aircraft, as shown by the angular speed of the radar antenna, automatic computers can predict the probable path of the aircraft and the proper direction for a missile to be fired to intercept this path; other servomechanisms are then used to position the missile launcher properly. All of this is accomplished without any human intervention.

Automatic Feedback Control. — Servomechanism systems or follow-ups, as they are sometimes called, are important tools in the field of engineering known as automatic feedback control or automatic regulation, serving that portion of the field concerned with controlling the position of an object. The systems have wide industrial uses in such tasks as the control of pressure, flow, liquid level, temperature, and many combinations of these in such industries as oil refining, chemical production and food processing.

Automatic feedback control of the more general sort is older in application; indeed, nature has utilized this phenomenon for the control of many functions of the human body. There is a body-temperature regulator; if there were none, the heat produced in 20 min. of muscular effort would cause the albuminous substances in the blood to harden like the white of a hard-boiled egg. At the slightest rise in body temperature, a series of operations goes into effect: the blood vessels dilate and constrict, diverting blood from the internal organs to the surface; blood volume is increased by dilution with fluid drawn from the tissues, thus producing further cooling; sweat glands produce more perspiration; the flow of blood is increased by more rapid pumping of the heart; and the respiratory rate increases to provide more air to the lungs. In addition, if there were no acidity regulator, the lactic acid produced from such muscular effort would upset the acidity of the blood and cause convulsions and death.

Common feedback control devices include the household thermostat, the speed governor on a household mixer, the temperature control in an electric iron and the pressure regulator in a household pressure cooker. Such devices are unified with servomechanisms by a common theory of operation even though they are concerned with the control of temperature or pressure rather than position. They all involve a closed loop of causal action; *i.e.*, the existence of an error causes the device to attempt a correction of the error. The result of this correction changes the error which in turn causes the device to act again. In actual operation these actions take place continuously and instantaneously. The only reason an error exists at all in a servomechanism is because the desired state or output is constantly changing and external influences are also tending to change the actual state of the object.

The principal measure of the excellence of performance of a servomechanism is the accuracy with which the output is positioned relative to its desired value; in other words, whether or not the error is within tolerable bounds. A consequence of this requirement is that the system be stable; *i.e.*, that the output not oscillate or "hunt" about its desired value.

These requirements can be illustrated by the example of a large ship at sea being steered in accordance with a desired heading. Assume first that a helmsman is in control whose job is to detect the difference between the actual heading of the ship, as given by a compass reading. and the desired heading, as given by orders from the captain. He is required to do this despite the disturbing influences of wind and waves, the hydrodynamic effect of the water through which the ship is passing and ocean currents that might tend to force the ship from the desired direction. If an error exists, the helmsman rotates his wheel; the ship slowly responds in accordance nith his signal, reducing the error. A considerable amount of turning momentum is built up in this process and an inexperienced helmsman may not realize this until the error is reducing rapidly to almost zero. Seeing that the ship is turning through the proper heading, he applies the opposite rudder in an attempt to once again bring the error to zero. The ship slowly responds to his signal again and eventually builds up a considerable amount of momentum to rotate it in the correct direction and reduce the error. The course of the ship might again overshoot its desired course and this process could continue indefinitely unless the skill of the helmsman improved.

Helmsmen learn with experience, however, that small errors should be met with small corrections. They also learn that after they have introduced a. rudder angle to correct an error, they must anticipate the tendency to overshoot and bring the rudder back to zero more swiftly than otherwise, or even apply a reverse rudder as the error reduces. By skillful application of this proportionate control and realization of the fact that the error is rapidly reducing and that something must be done before it reaches zero, a pilot may become very skilled, the oscillations practically nonexistent and the accuracy of the heading maintained despite external influences. An automatic pilot, which supplants the human pilot in a ship or aircraft, has the same problems and if properly designed can apply corrections in the same manner as the skillful human pilot.

Basic Components. — Every servomechanism consists of certain basic elements that combine to perform the functions described in the given examples. First of all. there must be an error detector. some device for detecting and measuring the difference between the desired position of an airplane, for example, and its actual position. There must also be a means of controling the source of power, involving some method of amplifying what may be a tiny signal from the error detector to sufficient power to operate the next element in the chain, the prime mover. In the case of the airplane, the prime mover might be an electrical-hydraulic system acting on ailerons and rudder to correct the position of the airplane and bring it into coincidence with the desired position. There must also be some means of modifying the performance of these devices in order to achieve the desired stability and accuracy.

These. then, are the essential elements of any servomechanism. When a human agency is involved, the methods of detection of the error are often the eyes and the brain. A man might also provide some or all of the muscular power needed to move the object to its desired position. His skill, experience and the fineness and swiftness with which he can move his hands cause him to supply corrections of the proper amount with proper anticipation in order to prevent oscillations. He may thus achieve the desired performance of stability and accuracy.

In the design of inanimate servomechanisms. components are carefully chosen for their desired application. The error is often detected in electrical form by means of potentiometers or rheostats nhich can give a voltage signal proportional to the angular difference between their shaft positions. In the case of the automatic pilot aboard ship, the shaft of one of the potentiometers is connected to the ship's compass, the shaft of the other is attached to a dial upon which the desired course can be indicated The difference between these angular positions of the two shafts appears as an electrical voltage that can be used to control the rudder. Other error-detecting devices rely on magnetic coupling of their parts to produce a voltage proportional to the error.

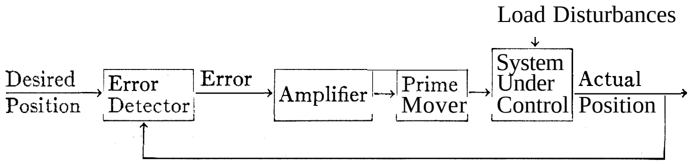
The means used to control the source of power involves amplification which can be electrical, electronic, hydraulic. mechanical or a combination of these.

A prime mover supplies the muscles which actually move the object to its desired position. If this object has a small mass, such as in computers or other type instrument applications. the pomer of the prime mover need not be large, and is commonly a small electric motor. On the other hand, if the mass involved is several hundred tons, a large electric motor or large hydraulic pump and motor might be used to position the mass.

To make the servomechanism satisfactorily stable, some kind of process that damps any oscillations must be employed. Damping can be achieved electrically by the introduction of networks in the electronic amplifier or by feeding back into the amplifier a signal from a generator or other device that measures the speed of the object being positioned. Knowing the speed with which an object is approaching the zero error position, the amplifier can combine this information with a measurement of the size of the error and achieve stability in the same manner that the skilled helmsman anticipates the motion of the ship in response to his correcting forces.

Performance in a servomechanism is measured by comparing its accuracy to the accuracy required of the system in which it is to be used. Some systems do not require a high order of accuracy and may be required to follow desired angular motions; only within an accuracy of 1°. However other applications such as the positioning of optical mirrors in gunfire control may require the mirrors to be aimed within one minute of arc, $\frac{1}{21,600}$ part of a circle. For such an application, the components of the system have strict requirements. For one thing, the error detector must be extremely accurate because the servomechanism is relying upon the error detector as its only means of knowing of an existing error in the position of the mirrors. The amplifier must likewise be capable of amplifying very minute error signals without distortion. These signals are very small because the servomechanism, if it is performing its job well, has a very small error and hence the signal from the error detector which is proportional to the error is also small. The error signals must be amplified many thousand-fold to be large enough to control a source of power such as an electric motor; the motor must be extremely responsive to signals from the amplifier. Some of the gearing used to connect the high-speed shaft of the motor to the relatively low-speed shaft of the mirror must be of a high order of accuracy so as not to introduce error into the system. Ingenious stabilizing devices must be used if the mirror is to follow its desired angle accurately and without oscillation.

Analysis **and** Design. — The analysis and design of servomechanisms is often carried out by the use of a block diagram which allows the designer to think more readily in terms of operational characteristics of the system rather than of the wires. vacuum tubes, hydraulic components and other elements involved in it. The block diagram is a graphical representation of the flow of information and the functions performed in the system. The designer can draw the block diagram by studying the operation of each element in order to recognize its function and by analyzing the relationship of the elements to learn how the information flows between them.



Block diagrams are also useful in learning about the fundamentals of servomechanisms. In the accompanying diagram, there are two bits of information of concern: the desired position of the object under control and its actual position. These two kinds of information flow into the error detector nhose function is to measure their difference and convert it into a usable form. The signal emanating from the error detector is the error; this is fed into the amplifier and then to the prime mover to effect the proper position of the system under control.

From such a block diagram, it is easy to see the closed loop of causal action in nhich continuous correction is taking place to reduce the error. It is also seen that any modification of the characteristics of any element in the chain can cause modification of the operation of the entire system. More complicated servomechanisms might be represented by block diagrams having many interconnected loops in which information is fed from various portions of the system to other elements.

In addition to experimental techniques, a number of mathematical methods are used to analyze and design servomechanisms. The most commonly employed are the applications of differential equations and the use of operational calculus and frequency-response studies. While mathematics does not give the final answer and adjustments must always be made experimentally, the use of mathematical analysis can greatly shorten the time required to design a servomechanism and indicate the characteristics of components necessary to achieve the required accuracy.

To solve a problem in servomechanism design or analysis, simultaneous differential equations are written relating the various signals in the servomechanism loop. These can then be solved by any of the standard techniques. Often the servomechanism is a linear one or can be considered so for the purpose of analysis. Under these conditions, the solution of the differential equations involves the elementary techniques for solving linear differential equations with constant coefficients *(see* DIFFERENTIAL EQUATIONS, ORDINARY).

A more flexible approach employs the use of operational calculus, the most popular form of which is the Laplace transformation. This enables derivatives, integrals and trigonomic functions to be expressed algebraically in terms of functions of a complex variable. Such a technique permits the dynamics of elements of a servomechanism to be described in terms of algebraic quantities called transfer functions. The characteristics of the whole system are. therefore, simply the combination of the transfer functions of each of the various elements. The designer can then consider the characteristics of each element separately and how each affects the performance of the entire servomechanism loop.

The most flexible technique of design analysis is the use of frequency-response studies. In such a method of analysis, a study is made of the response of each element of the system to sinusoidal signals whose frequencies vary from zero to infinity. When the response to these signals is known. the performance of the servomechanism can be predicted for any type of variation of the desired position or load disturbances after the methods of Fourier. The use of this method of analysis permits the servomechanism designer to utilize the entire field of functions of a complex variable nhich enables the stability and accuracy of the system to be predicted and the characteristics of any necessary corrective networks to be set forth.

In addition to the problem of performance of servomechanisms. there are other requirements which are of concern to the user. These include the expected life of the apparatus. its serviceability, its reliability under all operating conditions, the norkmanship of its manufacture, restrictions on materials that can be used and economic considerations. There might be other requirements as well concerning the weight, size and resistance to shock and vibration of the servomechanism. Other constraints on the designer are the type of electrical power available. its voltage and frequency variations and the temperature and atmospheric conditions surrounding the servomechanism. All these factors together with the mathematical considerations given above. give some hint of the complexity of servomechanisms and their design.

See also AUTOMATION; INFORMATION THEORY. (W. R. AH.)

SESAME (*Sesamum indicum*) (family Pedaliaceae) was one of the first oilseeds grown by man. It probably originated in eastern Africa and later spread to most of the tropical. subtropical and southern temperate zone areas of the world. Sesame is an erect annual plant of many types and varieties. Depending to some degree on the conditions of growth, varieties grow from two to ten feet tall with growth cycles of two to six months; some have branches, others none. One to three attractive flowers (and seed capsules) are born in the leaf axils. Flowering begins as early as six weeks after planting, continuing until maturity. The white or black seed contains from 45% to 63% edible oil and from 16% to 32% protein. The oil is noted for its stability (resistance to oxidative rancidity), and the meal remaining after oil extraction is a rich source of protein (especially the amino acid methionine), calcium, phosphorus and the vitamin niacin.

FROM KOEHLER "MEDICINAL PLANTS"

SESAME (SESAMUM INDICUM)
(A) Flower after removal of corolla and calyx; (B) Longitudinal section of flower; (C) & (D) Seeds of white and black varieties: (E) Ripe fruit

Sesame is used as a salad or cooking oil, in shortening and margarine and as a carrier for fat-soluble pharmaceuticals. The whole seed is used in a wide variety of confections and as a garnish for bakery goods. In normal sesame, capsules open (dehisce) when dry. allowing the seed to shatter. making necessary considerable hand labour in harvest to prevent seed loss. Discovery of an indehiscent (nonshattering) mutant in 1943 led to the possibility of complete mechanized production of this crop. (M. L. K.)

SESOSTRIS, the name of a legendary king of Egypt. According to Herodotus, Diodorus Siculus (who calls him Sesoosis) and Strabo, he conquered the whole world, even Scythia and Ethiopia. divided Egypt into administrative districts or nomes, was a great lawgiver, and introduced a system of caste and the worship of Serapis. He has been considered a compound of Seti I and Rameses II, belonging to the 19th dynasty. In Manetho, however, he occupied the place of the second Senmosri (formerly read Csertesen) of the 12th dynasty, and his name is now usually viewed as a corruption of Senwosri. So far as is known no Egyptian king penetrated a day's journey beyond the Euphrates or into Asia Minor, or touched the continent of Europe The kings of the 18th and 19th dynasties were the greatest conquerors that Egypt ever produced. and their records are clear on this point. Senwosri III raided south Palestine and Ethiopia, and at Semna beyond the second cataract set up a stele of conquest that in its expressions recalls the steles of Sesostris in Herodotus. Sesostris may, therefore, be the highly magnified portrait of this pharaoh. Khian, the powerful but obscure Hyksos king of Egypt, whose prenomen might be pronounced Sweserenre, is perhaps a possible prototype, for objects inscribed with his name have been found from Baghdad to Cnossus. Sesostris is evidently a mythical figure calculated to satisfy the pride of the Egyptians in their ancient achievements, after they had come into contact with the great conquerors of Assyria and Persia.

SESSA AURUNCA, a town and episcopal see of Campania, Italy, in the province of Caserta, on the southwest slope of the extinct volcano of Roccamonfina, 27 mi. W.N W of Caserta by rail and 20½ mi. E of Formia by the branch railuay to Sparanise, 666 ft above sea level. Pop. (1951) 5,396.

It is situated on the site of the ancient Suessa Aurunca, on a small affluent of the Liri. The town contains many ancient remains, notably the ruins of an ancient bridge in brickwork of 21 arches. of substructures under the church of S. Benedetto. of a very large cryptoporticus, belonging probably to a gymnasium, and of an amphitheatre. The Romanesque cathedral is a basilica with a vaulted portico and a nave and two aisles begun in 1103, a mosaic pavement in the Cosmatesque style. a good ambo resting on columns and decorated uith mosaics showing traces of Moorish influence.

The ancient chief town of the Aurunci. Aurunca or Ausona, is believed to have lain on the narrow southwestern edge of the extinct crater of Roccamonfina (3.297 ft). Here some remains of Cyclopean masonry exist; but the area enclosed is too small for anything but a detached fort of a time prior to Roman supremacy In 33i B.C. the town was abandoned in favour of the site of the modern Sessa In 313 a Latin colony under the name Suessa Aurunca was founded here.

See G. Tomassino, *Sessa Aurunca e i suoi avanzi archeologici* (1925).

SESSION, the period or time that a legislature, court or council meets for business, whether for the day or for the full term. A session of the British parliament is reckoned from its assembling until prorogation; usually there is one session each year. The congress of the United States similarly meets in session once a year the duration of each congress being two years. Since 1933 each session convenes on the third of January and adjourns at pleasure. This system, established by the 20th amendment, replaced that of long sessions meeting in December of odd-numbered years and adjourning normally in the following summer and of short sessions meeting in December of'even-numbered years and adjourning normally the following March 3, The president may call an extraordinary session at any time. Frequency and length of state legislative sessions vary greatly.

The term session is also applied to the sittings of various judicial courts, especially criminal. The sittings of the justices of the peace or magistrates in Great Britain are "sessions of the peace." *i.e.*, quarter sessions or "petty sessions." In the United States a court of general or special sessions is a local criminal court for lesser offences. The supreme court of Scotland is termed the "court of session." (See COURT.) The name is also given in the Presbyterian Church to the lowest ecclesiastical court.

SESTETT, the name given to the second division of a sonnet, which must consist of an octave, of eight lines, succeeded by a sestett, of six lines. In the usual course the rhymes are arranged *abc* | *abc,* but this is not necessary. Early Italian sonnets, and in particular those of Dante. often close with the rhyme arrangement *abc* | *cbn.* In the quatorzain, there is properly speaking no sestett, but a quatrain followed by a couplet. as in the case of Shakespeare's sonnets. Another form of sestett has only two rhymes. *ab* | *ab* · *ab;* as in Gray's sonnet "On the Death of Richard West." The sestett should mark the turn of emotion in the sonnet; as a rule it may be said that the octave having been more or less objective. in the sestett reflection should make its appearance, with a tendency to the subjective manner.

Wordsworth and Milton are both remarkable for the dignity with which they conduct the downward wave of the sestett in their sonnet. The French sonneteers of the 16th century. with Ronsard at their head. preferred the softer sound of the arrangement *aab* | *ccb* .

SESTINA, a most elaborate form of verse, employed by the medieval poets of Provence and Italy, and occasionally used by modern poets. The scheme was the invention of the Provencal troubadour. Arnault Daniel. who wrote many sestinas. Dante. a little later, wrote sestinas in Italian. In the De *vulgari Eloquentia,* Dante admits that he imitated Xrnault.

The sestina. in its pure medieval form. consists of six stanzas of six lines each of blank verse: hence the name. The final words of the first stanza appear in varied order in all the others. the order laid down by the Provençals being: *abcdef, faebdc, cfdabe, rcbjad, deacfb, bdfeca.*

After these stanzas followed a *tornada,* or *envoi,* of three lines. in which all the six key words were repeated in the middle and at the end of the lines in the following order: *b-e, d-c, f-a.* Petrarch cultivated a slightly modified sestina, but later the form fell into disuse, until it was revived by the poets of the Pleiade, in particular by Pontus de Tyard. In the 19th century. it was assiduously cultivated by the comte de Gramont. who. between 1830 and 1848. wrote a large number of examples, included in his *Chant du passe'* (1854).

A sestina in English was published in 1877 by Edmund Gosse; this was in the style of Daniel. It was subsequently frequently employed by English and American writers, particularly by Swinburne. who composed some beautiful sestinas on the French pattern: of these. that beginning "I saw my soul at rest upon a day" is perhaps the finest specimen in English. Swinburne's astonishing tour de force, "The Complaint of Lisa," is a double sestina of 12 stanzas of 12 lines each. The sestina was cultivated in Germany in the 17th century. particularly by Martin Opitz and Georg Weckherlin. In the 19th century an attempt was made, not without success, to compose German sestinas in dialogue, or eveqdouble sestinas. (G. W. A.; X.)

SETE (CETTE), a seaport of southern France in the *département* of Hérault. and the principal commercial port on the south coast after Marseilles. lies 322 km. (200 mi.) S. by W. of Lyons and 123 km. (76 mi.) S.W. of Avignon by road. Pop. (1954) 32,-865. The older part of the town occupies the foot and slope of the isolated Mont St. Clair (175 m.; 574 ft.). on a tongue of land between the Mediterranean and the large lagoon of Thau (7.500 ha, or 29 sq.mi.). This quarter is bounded on the east by the Canal de Sète, which leads from the lagoon to the outer harbour. Between this canal and the Canal Maritime are two islands divided by a wet dock; the two canals are joined at the north by the Canal Latéral. A huge breakwater protects the entrance to the harbour. and a south mole and east jetty enclose the Old basin (the fishing harbour) and the outer harbour, At the outer end of the Canal Maritime are the New and hiediterranean basins, and the oil basin from which refined oil products from Frontignan are exported by pipeline. Damage done during World War II has been repaired. Facilities for the bulk discharge and storage of wine are extensive. with mechanical loading and unloading of wine through 50 pipelines. and Sète is probably the world's foremost wine port. Export and import traffic increased from 1.630.000 tons in 1938 to more than 4.000.000 tons in the early 1960s. There is a fishing industry and shellfish are intensively cultivated in the lagoon. On one island is a marine biological station. Local industries include chemical products. phosphates and cement, and the manufacture of spirits and vermouths. Sète is well served by sea, rail and road. A sandy bathing beach stretches for about 9 mi. S.W. to Agde. Sète has become a considerable tourist resort. with many festivals including the ancient sport of water jousting.

The port was created in 1666 on the instructions of Colbert, minister of Louis XIV, and laid out according to plans made by Paul Riquet; its development was aided by the opening of the Canal du Midi later in the century. The present form of its name was fixed in 1927. Paul Valéry, the poet, was born and is buried in Sète, and a hall of the municipal museum is named after him.

SETEKH (SET). Egyptian god, originally the local deity of the town of Ombos in upper Egypt. Ombos' early political importance probably gave Set his role and title of "Lord of Upper Egypt." He became a rival of the sun-god Horus and, as a god of clouds and storm, entered with him into the myth of Osiris, the god of vegetation *(see* HORUS). With the expansion of Osirian belief, Set became evil personified, and both his name and his cult were proscribed. (J. CY.)

SETH (SHETH), one of the sons of Adam and Eve. According to the Priestly source he was the eldest son (Gen, v. 3: *cf.* also I Chron. i. I and Luke iii. 38). The main tradition of the Yahwist source. on the other hand. makes Cain the firstborn son and Seth the third (Gen. iv. 25). Num. xxiv. 17, the Moabites are called "sons of Sheth"; this may be due to confusions with the Sutu of the cuneiform records. a nomad people of the north Syrian desert. Seth is much more prominent in Jewish tradition than in the Old Testament and many fancies gathered around the name. In the Old Testament it is said of him only that he was the father of Enosh and other children.

SETON (*Family*). The Scottish family of Seton. Seyton or Seatoun. claims descent from a Dougall Seton who lived in the reign of Alexander I. The family honours include the earldoms of Wintoun (cr. 1600) and Dunfermline; of Eglinton through marriage with the hiontgomeries; and through alliance with a Gordon heiress a Seton became the ancestor of the earls and marquesses of Huntly and dukes of Gordon. The Setons were connected by marriage with the royal family of Scotland, and also with the Dunbars. Lindsays. Hays and Maitlands.

Sir Christopher Seton, son and heir of John de Seton. a Cumberland gentleman, and his wife Erminia Lascelles. was born probably in 1278. and came into his inheritance in 1299. He had married about 1301 Christian Bruce, sister of King Robert. who n-as possibly his second cousin. He was present at his brother-in-lax's coronation at Scone in 1306. and saved his life at thc battle of Methven later in the same year. According to Dugdale he shut himself up in Lochdoon castle in Ayrshire. and on the surrender of that castle was hanged as a traitor at Dumfries by order of Edward I. He left no heirs. His widow was in March 1307 in receipt of three pence a day from Edward I. for her support at the monastery of Sixhill in Lincolnshire. She was afterwards placed in the custody of Sir Thomas de Gray. His Cumberland estates. with the exception of his mother's dower, were given to Robert de Clifford. Xnother Seton. John de Seton, described as having no lands or chattels, was hanged for helping in the defence of Tibbers castle, and for aiding in the murder of John Comyn. with other prisoners of war, at Newcastle in August 1306.

Sir Alexander Seton (d. *c.* 1360) was probably the brother of Sir Christopher. He received grants of land from King Robert Bruce, and was one of the signatories of the letter addressed by the Scottish nobles to the pope to assert the independence of Scotland. He was tn-ice sent on embassies to England. and in 1333 he defended the town of Berwick against the English. He agreed with the English to surrender the town on a certain date unless he received relief before that time. giving his eldest surviving son Thomas as a hostage. On the refusal of the Scots to surrender at the expiry of the term Thomas Seton was hanged in sight of the garrison. This incident is related by Fordun and Boece, but with inconsistencies that have rendered it suspect. An elder son, Alexander, had perished in 1332 in opposing the landing of Edward Baliol; according to some authorities the third son. William. was hanged with his brother, but he is generally said to have been drowned during the siege; his daughter Margaret married Alan de Wintoun. The tragic death of young Thomas Seton was the subject of a ballad of "Seton's Sons," printed in Sheldon's *Minstrelsy of the Scottish Border;* of a tragedy, *The Siege of Berwick* (1794. printed 1882) by Edward Jerningham, and of another by James Miller (1824).

Sir William Seton of Seton (fl. 1371–1393) is said to have been ennobled with the title of Lord Seton, and his heirs laid claim that the barony of Seton was the oldest in Scotland. By his wife Catherine Sinclnir he had eight children. John succeeded him; Alexander married Elizabeth, daughter and heiress of Sir Adam de Gordon, by whom he became the ancestor of the Gordons of Huntly.

Sir John of Seton (d. *c.* 1441) was taken prisoner at Homildon hill in 1402. He was hostage in England for the earl of Douglas in 1405, and again in 1423 for James I. He married Lady Janet Dunbar, daughter of the 10th earl of March. His son Sir William was killed at Verneuil, fighting on the French side, leaving as heir GEORGE (d. 1478), 1st Lord Seton, who was created a lord of parliament in 1448 as Lord Seton. By his first marriage with Margaret, daughter of John Stewart. earl of Buchan, he had a son John, who died during his father's lifetime. He was succeeded by his grandson GEORGE, 2nd Lord Seton (d. 1508), who was a scholar of St. Andrews and Paris, and in common report a necromancer. He was captured by the Flemings, and on his release fitted out and maintained a ship for the purpose of harassing Flemish travelers. His son GEORGE, 3rd Lord Seton, was killed at Flodden in 1513. He redeemed estates which his father had sacrificed to support his enterprises against the Flemings. By his marriage with Janet, daughter of Patrick Dunbar, 1st earl of Bothwell, he left a son GEORGE. 4th Lord Seton (d. 1549), who allowed Cardinal Beaton to escape from custody in 1543. and received considerable grants of land in the sequel. The castle and church of Seton were burnt by Hertford in revenge for the part he had taken against the English in 1544.

George, 5th Lord Seton (1530?–1585), n-as a Catholic and a firm friend of Mary, queen of Scots. He was present at her marriage with the dauphin in 1557, and three years later he was again in France. When Mary returned to Scotland he became privy councilor and master of the household, but four years later he again found it advisable to retire to France. Mary and Darnley spent their honeymoon at Seton palace, and Mary found a retreat there after the murder of Rizzio and again after the murder of Darnley. She spent the night before Carberry hill under Seton's roof, and he was waiting for her on her escape from Lochleven in May 1568. He took her to his castle at Xiddrie, Linlithgowshire. and then to Hamilton. A week later he was taken prisoner at Langside. He was set free after the assassination of the regent Moray, and made his way to Flanders. where he was said to have made his living as a wagoner. He was, in fact, entrusted by Mary's supporters with a misssion to the duke of Alva, and sought in vain to secure for service in Scotland two regiments of Scots then in Spanish pay. He returned home in 1571, being apparently reconciled with the government, but he retained his Catholicism and his friendship for Mary. who wrote to Elizabeth in 1581 desiring a passport for Lord Seton that he might alleviate her solitude. In 1581 he was one of Morton's judges, and in 1583 he was sent as ambassador to France. where he sought interference on Queen Mary's behalf. He died soon after his return on Jan. 8, 1585. The 5th Lord Seton figures in Sir Walter Scott's *Abbot.* He was succeeded by his second and eldest surviving son. Robert, who became 6th Lord Seton and 1st earl of Wintoun. His third son. Sir John Seton of Barns. was a gentleman of the bedchamber to Philip II of Spain. He was recalled to Scotland by James VI, and served as lord of session from 1587 to 1594.

Mary Seton, one of the "Four Maries" attendant on the queen, is supposed to have been the 5th Lord Seton's half-sister. She had been educated with Queen Mary in France, being about a year older than her mistress, with whom she returned to Scotland in 1561. She helped Mary to escape from Lochleven by assuming her clothes. Later on she joined her at Carlisle, and remained with her in her various prisons until 1583. when prison life had undermined her health and spirits. She died in poverty at the abbey of St. Pierre at Reims in 1614.

ROBERT SETON (d. 1603) succeeded his father as 6th lord in 1585, and was created earl of Wintoun in 1600. He married, about 1582. Margaret, eldest daughter of Hugh Montgomerie, 3rd earl of Eglinton. His sons Robert and George were successively earls of Wintoun; the third, Alexander, became, in right of his mother, 6th earl of Eglinton; the fourth, Thomas, was the ancestor of the Setons of Oliveston.

GEORGE, 4th earl of Wintoun (1640–1704), succeeded his grandfather. George Seton, 3rd earl, in 1650. He saw some service in the French army, and fought against the Covenanters at Pentland and at Bothwell Bridge. By his second marriage, with Christian Hepburn. he had a son George, who quarrelled with his father and is said to have been working as a journeyman blacksmith abroad when he succeeded to the title in 1704. In 1715 the 5th earl joined Kenmure with 300 men at Moffat. but it was against his advice that the Jacobite army invaded England. He was lying in the Tower under sentence of death when he succeeded in making his escape, and proceeding to the continent, he became well known in Rome, where he was grand master of the Roman lodge of freemasons. He died there in 1749. With him the earldom became extinct, but it was revived in 1840 in favour of the earls of Eglinton.

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SETON, ELIZABETH ANN (née BAYLEY) (1774–1821), foundress of the American Sisters of Charity, was born in New York city on Aug. 28. 1774. Her concern for the sick and poor early merited her the title of "a Protestant Sister of Charity." In 1794 she married William Seton who died in 1803 in Italy, where the family had gone for reasons of health. leaving her with five children. Left destitute in a foreign land, Mrs. Seton turned to the Filicchi family, old acquaintances, whose devotion was to eventually lead her into the Roman Catholic Church. Upon her return to the United States and after a great spiritual struggle, she was received into the Catholic Church in 1805. At the invitation of Father Louis G. B. Dubourg, she opened a grade school in Baltimore in 1809. Soon several young women were placed under her care; this led to the taking of simple vows as the "Sisters of St. Joseph." The community decided to take as its model the Sisters of Charity of St. Vincent de Paul. but it was not until 1812, after the community moved to Emmitsburg, Md., that the constitution and rules were formally adopted. Elizabeth. now known as Mother Seton, was named first superior but was allowed to remain legal guardian of her children. Mother Seton has been called the first of the American Catholic sister-school nuns, and the mother of the parochial school system of the United States, although hers was not the first Catholic grade school. She died Jan. 4, 1821. Her cause for beatification was introduced about 1907.

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(E. R. V.)

SETTEE: see CHAIR AND SOFA.

SET THEORY (THEORY OF AGGREGATES). Set theory was created, almost without forerunners and against the opposition of most leading mathematicians of the time, between 1874 and 1897 by Georg Cantor (1845–1918). Since the beginning of the 20th century it has developed enormously and gained ever-increasing recognition and importance in both mathematics and logic, being applied in almost all fields of mathematics in view of the set-theoretical analysis of general mathematical concepts such as number, correspondence, function, order, etc. This article deals with the theory of abstract sets; *i.e.*, sets without discrimination as to the nature of their members.

Two principal attempts were made to define the concept of set: (1) as an arbitrary collection of "definite and distinct" objects (Cantor); and (2) by "comprehension" of the objects satisfying a given property. Both proved to be too general and led to contradictions, the antinomies of set theory. Although Bertrand Russell showed that the antinomies were of. a logical or semantical rather than mathematical nature, a new foundation became imperative, The main direction taken involved restricting the extent of sets, either axiomatically or by silent limitation. The term "class" is used for extremely comprehensive sets, but, to avoid confusion with the logical concept of class, it will not be used here.

Fundamental Concepts.—The fundamental relation of set theory is membership: a is a member of the set s; in symbols, $a\epsilon s$. For insrance. 2 is the onlv member of the set of even prime numbers; 1.2.3, . . . are among the (infinitely many) members of the set of positive integers. In principle it is sufficient for the needs of mathematics to restrict the members of sets to sets only. because numbers. functions, points, etc.. may also be conceived as sets (see *Cartesian Product; Functions as Sets*, below). The principle of extensionality states that sets which have the same members are considered equal; hence the set s with the members $a,b,c,$ . . . may be denoted by $s = \{a,b,c, \ldots\}$. It is then presupposed that with respect to every object x, it shall be definite whether $x\epsilon s$ or not—which, however. need not be decided generally.

Other important concepts are subset. equivalence and order. In principle they can be reduced to the membership relation, but usually this is done for the subset relation only: s is a subset of t ($s \subset t$) if every member of s is also a member of t. Hence $t \subset t$ for every set t. If t has at least one member which does not belong to s, s is called a proper subset. To avoid the confusion prevailing up to the end of the 19th century, mathematicians say that a set contains its members. but comprises (includes) its subsets. Usually a subset of s is defined by a property P which is meaningful for the members of s, namely. as the set of those $x\epsilon s$ which satisfy P. For instance. from the set **I** of all positive integers and the property "prime" there is obtained the set of all prime numbers. which is a subset of **I**. If no member of s has the property, there must be admitted a set which contains no member, the empty set or null set. ϕ.

If there exists a one-to-one correspondence between the members of s and those of t, s is called equivalent to t, in symbols $s \sim t$; then also $t \sim s$, and $s \sim t$, $t \sim u$ together imply $s \sim u$ (transitivity). A set D which is equivalent to the set $\mathbf{I} = \{1,2, \ldots ,k, \ldots\}$ of all positive integers is called denumerable (or countable); denoting by d_k the member of D which corresponds to the integer k, D can be written in the form

$$D = \{d_1,d_2,\cdots d_k,\cdots\}$$

The set of all positive integers **I** as such is a plain set. but it becomes an ordered set when a succession (order) of its members is introduced. subject to the conditions that for any two different members one and only one precedes the other and that this order relation is also transitive. Possible orders of **I** are; for instance. (1,2,3, . . .), (. . . ,3,2,1), (1.4.7,. . . 2.5,8, . . . 3,6,9, . . .). The parentheses indicate that the order has to be observed. An ordered set is said to be well-ordered if every (ordered and nonempty') subset has a first member. Accordingly. among the ordered sets above, the first and the third are well-ordered hut not the second, because the subset of all odd integers, as well as the set itself, has no first member.

If between the members of the ordered sets m and n there exists a one-to-one correspondence such that if a precedes b in m, also the image of a precedes the image of b in n, m and n are called similar ($m \simeq n$). None of the above ordered sets is similar to another, although, conceived as plain sets, they are equivalent and even equal. . Yet. for instance, $(1,2,3, \ldots) \simeq (2,4,6, \ldots)$.

Comparability: Transfinite Induction.— The enormous importance of the well-ordered sets, both for set theory itself and for its applications, lies in the comparability of their ordinal and cardinal numbers and in the availability of transfinite induction.

Equivalent sets are said to have the same cardinal (number), and similar ordered sets are said to have the same order type. The order type of a well-ordered set is called an ordinal (number). For finite sets, the three notions essentially coincide. Comparing (ordering) cardinals according to their magnitude causes great difficulties, and comparing order types is in general altogether impossible. In contrast. ordinals and even the cardinals of well-ordered sets can be compared. and one shown to be less than the other. The well-ordering theorem, one of the most important and most discussed theorems of modern mathematics (E. Zermelo, 1904). states that for any set there exists a well-ordered set with the same members; accordingly, the cardinals of plain sets are also comparable.

For nell-ordered sets a far-reaching generalization of ordinary mathematical induction becomes possible. If a statement involving the members of a well-ordered set W is true for the first member of W, and also true for any member w if true for all members that precede w, then the statement is true for all members of W. This theorem of proving by transfinite induction is almost trivial: far more profound is the fact that by this induction there can also be defined, for instance. the arithmetical operations between ordinals.

Finite and Infinite Sets.—The distinction between finite and infinite sets is fundamental. Dozens of definitions are in existence. among them many n-hich differ in principle. To show the difference it is sufficient to mention the following two definitions:

1. A set is called inductive if there exists a positive integer n such that the set contains just n members (the null set is also inductive); otherwise the set is noninductive.
2. A set is called reflexive if it is equivalent to a proper subset; otherwise it is nonreflexive. Hence the set **I** of all positive integers is both noninductive and reflexive; the latter fact follows, for instance, from the correspondence

$$\begin{array}{cccccc} 1 & 2 & 3\cdots & n-1 & n & \cdots \\ \updownarrow & \updownarrow & \updownarrow & \updownarrow & \updownarrow & \\ 2 & 3 & 4\cdots & n & n+1\cdots & \end{array}$$

which shows that **I** is equivalent to the subset obtained by dropping the member 1. It is also equivalent to the subset of all odd, even or prime numbers.

It seems as if "noninductive" and "reflexive" were the same property. namely, infinite; and that inductive and nonreflexive were another property. finite. Only in the first decade of the 20th century was it discovered that the equivalence between the definitions mentioned, as well as others, depends on a new principle of purely existential character: the principle (axiom) of choice or "multiplicative principle." which had not before been formulated and even in the 1960s is not yet generally accepted in mathematics and logic. Russell's formulation (1906) states: If S is a set of nonempty sets such that any two of these sets have no common member, then there exists a set which contains a single member out of each member of S. This principle is indispensable for many other purposes both inside and outside set theory: in the former. for the arithmetic of cardinals and order types. and for the \yell-ordering theorem, for whose proof the principle was explicitly introduced. By means of the multiplicative principle it can be proved that every noninductive set comprises a denumerable subset. and hence that every such set is reflexive. The equivalence between other definitions of finiteness and infinity can also be proved.

The virtual, though not conceptual, coincidence between cardinal and ordinal numbers of finite jets derives from the following theorem. which is proved for inductive sets by mathematical induction: By arranging the members of a finite set in any two different ways two ordered sets are obtained which. although different. are similar; *i.e.*, follow identical schemes of order: first. second. . . . . nth. with the same n terminating. The above examples of (essentially) different orders of the set **I** show that this theorem does not hold for infinite sets; in fact, to an infinite cardinal belong infinitely many different order types and ordinal numbers.

Boolean Algebra.—Prior to the invention of set theory, Boolean operations had been introduced and applied by G. Boole (1815–64) and others: set theory increased the applications of these operations. Two major and one minor operations between sets are fundamental. The union of two or more (or infinitely many) sets $s_1, s_2, \ldots$ is the set of those members which are contained in at least one set s_n and is denoted by $s_1 \cup s_2 \ldots$. Corresponding to this operation is the operation of intersection, which yields the set $s_1 \cap s_2 \ldots$ of the members contained in each of the sets s_n. Of minor importance is the difference $t - s$, which is essential only in the case $s \subset t$; then $t - s$ is the set of the members of t which are not contained in s. Here again the significance of the null set becomes manifest; without it the intersection of two sets having no common members, as well as the difference $t - t$, would not exist. In Boolean algebra, but not in general set theory, there is introduced, corresponding to the null set, the "universal set" U, which contains all members considered. The difference $U - s$ is called the complement of s.

Union and intersection are in many respects analogous to sum and product in arithmetic; the operations are commutative (by definition) and associative. The first distributive law,

$$s \cap (t_1 \cup t_2 \cup \cdots) = s \cap t_1 \cup s \cap t_2 \cup \cdots$$

corresponds to the arithmetical law $a(b + c) = ab + ac$; the second distributive law of Boolean algebra, however, viz.,

$$s \cup t_1 \cap t_2 \cap \cdots = (s \cup t_1) \cap (s \cup t_2) \cap \cdots$$

has no parallel in arithmetic. where $a + bc$ in general differs from $(a + b)(a + c)$. The validity of both laws is not accidental but is connected with a law of duality; this latter law may be based on the laws of A. de Morgan, which state that the complement of a union of sets is the intersection of the corresponding complements, and that the complement of an intersection is the union of the complements. From this it is concluded that, A being a set formed from sets $s_1, s_2, \ldots$ by repeated operations of union and intersection, the complement $A' = U - A$ is obtained by replacing the sets s_n by their complements, union by intersection, and intersection by union. Since $A = B$ implies $A' = B'$, any equality resulting from those operations remains true after the replacements have been effected, and if the equality is an identity (*i.e.*, true for any set) the transition to the complements becomes superfluous. For example, from $s \cup s' = U$ follows $s \cap s' = \phi$ and from $s \cup \phi = s$ follows $s \cap U = s$ for any set s; one distributive law follows from the other. From $s \subset s \cup t$ follows that $s \subset t$, $s \cap t = s$, $s \cup t = t$ are equivalent statements, as are $s = t$ and $s \cap t = s \cup t$.

Usually the term Boolean algebra is reserved for the abstract theory in which no reference is made to the meaning of union, intersection. complement and subset; a few of the statements mentioned above, and others, are then considered to be the axioms of Boolean algebra.

The significance of Boolean algebra in logic mainly derives from the fact that union corresponds to logical disjunction (in the sense of vel, not exclusive), intersection to logical conjunction, complement to negation and the subset relation to (material) implication. For instance, $s = U$ corresponds to "everything is an s," $s = \phi$ to "there is no s," $s \cap t \neq \phi$ to "some s are t," $s \cap s' = \phi$ to the logical law of contradiction and $s \cup s' = U$ to the law of the excluded middle.

The operation of union (but not of intersection) is basic for the arithmetic of cardinals, namely, for their addition: a sum of finitely or infinitely many cardinals is defined as the cardinal of the union of sets (representatives) with the respective cardinals, if no two representatives have common members. To be sure, the sum's independence of the particular representatives rests upon the principle of choice if the sum has infinitely many terms.

Cartesian Product; Functions as Sets.—In addition to union and intersection there are two other operations with sets which have great importance not for Boolean algebra but for the arithmetic of cardinals and to a lesser degree of order types, and for the applications of set theory to analysis. One is the Cartesian product. If s and t are sets, say without common members, the Cartesian product $s \times t$ is defined as the set of all pairs

$$\{\sigma, \tau\} \text{ with } \sigma \in s \text{ and } \tau \in t$$

For instance, if $s = \{1,2,3\}$, $t = \{4,5\}$, then $s \times t = \{\{1,4\}, \{1,5\}, \ldots\ldots, \{3,5\}\}$; *i.e.*, a set with $3 \times 2 = 6$ members. Therefore the product of two cardinals is defined as the cardinal of the Cartesian product of suitable set representatives. The definitions of both Cartesian products and of products of cardinals may be extended to any finite or infinite number of factors.

While it follows from the definition that a Cartesian product, among whose factors the null set occurs, is empty—hence a product of cardinals with the factor zero equals zero—the converse statement, for infinitely many factors, rests on the principle of choice or, more precisely, constitutes this principle. In fact, only by "choosing" one arbitrary member out of each factor set, none of which is empty by assumption, can it be generally ensured that the Cartesian product is not empty. This is the origin of Russell's term "multiplicative principle." Incidentally, Russell illustrated the difference between set formation by (constructive) "comprehension" and by purely existential "choice" by confronting a set of infinitely many pairs of shoes with another of pairs of stockings. To obtain a set that contains a single member of each pair, it suffices in the first case to take the set of all left shoes which is defined constructively; yet the existence of a set containing a single stocking of each pair is guaranteed only by the axiom of choice.

Finally, for the exponentiation of sets or cardinals a generalization of the ordinary concept of function is most appropriate. For functions $s = f(t)$, assume the domain of variability to be an arbitrary set T over which the argument t runs, whereas the function values s are members of a set S. The insertion set (SIT) shall be defined as the set of all such functions; *i.e.*, of all "insertions" of members of S into T. For instance, simultaneously casting four dice (whose sides show from one to six pips) produces a function $s = f(t)$ with $T = \{1,2,3,4\}$ and $S = \{1,2,3,4,5,6\}$; if two casts are considered equal only on condition that the same die shows the same number of pips, (S/T) contains $6 \cdot 6 \cdot 6 \cdot 6 = 6^4$ members. If T is the set of all positive integers and $S = \{0,1,2, \ldots, 9\}$, every function $f(t)$ may be considered to be a decimal fraction of the form $0 \cdot s_1 s_2 s_3 \ldots$ with values s_t taken from S; hence the insertion set contains all such decimals and its (infinite) cardinal is of the form $10 \cdot 10 \cdot 10 \ldots$, the factors forming a sequence. Thus general powers, with infinite bases and exponents, can be defined and calculated.

The most important case is the so-called power set of a set S; *i.e.*, the set whose members are all subsets of S. It may be conceived as an insertion of the pair (1.0) into S, where 1 is related to every $s \epsilon S$ contained in the respective subset and 0 to the members not contained in it. The so-called "theorem of Cantor" (1892) states that the power set of S has. for finite and infinite S, a greater cardinal than S; it constitutes the first step in ascending to ever-increasing infinite cardinals.

Independently of the concept of insertion set, a function can always be regarded as a set; for instance. a single-valued function $y = f(x)$ can be regarded as a set of ordered pairs (x,y) in which different pairs contain different values of x but not necessarily different values of y. Furthermore. integers and even infinite numbers may be regarded as sets: by means of the null set ϕ the integers 0,1,2,3, . . . may respectively be defined as the sets

$$\phi, \{\phi\}, \{\phi, \{\phi\}\}, \{\phi, \{\phi\}, \{\phi, \{\phi\}\}\}$$

and generally every ordinal number may be defined as the set of those preceding it. An elaborate theory of numbers in this sense was given by J. von Neumann in 1923. (See **Point Sets**.)

Applications.—The applications of set theory penetrate most branches of mathematics; as N. Bourbaki puts it: "Today it is possible to derive almost all contemporary mathematics from a single source. the Theory of Sets." (*Actualités Scientifiques et Industrielles*, vol. 1212. Paris, 1954.) The applications are most spectacular. through the theory of point sets, in analysis: perhaps the greatest analytical achievements of set theory are the modern theories of measure and integration. In geometry and topology many concepts and problems such as "curve" and "dimension," which had defied the cruder conservative methods, were treated set-theoretically; Cantor solved the riddle of the linear continuum (unsuccessfully attacked from Greek antiquity to the 19th century) in terms of a perfect set; namely, one which densely comprises a denumerable subset. In abstract algebra. the well-ordering theorem and transfinite induction (or an equivalent maximum principle) solve problems such as algebraically closed extensions of a field. The theory of probability owes important achievements to set theory, and there are also applications to the theory of games, to physics and even to chemistry.

The modern development of logic has been closely connected with the development of set theory, and the antinomies have neither checked the development of these sciences nor seriously impaired the agreement of most mathematicians with D. Hilbert's description (1925) of the "paradise created by Cantor from which nobody will ever expel us."

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SETTLE, ELKANAH (1648–1724), English playwright and miscellaneous writer, scathingly satirized by Dryden, whose unworthy rival and antagonist he was. Born at Dunstable on Feb. 1. 1648, he went to Westminster school and entered Trinity college, Oxford, in 1666 but left without a degree. His first tragedy, *Cambyses, King of Persia,* was produced in 1666. He was encouraged as Dryden's rival by Rochester, through whose influence Settle's *Empress of Morocco* was twice acted at Whitehall: it also succeeded on the public stage in 1670–71. In the dedication of the printed edition (1673) Settle referred scornfully to other dramatists' effusive dedications, obviously aiming at Dryden who in 1674 co-operated with John Crowne and Thomas Shadwell in an abusive pamphlet condemning the play. Settle replied in kind.

Neglected by the court after 1675, he continued to have his bombastic plays published and performed. However in 1679 the earl of Shaftesbury engaged him to organize a "pope-burning" pageant and thereafter he wrote copiously for the Whig interest. He published a reply to Dryden's *Absalom and Achitophel* in 1682 and was ridiculed as "Doeg" in the second part of his rival's satire. After Shaftesbury's downfall: he turned Tory, attacked Titus Oates and even enlisted in James II's army, but soon rejoined the Whigs on the accession of William III.

"Recanting Settle" was appointed the last poet laureate of the city of London in 1691 and devised ten lord mayor's shows during his term of office. Hoping for patronage, he made a practice of composing occasional poems, elaborately bound and now very rare, which he presented to persons of note. He also wrote entertainments for Bartholomew fair, where in his old age, clad in a green leather suit. he is said to have played the dragon in his own droll, *St. George for England.*

Pope makes him a type of the dull writer in the *Dunciad,* and puts into his mouth the couplet:

> "Yet lo! in me what authors have to brag on!
> Reduc'd at last to hiss in my own dragon." (iii, 286–87)

He entered the Charterhouse in 1718, and died there on Feb. 12, 1724.

See F. C. Brown, E. *Settle* (1910); *Five Heroic Plays,* ed. by B. Dobrée (1960).

SETTLE, a market town in the Skipton parliamentary division of the West Riding of Yorkshire, Eng.. 41½ mi. N.W. of Leeds by road. Pop. (1951) 2,297. It is situated at the foot of Castleberg, a limestone cliff 300 ft. in height, in the upper portion of the Ribble valley amid wild scenery.

In this district of almost pure limestone are found the characteristic features of a karst topography, with dry valleys, bare rock surfaces. caves and gorges. Included in the rural district (237.6 sq.mi., pop. [1961] 13,782) are Ribblesdale, Airedale and Littondale: the summits of Ingleborough, Whernside and Penyghent; the gorges and waterfalls of Ingleton, Malham "cove" and Gordale scar. (See PENNINES.) In the museums are the prehistoric and Roman remains from the Victoria cave.

The tonn, mentioned in Domesday Book as Setel, was granted a charter in 1248. It is an agricultural market town and has two cotton spinning mills. To the west of the town is Giggleswick school. founded in 1512.

SETTLEMENT, in law, a compromise or agreement between litigants to settle the matters in dispute between them in order to dispose of and conclude their litigation. Generally, when litigants settle their differences, prosecution of the action is simply terminated and the action is withdrawn or dismissed without any judgment being entered. In such a case the settlement itself, as a binding contract between the parties, prevents reinitiation of the litigation. But the parties may, and often do, incorporate the terms of the settlement into a consent judgment. Such a judgment may afford the same protection against a reopening of the dispute in litigation as is provided by a court judgment at the conclusion of a fully litigated case.

Settlements commonly provide or are construed to allow either party to enforce their terms or at his election ignore them and reopen the underlying dispute should the other party fail to fulfill the terms and conditions agreed upon. Since in modern litigation by far the greater number of suits brought are either withdrawn or settled. the settlement constitutes an important feature of the litigatory process. See JUDGMENTS AND DECREES; PRACTICE AND PROCEDURE. (C. E. CL.)

SETTLEMENT, ACT OF, the name given to the act of parliament passed in June 1701, which. since that date, has regulated the succession to the throne of Great Britain. Toward the end of 1700 William III was ill and childless; his sister-in-law, the prospective queen. Anne, had just lost her only surviving child, William, duke of Gloucester; and abroad the supporters of the exiled king, James II, were numerous and active. The need for the act was obvious. It decreed that, in default of issue to either William or Anne, the crown was to pass to "the most excellent princess Sophia, electress and duchess dowager of Hanover," a granddaughter of James I, and "the heirs of her body being Protestants." The act is thus responsible for the accession of the house of Hanover to the British throne. In addition to settling the crown, the act contained some important constitutional provisions (many of which are manifest censures on the policy of William 111), of which the following are still in force. (1) That whosoever shall hereafter come to the possession of this crown shall join in communion with the Church of England as by law established. (2) That in case the crown and imperial dignity of this realm shall hereafter come to any person not being a native of this kingdom of England, this nation be not obliged to engage in any war for the defense of any dominions or territories which do not belong to the crown of England, without the consent of parliament. (3) That after the said limitation shall take effect as aioresaid, judges' commissions be made *quamdiu se bene gesserint* (during good behaviour), and their salaries ascertained and established; but upon the address of both houses oi parliament it may be lawful to remove them. This clause established the independence of the judicial bench. (4) That no pardon under the great seal of England be pleadable to an impeachment by the commons in parliament.

The act as originally passed contained four other clauses. One of these provided that after the Hanoverian succession "all matters properly cognizable in the Privy Council . . . shall be transacted there," and that all resolutions "shall be signed by such of the Privy Council as shall advise and consent to the same." Another declared that all officeholders and pensioners under the crown should then be incapable of sitting in the house of commons. The first of these clauses, which was an attempt to destroy the growing power of the cabinet, was repealed and the second seriously modified in 1706. Another clause, repealed in the reign of George I, forbade the sovereign to leave England, Scotland or Ireland without the consent of parliament. Finally, a clause said that "no person born out of the kingdoms of England, Scotland, or Ireland, or the dominions thereunto belonging (although he be naturalized and made a denizen), except such as are born of English parents, shall be capable to be of the Privy Council, or a member of either House of Parliament, or to enjoy any office or place of trust, either civil or military, or to have any grant of lands, tenements, or hereditaments from the Crown to himself, or to any other or others in trust for him." By the Naturalization act of 1870 this clause was virtually repealed for all persons who obtain a certificate of naturalization.

The importance of the Act of Settlement appears from the fact that, in all the regency acts, it is mentioned as one of the acts to the repeal of which the regent may not assent. To maintain or affirm the right of any person to the cro n, contrary to the provisions of the act, is high treason by an act of 1707.

For the full text *see* W. C. Costin and J. S. Watson (ed.), *Law and Working of the Constitution,* vol. i, pp. 92–96 (1952).

SETTLEMENT, SOCIAL: see SOCIAL SETTLEMENTS.

SETÚBAL, a seaport of Portugal, in the district of the same name, 18 mi. S.E. of Lisbon. It was formerly called St. Ubes in English and St. Yves in French. Pop. (1960) 59,024 (mun.). Setúbal is on the north shore of a deep estuary formed by the rivers Sado, Marateca and São Martinho. Setubal exports large quantities of fine salt, oranges and muscatel grapes; it has many sardine-curing and boat-building establishments and manufactures of fish manure and lace. Under John II (1481–1495) Setúbal was a favourite royal residence and one of the churches dates from this period, but most of the ancient buildings were destroyed by the great earthquake of 1755. In the sand hills of a low-lying promontory in the bay opposite Setúbal are the so-called ruins of "Troia," uncovered in part by heavy rains in 1814 and excavated in 1850. These ruins are those of Cetobriga, which flourished A.D. 300–400.

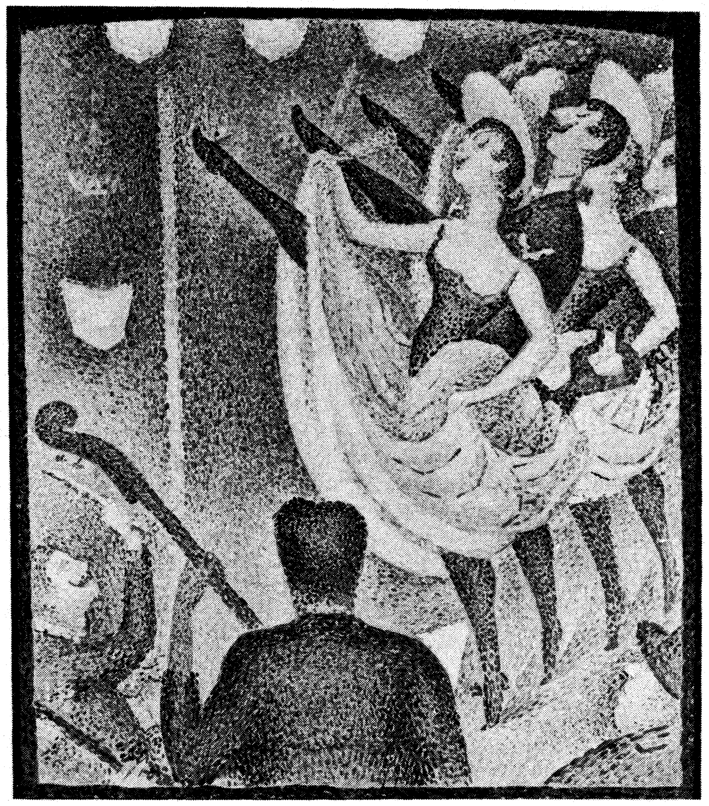
SEURAT, GEORGES PIERRE (1859–1891), French painter. the leading figure among a small group of painters known as the Neoimpressionists, was born in Paris on Dec. 2, 1859. From the very start his search for scientific truth and for an applicable formula carried him beyond the limits of academic training; at the same time, he departed from the concept of fleeting pictorial impressions which Claude Monet and his group had developed. The result was a new and valid form of monumentality for easel painting that reinstated a firm structure of composition and re-established the formal value of the subject.

Seurat's artistic career comprised a bare decade and was outwardly uneventful. He began to study drawing when he was 15 and entered the École des Beaux-Arts in 1878 in the class of Henri Lehmann, a pupil of Ingres. Supplementing his formal training with untiring studies in the Louvre and in the libraries. he copied Ingres, Raphael, Holbein and Poussin; he also pored over scientific studies of colour by M. E. Chevreul, O. N. Rood, H. L. F. Helmholtz, D. Sutter and C. Blanc.

After a year of military training at Brest, where he did many studies of people and the sea. Seurat returned to Paris late in 1880. For some time he concentrated mainly on drawing, developing a completely new technique which enabled him to replace line by volume and to create an intricate pattern of light and shade. He also began making small studies in detached strokes of pure colour. In 1883 Seurat began his first major project in painting, "Une Baignade," a large scene with bathers (Tate gallery, London) for which many drawings and studies are extant. When this painting was rejected by the salon of 1884, Seurat, with Paul Signac, H. E. Cross. C. Angrand, A. Dubois-Pillet, M. Luce and, for a short while, Camille Pissarro, helped found the Société des Artistes Indépendants. These painters were also called the Pointillists, Divisionists or Chromatic Luminarists.

In 1884 Seurat began work on his second large composition, "La Grande Jatte" ("A Sunday Afternoon on the Island of la Grande Jatte"). For months the artist was on the island every day sketching. Back in his studio he developed the theme in endless studies, drawings, sketches of sections and complete and carefully executed studies of the whole scene. For the final painting (now at the Art Institute of Chicago) Seurat prepared a palette exactly according to Chevreul's colour disk. Four basic colours and their intermediaries were only to be mixed with varying amounts of white before they were applied in a veritable maze of small, carefully separated dots.

When shown at the last exhibition of the Impressionists in 1886 "La Grande Jatte" caused a great controversy in which only a few artists, among them Signac and Pissarro, and the poet and art critic Felix Fénéon defended Seurat's work. In 1887 Seurat exhibited the painting again in Brussels with "Les Vingts" ("The XX"), a small group of independent Belgian painters; here it received a more favourable reception.



BY COURTESY OF THE BUFFALO FINE ARTS ACADEMY, ALBRIGHT ART GALLERY

SECOND STUDY FOR "LE CHAHUT." PAINTED BY SEURAT IN 1889

After finishing "La Grande Jatte," Seurat was so completely in command of his new method that the works that followed required fewer and fewer preparatory sketches. He painted only five more major compositions: "Les Poseuses," 1887 (Barnes foundation, Merion, Pa.); "La Parade," 1887 (Stephen C. Clark, New York city); "Le Chahut." 1889–90 (Rijksmuseum Kroller-Miiller, Otterlo); "Jeune Femme se poudrant," 1889–90 (Courtauld institute, London); and "Le Cirque," begun in 1890 (Louvre). In each of these Seurat further explored new facets of the pictorial and technical problems which interested him: the study of space and perspective, of artificial light and varying moods, the sensation of air moving around objects.

During the summer months from 1885 to 1890 Seurat painted out-of-doors a number of pure landscapes and marines. Though done in the same strictly scientific method, they are intimate and yet lasting records of nature.

When Seurat unexpectedly died in Paris on March 29, 1891, at the age of 31, he had produced 7 monumental compositions, 40 smaller paintings and sketches, about 500 drawings and several sketchbooks. These show him as one of the greatest artists of his time, contributing immeasurably to the development of 20th-century art.

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(W. M. V. D. R.)

SEVASTOPOL or SEBASTOPOL, a natural harbour of the U.S.S.R. in the Crimean *oblast,* Ukrainian Soviet Socialist Republic, on the southwest coast of the Crimean peninsula, in 44° 37′ N., 33° 35′ E., connected by rail with Moscow via Kharkov. It is available at all times for large steamers. and has a depth of 36 to 240 ft. over the whole port. The estuary, which is one of the best roadsteads in Europe and could accommodate the combined fleets of Europe. is a deep and thoroughly sheltered indentation among chalky cliffs, running east and west for nearly four miles, with a width of three-quarters of a mile, narrowing to 930 yd. at the entrance. The main inlet has also four smaller indentations, and a small river, the Chernaya, enters the head of the inlet. Since 1890 it has been exclusively a naval arsenal and no foreign vessels call at the port unless they have machinery or coal for the government or the state railways. Its trade has been diverted to Theodosia and Nikolayev, but it has manufactures of machinery, macaroni, four, leather. soap and tiles. Sevastopol sustained a memorable 11-month siege in 1854, when the English, French and Turkish troops bombarded it; it was evacuated by the Russians in Sept. 1855, when the fortifications were blown up by the allies, and barely a dozen buildings escaped uninjured. By the treaty of Paris the Russians were bound not to restore the fortress, but during the Franco-Prussian War, in 1870, Sevastopol was again made a naval arsenal. For many years after the siege the town was practically deserted. but it is now flourishing. Pop (1959) 148,000. Its museum of biology and marine biological station are famous. and there are schools of navigation.

In the jth century B C. a Greek colony was founded on the peninsula between the bay and the Black sea and remained independent for three centuries, when it became part of the kingdom of the Bosporus, and later tributary to Rome. Under the Byzantine empire Chersonesus was an administrative centre. Vladimir, prince of Kiev, conquered Chersonesus (Korsuñ) before being baptized there, and restored it to the Greeks on marrying (988) the princess Anna. Subsequently the Slavs were cut off from relations with Taurida by the Mongols, and only made occasional raids such as that of the Lithuanian prince Olgierd. In the 16th century a new influx of colonists. the Tatars, occupied Chersonesus and founded a settlement named Akhtyar. This village, after the Russian conquest in 1783, was selected for the chief naval station of the empire in the Black sea and received its present name ("the August City"). In 1826 strong fortifications were begun. Before the Crimean War Sevastopol was a beautiful, well-built city. Some years after the siege an active period of rebuilding began. *See* also CRIMEAN WAR.

SEVEN CHAMPIONS OF CHRISTENDOM, the name given in mediaeval tales to the seven national saints—of England, Scotland, Ireland, Wales, France, Spain and Italy—*i.e.,* Saints George, Andrew, Patrick, David, Denis, James and Anthony. The classical version of their achievements is that of Richard Johnson (1j7j–c. 16jy), *Famous Historie of the Seaven Champions of Christendom* (3 parts, 1596, 1608, 1610).

SEVEN DAYS' BATTLE, a name given to a series of combats in the neighbourhood of Richmond, Va., during the American Civil War, June 26–July 2, 1862. The Federal Army of the Potomac, advancing up the Yorktown peninsula to White House on the Pamunkey and then over the Chickahominy on Richmond, had come to a standstill after the battle of Seven Pines (or Fair Oaks), and Gen. Robert E. Lee, who succeeded Joseph Johnston in command of the Confederates, initiated the series of counterattacks upon it which constitute the "Seven Days."

Gen. George McClellan had lingered north of Richmond. despite President Lincoln's constant demand that he should "strike a blow" with the force he had organized and taken to the Yorktown peninsula in April, until Gen. Lee had concentrated 73.000 infantry in his front; then the Federal commander, fearing to await the issue of a decisive battle, ended his campaign of invasion in the endeavour to "save his army"; and he so far succeeded that on July 3 he had established himself on the north bank of the James where reinforcements and supplies could be brought from the north by water without fear of molestation by the enemy. But he lost 15,000 men in his seven days' retreat, and 20% of the remainder became ineffective from disease. McClellan described this flight to the James as a change of base. a move which he had previously contemplated. It was actually the sequel to the action of Lee, who in the middle of June summoned Jackson's corps from the Shenandoah valley (see SHENANDOAH VALLEY CAMPAIGNS).

Jackson preceded his troops to confer with Lee, and appointed the morning of June 26 for his appearance north of the Chickahominy to lead the march and attack McClellan's right wing under Gen. Fitzjohn Porter. Jackson was to be supported by the divisions of A. P. Hill. Longstreet and D. H. Hill. Lee's other divisions under Magruder, Huger and Holmes were to defend the lines which covered Richmond from the east and so prevent McClellan effecting a counterstroke. Huger had demonstrated on the Williamsburg road on June 25 in order to draw McClellan's attention to his left wing, and though on June 26 Jackson had failed to appear, Gen. A. P. Hill at 3 P.M. crossed the Chickahominy and attacked the enemy's right wing at Beaver Dam creek assisted by D. H. Hill, while Longstreet crossed at Mechanicsville. Gen. Lee and President Davis were present, and witnessed the loss of 2,000 men in a frontal attack which continued till 9 P.M. Meanwhile Gen. Jackson, with Stuart's cavalry corps, "marched by the fight without giving attention, and went into camp at Hundley's Corner half a mile in rear of the enemy's position."

The Federal detachment retreated during the night to a stronger position in rear at Gaine's Mill near Cold Harbor, and on June 27 the Confederates again attacked Porter's corps. The resistance of the Federals was stubborn; at 5 P.M. Gen. Lee required Longstreet to attack the enemy's left, and at this moment he procured the assistance of some part of Jackson's corps, which had become separated from the remainder. About sunset the Federals under Porter (three divisions) yielded to the pressure of the attack at all points, and withdrew after nightfall across the Chickahominy, leaving 5,000 prisoners in the hands of Gen. Lee. That night McClellan issued orders for the movement to the James.

Lee's right wing had in the meantime demonstrated against the main body of the Federals about Fair Oaks, on the south bank of the river. On June 28 complete inactivity supervened among the Confederates north of the Chickahominy save that Stuart's cavalry and Ewell's division were advanced as far as the railway to reconnoitre, but on this day McClellan was making good his retreat southwards to the James with little interference, for Magruder was instructed to "hold his lines at all hazards," and accordingly acted on the defensive except that Jones's division opposed a Federal division under W. F. Smith near Fair Oaks. On June 29 Gen. Lee became aware of the situation and then issued orders for his six divisions to cross the Chickahominy in pursuit. Jackson's corps and D H Hill's division were to follow the enemy, while Longstreet and A. P. Hill were to move their divisions via New Bridge to the Darbytown or James river road to cut off McClellan from the James Stuart was to operate at his discretion north of the Chickahominy, and it seems that he was attracted by the enemy's abandoned depot at White House more than by McClellan's retreating army. On this day Magruder with two divisions attacked superior forces about Fair Oaks and was repulsed, and again attacked at Savage station with like results Gen Lee, however, rebuked Magruder for slackness in pursuit. Holmes's division was moving in front of Longstreet on the James river road, but two Federal divisions were holding the route at Willis church and at Jordan's ford On June 30 Jackson got into action with Whiting's division at White Oak Swamp, while Longstreet encountered the Federals at Frazier's farm (or Glendale). Longstreet was supported by A. P. Hill and together they lost 3,200 men; it was hoped that Jackson's corps would come up during the engagement and attack the enemy's rear, and Huger's division assail his right, but Federal artillery stopped Huger, and of Jackson's three divisions only one came into action. Magruder and Holmes were engaged to their own advantage at Turkey bridge Longstreet and Hill were thus opposed to five Federal divisions, while Gen. McClellan was pushing his wagons forward to Malvern hill, on which strong position the Army of the Potomac was concentrated at nightfall On July 1 Jackson's corps and D. H. Hill's division had been drawn again into the main operation and followed the Federal line of retreat to Malvern hill with Huger and Magruder on their right. The divisions of Longstreet and A P. Hill were in support.

Gen. Lee had thus on the seventh day concentrated his army of ten divisions in the enemy's front; but Jackson's dispositions were unfortunate and Gen. Lee's plan of attack was thus upset; and while seeking a route to turn the enemy's right the Confederate commander was apprised that a battle had been improvised by the divisions in advance. In the result these troops were repulsed with a loss of 6.000 men. Gen Lee's offensive operations now ended, though Stuart's cavalry rejoined the main army at night and followed the enemy on July 2 to Evelington Heights, while Lee rested his army. Stuart discovered a position which commanded the Federal camp, and maintained his cavalry and horse artillery in this position until the afternoon of July 3, when, his ammunition being expended, he was compelled to retire before a Federal force of infantry and a battery. Longstreet and Jackson had been despatched to his support, but the former did not arrive before nightfall and the latter failed to appear until the next day (July 4). Stuart afterwards moved farther down the James, and shelled McClellan's supply vessels in the river until recalled by Gen. Lee, who on July 8 withdrew his army towards Richmond. (G. W. R.)

SEVENOAKS, a market town and urban district in the Sevenoaks parliamentary division of Kent, Eng., 24 mi. S.E. of London by road. Pop. (1961) 17,604. Area 5.8 sq.mi. Residential in character, it is the shopping centre for the surrounding rural district. Sevenoaks school and almshouses were founded under the mill of William Sevenoke (1432), a foundling who became mayor of London. St. Nicholas Church nearby dates in part from the 13th century. Cricket has been played on the famous Vine ground for over zoo years.

Knole house, since 1456 owned by monarchs, archbishops, and, from *c.* 1603, by the Sackville family, is one of the finest houses in England. Given to the National trust in 1946 by the 4th Lord Sackville, who lives in a part of it, it contains rare furniture, tapestries and historic paintings.

See V. *M.* Sackville-West, *Knole and the Sackvilles,* new ed. (London, 1947).

SEVEN SLEEPERS OF EPHESUS, THE, according to the most common form of a legend first referred to in western literature by Gregory of Tours, seven Christian youths of Ephesus, who, in the Decian persecution (A.D. 250), hid themselves in a cave. Their hiding place was discovered and its entrance blocked. The martyrs fell asleep in a mutual embrace. Nearly zoo years later a herdsman rediscovered the cave on Mt. Coelian. and, letting in the light, awoke the inmates: who sent one of their number to buy food. The lad was astonished to find the cross over the gates of Ephesus, and to hear the name of Christ openly pronounced. By tendering coin of the time of Decius at a baker's shop, he roused suspicion, and was taken before the authorities. He confirmed his story by leading his accusers to the cavern where his companions were found, youthful and beaming with a holy radiance. The emperor Theodosius II, hearing what had happened, hastened to the spot and heard from their lips that God had wrought this wonder to confirm his faith in the resurrection of the dead. This message delivered, they again fell asleep.

Gregory. says he had the legend from the interpretation of "a certain Syrian"; in point of fact the story is common in Syriac sources. It forms the subject of a homily of Jacob of Sarug (d. A.D. 521), which is given in the *Acta sanctorum.* Another Syriac version is printed in Land's *Anecdota,* iii. 87 *et seq.* According to Biruni, certain undecayed corpses of monks were shown in a cave as the sleepers of Ephesus in the 9th century.

SEVENTH-DAY ADVENTISTS: see ADVENTISM.

SEVEN WEEKS' WAR. This name is given to the war of 1866, fought between Prussia on the one side and Austria, Bavaria, Saxony. Hanover, and certain minor German states on the other. The issue was decided in Bohemia, where the principal Prussian armies met the main Austrian forces and the Saxon army. A Prussian detachment, known as the army of the Main, meanwhile dealt with the forces of Bavaria and of the other German states which had sided with Austria. Simultaneously, a campaign was fought in Venetia between the Austrian army of the south and the Italians, who had made an alliance with Prussia; this campaign is described under ITALIAN WARS.

THE ORIGINS AND OUTBREAK OF THE WAR

The 1866 campaign was a definite and carefully planned stage in the unification of Germany under the Hohenzollern dynasty. of which Bismarck was the principal agent. The issue was clear-cut: Prussia deliberately challenged Austria for the leadership of the Germanic confederation. And, however unscrupulous the Prussian government may have been in its methods of designedly provoking a war at its chosen time, Prussia did represent progress and enlightenment in comparison with Austria's intolerance and inefficiency. Prussia had thrown down the glove in 1850, but the complete failure of its mobilization in that year compelled the postponement of the conflict and the acceptance at Olmütz of the somewhat humiliating terms of Austria. Since then Prussia, with Bismarck as statesman, Count Helmuth von Moltke as strategist, and von Roon as army organizer, had prepared methodically for a fresh challenge. The actual pretext found by Bismarck in 1866 was a dispute over the administration of Schleswig and Holstein, which Austria and Prussia had seized from Denmark in 1864, and had since held jointly. Diplomatic exchanges began in January and military preparations a little later, but hostilities did not actually break out till the middle of June. By the alliance with Italy, Bismarck contrived to divert part of the Austrian forces to the south. Not only did the majority of the other German states join Austria, but also the war was far from popular with the people of Prussia itself, nho did not understand the policy underlying it, and could see no good cause of quarrel with Austria.

The Opposing Forces Compared.—Numerically, the armies of Austria and Prussia were approximately equal. Each mobilized a total of about 550,000 men, of whom some 320,000 constituted the field armies, the remainder being reserves and garrisons. But Austria could also count on the direct support of the Saxons (25,000), and the indirect aid of the forces of Bavaria and other German states (about 150,000). This preponderance in favour of Austria was partly neutralized by the Italian intervention, which withdrew three Austrian corps from the main theatre. Von Moltke, trusting to lack of co-operation between the German states hostile to Prussia, and aware of the comparative inefficiency of their armies, detached a force of under 50,000 to deal with them. Thus in the decisive theatre there was virtually numerical equality; some 270,000 Prussians (if a reserve corps of 25,000 be included) opposed 245,000 Austrians and 25,000 Saxons.

Contemporary military opinion held that the Austrian army, with its longer period of active service (seven years against the Prussian three or four) and its recent experience of war, would prove greatly superior to the Prussian army, which had not been engaged in battle for more than 50 years. Contemporary military opinion was quite wrong. The Prussians proved to be better trained, better organized, and better led. They had, besides, a great advantage in the possession of a breech-loading rifle. The Austrian muzzle-loading rifle, though a longer-ranging and more accurate weapon, not only had a much slower rate of fire but also could not be reloaded without exposure of the firer. The superiority conferred by the breechloader was not, however, recognized at the outbreak of war; and the newer and rather better pattern of gun, with which the Austrian artillery was armed, was fully expected to counterbalance the Prussian advantage of a breech-loading rifle. The Austrian cavalry was considered to be greatly superior in manoeuvre and horsemanship. Though a proportion of the cavalry on both sides was armed with a carbine, little use was made of dismounted action; shock action was held to be the principal, if not the only, role of cavalry on the battlefield. The Austrian infantry, also, relied on shock action rather than on fire effect: the Prussians, in spite of their lack of war experience, had arrived at a juster appreciation of the power of the rifle and the possibilities of rapid fire. Both forces were organized into army corps of 25,000 to 30,000 men, comprising four brigades of infantry. But whereas the Prussian corps was subdivided into two divisions each of tno brigades, the Austrians had no divisional link, the four brigades working directly under the corps headquarters.

The Rival **Commanders.**—Since the leadership and strategical handling of the armies in this campaign have been much, even hotly, debated, it is worth while to devote some attention to the personality of the principal commanders on either side. The illustrious Von Moltke, who as chief of the general staff to King William. was the virtual leader of the Prussian armies, came later to war than any other of the great captains of history. He was 66 years of age at the beginning of this, his first campaign, He had held the position of C.G.S. since 1857, and had been working at the problem of a war against Austria in the closest detail since 1860 (the date of no. 1 of the famous "projects"). He was a student of war rather than a battlefield general; the soldiers who won victories under his direction can rarely have set eyes on this quiet, professorlike man, who was calm and inflexible in a crisis. But, though his reputation as a commander in the field has been much and vehemently assailed (the French have never tired of pointing out to their conquerors of 1870 what would have happened had they met the real Napoleon), no more nor greater mistakes have been proved against him than must be made by every leader of large bodies in this blindfold game of war. And, whatever the verdict on his generalship, his fame in military history is secure as the originator of scientific education for war. He was the first to insist on close study of the principles of their profession by all grades of commander.

King William, though he wisely deferred to Von Moltke's views on matters of strategy, was no mere figurehead. He was a good judge of men and could make his influence felt. The two royal princes who commanded the I and II Prussian armies, Frederick Charles and the crown prince, were not great generals, but were both brave soldiers, well' grounded in the profession of arms. The Prussian corps commanders and their principal staff officers had all been carefully selected.

The Austrian commander in chief, Ludwig Benedek, was a complete contrast to Von Moltke. He had fought with distinction in several campaigns, but had little military education. A Protestant in an almost fanatically Catholic country, of humble origin in an army where birth was almost the first qualification for high command, he had risen by his personal valour and bold, energetic leadership on the battlefield. He was, in fact, an excellent corps commander, but he was no strategist, knew little of the theory of his profession, and had no military imagination. He was only too well aware of his limitations, knew himself unfitted for the handling of large forces, and accepted the command of the Austrian army of the north with great reluctance, out of loyalty to his emperor. His own wish had been for the command against Italy, a smaller and less responsible task in a theatre of war which he knew well. To trust the fate of an empire to one who so mistrusted himself was obvious folly. Yet Benedek's appointment was very popular with the great mass of the Austrian army, though his relations with his aristocratic corps commanders were never cordial. He needed a really able and tactful chief of staff to supply the necessary technical knowledge and to give him the confidence he lacked.

His nominal chief of the staff was Von Henikstein, amicable and rich—civil rather than military virtues—personally brave, but without any real qualification for his important post. He could bring to Benedek neither military knowledge, for he had little, nor confidence, for he was himself of a pessimistic turn of mind. In the actual conduct of operations Von Henikstein seems to have been a cipher, and the virtual arbiter of Austrian strategy was Krismanid, head of the operations branch of the general staff. He had been a professor at the staff college and had made a special study of the topography of Bohemia. He was a clever, plausible man, full of self-confidence, and oozed theory of war from every fingertip. Unfortunately his studies had led him to a conviction of the superiority of the defensive. He based the strategy of this campaign on the successful defensive campaign of the Austrians against Frederick the Great in Bohemia in 1757. He was an armchair strategist, a maker of war by rote and by diagram, rather than a practical soldier. The Austrian corps commanders were great nobles, who treated war as a sport and usually troubled themselves little about the theoretical or scientific side of their profession. To sum up, the Austrian army was led by amateurs, the Prussian by professionals.

John Bartholomew & Son, Ltd., Edinburgh.

Topography of the Theatre of Operations.—Bohemia, where the main campaign was fought, is, generally, a country of open rolling plains, highly cultivated. Except the rivers, there are few obstacles to the movements of troops of all arms. But on the northern marches, between Bohemia and Prussia, lies a crescent of mountains, from 2,000 to 4,000 ft. in height. These mountains are known in the east, on the Silesian frontier, as the Sudeten Gebirge, in the centre as the Riesen Gebirge and in the west, on the Saxon frontier, as the Erz Gebirge. The Riesen Gebirge are the most formidable. They constituted a definite barrier, some 36 mi. in length and 20 in depth, to the movement of large forces. The principal routes from Prussia into Bohemia passed round either end of the Riesen Gebirge, through the lower and less rugged Sudeten and Erz Gebirge—a fact which had, as will be seen, an important bearing on Prussian strategy. The Sudeten and Erz Gebirge were not steep, troops of all arms could move freely off the roads (except where the country was thickly wooded), and the so-called "passes" were in no sense defiles such as those in the Alps or on the northwest frontier of India. Of the rivers, the Elbe, which rises in the Riesen Gebirge and eventually leaves Bohemia through the Erz Gebirge, is a considerable obstacle, 60 to 70 yards broad at Königgratz. The Iser, too is deep, swift and broad, and had some strategical and tactical significance. The other streams in the theatre of operations were unimportant, except the Bistritz, as will be seen, at the battle of Sadowa.

Mobilization and Concentration.— After a long period of diplomatic negotiation, during which both sides had made certain military preparations, Austria ordered the mobilization of its army of the north on April 27. Prussia followed suit a week later. Mobilization arrangements had not then reached the nicety of timing that in 1914 made a delay of even a few hours dangerous and thus rendered the mobilization of a European state practically equivalent to a declaration of war. The Prussian corps were originally concentrated in their recruiting areas, a waste of time, since they had again to be broken up for the movement to the frontier by rail, which began on May 16 and was completed by June 5 (the most considerable use of railways in war up to that time).

Much ink has been spilled in criticism and defense of Von Moltke's strategical deployment of the Prussian forces for this campaign, of which space permits only the barest possible outline here. The outstanding features of a strategical problem, which Von Moltke had been studying in all its bearings for six years, were firstly, the mountain belt, with the almost roadless Riesen Gebirge in the centre, which had to be crossed if an offensive campaign into Bohemia were contemplated, and secondly, the salient formed by the province of Silesia, which greatiy complicated the problem of defense should the enemy obtain the initiative. Von Moltke believed that Prussia's better transport arrangements would enable its armies, in spite of their later mobilization, to forestall the Austrians in northern Bohemia, provided they were moved thither with all speed, passing through the mountains on a broad front. Thus the importance of time, which impelled him to use all available railways, motived the original detrainment on a front of 275 miles, from Halle to Neisse. Thence the corps were moved inward, and by June 8 stood in three groups on a front of about 150 miles: army of the Elbe (VIII corps, 14th div.), centre about Torgau; I Army (II, III, IV corps) under Prince Frederick Charles, Senftenburg to Gorlitz; II army (I, V, VI corps) under the crown prince, centre about Landshut; the guard corps was still at Berlin. Von Moltke mould have liked to unite the armies by a movement into Bohemia. But there followed a delay of nearly a fortnight due to the reluctance of King William to appear the aggressor in the conflict. This delay was almost fatal to the Prussian plan.

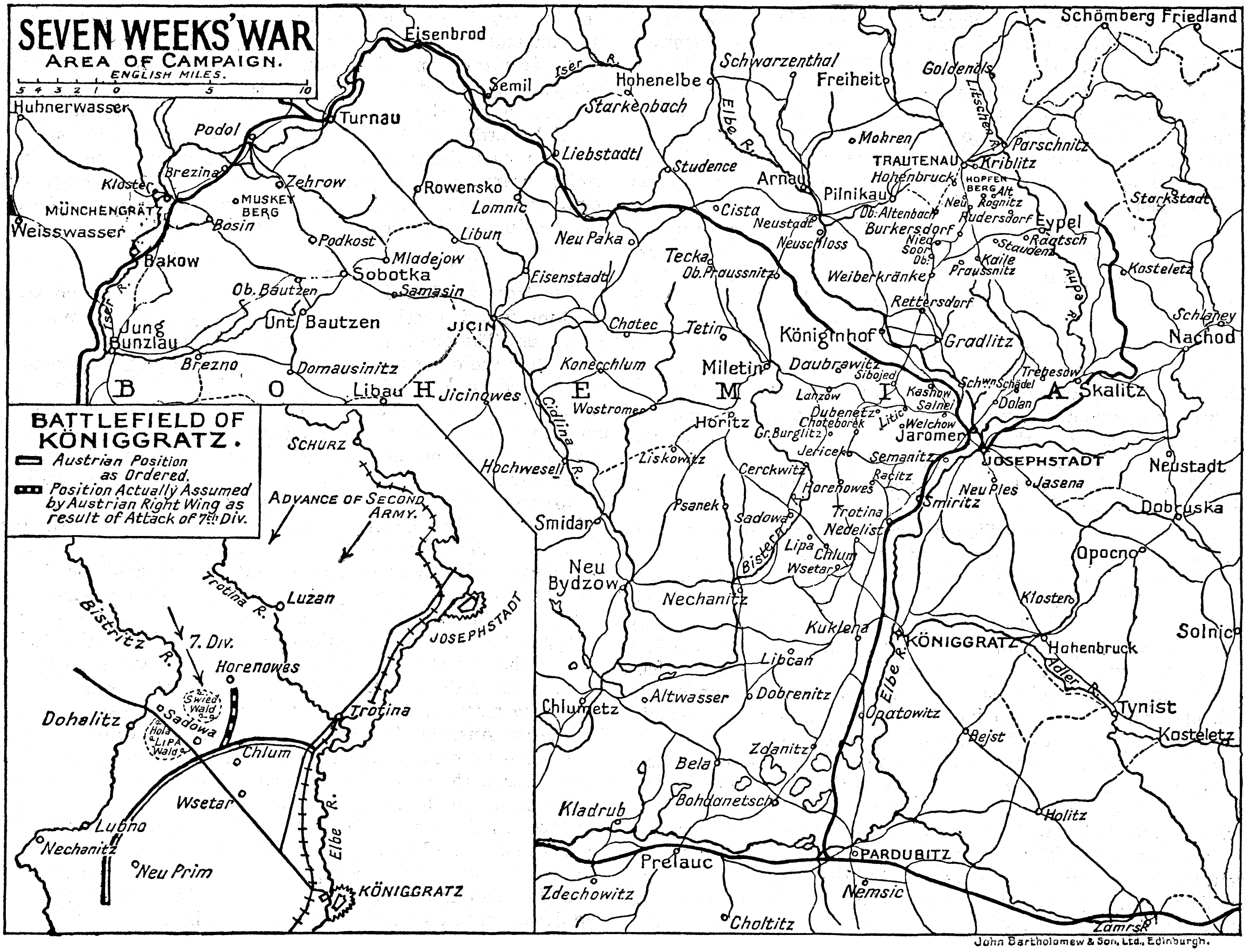
Meanwhile the Austrian army had concentrated round Olmütz in Moravia, near the Silesian frontier, with a detachment of the I corps and a cavalry division in northern Bohemia. The crown prince, the commander of the Prussian II army, convinced that an Austrian invasion of Silesia mas imminent, proposed to move his army eastward to about Neisse, to meet the danger, and also requested the strengthening of his army by the guard corps, originally allotted to the I army. Von Moltke was somewhat reluctantly compelled to agree to a move that still further separated the II army from the I and exposed it to the danger of having to meet, unsupported, an attack by the Austrian main forces. This extension of front, for which Von Moltke has been criticized, was probably less dangerous than it appeared. Von Moltke was sure of the tactical superiority of the Prussian infantry, with its breech-loading weapon, and could, therefore, count on the ability of the II army to delay any Austrian invasion long enough for the I army to intervene; he was also probably aware of the predilection of the Austrian high command for defensive strategy.

On June 1j King William relieved Von Moltke of some of his anxieties by sanctioning the invasion of Saxony by the army of the Elbe. Dresden was occupied on June 19 without fighting, the Saxon army retiring into Bohemia. This brought the army of the Elbe into close touch with the I army and it was placed under the command of Prince Frederick Charles. There was still a wide gap between the I and II armies, and a forward concentration in Bohemia nas hazardous, since Benedek had on June 17 ordered the march of the whole Austrian army from Olmütz toward Josefstadt. Nevertheless, Von Moltke chose the bold part, and on June 22 issued his famous order for the advance of the I and II armies toward a point of junction at Gitschin. The forces of both combatants were thus hurrying toward the same area—the Austrians united, the Prussians seeking to unite.

THE ADVANCE TO KÖNIGGRÄTZ

The Prussian I Army.— The danger threatening two separated forces which seek to unite within range of an active enemy is obvious. The one may be delayed and held fast by a detachment while the other is overnhelmed by the enemy's main mass. It appeared to Von Moltke that the II army was the more exposed and had the harder task to win a passage through the mountains; he therefore enjoined on the commander of the I army a rapid advance on Gitschin in order "to shorten the crisis." Prince Frederick Charles with the I and Elbe armies had an unexpectedly easy task at first, since he was allowed to pass the defiles of the Erz Gebirge without opposition. The Austrian detachment on this wing (Saxon corps, I corps, 1st light cavalry division) had been ordered by Benedek to hold the line of the Iser. In the advanced guard combats of Huhnerwasser and Podol on June 26 the Prussians secured crossings over this river, and the Austrians had their first experiences of the deadliness of the breechloader. Prince Frederick Charles spent the whole of the 27th in manoeuvring his forces into position for an enveloping battle at Miinchengratz, where he supposed the main body of the Austrian detachment to be, and practically the whole of the 28th in manoeuvring them back into line of march, when he found that the enemy had retired on Gitschin without awaiting his blow. In the battle of Gitschin on the 29th the ground favoured the Austrians, who had an opportunity of crushing the head of one of the Prussian columns before the other could reach the field of battle. But the superior weapon and skilful handling of the Prussian infantry won the day and in the end the Austrians and Saxons suffered a severe defeat. Thus by the 30th the I and Elbe armies had reached their original rendezvous. Their commander had, however, been guilty of several errors. Of these the most flagrant was the placing of his cavalry in the rear, with the result that he was always in ignorance of his enemy's dispositions and moves. His unjustified halt of the I army on June 25 before it was clear of the mountains, and his faulty dispositions at Gitschin might have been severly punished had the Austrian high command been less inept.

Engagements of the **II** Army.— Meanwhile the II army had been fighting hard to win through the mountains and to reach the line of the Upper Elbe. The first engagements on this wing took place on June 27. The Prussian advance on that day was in three columns: on the right the I corps was to push through Trautenau; on the left the V corps mas directed on Nachod; in the centre the guard corps was given Eipel as its destination, with the task of supporting the corps on its right or left at need. The advanced guard of the I corps drove back a part of the Austrian X corps, and early in the afternoon secured the exits from the defile at Parschnitz. But the Prussian commander, Bonin, thinking the action was over, neglected to hasten the deploynient of the remainder of his corps and refused the proffered assistance of a division of the guard. Later in the afternoon the remainder of the Austrian X corps reached the battlefield, and counterattacked vigorously. They drove in the Prussian advanced troops and caused the I corps to retreat in complete disorder across the frontier. On the same day the Prussian V corps won an important success at Nachod against the Austrian VI corps. Here, as at Trautenau, the Prussian advanced guard was attacked by a greatly superior force before the main body was clear of the defile behind. But Von Steinmetz, commander of the V corps, a veteran who had fought in the Napoleonic wars, was of more resolute mettle than Bonin, and after a hard struggle won clear



of the defile and drove back his enemy. On the following day the 28th, the Prussians continued their advance and won two successes. The guard corps at Soor defeated the Austrian X corps, the victors of Trautenau, while Von Steinmetz's V corps at Skalitz drove back the Austrian VIII corps, which had relieved the VI corps in front of him. The success of the guard corps opened the Trautenau defile and enabled the rallied I corps to resume its advance. On the 29th Von Steinmetz won a third success, at Schweinschadel, this time over the Austrian IV corps. By the evening of June 30, the II army had disposed of the irresolute and unco-ordinated opposition of its enemies and had established itself on the line of the upper Elbe, with its centre about Koniginhof. The I army and army of the Elbe, which had received orders to continue their advance beyond Gitschin in the direction of Königgrätz, mere now within a day's march of the II army. Von Moltke's first strategical aim, the junction of the Prussian forces, had practically been accomplished. On the same date, the 30th, Benedek gave orders for a retreat of the Austrian army on Koniggratz, and thus acknowledged that he had forfeited the advantage which a central position between two separated hostile forces might have given him.

Benedek's Vacillation.—Von Moltke's bold gambit had gone unpunished and had given him a winning strategical position. Let us turn to the Austrian side of the board, consider Benedek's handling of the pieces during these last ten days of June, and enquire whether (as most critics hold) he missed an opportunity of defeating his enemies in detail, and if so, by what false moves. In the first place, he was probably correct in his decision to advance into northern Bohemia rather than to invade Silesia, and his march of some 200,000 men from Olmiitz to Josefstadt was well enough ordered. But he had already lost time—the most precious element of war, as of chess—and was always at least one move in the game behind his opponent. Thus while the Prussian armies were widely separated in a lateral direction, the Austrian army as it approached the critical point of Josefstadt was also widely dispersed—from front to rear. If Benedek was to use his central position to strike to right and left alternately, he must first gain time to close up his army. He could gain this time only by his own efforts, by so using detachments from his main force as to impose delay on the forward march of the divided armies of his opponents. This fact he never grasped, he seems hardly to have realized any especial need for haste, but to have assumed that he would be given time to assemble, and even to rest his forces before having to make up his mind and to assume the offensive. Certainly his instructions to his detachments show no sense either of a definite plan or of the importance of keeping elbow-room for manoeuvre. His western detachment (I corps and Saxons) properly handled, should have been able seriously to delay the Prussian I army in the mountains and on the line of the Iser. But Benedek's instructions were vague, and the commander of the I corps, Clam Gallas, was incompetent, so that the Prussians were able to advance to Gitschin with hardly a check. On the other wing, the opportunity to delay or destroy the crown prince's army at the exits from the mountains was also lost through want of clear orders and energetic action.

Military writers who have commented on the campaign have satisfied themselves that Benedek should have delayed the I Prussian army and army of the Elbe and have thrown his whole weight in the first instance against the crown prince, before the latter could extricate himself from the mountains. Benedek's own conception, so far as he had any definite plan, seems to have been the opposite—to delay the crown prince and to attack the armies of Prince Frederick Charles. But he never formulated a clear-cut scheme either for holding up the one enemy or for offensive action against the other. And under their relentless pressure he presently abandoned his own plans, took up a position and passively awaited attack. Much of Benedek's irresolution can probably be traced to the influence of Krismanić's defensive theories, but it was rooted in his sense of having to perform a task beyond his powers. The result of his half measures had been disastrous. In the engagements between June 26 and June 30, six of the eight Austrian corps had met defeat and had suffered severely in their massed formations against the fire of the breechloader. The Austrian losses had been well over 30.000, while those of the Prussians were less than a quarter of that total. It was a disillusioned army that retired on Koniggratz, under a leader who was not far from being demoralized.

THE BATTLE OF KÖNIGGRÄTZ (OR SADOWA)

The Prussian Plans.—On July 1 two great hosts of nearly a quarter of a million men each (the largest forces that met on one battlefield till World War I) lay within a few miles of each other. It might have been expected that a "set-piece" battle would ensue; that the Austrian army, now thrown on the defensive, would select the most favourable position in which to await attack, and that the Prussians after due reconnaissance would assault, if unable to manoeuvre their enemies out of their selected position. Actually, on July 3, 1866, these two great armies blundered into battle on a field and in circumstances which neither commander had chosen nor foreseen. The incidents which led up to this result deserve some attention. They showed that the art of reconnaissance had been forgotten with the passing of Napoleon. Neither Prussian nor Austrian army had any other employment for its numerous cavalry than to await the opportunity for a charge on the battlefield. Hence, though only a few miles apart, they completely lost touch with each other for more than 48 hours, and made their dispositions blindfold.

To consider first the Prussian plans. Von Moltke had deliberately kept an interval of half a day's march between the I and II armies, though there was no longer any bar to their close assembly. He had realized—he was the first to do so—that the union of two forces from different points *on the* field *of battle itself,* the one striking the enemy frontally, the other in flank, had been made possible by modern inventions and would lead to decisive results. The method by which he proposed in this instance to put his theories into practice is characteristic. He set himself a tactical problem—to select the best defensive position for the Austrian army—solved it to his own satisfaction by plating his opponents east of the Elbe with flanks on the fortified crossings of Josefstadt and Koniggratz, and issued orders to the Prussian forces accordingly, without ascertaining by reconnaissance whether or not Benedek had arrived at the same able solution of the problem. Von Moltke's orders for July 3 directed the I army and army of the Elbe toward Koniggratz and Pardubitz, while the II army on the left bank of the Elbe was to reconnoitre the line of the Aupa and Mettau rivers with a view to advancing next day against the supposed right flank of the Austrians. Actually, the Austrian army was still west of the Elbe, so that had Von Moltke's orders been executed the I army would have been exposed unsupported to the whole Austrian army, and could hardly have avoided defeat. The chain of events which modified these orders and made a Prussian victory possible was as follows. On the evening of July 2 Prince Frederick Charles sent out reconnaissances and discovered that there was a large Austrian force between the Bistritz and the Elbe, though he did not yet realize that the whole Austrian army was there. He at once made preparations to attack this force on the morning of the 3rd, and sent a letter to the crown prince to ask for one of the latter's corps to cover his left flank. The crown prince was asleep when the letter reached his headquarters at 2 A.M. and his chief of staff, Leonhard Rlumenthal, without awakening him refused Prince Frederick Charles' request. Meanwhile, however, duplicates of the I army's orders had reached Von bfoltke, who was prompt to realize the situation and instant to decide. Orders were sent forthwith from Imperial headquarters for the crown prince to co-operate with his whole army. These orders did not reach him till 4 A.M. of the morning of the battle.

Austrian Dispositions.—The retreat toward Königgrätz on July 1 had been confused by bad staff work. On July 2 therefore the army halted to rest instead of crossing to the east of the Elbe, as seems to have been the original intention. Meanwhile Benedek, who had now lost all faith in his advisers and in his troops as well as in himself, telegraphed to his emperor advising the immediate conclusion of peace. The emperor's reply "Has a battle been fought?" seems to have resolved Benedek to stand and fight. The full history of his correspondence with the emperor and of the instructions he received at this crisis have never been disclosed. Pressure was probably brought on him to give battle against his better judgment, but after the disaster he accepted his disgrace and loyally kept silence. Whether in any case he intended to fight a decisive battle west of the Elbe or on July 3 is doubtful. His orders, issued late at night on July 2, are almost incredibly bad judged as orders for a decisive battle. Bonnal, the author of *Sadowa,* says: "Except at Ulm and Sedan, no worse dispositions for an army about to accept battle have ever been made." It is, however, more likely that Benedek's dispositions were made merely with a view to providing for the safety of his army during another day's rest, after which he proposed to take up a position behind the Elbe. If so, he once again showed his disregard of the time factor. The orders provided for the army to occupy a semicircular position between the Trotina and Bistritz streams with the centre in front of the village of Chlum, about 10 miles northwest of Königgrätz. A mile or so north of Chlum lies the Swiep Wald, in the struggle for which the issue of the battle was decided. The position might have been made a reasonably strong one, but the orders were vague and crude and did not reach some of the Austrian corps till 6 A.M., by which time the advanced troops on both sides were already in contact. Henikstein and Krismanić, as well as Clam Gallas, had been superseded, but the new chief of staff, Baumgarten, did not arrive till the morning of the battle.

The Battle.—The numbers engaged were: Prussians 220,000 (including 14,000 cavalry) with 780 guns, Austrians and Saxons 215,000 (including 24.000 cavalry) with 770 guns. Early in the morning (which was dull and rainy) Prince Frederick Charles advanced his force to the Bistritz, intending to hold the line of that river until the II army could appear on the field. But his hand was forced by the action of his left division (VII) under Eduard S. Von Fransecky, which was already across the Bistritz and advanced into the Swiep Wald, where it drew on itself the whole weight of the Austrian right wing, IV and II corps, and caused these corps to face west instead of north. It fought magnificently against heavy odds, but its danger led to the premature advance of the remainder of the I army across the Bistritz. Thus during the whole morning the I army was struggling against greatly superior Austrian forces and was hard pressed. Meanwhile the advanced guard of the army of the Elbe was engaged on the right with the Saxon army at Kechanitz. Shortly after noon the leading troops of the II army appeared on the field and soon decided the conflict. They caught the Austrian II and IV corps in the act of retiring from the Swiep Wald to the positions they had originally been ordered to hold from Chlum and Nedelist to the Elbe, quickly routed them, and seized Chlum. The Austrian reserve corps then made two counterattacks on Chlum. These failed, and by 4:30 P.M. the Austrians were in full retreat, gallantly covered by the self-sacrificing charges of their cavalry and by the steadiness of their artillery. There was great confusion at the river crossings, but the pursuit was not pressed, the victors themselves being in almost as great confusion as the vanquished owing to the lines of advance of the I and II armies having converged. The Austrian losses were about 45,000, of whom 20.000 were prisoners, and 150 guns; the Prussian losses were under 10,000. The features of the battle were, on the Prussian side, the extraordinary influence of the gallant fighting of Fransecky's division in the Swiep Wald, the deadliness of the breechloader, and the spirit which animated the swift and resolute march of the II army to the rescue of the I army. On the Austrian side, the artillery was brilliantly handled throughout the battle, and the cavalry by their devotion at the end made some amends for their failures in reconnaissance.

Benedek withdrew his army unmolested to the fortress of Olmiitz to recuperate, thus placing himself on the flank of the Prussian advance on Vienna. There is no virtue, however, in a flank position unless the troops have the power to issue offensively from it, as these had not. The Archduke Albert, who had succeeded to the chief command, ordered the army from Olmütz to Vienna, to join the two corps brought back from Italy in the direct defense of the capital. The Austrians eventually succeeded in assembling at Vienna, though an engagement with the Prussian II army at Tobitschau on July 15 forced the three rear corps from Olmütz to make a wide detour. Prussians and Austrians were facing each other outside Vienna when an armistice was agreed to on July 22, followed by peace on Prussia's terms.

The Campaigns in Western Germany.—Space permits only a brief reference to the operations of the army of the Main under Gen. von Falkenstein, to whom had been given the task of dealing with the minor German states allied to Austria. The Hanoverian army on its way to join the Bavarians won a success over a Prussian column at Langensalza on June 27, but was surrounded and forced to capitulate two days later. The operations against Bavaria lasted all July and consisted of a series of small actions, as a result of which the territory of the states hostile to Prussia had mostly been overrun when an armistice was concluded early in August.

Comments.—The campaign of 1866 marks the dawn of modern war, and may be said to represent the passing of the military art from an amateur to a professional basis. The characteristic of the professional is constant and assiduous practice at all times not only when engaged in a match. Similarly, Von Moltke introduced unceasing preparation in peace for every detail in war and enjoined diligent study on commanders of all grades. Von Moltke's theories of war (enunciated in his famous "Memorandum for the Guidance of Superior Officers," issued in 1868) also mark a stage in the science of strategy, which may be studied in Caemmerer's *Development of Strategical Science.* Historians a century hence may write that Clausewitz and his disciple Von Moltke killed war by making it so serious, so dull and so deadly.

Bibliography.—The English translation of Bonnal's *Sadowa* (1907) contains a full bibliography of works published up to that date. Neill Malcolm, *Bohemta 1886* (1912), and translations of Von Moltke's *Projects* and *Correspondence* are the principal works published in English since that date. (A. P. W.)

SEVEN WISE MASTERS, THE, a cycle of stories of oriental origin. A Roman emperor causes his son to be educated away from the court in the seven liberal arts by seven wise masters. On his return to court his stepmother the empress seeks to seduce him. He is bound over to a week's silence. During this time the empress accuses him and seeks to bring about his death by seven stories which she relates to the emperor; but her narrative is each time confuted by tales of the craft of women related by the sages. Finally the prince's lips are unsealed, the truth exposed, and the wicked empress is executed.

An analogous collection of stories occurs in Sanskrit, but the Indian original is unknown. Travelling from the east by way of Arabic, Persian, Syriac and Greek, it was known as the book of Sindibâd, and was translated from Greek into Latin in the 12th century by Jean de Hauteseille, with the title of Dolopathos (edit. H. Oesterley, Strasbourg, 1873). This was translated into French about 1210 by a *trouvère* named Herbers as *Li Romans di Dolopathos.* The German, English, French and Spanish chapbooks of the cycle are generally based on a Latin original. Three metrical romances probably based on the French, and dating from the 14th century, exist in English. The most important of these is *The Sevyn* Sages by John Rolland of Dalkeith, edited for the Bannatyne club (183;).

The Latin romance was frequently printed in the 15th century, and Wynkyn de Worde printed an English version about 1515. *See* G. Paris, *Deux rédactions du roman des sept sages de Rome* (1876, Soc. des. anc. textes fr.); Biichner, *Historia septem sapientium* . . . (Erlangen, 1889); K. Campbell, *A Study of the Romance of the Seven Sages with special reference to the middle English versions* (Baltimore, 1898); D. Comparetti, *Researches respecting the Book of Sindibâd* (Folk-Lore Soc., 1882).

SEVEN WISE MEN OF GREECE, THE, a collective name for certain sages who flourished *c.* 620–550 B.C. The generally accepted list is Bias, Chilon, Cleobulus, Periander, Pittacus, Solon, Thales (*qq.v.*), although ancient authorities differ as to names and number.

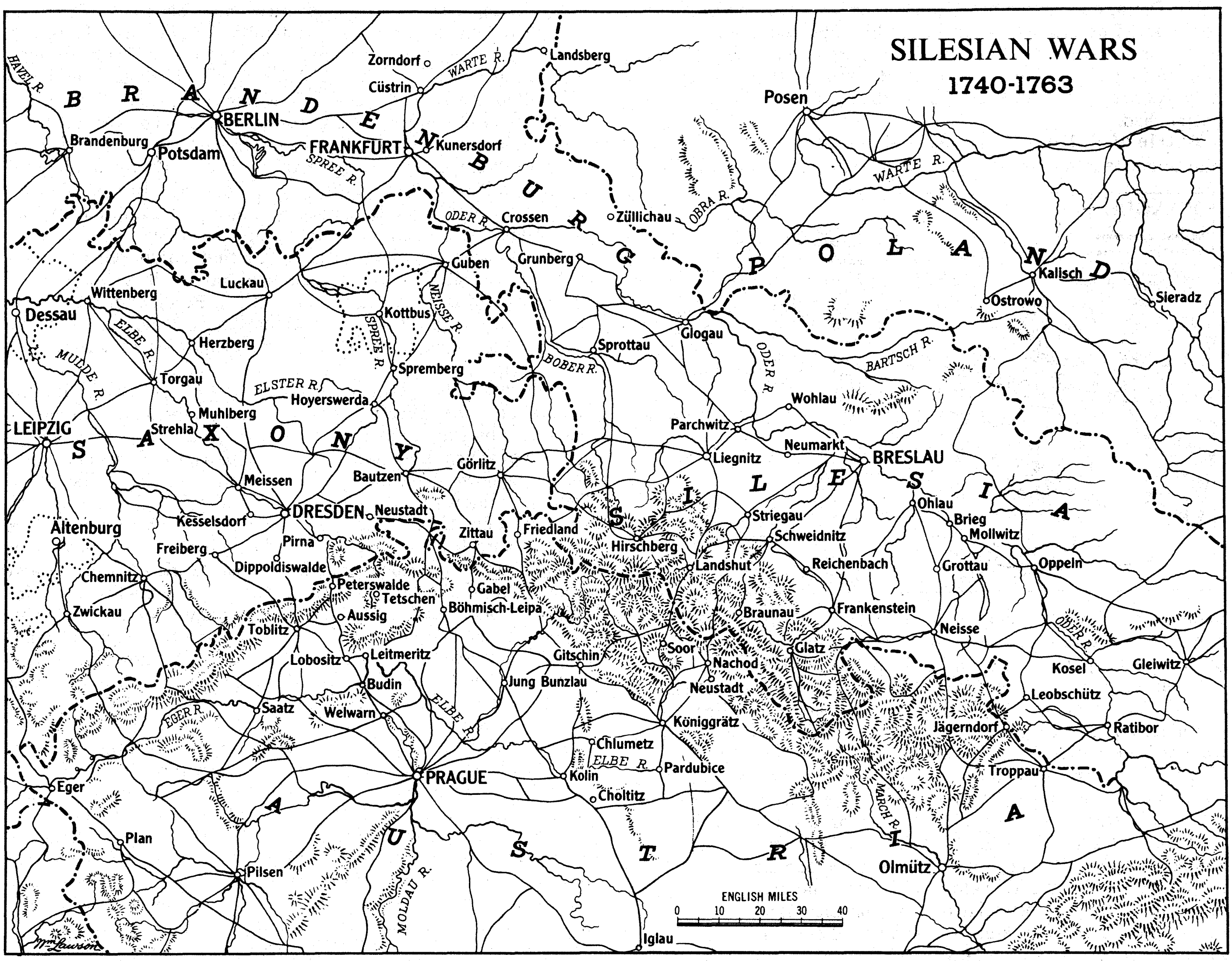
See "Septem sapientium carmina et apophthegmata," with short biographies in F. Mullach, *Fragm. philosophorum Graec.,* i. (1860); H. Diels, *Die Fragmente der Vorsokratiker,* Bd. 2 (4th ed., 1922) and Uberweg, *Grundriss der Gesch. der Philosophie,* Bd. I. (1926).

SEVEN WONDERS OF THE WORLD, the name conferred on a group of ancient works of art which had obtained pre-eminence among the sight-seers of the Alexandrian era. The earliest extant list, doubtless compiled from the numerous guide books then current in the Greek world, is that of the epigrammatist Antipater of Sidon (2nd century B.C.). A second and slightly divergent list, from the hand of a Byzantine rhetorician has been incorporated in the works of Philo of Byzantium. The monuments are as follows:—(I) the pyramids of Egypt, (2) the gardens of Semiramis at Babylon, (3) the statue of Zeus at Olympia (see Phidias), (4) the temple of Artemis at Ephesus, (5) the Mausoleum at Halicarnassus (*see* Monuments and Memorials), (6) the Colossus at Rhodes, (7) the pharos (lighthouse) of Alexandria, or the Walls of Babylon.

See "Philo," *De septem mundi miraculis* (ed. Hercher, Paris, 1858).

SEVEN YEARS' WAR (1756–1763), the name given to the European war which arose from the formation of a coalition between Austria, France, Russia, Sweden and Saxony against Prussia, with the object of destroying, or at least crippling, the power of Frederick the Great. Prussia was joined by England, and between England and France, as usual, a maritime and colonial war broke out at the first pretext; this war laid the foundations of the British empire, for ere the seven campaigns had been fought in Europe, the French dominion in Canada and the French influence in India, in spite of Dupleix, Lally and Montcalm, had been entirely overthrown by the victories of Clive, Amherst and Wolfe. Great as was the effect of these victories on the history of the world, however, it is at least questionable whether the steadfast resistance of Prussia, almost single-handed as she was—the resistance which laid the solid, if then unseen, foundations of modern Germany—is not as important a phenomenon and from the technical military standpoint Rossbach and Leuthen, Zorndorf and Kunersdorf possess an interest which it would be possible perhaps to claim for Plassy and for Quebec, but not for border conflicts in Canada and India. It is not only battles, the distinct and tangible military events, that make up the story of Frederick's defence. There are countless marches and manoeuvres, devoid of interest as regards their details; but, as indications of the equilibrium of forces in 18th-century warfare, indispensable to a study of military history as a whole.

Pirna.—Learning of the existence and intentions of the coalition, Frederick determined to strike first, and he concentrated his 150,000 men as follows:—11,000 men in Pomerania to watch the Swedes, 26,000 on the Russian frontier, 37,000 men under Field Marshal Schwerin in Silesia and a main body of 70.000 in three columns ready to advance into Saxony at a moment's notice, the king being in chief command. On Aug. 29, 1756 the Saxon frontier was crossed. Dresden was occupied on Sept. 10, the Saxon army, about 14,000 strong, falling back before the invaders to the entrenched camp of Pirna, an almost inaccessible plateau parallel to the Elbe and close to the Bohemian frontier. The secret of the Prussian intentions had been so well kept that the Austrians were still widely distributed in Bohemia and Moravia. 32,000 men under Field Marshal Browne were at Kolin, and 22,000 under Piccolomini at Olmütz, when on Aug. 31 the news of the invasion arrived, and such was their unreadiness that Browne could not advance till Sept. 6, Piccolomini until Sept. g. Meanwhile the Prussians, leaving detachments to watch the exits from Pirna, moved up the Elbe and took post at Aussig to cover the investment of the Saxons. Learning of Browne's approach on Sept. 28, the king, assuming the command of the covering force, advanced yet farther up the Elbe to meet him, and the two armies met at Lobositz (opposite Leitmeritz) on the morning of Oct. 1. The battle began in a thick fog, rendering dispositions very difficult, and victory fell to the Prussians, principally owing to the tenacity displayed by their infantry in a series of disconnected

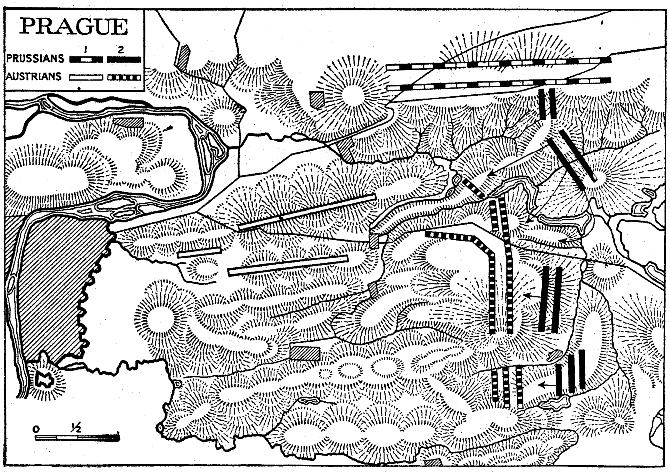


local engagements. The nature of the ground rendered pursuit impossible. and the losses on both sides were approximately equal —viz. 3.000 men—but the result sealed the fate of the Saxons, who surrendered on Oct. 14, and were taken over bodily into the Prussian service. Prussian administrators were appointed to govern the country, and the troops took up winter quarters.

The coalition had undertaken to provide 500,000 men against Prussia. but at the beginning of the year only 132,000 Austrians stood ready for action in northern Bohemia. Against these the king was organizing some 250,000, 45,000 of whom were paid for by British subsidies and disposed to cover Hanover from a French attack. After leaving detachments to guard his other frontiers. Frederick was able to take the field with nearly 150,000 men, but these also were scattered to guard a frontier some 200 mi. in length—the left wing in Silesia under Schwerin and the duke of Brunswick-Bevern, the centre and right under the king. In April the operations began. Schwerin and Bevern crossed the mountains into Bohemia and united at Jung Bunzlau, the Austrians falling back before them. The king marched from Pirna and Prince Maurice of Dessau from Zwickau on Prague, at which point the Austrian commands were ordered to concentrate.

Battle of Prague.--On the morning of May 5 the whole army, except a column under Field Marshal Daun, was united here under Prince Charles of Lorraine, and the king, realizing the impossibility of storming the heights before him, left a corps under Keith and a few detachments to watch Prague and the fords across the river, and marched upstream during the night and, crossing above the Austrian right. formed his army (about 64,000) for attack at right angles to the Austrian front. The ground had not been reconnoitred, and in the morning mist many mistakes in the deployment had been made, but as Daun was known to be but 20 mi. away and the Austrian army was changing its front to meet the unexpected attack, the king threw caution to the winds and sending Zieten with his cavalry by a wide detour to cover his left, he ordered the whole to advance. One of the most savage battles in history was the result. Almost immediately the Prussian infantry became entangled in a series of morasses, the battalion guns had to be left behind and the troops had to correct their alinement under the round shot fired by the Austrians, who had completed their change of front in time and now stood ready to sweep the open glacis before them. Before the storm of bullets and the grape and canister of the heavy and battalion guns the Prussian first line faltered and fell in thousands. Their attempts to prepare the way for the bayonet assault broke down. Schwerin was killed. But the second line carried the survivors on, and in the nick of time Zieten's cavalry drove the Austrian horsemen off the field and broke in on the flank and rear of their infantry. This turned the scale, and the Austrians retreated into Prague in hopeless confusion, leaving some 10,000 men (14.8%) on the ground, and 4.275 prisoners, out of about 66,000, in their enemy's hands. The Prussians lost 11,740 men killed and wounded and 1,560 prisoners. and in all 20.8% of their strength. The actual fighting seems only to have lasted about two hours, though firing did not cease till late at night; 16,000 Austrians managed in the confusion to evade capture and join Daun, who made no movement either on this or succeeding days to come to the assistance of his comrades. but began a leisurely retreat towards Vienna. The Prussians immediately began the siege of the town, and after a month's delay Daun, now at the head of some 60,000 men, moved forward to the relief of the city. Learning of his approach, the king, taking with him all the men who could be spared from the investment and uniting all available detachments, moved to meet him with only 34,000 men, and on June 18 he found Daun strongly entrenched.

Battle of **Kolin.**—He immediately endeavoured to march past him and attack him on the right flank—a repetition of the Prague

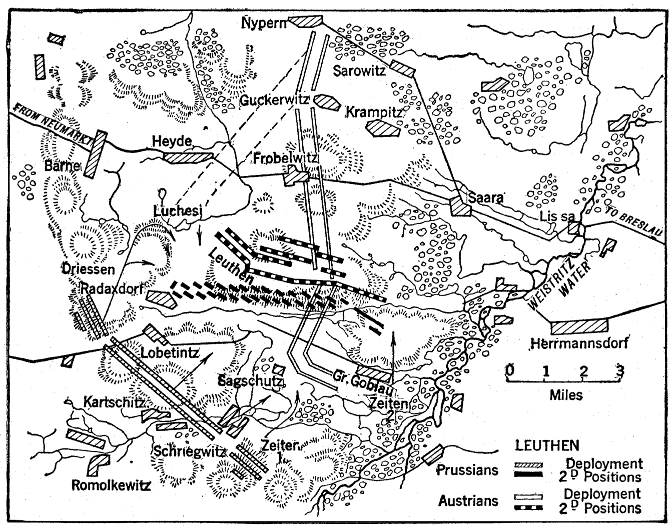


manoeuvre without its concealment—but the Austrian light troops harassed his columns so severely during the movement that without orders they wheeled to drive them off and, being thus thrown into disarray, they took three divergent objectives. Their disunited attacks all fell upon superior numbers, and after a most obstinate struggle they were badly beaten with a loss in killed and wounded of 6,710 (18·6%) and 5.380 prisoners with 45 guns. The fighting lasted 5½ hours. The Austrian loss was only 8,000 out of 53,500, or 15·2%, of whom only 1,500 were taken prisoners.

This disaster entailed raising the siege of Prague, and the Prussians fell back on Leitmeritz. The Austrians, reinforced by the 48,000 troops in Prague, followed them 100,000 strong, and, falling on Prince August Wilhelm of Prussia, who was retreating eccentrically (for commissariat reasons) on Zittau, inflicted a severe check upon him. The king was compelled to abandon Bohemia, falling back on Bautzen. Having re-formed his men and calling in Keith's 27,000 men from Pirna, he again advanced, but found the enemy so strongly posted at Burkersdorf (south of Bischofswerda) that he relinquished his purpose and retreated on Bernstadt.

Frederick in the West.—Meanwhile his enemies had been gathering around him. France had despatched 100,000 men under d'Estrées against Hanover, where Cumberland with 54,000 stood to meet him, and another 24,000 men were marching through Franconia to unite with the "Army of the Holy Roman Empire" under the prince of Saxe-Hildburghausen. Fortunately this latter army was not as formidable as its title, and totalled only some 60,000 most undisciplined and heterogeneous combatants. In the north 100,000 Russians under Apraxin were slowly advancing into East Prussia, where Lehwald with 30,000 was preparing to confront them, and 16,000 Swedes had landed in Pomerania. On June 26 Cumberland had been beaten at Hastenbeck by d'Estrées, and the French overran Hanover and Brunswick. The king, leaving Bevern with only 13,600 men in Silesia to watch the Austrians, began to march across Germany to succour Cumberland. Arrived at Leipzig on Sept. 3, he heard of Lehwald's defeat at Gross-Jagerndorf on Aug. 30, and immediately afterwards of Cumberland's convention of Kloster Seven, which gave up Hanover to the French. Fearing that the French army no set free in Hanover might unite with the Army of the Empire under Hildburghausen and with 150,000 men march direct on Berlin, Frederick, taking with him 23,000 men, marched to join Prince Ferdinand in the district about Halberstadt, hoping to strike his blow before the enemy's junction could be completed. Nobility, therefore, was the first consideration, and arrangements for supply having been made in advance along his road, his troops covered 170 m. in 12 days (September 1–13). But Hildburghausen, not having been joined by d'Estrées, refused to fight and fell back into the wooded districts of Thuringia and Franconia. Bad news now reached Frederick from Silesia; leaving Ferdinand to observe Hildburghausen, he marched with all haste to Eckersberg to support Bevern. Arrived here, he found more bad news from Berlin, which had been entered by a body of Austrian raiders under Hadik and plundered. Prince Maurice and Seydlitz were sent by forced marches to its aid, and before them Hadik retired at once (Oct. 18). Finding the Austrians for the moment quiescent and hearing that Hildburghausen was again advancing, the king now concentrated all available men on Leipzig and marched to support Prince Ferdinand. Hildburghausen took up a position about Meucheln on Nov. 2, and on the 5th moved off to repeat Frederick's manoeuvre of Prague against its inventor.

Rossbach.—The Battle of Rossbach (*q.v.*) followed. In this Seydlitz and the Prussian cavalry won imperishable renown. Aided only by the fire of 18 guns and of 7 battalions of infantry, only two of which fired more than five rounds, the Prussian squadrons swept down upon the marching columns of the Allies and in about 40 minutes the whole 64,000 were in full flight. Never was a victory more timely, for the Prussian army was almost worn out and more bad news was even then on the way. Bevern in Silesia, who had been beaten at Moys near Gorlitz (Sept. 7) and in the battle of Breslau on Oct. 22, had been compelled to retire behind the Oder, leaving the fortresses of Schweidnitz and Breslau to their fate, and both had capitulated within a few days. Leaving a small reinforcement for Ferdinand, the king now moved by forced marches to Liegnitz. The distance, about 170 m. through difficult country, was covered again in 12 days, but the numbers were small, only 13,000, which shows how tremendous had been the drain upon the men of the previous six weeks' exertions. On the night of Dec. 4, having joined the beaten forces of Bevern at Parschwitz, making in all 43,000 men of very unequal fighting value, he decided to attack the 72,000 Austrians who lay across the Breslau road, their centre marked by the village of Leuthen (*q.v.*). His position appeared so desperate that he sent for all his generals, laid the facts before them, announced his decision to attack and offered to accept any man's resignation without preju-



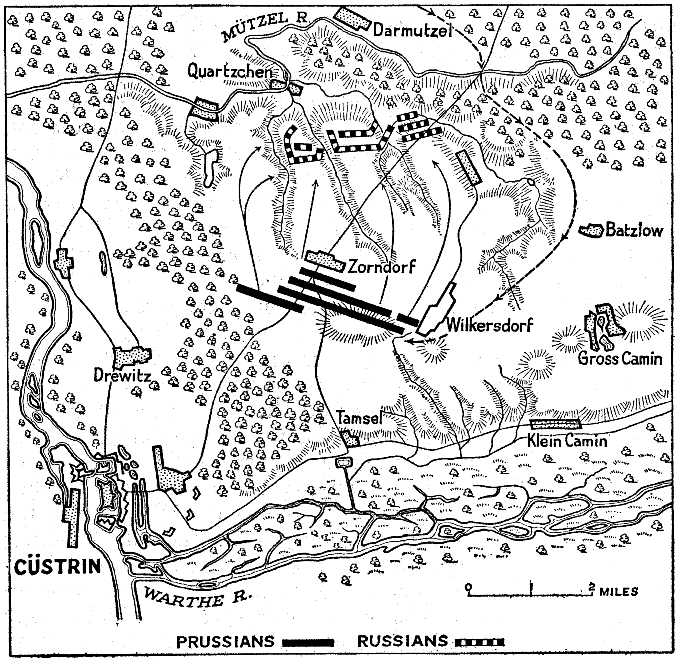
dice to his character should he deem the risk too hazardous Needless to say, not one accepted the offer.

Battle of Leuthen.— Covered by the low rolling hillocks of the district, the army now moved off to its right across the Austrian front, the advance led by Zieten and half the cavalry, the rear covered by Driessen with the remaining half—some 40 weak squadrons. The infantry having gained a position sufficiently on the Austrian flank, now wheeled into line and attacked in Cchelon of battalions from the right. The battle soon became desperate, and the Austrian cavalry on their right wing under Luchesi, unaware of Driessen's presence as a flank guard, issued out of their lines, wheeled to their left and swept down upon the refused flank of the Prussian infantry; but they never reached them, for Driessen, seizing his opportunity, set his squadrons in motion and attacked. The Austrians, completely surprised, were ridden down and driven back on to the front of their own infantry, and the pressure of the fugitives threw the rear of their left wing into confusion and in a short time the ruin of their army was completed. When the news of Driessen's charge was brought to the king his astonishment was expressed in the single phrase, "What, that old fool Driessen?" The fighting, however, had been desperate, and though the Austrians out of their 72,000 lost 37% including 20,000 prisoners, with 116 guns, the Prussians lost 6,200 (14%) making with the other battles of the year a total of nearly 75,000 men, and not including losses in minor skirmishes and on the march.

Campaign of 1758.—The raid upon Berlin had accomplished nothing, and the advance of the Russian main body had died out for want of resolution to seize the opportunities offered by Frederick the Great's absence. The Tsaritsa, annoyed by his slowness, recalled Apraxin and appointed Fermor in his place. Utilizing the winter snows, he collected some 31,000 men and crossed the frontiers of East Prussia (Jan. 10, 1758) and attempted to annex the province, driving out all the Prussian officials who refused to swear fealty to Elizabeth. This took time, and when the period of thaw supervened the Russians were immobilized and could not advance until approaching summer had dried the roads again. For the moment, therefore, no danger threatened Frederick from this quarter, and Rossbach had effectually tamed the French. The Swedes, too, showed little energy, the "roadless" period affecting them equally with the Russians.

Frederick therefore resolved to seize the opportunity to renew his invasion of Austria. As a beginning he recaptured Schweidnitz in April with 5,000 prisoners. The Austrian field army under Daun lay about Koniggratz, covering all the passes out of Silesia; but covered by the newly formed "Free Corps" (his answer to the semi-savage Croats, Pandours and Tolpatches of the Austrians), Frederick marched right across their front on Olmütz, whilst a special corps (30,000) under Prince Henry threatened their left from Saxony and the Elbe. He had with him about 40,000 men. But Olmütz lay 90 m. from the Prussian frontier, and the Austrian light troops swarmed in the intervening district. Ultimately a great Prussian convoy was destroyed in the action of Domstädl, and the siege of Olmütz had to be raised (July 1); but instead of marching back the way he had come Frederick led his troops through Bohemia practically in the rear of Daun's army, and on July 14 entered Daun's empty entrenchments at Koniggratz. Fermor's Russians were now again in the field and had reached Posen, burning and plundering horribly. By skilful manoeuvring the king deceived the Austrians till the roads to Silesia by Skalitz and Nachod were open and then by a rapid march passed over into Silesia, reaching Grussau (near Landshut) on Aug. 8. Leaving Keith with half his force to hold this district, he then marched to Frankfurt-on-the-Oder, taking with him only some 15,000 men, to strengthen the wing already engaged against the Russians. Frankfurt was reached on Aug. 20. Fermor was then besieging Custrin with 52,000 men, and hearing of the king's approach he raised the siege and placed himself behind a formidable obstacle facing north, near Zorndorf, from which direction the king was approaching.

Battle of Zorndorf.—Seeing that the same obstacle that prevented him from attacking the Russians prevented them equally from attacking him, the king marched right round Fermor's eastern flank—the Russians gradually forming a fresh front to meet him—so that when the Prussian attack began on the morning of Aug. 25 they stood in three irregular squares, divided from each other by marshy hollows, and thus unable to render one another support. The king made his first effort against the square on the right—Seydlitz with his squadrons covering the movement. But the Russian troops fought with far more spirit than the Austrians had ever shown, and things were going very badly with the Prussians when Seydlitz, who in the meanwhile had succeeded in making paths across the Zaberngrund on which the Russian right rested, flung himself upon the great square, and rode over and destroyed the whole mass in a prolonged mêlée in which quarter was neither given nor asked. Relieved by this well-timed charge, the king now re-formed the infantry already engaged, and concentrated all his efforts on the south-west angle of the great centre square. Again the Russians more than held their own, issuing forth from their squares and cap



BATTLE OF ZORNDORF

turing many field pieces. Some of the Prussian infantry was actually broken and in full flight when Seydlitz, with his ranks re-formed and his horses rested, returned and again threw himself upon the square exactly as on the previous occasion and with the same result—the square, as a formation, was broken, but groups still stood back to back and the most savage butchery ensued. Darkness put a stop to the slaughter. Of 36,000 Prussians 12,500 were killed or wounded, 1,000 prisoners or missing (37.5%), and of 42,000 Russians about 21,000 had fallen (50%).

In the night the survivors gradually rallied, and morning found the Russians in a fresh position a couple of miles to the northward, but Frederick's troops were too weary to renew the attack. Gradually the Russians withdrew towards Landsberg and Königsberg, and the king, leaving Dohna to follow them up, marched with the remainder of his forces on Sept. 2 for Saxony, covering 22 m. a day. They arrived only in the nick of time, for Daun had united with portions of the Empire Army and was threatening to crush Prince Henry under the weight of more than two-fold numbers. The prince had been driven into an entrenched position above Gahmig near Dresden and Dnun was about to attack, but the mere name of Frederick was enough, and learning of his arrival Daun fell back to Stolpen on Sept. 12.

The Prussian army now lay around Grossenhain, Prince Henry's force covering Dresden and the Elbe bridges. The Empire Army was at Pirna, Daun at Stolpen, and in these positions they remained until Sept. 26, the Prussians getting the rest they so urgently needed. On that date, however, the state of truce was broken and the king moved towards Bischofswerda, where Daun's subordinate Loudon was posted. The latter retired, opening the road to Bautzen. The king arrived at Bautzen on Oct. 7 and had to wait until the 10th for provisions from Dresden. He then moved forward to Hochkirch, where he found Daun strongly entrenched across his path at Kittlitz with 90,000 men, the Prussians having only 37,000. The king determined to attack the Austrian right. So confident had the Prussians become in the belief that Daun would never take the offensive himself that the most elementary precautions of safety were forgotten.

Battle of **Hochkirch.**—During the night of the 13th the Austrians, leaving their watchfires burning and moving silently through the woods, which covered much of the ground, formed up almost all round the Prussian camp. At 5 A.M. the attack was delivered from all quarters simultaneously and a most desperate struggle ensued. Nothing but the superb discipline of the Prussians saved the situation. Zieten with his squadrons managed to keep a way of escape open, and after a most obstinate conflict the wreck of the army succeeded in withdrawing, leaving 101 guns and 9,450 men on the ground or in their enemies' hands (25.5%). The Austrians, in spite of the advantage of a well-conceived surprise, lost 7,590 men and were too shaken for pursuit. They fell back to their old camp, where they remained for a week, thus giving Frederick time to bring up reinforcements from Dresden (6,000 men) and, starting on the 23rd, he marched right round the Austrian right and raised the siege of Neisse, the prime object with which he had set out. Daun, learning that the king had gone past him into Silesia, now laid siege to Dresden. On Nov. 15 he heard that Frederick was marching to its relief through Lusatia and incontinently gave way, retiring on Pirna. The king was in Dresden again on the 20th.

Campaign of 1759.—The drain on Frederick's resources had been prodigious. On the battlefields of the previous three years he had lost at least 75,000 men, not counting the waste of life in his marches and skirmishes; but he still managed to keep 150,000 men in the field, though for want of the old two years' training in loading, firing and manoeuvring the average efficiency had much diminished. In cavalry, too, he was relatively weaker, as there was no time to train the remounts. His enemies felt their losses far less and were beginning to understand his tactics; fortunately they remained incapable of combined action.

After minor operations on the frontiers the Russians took the field. Fermor had been superseded by Soltikov, and Dohna with his 18,000 men proved quite inadequate to arrest the Russians' progress. He was superseded by Wedell, who, on July 23, with 26,000 men boldly attacked the 70,000 Russians whilst on the march near Züllichau. He was defeated with a loss of 6,000 and fell back to Crossen bridge, 5 m. below Crossen, which Soltikov occupied next day, thence he moved down the river towards Frankfurt, keeping on the eastern bank. Daun had detached Loudon and Hadik with 35,000 men to join him, and it became vital to Frederick to prevent the combination. Leaving Prince Henry at Schmottseifen to watch Daun, he marched with all available forces and joined Wedell on Aug. 6 at Müllrose near Frankfurt, after vainly searching for the Hadik-Loudon force. Here he was joined on the 10th by Finck with 10,000 men, bringing his whole force up to 50,000 against the Russian and Austrian 90,000, who lay entrenched in the sandhills about Kunersdorf.

Battle **of Kunersdorf.**—On the 11th he crossed his whole force over the Oder at Reitwein and on the 12th marched forward, intending to envelop the Russians on both flanks; but his columns lost their way in the woods and their attacks were delivered successively. In spite of their usual disciplined gallantry, the Prussians were completely beaten, even Seydlitz and his squadrons failed to achieve the impossible, and the night closed down on the greatest calamity Frederick had ever experienced. Of 43,000 men 20,720 (48.2%) mere left on the ground and 178 guns fell into the hands of the enemy; and the allied Austro-Russian force only lost 15,700. The battle had only lasted six hours. In the depression following this terrible day he wrote to Schmettau, commanding at Dresden, telling him to expect no help, and on Sept. 4 Dresden fell.

As usual Frederick was saved by the sluggishness of his enemies, who attempted no pursuit, and being reinforced the day after the battle by 23.000 men, and having ordered up Kleist (who had been watching the Swedes), he was again at the head of an army. Week after week went by, during which he countered all attempts of Daun and Soltikov to combine, and ultimately the Russians, having consumed all the food and forage in the districts they occupied. were compelled to fall back on their own frontiers. Then, uniting with Prince Henry, the king turned to fall upon Daun; but his contempt for his adversary proved his own undoing.

Battle of **Maxen.**—He sent a detachment of 12,000 men under Finck to work round the Austrians' flank by Dippoldiswald to Maxen, but the latter, learning of the movement and calling up a wing of the Empire Army to their assistance, fell upon Finck with 42,000 men and compelled him to surrender afrer two days' hard fighting. The combination having failed, the two armies stood facing one another till far into the winter. But for Prince Ferdinand's glorious victory at Minden on Aug. 1, the year would have been one catalogue of disaster to the Prussian arms, and these operations must now be mentioned.

In the early part of 1758 Prince Ferdinand with 30,000 men had advanced from Liineburg and was joined by Prince Henry with 8.600 from Halberstadt. The approach of the latter threatened the right wing of the French army under Clermont, which was posted along the Aller, and the whole line gave way and retreated without making any serious stand behind the Rhine. Prince Ferdinand followed and defeated them on June 23 at Crefeld. Clermont was relieved by Contades and at the same time Soubise, who had at last reorganized his command, shattered by the disaster of Rossbach, moved forward through Hesse and compelled Prince Ferdinand to withdraw from his very advanced position. No engagement followed; Soubise fell back upon Frankfurt and Prince Ferdinand held a line through Münster, Paderborn and Cassel during the winter.

Fortunately events in Canada and the glory of his victories had made Frederick's cause thoroughly popular in Great Britain, and at last it became possible to detach a considerable force of British troops to Prince Ferdinand's assistance, whose conduct turned the scale in the critical moment of the campaign. During the winter the French had organized their forces in two columns—based on Frankfurt and Wesel respectively. Broglie was now in command of the former; Contades still led the latter.

In April Prince Ferdinand advanced to drive the French out of Hesse and Frankfurt, and actually reached Bergen, a village some 10 m. to the north, but here he was defeated by Broglie (April 13) and forced to retreat the way he had come, the French following along their whole front and by sheer weight of numbers manoeuvring him successively out of each position he assumed. On July 10 Broglie surprised Minden, thus securing a bridge over the Weser and free access into Hanover, and light troops overran the south of the electorate. On the 16th Contades with the left column joined Broglie and the French now had some 60,000 men against the 45,000 Ferdinand could muster. The latter's position was extremely difficult, for the French had only to continue in possession of the bridges at Minden to ruin the whole country by their exactions, and the position they held was too well protected on the flanks and too strong in front for direct attack. Nevertheless Prince Ferdinand drew up before it and met the French plundering raids by a threat on their communication with Cassel, and as a further inducement to tempt Contades to attack him, he detached a column under Wangenheim, which entrenched itself across the only outlet by which the right of the French army could debouch from behind the marshes which lie in the angle between the Weser and the Bastau. The bait took, and during the early hours of Aug. 1 the French army moved out to attack Wangenheim.

Battle of Minden.—But Ferdinand's troops had been lying in instant readiness for action, and as soon as the outposts gave the alarm they were in motion in eight columns, *i.e.,* practically deployed for action to meet the French as they emerged from their positions. Unfortunately the outpost reports were delayed by about two hours, owing to the heavy gale and storm that was prevailing, and the French had made far greater progress with their deployment than Ferdinand had reckoned on. An almost front-to-front engagement ensued. Things were going badly with the Prussians when, through a mistake in the delivery of an order, the British brigade (12th, 20th, 23rd, 25th, 37th, 51st regiments), followed by some Hanoverian battalions. began to advance straight upon the masses of French cavalry who stood protected by the crossfire of several batteries. Once launched, neither fire nor shock could check their progress; halting for a moment to pour volleys into the charging squadrons hastily thrown against them, they swiftly resumed their advance. French infantry too were hurled against them, but were swept away by fire and bayonet, and presently they had pierced right through the French line of battle. Now came the moment when cavalry should have been at hand to complete the victory, and this cavalry, the Blues, the 1st and 3rd Dragoons, Scots Greys and 10th Dragoons under Lord George (afterwards Viscount) Sackville (*q.v.*) stood ready, waiting only the order to advance. This Sackville refused to give, though called on three times by the prince; no satisfactory explanation of his conduct has ever been discovered, but he was tried by a general court-martial and cashiered. Nevertheless, so brilliant had been the conduct of all the troops engaged, especially of the infantry brigade that the victory was won even in spite of this failure of the cavalry, and before evening the French were retreating as a demoralized mass towards Cassel, leaving some 10,000 men and 45 guns in the hands of the victors, who on their side out of 43,000 had lost 2,600 killed and wounded. Of the six British regiments that went into action 4,434 strong, 1,330 (30%) had fallen, but their feat is not to be measured only by the losses victoriously borne—these were not unusual in the period—but by the astounding discipline they maintained throughout the advance, resuming their march after beating off cavalry charges with the cool precision of a review in peace-time. Ferdinand followed up his victory by a pursuit which was vigorous for three days and had all but reached the Rhine when his movement was stayed by the necessity of detaching 12,000 men to the king to make good the losses of Kunersdorf.

Campaign of 1760.—The year opened gloomily for Frederick. His embarrassment both for men and money was extreme, and his enemies had at last agreed on a combined plan against him. They purposed to advance in three columns concentrically upon him: Daun with 100,000 men in Saxony, Loudon with 50,000 from Silesia, Soltikov's Russians from East Prussia; and, against whichever column the king turned, the others were to continue towards Berlin. Only in Hanover were the conditions more favourable, for Ferdinand had 70,000 (20,000 British) against the 125,000 of the French.

Early in April the king stood with 40,000 men, west of the Elbe near Meissen facing Daun, Prince Henry with 34,000 in Silesia from Crossen to Landeshut, 15,000 under Forcade and Jung-Stutterheim in Pomerania facing the Swedes and Russians. Towards the end of May Loudon moved to besiege Glatz, and Fouqué, who commanded at Landeshut, marched with 13,000 to cover Breslau. Loudon at once seized Landeshut, and Fouqué, returning in response to urgent orders from the king, was attacked by Loudon with 31,000 men and almost destroyed. Meanwhile, Prince Henry had moved to Landsberg against the Russians, but failed to seize his opportunities and thus Silesia lay open to the Austrians. Frederick decided to march with his main body against Loudon and attack him if unsupported, but, if his movement induced Daun to move to Loudon's support, then to double back and besiege Dresden. For this purpose a siege train was held in readiness at Magdeburg. He marched rapidly on Bautzen, then hearing that Daun was approaching to support Loudon he returned and besieged Dresden (July 12). The town was bombarded, there being no time for regular siege approaches, but it held out, and by the 28th of July Daun's army returning had almost surrounded Frederick. The siege had to be raised, and during the night of July 29 the Prussians slipped away to Meissen. On the same day Frederick learnt that Glatz, the key to Southern Silesia, had fallen into the hands of the Austrians, but as a set-off the news shortly afterwards arrived of Prince Ferdinand's brilliant victory at Warburg, in which the British cavalry led by the marquis of Granby amply wiped out the disgrace incurred by Sackville.

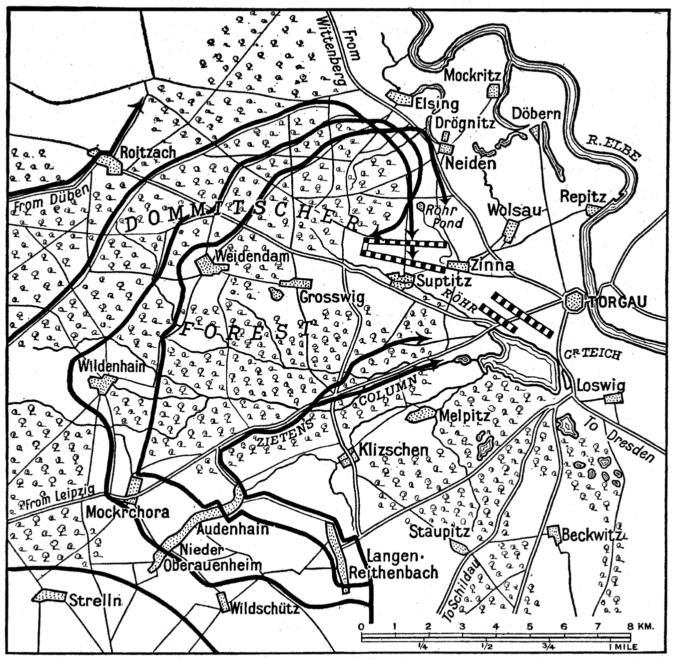
On Aug. 1 Frederick began his march into Silesia, summoning Prince Henry from Landsberg to join him, which he did by a splendid march of some 90 m. in three days. The king's march was almost as remarkable, for the roads were very bad and the Austrians had freely obstructed them; nevertheless in five days he reached Bautzen, having marched more than 100 m. from his starting-point, and crossed five considerable rivers on his way. Thence he continued more easily to Bunzlau. Daun was in front of him and Lacy with clouds of light troops on his right, the Russians under Czernicheff with Loudon not far away to his left front, 114,000 men in all to his 30,000, but he held to his decision to reach Schweidnitz. With this purpose in view he moved south-east on Jauer, marching 25 m. on Aug. 9, but the enemy was still in front of him and hovering on his flanks. On the 10th he tried the Liegnitz road with the same result, and his position became desperate as his food was almost exhausted. He had already covered 15 m. that day, but at 11 P.M. he called on his men for a night march and formed up again on his old position next morning, Aug. 11. He appeared to be completely surrounded, and things looked so desperate that Mitchell, the British ambassador, burnt his papers and cipher key. At sunset on the 12th, however, Frederick again broke camp and by a night march evaded the enemy's scouts and reached Liegnitz at noon on the 13th, the Austrians appearing a couple of hours later. The troops rested during the 13th and 14th, but at nightfall, leaving their watch-fires burning, marched off by the Glogau road, and the only way of escape still open. The Austrians, however, had planned a night attack, and Loudon's columns were moving to close this last loophole of escape. Fortunately for the Prussians they arrived just a few minutes too late, and in the combat that ensued 15,000 Prussians inflicted a loss of 10,000 men and 82 guns upon their assailants, afterwards resuming their march undisturbed.

But the danger was not yet over. Czernicheff was known to be in the immediate vicinity; so as to get him out of the way, Frederick gave to a peasant a despatch addressed to Prince Henry containing the words: "Austrians totally defeated to-day, now for the Russians. Do what we agreed upon." The peasant was to take care to be captured by the Russians and only give up the paper to save his life. The plan worked as he had anticipated, the paper duly reached Czernicheff's hands and he immediately evacuated the dangerous neighbourhood. Elated with his success the king now abandoned his retreat on Glogau and determined to press on at all hazards to Breslau, which in spite of many anxious moments he reached on Aug. 17.

The Russians now abandoned the campaign in the open field and besieged Colberg on the Baltic coast. Frederick in Silesia manoeuvred for some weeks between Breslau, Schweidnitz and Glatz, but was suddenly recalled by the news of the capture of Berlin on Oct. 9 by Cossacks and portions of the Empire Army and Austrians from Saxony. On Oct. 11 the king was in full march, but the news of his approach was enough and the enemy dispersed, the Austrians and Empire Army making for Torgau Daun, relieved of Frederick's pressure, now also moved to Torgau, leaving Loudon in Silesia, and had concentrated over 64,000 men at and around Torgau before Frederick had collected an attacking force of 45,000.

Battle of Torgau.—The position held by the Austrians was an entrenched camp fronting in all directions, but it was too cramped for their numbers and difficult to leave for a counter-stroke. Frederick determined to attack it both front and rear, and leaving Zieten to act against the former, he marched off at 6.30 on Nov. 3 to attack it as soon as Zieten should have thoroughly attracted the enemy's attention. But for once Zieten failed; he allowed himself to be drawn off by the Austrian light troops, and Frederick, in ignorance of the real state of affairs, launched his grenadiers against a thoroughly intact enemy, strongly entrenched, with, it is said, 400 guns in position to sweep the approaches. The grenadiers were simply swept away by grape and case—only 600 out of 6,000 remained, and Prussian batteries hurrying up to their support were destroyed before they had time to load. The attack was, however, renewed by fresh brigades as they came to hand, and the Prussian artillery did something to diminish the intensity of the Austrian case fire. The action began at 2 P.M. At 4.30, as the sun was setting, the king's last reserve of horse and foot at last succeeded in breaking the Austrian line and in the darkness there ensued a confused slaughter as at Zorndorf. The result was still in the balance when at length Zieten reached the field and attacked at once. For an hour or so the struggle still raged, but the Austrians were by now completely spent and withdrew gradually into the fortress and then across the river. Out of 44,000 the Prussians had lost 13,120 men (30%), out of 65,000 the Austrians only 11,260 (17·3%), but of these over 7,000 were prisoners. Both sides, however, were completely paralysed by the struggle, and the year ended without further serious fighting.

On the western theatre of war Prince Ferdinand after the victory of Warburg had pressed the French back to the Rhine and



BATTLE OF TORGAU

besieged Wesel, but was compelled to raise the siege after suffering the defeat of Kloster-Kamp (Oct. 16) and to withdraw to Lippstadt and Warburg.

Campaign of 1761.—Torgau proved to be Frederick's last great battle All parties were now so completely exhausted that they no longer were able to face the risks of a decision on the field. In the west Prince Ferdinand was first in the field, and in February and March he drove the French southward as far as Fulda, but an attempt to capture Marburg failed and the gradual pressure of French numerical superiority, together nith the reduction of the British contingent on the death of George II., compelled him to retreat gradually until by the beginning of October both Brunswick and Wolfenbüttel fell into their hands In the east the king had barely 100.000 men against 300.000 Austrians and Russians. Leaving Prince Henry to observe Daun in Saxony he marched to join von der Goltz, who with 23,000 stood about Schweidnitz. The Russians (50,000) under Buturlin were approaching from Posen, and Loudon with 72,000 men starting from Glatz manoeuvred to join them. After two months' skirmishing and marching the Allies effected their junction between Liegnitz and Jauer, having completely severed Frederick's communications with Prussia. But Frederick depended for his food and immediate supplies on Southern Silesia, and not caring to risk a battle with odds of three to one against him he withdrew into the entrenched camp of Bunzelwitz, where the Allies did not dare to attack him Ultimately, as usual, the Russian commissariat broke down, and in September Buturlin withdrew the way he had come. Relieved of this antagonist, Frederick manoeuvred to draw Loudon out of his positions and compel him to fight in the open, but Loudon refused the challenge and after an attempt to surprise Schweidnitz. which failed, withdrew into winter quarters. Prince Henry in Saxony held his own against Daun

England now threatened ro withdraw her subsidies. and as the Prussian armies had dwindled to 60 ooo men the end seemed very near. But a turn of fortune was already at hand. On Jan 5, 1762, the tsaritsa died, and her successor, Peter III., at once offered peace. On March 16 an armistice was agreed to, and shortly afterwards the treaty of St. Petersburg was signed, by which Pomerania was given back to Prussia and a contingent of 18,000 men placed at Frederick's disposal. The withdrawal of the Russians led in turn to the withdrawal of the Swedes, and thus only France and Austria remained—the former bled white by the strain of her colonial disasters, the latter too weary to make further great exertions. Though the war dragged on for some months, and Prince Henry, assisted by Seydlitz, won the victory of Freiberg over the Empire Army (Oct. 29, 1762), no great battle was attempted, and although a revolution at St. Petersburg deprived Frederick of Russian assistance, in the autumn Ferdinand drove the French back over the Rhine, and thereupon an armistice was agreed upon by all. Final terms of peace were adjusted on *status* quo *ante* basis at Hubertusburg on Feb. 15, 1763. (F. N. M.)

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NAVAL OPERATIONS

When the Seven Tears' War broke out, with the Prussian invasion of Saxony on Aug 29, 1756, eight years had elapsed since the Peace of Aix-la-Chapelle. 1745, which concluded the War of the Austrian Succession During the years 1754 and 1755 the French performed a number of hostile acts against the British on land and sea in various parts of the world to which the British retaliated, especially in the Mediterranean and along the frontier between French Canada and British America. Thus there existed during those two years a state of affairs which can be best described as an unofficial war of outposts between the British and French. Although no part of the Seven Years' War, it is convenient to review briefly the naval operations of those three years.

In June 1755 a British squadron under Boscawen was sent into the Straits of Belle Isle to intercept French ships carrying soldiers and stores. On June 8 Boscawen seized two French line-of-battle ships fitted as transports, the "Alcide" and the "Lys." Hawke was sent to sea with the Western Squadron and a general seizure of French merchant ships followed. The Government of Louis XV. did not reply by a declaration of war, but prepared to retaliate by a surprise invasion of the British Isles, which soon degenerated into a threat, which was. however, kept up as a feint to cover an expedition against Minorca.

A squadron of 12 sail of the line was prepdred at Toulon under La Galissonière. It escorted transports carrying 15,000 troops under the duc de Richelieu. The danger to Minorca, where the garrison had been allowed to fall below its due strength, was well known to the British ministers On March 11 they appointed Admiral John Byng to command a squadron which was to carry reinforcements. He had ten sail of the line, and reached Gibraltar on May 2. The French invasion of Minorca had been carried out on April 19 The governor of Gibraltar, Gen. Fowke, refused to part with any of his soldiers to reinforce Minorca, though under orders to do so, and on May 8 Byng sailed, and was off Minorca on the 19th. Before the officers of the garrison, whom he carried, could be landed, the French fleet came in sight. Byng had been joined by three ships of the line at Gibraltar, and had therefore 13 ships to 12. On the morning of May 20 he gained the weather-gouge, and then bore down on the enemy at an angle, the van of the English steering for the van of the French. The sixth ship in his line, the "Intrepid" (74), having lost her foretopmast, became unmanageable and threw the vessels behind her out of order Thus the six in front were exposed to the fire of all th'e French, who were with difficulty repulsed. Being now much disturbed by the crippled state of the ships in his van, Byng made no effort either to land the soldiers he had on board or to renew the action; and after holding a council of war on May 24, which confirmed his own desire to retreat, he sailed for Gibraltar, and Minorca surrendered in June, which gave the French a great advantage in the Mediterranean.

In 1757 the naval war began to be pushed with considerable vigour. The elder Pitt became the effective head of the Government, and was able to set about ruining the French power at sea. He sent out, during the last months of 1757 and the whole of 1758, a series of combined expeditions against the French coast which, though costly and for the most part unsuccessful, forced the French to divert large bodies of troops from the Rhine frontier. In the East Indies, the squadron under Vice-admiral Watson, with the assistance of the Company's troops under Clive, recaptured Calcutta in Jan. 1757 and Chandernagore in March. On Watson's death, Rear-admiral George Pocock succeeded to the command, and fought an indecisive action with the French squadron under M. d'Aché on April 29, 1758, off Cuddalore, and again on Aug. 3 off Negapatam, after which M. d'Aché retired to Mauritius. Meanwhile the French were so occupied on their eastern frontier and their Atlantic ports were so well watched, that they were unable to send sufficient reinforcements to their Colonists in Canada. Consequently, Boscawen and Gen. Amherst were able to undertake a combined operation against Louisburg, which capitulated on July 26, 1758, thus giving England control of the whole of Cape Breton island and the mouth of the St. Lawrence.

On the West Coast of Africa, Commodore Henry Marsh captured Senegal in May 1758, and Commodore Augustus Keppel captured Gorée in December. In 1759 the French made a last effort to retrieve their naval position. In European waters they again made plans for an invasion of the British Isles; but the attempted concentration of the Toulon fleet under de la Clue at Brest was defeated by Boscawen in a running fight ending in Lagos bay in August. On Nov. 20 Hawke, in Quiberon bay, defeated the Brest fleet under Conflans, which had slipped out while Hawke had had to withdraw the blockading forces owing to bad weather. Hawke and Boscawen's watch on the French Atlantic and Mediterranean ports had been so close that few ships of the line had been able to leave them during the year, and French colonial possessions had become completely isolated.

Throughout the summer Vice-admiral Charles Saunders conducted operations in the St. Lawrence, which resulted in his enabling General James Wolfe to surprise the French above Quebec, and defeat them on the heights of Abraham. This led to the immediate capitulation of Quebec on Sept. 18 and later to the capture of Montreal and the whole of French Canada. In the East Indies M. d'Aché fought one more action with Pocock, on Sept. 8, and then retired to Pondicherry, which fell in Jan. 1761. In the West Indies Commodore John Moore failed to capture the important French island of Martinique, but took Guadeloupe on May 1, 1759, after which many other islands fell into his hands.

During 1760 and 1761 the French fleet made no attempt to keep the sea. The British navy went on with the work of conquering French possessions. During 1760 it co-operated on the Lakes and on the St. Lawrence in the final conquest of Canada. Between April and June of 1761 it captured the island of Belle-Ile on the French coast, which both strengthened its means for maintaining blockade and gave the British Government a valuable pledge to be used for extorting concessions when the time for making peace arrived. The complete ruin of French merchant shipping and the collapse of the navy left the maritime population free to seek a livelihood in the privateers. Commerce-destroying was carried on by them with considerable success. The number of British merchant ships taken has been put as high as one-tenth of the whole. This was the price paid for the advantage gained by the ruin of the French as commercial rivals.

By the close of 1761 the maritime war was revived for a few months by the intervention of Spain. A close alliance, known as "the family compact," had been cemented with France earlier in the year. The secret was divulged, and Pitt would have made war on Spain at once. He was overruled and resigned. So soon, however, as the treasure ships from America had reached Spain, the Spanish Government declared war. Its navy was incapable of offering a serious resistance to the British, nor did it even attempt to operate at sea. The British Government was left unopposed to carry out the plans which Pitt had already prepared. The only aggressive movement undertaken by the Spanish Government was an attack on Portugal, which was the close ally of Great Britain and gave her the free use of Portuguese ports. Great Britain supported her ally, with a small force, and the Spaniard eventually retired. But the most effective blows against Spain were directed at her colonies. The British troops, left free by the recent success against the French in America, were employed firstly in a combined attack on Martinique under Rear-admiral G. B. Rodney, who captured the whole island by Feb. 1762. This was quickly followed by the capitulation of Grenada and St. Lucia. A powerful fleet left England in March 1762 bringing still more troops, with Pocock, who had recently returned from the East Indies, in supreme command. The expedition was ordered to attack Havana, and was off Cuba by June. The worst losses of the besiegers were due to the climate of Cuba, aided by bad sanitary arrangements. Of the 10,000 troops landed, three-fourths are said to have suffered from fever or dysentery, and the majority of the sick died. Yet the Morro was taken on Sept. 30, and Havana, which could have made a longer resistance, surrendered on Oct. 10. In the East Indies, where the surrender of Pondicherry had left other forces free, a combined expedition under Rear-admiral Cornish and Col. Draper captured Manila in Sept. 1761. The blockade of the French ports, and the defeat of their main battle fleets, had ruined all their hopes of invading the British Isles, and left their colonial possessions completely isolated. These were now practically all lost, and they could only set against them the capture of Minorca.

The preliminaries of the peace of Paris were signed on Nov. 3, 1762.

See Sir Julian Corbett, *England in the Seven Years' War* (1918); Sir W. L. Clowes, *The Royal Navy,* vol. iii (1898); M. Burrows, *Life of Admiral Lord Hawke* (1896). (G. A. R. C.; W. C. B. T.)

SEVERIANA, VIA, an ancient highroad of Italy, running southeast from Ostia to Terracina, 73 mi. along the coast, taking its name from the restoration of an existing road by Septimius Severus.

The Via Severiana ran along the shore at first, just behind the line of villas nhich fronted upon the sea, and are now half a mile inland. Farther on, the ancient and modern coastlines coincide, and the road ran on the outside of the lagoons which lie to the north of the Circeian promontory.

SEVERING, KARL WILHELM (1875–1952), German statesman, was born at Herford, Westphalia, on June 1, 1875, the son of a cigar sorter.

He worked for ten years in Bielefeld, Barmen and Zürich as a locksmith, and after acting as secretary to the metal workers' union in Bielefeld (1902–10), obtained a post on the staff of a Socialist newspaper. He was commissioner for the Rhineland and Westphalia, and was responsible for the negotiations with the workmen who revolted in the Ruhr.

Severing was Prussian minister of the interior, 1920–25 and 1930–32, and Reich minister of the interior, 1928–30. He aided the suppression of the reactionary disturbances of 1923, and was arrested by the Nazis in 1933. President of the Social Democratic party in Westphalia in 1946, he became a member of the north Rhine-Westphalian diet in 1947. He died at Bielefeld, Ger., July 23, 1952.

SEVERINUS, pope from 638 to 640, was elected to succeed Honorius I (d. Oct. 638) but was not consecrated till May 28, 640 (little more than two months before his death, Aug. 2), as the emperor Heraclius hesitated to ratify his election pending his acceptance of the *Ecthesis*. Meanwhile the exarch of Ravenna, supported by the Roman soldiery, occupied the Lateran and seized the church's treasure.

SEVERN, JOSEPH (1793–1879), English portrait and subject painter, was born at Hoxton on Dec. 7, 1793, the son of a musician. During his earlier years he practised portraiture as a miniaturist. In 1818 he gained the gold medal of the Royal Academy for his "Una and the Red Cross Knight in the Cave of Despair." He was an intimate friend of Keats, whom he accompanied to Italy in 1820 and nursed till his death in 1821.

In 1861 Severn was appointed British consul at Rome, a post he held till 1872, and during a great part of the time he also acted as Italian consul. His best-known work is the "Spectre Ship" from the *Ancient Mariner*. His portraits include several of Keats. He died at Rome on Aug. 3, 1879.

SEVERN (Welsh HAFREN; Roman SABRINA), a river of Wales and England. The longest river in Great Britain, the Severn rises on the northeast side of Plynlimmon, on the southwest border of Montgomeryshire, and flows with a nearly semicircular course of about 180 mi. to the Bristol channel. Its course at its beginning is southeasterly and for the first 15 mi. it flows over a rough precipitous bed. At Llanidloes it bends northeast through the Vale of Powys to its junction with the Vyrnwy and then flows eastward following a winding course across the plain of Shropshire. After passing Shrewsbury it meanders southward in a wide open plain as far as Buildwas where it enters the Ironbridge gorge. The river formerly flowed northward to join the Dee but when that course was temporarily blocked during the Ice Age the impounded waters cut a deep channel across Wenlock Edge to join one of the headstreams of the Stour. From Stourport, where the Stour now joins it, the Severn follows the wider and older valley cut by that river in the soft Triassic beds, past Worcester and the junction with the Warwickshire Avon near Tewkesbury, to Gloucester. There the river becomes tidal and meanders in wide loops to its estuary in the Bristol channel. The Usk, on the right bank, is usually regarded as the last tributary of the Severn. In the lower loops at certain times the rising tide creates a bore, its crest passing upstream as a rapidly moving wave which may temporarily check the river flow as high as Tewkesbury. The Severn and its tributaries drain an area of over 4,350 sq.mi. and carry more water to the sea than the Thames.

The unusual almost semicircular course of the Severn, the parallelism of the major right-bank tributaries, the variations of gradient and valley width, all suggest that its development has been long and eventful. It is now generally accepted that, like other English rivers, the Severn system originated on an Upper Cretaceous surface with a generally eastward slope. A slightly upraised central watershed about in the latitude of Birmingham divided this surface into two basins occupied by the original Trent and Thames respectively. The upper Severn developed the Vale of Powys and flowed to the Trent; the Usk, Wye, Teme, ancient Stour and right-bank tributaries of the Avon, were all tributary streams of the ancient Thames. As the cover of Cretaceous beds was removed by denudation all these streams persisted in their general direction, cutting their valleys down into the older rocks. New streams developed valleys in the softer beds of the rocks thus exposed, and captured and diverted some of the earlier rivers. Thus in the north the lower Dee cut off the headwaters of the ancient Trent, including the Vyrnwy and the upper Severn. In the south a stream developing on the outcrop of the Lias beds cut off the streams flowing to the Thames and thus became what are now the lower Severn and the Warwickshire Avon. The opening of the Ironbridge gorge was the final major episode.

The upper part of the Severn estuary is difficult of navigation, and therefore the Sharpness to Gloucester ship canal (16 mi. long) was opened in 1827, admitting vessels carrying 750 tons of cargo to Gloucester. At Worcester the river is joined by the Worcester and Birmingham canal and the navigation extends up to Stourport, where the Staffordshire and Worcestershire canal gives access to the Midland canal system. There is no longer any connection with the Thames.

The Severn is a good salmon river and is famous for its lampreys (*see* GLOUCESTER), while many of the tributaries, such as the Teme and the Vyrnwy, afford fine trout fishing.

The Severn tunnel (1873–86), carrying the railway under the estuary, forms the direct route between the south of England and south Wales. There has long been discussion of a proposal to construct a barrage across the upper estuary. In this way the very high tidal range would be used to generate electric power while the dam itself could carry a much-needed motor highway to shorten the routes between the south Wales ports and the industrial midlands and southern England. Preliminary surveys have shown that difficult engineering problems would be encountered and the very heavy costs thus involved made it a doubtful economic proposition in the mid-1950s. (T. HER.)

SEVERUS, LUCIUS SEPTIMIUS (A.D. 146–211), Roman emperor, was born of an equestrian family, on April 11, 146, at Leptis Magna on the coast of Africa. He had to learn Latin as a foreign language, and kept an African pronunciation all his life. Some time between 164 and 170 he came to Rome and studied law under Q. Cervidius Scaevola; he had Papinian as a fellow-pupil. Marcus Aurelius gave him the *latus clavus,* and at the age of 26 he went as *quaestor militaris* to Baetica, in Spain. While he was away in Africa, in consequence of his father's death, the emperor took over Baetica from the Senate, and gave them Sardinia, of which Severus became quaestor. In 174 or 175 he was legate to the proconsul of Africa, and then was tribune of the plebs, an office of dignity rather than importance. In that year he married Marcia, his first wife. In 178 or 179 he was praetor, and went to *Hispania Citerior* as *legatus iuridicus;* after that he commanded a legion in Syria. After the death of Marcus Aurelius he was unemployed for some time, and studied at Athens. He was governor of *Gallia Lugdunensis* in 186, and during his governorship occurred the revolt of Maternus. Niger, with whom he was afterwards to dispute the succession, was sent by Commodus to deal with it, and a letter from Severus to Commodus records his admiration for his future rival. At this period also, probably in 187, he married Iulia Domna, daughter of a priest of Baal at Emesa, and his son Caracalla was probably born on April 4, 188. He was proconsul of Sicily in 189, and *consul suffectus* in 190. Next year he went to Pannonia as governor. Here, in a province recently upset by the wars of the Antonines, he was in command of three legions, with his headquarters at Carnuntum. On the last day of 192 Commodus was murdered; Septimius' complicity is doubtful. His successor Pertinax, appointed by the senate, was murdered on March 28, 193, and another senator, Iulianus, bought the support of the praetorians. But it was not the guard but the legions that had the disposal of the throne. As soon as the news of the death of Pertinax reached him Severus gathered his troops, received their acclamation as emperor, and set out at once for Rome, having already indicated his role of avenger of Pertinax by adopting his name. Meanwhile two other governors had taken the same steps, but they were not his equals in speed, in strength, or in the important factor of proximity to Rome. Roughly, the continent of Europe was his, the legions of Britain had proclaimed for Albinus, and Syria for Niger. Albinus for the moment accepted the offer of the title of Caesar, which made him heir-apparent. Severus' march on Rome was desperately swift; no soldier took off his breastplate between Carnuntum and Rome, according to Dio, and his first success was the surrender of the fleet and town of Ravenna. Iulianus was quite inadequate, and when the praetorians deserted the Senate went over too.

Iulianus was murdered and Severus was immediately proclaimed emperor. Before entering the city he disbanded the guard and exiled them 100 miles from Rome; the new guard he formed was open to soldiers from all provinces of the empire. He then made a magnificent entry, performed funeral and deificatory rites over Pertinax, and before the end of July left for the East. The contest between Severus and Niger was practically decided by two or three engagements fought by Severus' officers. The last battle, at Issus, ended in the defeat and death of Niger (194). After this the emperor spent two years in successful attach on the peoples bordering on Syria, particularly in Adiabene and Osrhoene. Byzantium, the first to be attacked, was the last to fall, after a glorious defence.

Late in 196 Severus turned westward, to reckon with Albinus, leaving affairs in the East by no means settled. As Severus was nearing Italy he received the news that Albinus had been declared emperor by his soldiers. The first counter-stroke of Severus was to affiliate himself and his elder son to the Antonines by a spurious and posthumous adoption. Bassianus, the elder son of Severus, thereafter known as Aurelius Antoninus, was named Caesar in place of Albinus, and was thus marked out as successor to his father. Without interrupting the march of his forces, Severus contrived to make an excursion to Rome. Here he availed himself with much subtlety of the sympathy many senators were known to have felt for Niger. Though he was so far faithful to the decree passed by his own advice that he put no senator to death, yet he banished and impoverished many whose presence or influence seemed dangerous or inconvenient to his prospects.

The collision between the forces of Severus and Albinus was the most violent that had taken place between Roman troops since the contest at Philippi. The decisive engagement was fought on February 19 of the year 197 on the plain between the Rhône and the Saône, to the north of Lyons, and resulted in a complete victory for Severus.

Thus, released from all need for disguise, he "poured forth on the civil population all the wrath which he had been storing up for a long time" (Dio). He frightened the senate by calling himself the son of Marcus and brother of Commodus, whom he deified. He read a speech in which he declared that the severity and cruelty of Sulla, Marius and Augustus had proved to be safer policy than the clemency of Pompey and Julius Caesar, which had wrought their ruin. Over 60 senators were arrested on a charge of having adhered to Albinus, and half were put to death.

The next years (197–202) were devoted to war against the Parthians, who had invaded Mesopotamia, and Severus recovered and annexed Mesopotamia, and spent some time in what seems to have been a rather unsuccessful punitive expedition. On his return journey he visited Egypt; Dio observes that he was not the man to leave anything, human or divine, uninvestigated. He returned to a triumph, commemorated still by the arch that bears his name. For the next six years (202–208) Severus lived at Rome. Nothing of great importance happened except the fall of Plautianus, praefect of the guard, an African like his master, who exercised a more complete dominance than any favourite since Seianus. He was thoroughly hated by both Iulia and Caracalla, and Caracalla invented a plot against the emperor's life in which Plautianus was supposed to be implicated, and had him put to death in 205. Severus spent the last three years of his life (208–211) in Britain, which had been unsettled for some time. He seems to have welcomed military service as a chance of healing the strife between his sons Caracalla and Geta, and getting them away from Rome. He died at York on Feb. 4, 211.

Administration.— In military history his reign is important, marking the beginning of the admittedly military despotisms. His main work in this sphere was the throwing open of the praetorian guard to the empire, the establishment of a centralised force in Italy (a long step towards the complete assimilation of Italy to the provinces), and a series of improvements in the conditions and rewards of service, including permission to the soldiers to have their wives with them, and the opening of the equestrian civil service career to the veterans.

In his home administration the chief feature is the further reduction in the importance of the senate, combined with an increase in the powers and duties of the equites, and especially of their chief members, the *praefecti praetorio.*

The Legal Praefect becomes the most important subject in the empire, with administrative as well as judicial powers; the *praefectus annonae* disappears in this reign, and his duties are absorbed by Papinian, the first and most distinguished of a long line of judicial *praefecti.* They repaid their advancement by working the theory of absolutism into Roman law. Severus' laws show a growing humanitarian tendency, and a renewed attempt to carry out the social policy of the *Lex Iulia de adulteriis.* His financial policy is marked by the growth of a new treasury, the *res privata,* the emperor's personal property, distinct from the Crown property.

As a result of his own troubles with the holders of big provincial commands he tended to split up the largest, *e.g.,* Britain, Syria and Africa, into divided commands On the whole the reign of Severus was one of peace and prosperity in the provinces.

The foregoing account, though mainly confined to undisputed facts, implies a favourable estimate of Severus' administration, and is based on Platnauer (see *inf.).* Mention must be made, however, of the view of Rostovtzev (*infra*), who bases on the same facts a wholly different interpretation, in which Severus appears as responsible for the demoralisation and, if not the barbarisation, yet at least the "democratisation and provincialisation" of the army, as responsible for the abandonment of the policy of the Antonines in favour of a dynasty supported by the army, and as having sacrificed the upper classes of the empire to the peasants, from whom the army was now drawn. Where they differ flatly is in their estimate of the condition of the provinces during the reign.

In literature and philosophy the reign is undistinguished, but interesting on account of Iulia Domna, the philosophic Empress, and her circle, which included Diogenes Laertius, Galen, Aelian, the lawyers Papinian and Ulpian, and Philostratus, the author of that abortive gospel, the *Life of Apollonius of Tyana.* Severus himself was markedly superstitious, but there is nothing to connect him with the surge of Eastern mysticism that his wife fostered. What we have of his is a definite edict against conversion to Christianity.

Bibliography.—Dio Cassius; Herodian; Script. Hist. Aug. The principal modern works relating to this emperor, after Tillemont and Gibbon, are—J. J. Schulte, *De imperatore L. Septimio Severo* (Münster, 1867); Hofner, *Untersuchungen zur Geschichte des Kaiters L. Septinzius Severus* (Giessen, 1875); *Untersuchungen zur römischen Kaisergeschichte,* ed. by *M.* Budinger; H. Schiller, *Geschiclzte der romischen Kaiserzeit* (Gotha, 1880–1883); De Ceuleneer, *Essai sur la vie et le règne de Septime Sévère* (Brussels, 1880); Réville, *La Religion à Rome sous les Sévères* (Paris, 1886); Fuchs, *Geschiclzte des Kaisers L. Septimius Severus* (1884). On Iulia Domna, *see* M. G. Williams, in *American Journal of Archaeology,* vi. (1902), pp. 259-306. M. Platnauer, *Life and Reign of the Emperor Septimius Severus* (Oxford, 1918); M. I. Rostovtzev, *Social and Economic History of the Roman Empire* (Oxford, 1926).

SEVERUS, MARCUS AURELIUS ALEXANDER: *see* Alexander Severus.

SEVERUS, SULPICIUS (c. 363–*c.* 425), Christian writer, was a native of Aquitania. He was imbued with the culture of his time and of his country, which was then the only true home of Latin letters and learning. Almost all that we know of Severus' life comes from a few allusions in his own writings, and some passages in the letters of his friend Paulinus, bishop of Nola. In his early days he was famous as a pleader, and his knowledge of Roman law is reflected in parts of his writings. He married a wealthy lady belonging to a consular family, who died young, leaving him no children. At this time Severus came under the powerful influence of St. Martin, bishop of Tours, by whom he was led to devote his wealth to the Christian poor, and his own powers to a life of good works and meditation.

'The chief work of Severus is the *Chronica* (*c.* 403), a summary of sacred history from the beginning of the world to his own times, with the omission of the events recorded in the Gospels and the Acts, "lest the form of his brief work should detract from the honour due to those events." The book was a text-book, and was used as such in the schools of Europe for about a century and a half after the *editio princeps* was published by Flacius Illyricus in 1556. As a historian of the past Severus has little value. The real interest of his work lies, first, in the incidental glimpses it affords all through of the history of his own time; and in the information he has preserved concerning the struggle over the Priscillianist heresy, which disorganized and degraded the churches of Spain and Gaul, and particularly affected Aquitaine. The sympathies here betrayed by Severus are wholly those of St. Martin. Severus loses no opportunity for laying stress on the crimes and follies of rulers, and on their cruelty, though he once declares that, cruel as rulers could be, priests could bc crueller still. This last statement has reference to the bishops who had left Maximus no peace till he had stained his hands with the blood of Priscillian and his followers. Martin, too, had denounced the worldliness and greed of the Gaulish bishops and clergy. Severus also fully sympathized with the action of St. Martin touching Priscillianism.

After the *Chronica* the chief work of Severus is his *Life of Martin*, a catalogue of miracles, told in all the simplicity of absolute belief. Two *Dialogues* and the *Epistles* on the death of Martin complete the list of Severus' genuine works.

AUTHORITIES.—The text of the *Chronica* rests on a single 11th century ms., one of the Palatine collection now in the Vatican; of the other works mss. are abundant, the best being one of the 6th century at Verona. The complete works of Severus were edited by Halm (forming vol. i. of the *Corpus scriptorum ecclesiasticorum Latinorum*, Vienna, 1866).

SEVIER, JOHN (1745–1815), American frontiersman, and first governor of Tennessee, was born in Rockingham county, Va., Sept. 23, 1745. He settled on the Watauga river west of the Alleghanies. When this territory was annexed to Tennessee in 1776, Sevier was elected as its representative to the provincial congress which drew up the first state constitution. He served as captain in Lord Dunmore's War in 1774. He took an active part in the battle of King's Mountains in 1780, and in the following year he served under General Francis Marion against the British in the Carolinas and Georgia. In 1780 he defeated the Cherokees at Boyd's Creek. When North Carolina ceded her western lands to the Federal government in 1784, Sevier took part in the revolt against the parent state which resulted in the formation of the separate state of Franklin and was elected its first governor. By 1786 the Conservative party had regained control, and Sevier was tried for high treason and convicted, but was subsequently pardoned. In 1789 he was a member of the North Carolina Senate, and in 1790–91 of the National House of Representatives. After the final cession of its western territory by North Carolina to the United States in 1790 he was appointed brigadier-general of militia for the eastern district of the "Territory South of the Ohio"; and when Tennessee was admitted into the Union as a state, Sevier became its first governor (1796–1801) and was governor again in 1803–09. He was a member of the National House of Representatives in 1811–15, and then was commissioner to determine the boundary of Creek lands in Georgia. He died near Fort Decatur (Ga.), Sept. 24, 1815.

See J. R. Gilmore, *The Rear-Guard of the Revolution* (New York, 1896), and *John Sevier as a Commonwealth Builder* (New York, 1887); errors in Gilmore's books are pointed out in Theodore Roosevelt's *The Winning of the West* (New York, 1894–96).

SEVIGNE, MARIE DE RABUTIN-CHANTAL, MARQUISE DE (1626–1696), French letter-writer, was born at Paris on Feb. 5, 1626. The family of Rabutin (if not so illustrious as Bussy, Madame de Sévigné's notorious cousin, affected to consider it) was one of great age and distinction in Burgundy. Marie's father, Celse Bénigne de Rabutin, Baron de Chantal, was killed during the English descent on the Isle of Rhé in July 1627. His wife did not long survive him many years, and Marie was left an orphan at the age of seven. At the age of ten she passed into the guardianship of her uncle Christophe de Coulanges, abbé de Livry. Readers of his niece's letters know how well "Le Bien Bon" fulfilled the trust. Long after his nominal duties were ended he was in all matters of business the good angel of the family, while for half a century his abbacy of Livry was the favourite residence both of his niece and her daughter. Coulanges provided his niece with an admirable education. Jean Chapelain and Gilles Ménage are specially mentioned as her tutors, and Ménage at least fell in love with her. Another literary friend of her youth was the poet Denis Sanguin de Saint-Pavin. She was intimate with all the coterie of the HBtel Rambouillet, and her special ally was Mademoiselle de la Vergne, afterwards Madame de la Fayette. In person she was extremely attractive, though the minute critics of the time objected to her divers deviations from regular beauty. Her long minority, under so careful a guardian as Coulanges, had also raised her fortune to the amount of 100,000 crowns. She married (1644) Henri, marquis de Sévigné, a Breton gentleman of good family, allied to the oldest houses of that province, but of no great estate. They settled at Sévigné's manor-house of Les Rochers, near Vitré. It may be suspected that the happiest days of Madame de Sévigné's brief married life were spent there. For there at any rate her husband had less opportunity than in Paris of neglecting her, and of wasting her money and his own. Henri de Sévigné was one of the innumerable lovers of Ninon de l'Enclos, and made himself even more conspicuous with a certain Madame de Gondran, known in the nickname slang of the time as "La Belle Lolo." He was wildly extravagant. That his wife loved him and that he did not love her was generally admitted. He quarrelled with the Chevalier d'Albret about Madame de Gondran, fought with him and was mortally wounded on Feb. 4, 1651.

There is no reasonable doubt that his wife regretted him a great deal more than he deserved. Though only five and twenty, and more beautiful than ever, she never married again. For the rest of her life she gave herself up to her two children, Françoise Marguerite (b. 1646), and Charles (1648). To Charles Madame de Sévigné was an indulgent, a generous (though not altogether just) and in a way an affectionate mother. Her daughter, the future Madame de Grignan, she worshipped with an almost insane affection. For nearly ten years she lived an uneventful life at Paris in a house she occupied in the Place Royale (not as yet in the famous Hôtel Carnavalet), at Les Rochers, at Livry or at her own estate of Bourbilly in the Mâconnais. She had, however, in 1658, a quarrel with her cousin Bussy over a loan. He gives a malicious portrait of her in his *Histoire amoureuse*. The quarrel was never quite healed, though after Bussy's disgrace in 1666 correspondence was renewed.

In 1661, at the downfall of the Superintendent Fouquet, it was announced on indubitable authority that communications from Madame de Sévigné had been found in the coffer where Fouquet kept his love letters. Bussy obtained from Le Tellier, who as minister had examined the letters, a corroboration of her protest that the letters were merely those of a friend. Nevertheless, there have always been those who held that Madame de Sévigné regarded Fouquet with at least a very warm kind of friendship. During these earlier years Madame de Sévigné had a great affection for the establishment of Port Royal.

Madame de Grignan.—The bulk of Madame de Sévigné's letters are addressed to her daughter, who married in 1668 François d'Adhémar, comte de Grignan, a Provencal, of one of the noblest families of France. He had been twice married, and his great estates were heavily encumbered. Neither did the large dowry (300,000 livres) which Madame de Sévigné, somewhat unfairly to her son, bestowed upon her daughter, suffice to clear encumbrances. In 1669 RI. de Grignan, who had previously been lieutenant-governor of Languedoc, was transferred to Provence. The governor-in-chief was the young duke of Vendôme. But at this time he was a boy, and he never really took up the government, so that Grignan for more than forty years was in effect viceroy of this important province. His wife liked the part of vice-queen; but their peculiar situation threw on them the expenses without the emoluments of the office, so that the Grignan money affairs hold a larger place in Madame de Sévigné's letters than might perhaps be wished.

1671–1691.—Madame de Sévigné lived in Paris from 1677 onwards in the Hôtel de Carnavalet, but she spent part of the year usually on her estate at Les Rochers. She was there when the estates of Brittany were convoked at Vitré in 1671, and she was there in 1675 when the province was being punished for its resistance to illegal taxation. Occasionally she was able to enjoy her daughter's society. She spent a year with the de Grignans in Provence in 1672–3, and the whole Grignan family paid a long visit to the Hôtel de Carnavalet in 1677. Between 1680 and 1688 the Grignans were in Paris for a great part of their time. The bulk of the letters from Madame de Sévigné to her daughter therefore belong to the period before 1677.

In 1679 Madame de Sévigné lost La Rochefoucauld, the most eminent and one of the most intimate of her close personal friends and constant associates. In 1684 Charles de Sévigné married a young Breton lady, Jeanne Marguerite de Mauron, who had a considerable fortune. In the arrangements for this marriage Madame de Sévigné practically divided all her fortune between her children (Madame de Grignan of course receiving an unduly large share), and reserved only part of the life interest. In 1687 the Abbé de Coulanges died. In the same year Madame de Sévigné was present at the Saint-Cyr performance of *Esther*, and some of her most amusing descriptions of court ceremonies and experiences date from this time. 1689 and 1690 were almost entirely spent by her at Les Rochers with her son; and on leaving him she went across France to Provence. 1691 was passed at Grignan and other places in the south, but at the end of it Madame de Sévigné returned to Paris, bringing the Grignans with her; and her daughter stayed with her till 1694.

Last Years. — The year 1693 saw the loss of two of her oldest friends — Bussy Rabutin, her faithless and troublesome but in his own way affectionate cousin, and Madame de la Fayette, her life-long companion, and on the whole perhaps her best and wisest friend. Another friend almost as intimate, Madame de Lavardin, followed in 1694. Madame de Sévigné spent but a few months of this latter year alone, and followed her daughter to Provence. She never revisited Brittany after 1691.

During an illness of her daughter Madame de Sévigné herself was attacked by smallpox in April 1696, and she died on the 17th of that month at Grignan, and was buried there. Charles de Sévigné died on March 26, 1713. His widow survived him twenty years. Madame de Grignan had died on August 16, 1705. Her son, who had fought at Blenheim. had died of the same malady at Thionville the year before. Marie Blanche, her eldest daughter, was in a convent, and, as all the comte de Grignan's brothers had either entered the church or died unmarried, the family, already bankrupt in fortune, was extinguished in the male line by Grignan's own death in 1714, at a great age.

The Letters. — Madame de Sévigné was a member of the strong and original group of writers — Retz, La Rochefoucauld, Corneille, Pascal, Saint-Evremond, Descartes and the rest — who escaped the influence of the later 17th century, while they profited by the reforms of the earlier. According to the strictest standard of the Academy her phraseology is sometimes incorrect, and it occasionally shows traces of the quaint and affected style of the *Précieuses;* but these things only add to its savour and piquancy. In lively narration few writers have excelled her, and in the natural expression of domestic and maternal affection none. She had an all-observant eye for trifles and the keenest possible appreciation of the ludicrous, together with a hearty relish for all sorts of amusements, pageants and diversions, and a deep though not voluble or over-sensitive sense of the beauties of nature. But with all this she had understanding.

Unlike her daughter, she was not a professed blue-stocking. But she had a strong affection for theology, in which she inclined (like the great majority of the religious and intelligent laity of her time in France) to the Jansenist side. Her favourite author in this class was Nicole. She has been reproached for her fondness for the romances of Mlle. de Scudéry and the rest of her school. But probably many persons who make that reproach have themselves never read the works they despise, and are ignorant of how much merit there is in them. In purely literary criticism Madame de Sévigné was no mean expert. Her preference for Corneille over Racine has much more in it than the fact that the elder poet had been her favourite before the younger began to write; and her remarks on La Fontaine and some other authors are both judicious and independent. Nor is she wanting in original reflections of no ordinary merit. But to enjoy her work in its most enjoyable point — the combination of fluent and easy style with quaint archaisms and tricks of phrase — it must be read as she wrote it, and not in the trimmed and corrected version of Perrin and Madame de Simiane.

BIBLIOGRAPHY. — The publishing history of Mme. de Sévigné's correspondence is long and tortuous. The first letters appeared in the memoirs and correspondence of Bussy Rabutin (1696–97). Numerous unauthorized editions led Mme. de Simiane, the daughter of Mme. de Grignan, to publish an authorized version of the letters to Mme. de Grignan (6 vol., 1734–37), ed. by the chevalier de Perrin; supplementary volume (1751); last edition of the whole (8 vol., 1754). Numerous editions in the last half of the 18th century contained important additions: that of 1756 giving the letters to Pomponne on the Fouquet trial; 1773, the letters to Moulceau; 1775, the Bussy letters separate from the memoirs. An important collected edition of these fragments in 10 vol. by the abbe de Vauxcelles appeared in 1801. Gouvelle put the letters in chronological order (8 vol., 1806) and added unpublished letters that had appeared separately (12 vol., 1819). In that year appeared the first edition of Monmerqué, which culminated after his death, being completed by Mesnard, Regnier and Sommer, in 12 vol. of text with 2 vol. of lexicon and an album (1862–68). A critical re-examination of this was published by E. Gerard-Gailly (4 vol., 1953 ff.). *Lettres inedites*, 2 vol., ed. by C. Capmas, appeared in 1876. The first English translation appeared in 2 vol in 1727; in 8 vol., 1760–65; 10 vol., 1764. Later reprints of English translations include one with a preface by Mme Ducloux (10 vol, 1928) and one with an introduction by A. E. Newton (7 vol., 1928). *See* also a newly translated selection by Violet Hammersley (1956).

Nearly all the great French critics from Sainte-Beuve on wrote essays on Mme de Sévigné Of biographies, C. Walckenaer's (5 vol., 3rd ed., 1856) is the most elaborate, *See* also E. Fitzgerald, *Dictionary of Madame de Sévigné* (2 vol., 1944); Mme. Saint-René Taillandier, *Mme. de Sévigné et sa fille* (1938), *Adieu! Mnze. de Sévigné* (1947).

SEVILLE, an inland province of southern Spain, one of the eight provinces into which Andalusia was divided in 1833; bounded north by Badajoz. northeast by Córdova, south by Málaga and Cádiz and west by Huelva. Pop. (1950) 1,101,595. Area 5,429 sq.mi. The province is bisected by the navigable Guadalquivir (*q.v.*) river. which there receives the Genil and Guadaira on the left and the Guadalimar on the right. West of the Guadalquivir the surface is broken by low mountain ranges forming part of the Sierra Morena; the eastern districts are comparatively flat and very fertile except along the borders of Cádiz and Málaga, where rise the sierras of Gibalbin and Algodonales; and there are extensive marshes near the Guadalquivir estuary. Coal, copper, iron ore, silicate of alumina, marble and chalk are the chief mineral products; the province is famous for its oranges, and also exports wheat, barley, oats, maize, olives, oil, wine and chick-peas. Seville is the capital.

Other important towns (with 1950 municipality populations) are Écija (41,621), Carmona (26,887), Utrera (35,069), Morón de la Frontera (30,168). Osuna (23,350) and Marchena (20,534). Nationalists occupied the province during the first weeks of the civil war of 1936–39.

SEVILLE (SEVILLA), the capital of the Spanish province of that name, is the chief city of Andalusia and of all southern Spain. The town is situated on the left bank of the Guadalquivir river about 54 mi. from the Atlantic, about the same distance north of Jerez, the centre of the sherry trade, and 355 mi. S.W. of Madrid by rail. Seville is an archiepiscopal see and ranks as the fourth city in Spain. It lies low in the river valley, few parts of the city being more than 30 ft. above sea level, and was long subject to floods; these have been mitigated by modern dikes and embankments and by the diversion of the Tagarete, a tributary of the Guadalquivir. The climate is relaxing and in summer it is apt to be excessively hot. Pop. (1950) 324.553.

Seville is famous for the magnificently impressive ceremonies and processions of Holy Week, and for the gaieties of the ***feria*** ("fair") which immediately follows Easter. During the ***feria***, Seville is alive with bright costumes, gypsy music and the flamenco dancing of Andalusia. Important bullfights are held, and throughout these two contrasting weeks the city is full of visitors and many normal activities come to a standstill. Yet at all times the city has great character and a strong feeling of the south, with its many ***bodegas*** ("bars") open to the pavements, and restaurant meals served out of doors. Typical of many charming touches are the ceramic plaques bearing street names and other plaques indicating houses and streets which figure in the works of Cervantes. Velázquez and Murillo were both natives of Seville, and a house in the Barrio de Santa Cruz was the birthplace. in 1802, of Nicholas Cardinal Wiseman, the first archbishop of Westminster.

The City. — Old Seville is mostly an irregularly planned city, a maze of narrow, twisting streets and small enclosed squares; its houses, built and adorned in the Moorish manner, offer glimpses through doorways to beautiful little arcaded patios. There is a more spacious layout in the district near the cathedral and the Alcázar and in a few of the streets and squares. The broad Alameda de Hercules, laid out under Philip II, with its two Roman pillars bearing statues of Julius Caesar and Hercules, its gardens and rows of trees, is an exception to the normal Seville pattern. More spacious and regular planning is found outside the limits of the old Moorish and medieval city, and the Maria Luisa park is a particularly beautiful district; its avenues lead to the elaborate buildings of the Hispanic-American exhibition of 1929. But east of the Alcázar the Barrio (or quarter) de Santa Cruz. which was once the ghetto, is typically picturesque in the Sevillian manner; it is popular with tourists for its associations with Doiia Elvira, Don Juan and Figaro. Over the river is the centre of Seville's ceramic industry, the Barrio de Triana, with its attractive narrow streets; in the modern suburb of Los Remedios next to it is the tobacco factory built to replace the one associated with the opera Carmen.

In the Macarena quarter there is a much altered section of the Roman walls, and some of the Roman aqueduct is also preserved on the eastern side of the city. The chief Roman remains, however, are those of the large town of Italica, the birthplace of the emperors Trajan and Hadrian, at Santiponce 5 mi. N.W. The ruins of the amphitheatre are especially imposing, and the outlines of streets and houses are also visible. By mid-20th centurv much of Italica had yet to be excavated from beneath fields and olive groves.

From the Arab or Moorish period the most splendid survival is the Alcazar palace, which was begun in 1181. A decagonal, brick tower, the Torre del Oro (1220). part of the outer fortifications, is a striking feature on the riverbank; it houses a maritime museum. The splendid courts and state apartments in the Alcazar, from the Moslem or the Mudéjar period when the Moorish style continued under Christian rule, may be compared in beauty with those at Granada. Other examples of Moorish building are the tower of the church of San Marcos (once the minaret of a mosque), the Puerta del Perdón, two sides of the cathedral's Patio de Naranjos (court of orange trees) and the lower part of the Giralda, or belfry, of the cathedral. This was the minaret of Moslem Seville's chief mosque. Built about 1180–1200 by Ahmad ibn Baso for Yusuf I, it has surfaces almost entirely covered with beautiful yellow brick and stone paneling of Moorish design; its upper stages were added during the reign of Philip II. Seville also has several fine Mudéjar buildings. the Casa de Pilatos and the Casa de las Dueiias being among the best.

The building of Seville's churches started soon after the conquest of 1248. Among them, San Marcos and Santa Ana are good specimens of comparatively early Spanish Gothic. The exquisite chapel of the Old Seminary is of the 15th century. The brickwork of the convent of Santa Paula is late Gothic and is brightly decorated with Italian majolica.

For a century and a half the principal mosque, with adaptations, served Seville as its cathedral. The new cathedral of Santa Maria de la Sede, the second largest in area of all Gothic churches, was started in 1402; most of the building was finished by 1506. It has stylistic affinities both with the late Gothic of France and with English Perpendicular. The nave and choir are flanked by vast double aisles. the external breadth being 295 ft. and the nave vault 100 ft. above the pavement. The royal chapel at the east end, with the tombs of Ferdinand III and Alfonso the Wise, was completed by 1575 in the Plateresque style, and at the northwest corner is the baroque chapel, added in the 17th century, which serves as the parish church. The numerous windows of the cathedral range in date from the 15th to the early 19th century. Pictures include works by Alejo Fernández, Luis de Vargas and Murillo. The numerous chapels are enclosed by iron screens (*rejas*) of varying dates, many of them of sumptuous beauty, and many of the altars are backed by fine altarpieces of the baroque and earlier periods. In the choir the richly carved 15th-century stalls lead on, past two huge iron screens, to the high altar and its great Gothic reredos, a towering masterpiece of carved woodwork started by the Fleming Hyamson Dancart in 1482 and finished half a century later. Before the high altar, at the festivals of Corpus Christi and the Immaculate Conception, the altar boys (seises) stage their unique ceremony of a dance with castanets, an old custom the origin of which is obscure.

Renaissance and baroque churches in Seville have domes or belfries picked out with brightly coloured *azulejos,* or decorative tiles. La Magdalena, San Luis and San Salvador are among Seville's most imposing baroque churches. The palace of San Telmo, once a naval academy and now the diocesan seminary, has a splendid Churrigueresque (*q.v.*) portal, and rococo art is brilliantly represented by the ornate work in Santa Maria la Blanca and in the chapel of San José in the very middle of the city. Severer Renaissance architecture is seen in the Casa Lonja, built from designs by Juan de Herrera, the architect of the Escorial, and finished in 1598. First used by the merchant community, the building has housed the Archivo de Indias since 1785; the impressive staircase of red marble was built for this new purpose by Charles III. The Archivo has a superb collection of books, plans, manuscripts and several million documents, all bearing on the history and administration of Spain's empire in the Americas.

The university, originally a school but given university status in 1502, now uses the large, imposing fortified buildings of the old tobacco factory, completed in 1757 under Ferdinand VI. It has a charming chapel and a richly sculpted baroque portal. The museum, formerly the Mercedarian convent, has a fine collection of

JOSEF MUENCH

THE TORRE DEL ORO (TOWER OF GOLD). PART OF THE ALCÁZAR PALACE FORTIFICATIONS. ON THE GUADALQUIVIR RIVER, SEVILLE. THE GIRALDA, THE BELL TOWER OF THE CATHEDRAL. CAN BE SEEN IN THE BACKGROUND AT LEFT

paintings of the Seville school, which flourished during the 16th and 17th centuries. Among the artists represented are Velázquez, Murillo. Goya and Martin de Vos.

History.—Seville appears originally to have been an Iberian town. In the Roman period it flourished from the 2nd century B.C. onward, and was captured by Julius Caesar in 45 B.C., after the defeat of the Pompeians at Munda. Under the empire it became the headquarters of one of the four judicial subdivisions (*conventus juridici*) set up in the province of Hispania Baetica, the capital of which was at Córdova. Early in the 5th century the Silingian Vandals made it the seat of their empire; later, in the 6th century, the town passed under Visigothic rule. The Moors besieged and took the city in 712, and under their rule Seville flourished greatly. Idrisi speaks in particular of its great export trade in the olive oil of Aljarafe. About 741 much of this part of Spain was occupied by Syrian Arabs from Emesa, and a member of one of these Emesan families, Abul Kasim Mohammed, cadi of Seville, headed a revolt of the townsmen against the Berbers in 1023 and became the founder of the Abbadide dynasty whose capital was Seville. This regime lasted under his son al-Mutadid (1042–69) and his grandson al-Mutamid (1069–91), after which the city was taken by the Almoravides. The Moslems of Spain found the later years of Almoravide rule highly oppressive, and were even ready to welcome the victorious arms of Alfonso VII who was crowned emperor in 1135. Eleven years later all Andalusia rebelled, and Almohade troops took Seville in 1147. Under the Almohades, their capital, Seville, was the scene of great prosperity and artistic endeavour, but after the decline of that dynasty Ferdinand III captured it for Christendom in 1248; temporary ruin followed as many thousands of its people are said to have gone into voluntary exile.

Seville's geographic position was too favourable for it to decline altogether as a trading port, however, and by the 15th century it was again able to derive full benefit from Columbus' discoveries and Spanish colonization in the Americas. The Casa de Contratación, or house of trade, was established there in 1503, and Seville thus became the temporary residence of the casa's *pilotos mayores,* or chief navigational advisers, who included Amerigo Vespucci and Sebastian Cabot. For two centuries Seville held a dominant position in Spain's new world commerce, and many emigrants to the Americas sailed from its quays. Hydrographic conditions in time favoured the Atlantic port of Cidiz, and Seville, despite its great silk factories, shared in Spain's 17th-century economic decline. In 1800 an outbreak of yellow fever killed about 30,000 people, and in 1810 the city was severely plundered by the French under Marshal Soult.

Politically, Seville long had a reputation of peculiar loyalty to the throne and was therefore much favoured by the Spanish monarchs. For its loyalty in the revolt of the Comuneros, Charles V gave it the motto *Ab Hercule et Caesare nobilitas; a se ipsa fidelitas* ("Nobility came from Hercules and Caesar; loyalty from within itself"). The Central Junta against Napoleon (the committee to organize resistance to invasion by the French) was formed in Seville in 1808, and in 1823 the *Cortes* brought the king with them from Madrid to Seville. In the civil war of 1936–39 it was early occupied by the nationalists and remained in their hands; as a result its churches and other fine buildings escaped virtually intact. Since the civil war Seville has retained its position as the leading commercial centre of Andalusia and has fully regained its attraction for tourists and lovers of architecture.

(BN. L.)

Commerce and Industries.—Although an inland port, Seville was always one of the chief outlets for the wealth of Spanish trade. The windings of the Guadalquivir, from its mouth to Seville, where it is still tidal, render it dangerous for shipping. The construction of a 4-mi.-long ship canal from the Punta de los Remedios to the Punta de los Verde—two points between which navigation was especially dangerous—was therefore undertaken in 1907. On its completion, vessels drawing 25 ft. were enabled to reach Seville. Especially after World War II shipbuilding was greatly developed downstream from the town. One of the chief shipyards is owned by the Empresa Nacional Elcano and is supported by the government. The left bank quay, 4,500 ft. long, is equipped with powerful cranes and has large storage sheds.

The principal exports are sherry and other wines; Seville oranges and lemons, olives, oil and cork; pyrites, mercury and iron and lead ores. Hemp, jute and farm implements are also manufactured, and there are iron foundries and a royal artillery works. Seville has a famous tobacco and cigar factory associated with Carmen in Bizet's opera of that name. Pottery has been the characteristic industry of the Triana from time immemorial, and there is a porcelain and earthenware factory in the Carthusian convent. Justa and Rufina, the city's patron saints, are said to have been potters. Nearby butane gas deposits have also increased Seville's commercial potential.

The main-line railway from Seville to Madrid goes via Córdova, and there are branch lines to Badajoz and Lisbon; other lines connect Seville with Huelva and Cidiz. It is linked by road to other main cities. From the airport at San Pablo, $7\frac{1}{2}$ mi. from the city, there are services to Madrid, Valencia and Morocco.

(SH. H.)

SÈVRES, a town of northern France, in the *dkpartement* of Seine-et-Oise, on the left bank of the Seine, midway between Paris and Versailles, about 3 mi. from the fortifications of the former. Pop. (1954) 16,938.

The town owes its celebrity to the porcelain manufactory established there in 1756 and tdken over by the state three years later. The works museum has a general collection of pottery and the whole series of models ernployed at Sèvres from the beginning of the manufacture, for an account of which *see* POTTERY AND PORCELAIN~ A technical school of ceramics is attached to the factory.

SEVRES, TREATY OF, the treaty of peace concluded between the Allied and Associated powers and Turkey on Aug. 10, 1920. It was not ratified and was later superseded by the treaty of Lausanne which was signed on July 24, 1923. The principal arrangements of the treaty of Sèvres were as follows:—

The king of Hejaz was recognized as independent. The boundaries of Turkey were so drawn as to exclude it from control of any other Arabian states or of Syria, Palestine and Mesopotamia, and Turkey renounced in favour of the principal Allied powers rights over territory outside Europe that lay outside its new frontiers (Egypt, Sudan, Libya [Tripoli], Morocco and Tunis). Palestine was to be entrusted to a mandatory power, Syria and Mesopotamia "provisionally recognized as independent states to be advised by Mandatory Powers." Smyrna and the Ionian hinterland were placed under Greek administration for five years, when further arrangements would be made. The Dodecanese Islands were ceded to Italy, Imbros and Tenedos to Greece, and Turkey recognized Greece's sovereignty in Lemnos, Samothrace, Mitylene, Chios, Samos and Nikaria. The zone of the straits from Constantinople and Scutari to the Dardanelles and a zone on the Asiatic mainland were handed over to an international commission to be internationalized and demilitarized. Western Thrace, which had already been ceded to the Allies as a whole, was ceded by them to Greece by separate treaty. Turkey ceded to Greece Eastern Thrace, to the Chatalja lines. Turkey agreed to recognize Armenia as "a free and independent state" while Kurdistan was to receive local autonomy. The Turkish army was to be reduced to 50,000, all Turkish aircraft were to be surrendered and all the fleet except a few ships and torpedo boats.

The financial clauses charged Turkey with loss, with damage and with war guilt, but admitted that, as its resources were unequal to payment, such claims should be waived. But immense powers were conferred on a financial commission of British, French and Italian representatives with a Turkish representative in a consultative capacity, which was practically empowered to control the budget and the financial laws and regulations of Turkey. The Council of the Ottoman Public Debt was to be similarly formed and to have complete powers over its administration. The capitulations were to be re-established for the Allies but not for enemy powers, and the separate postal system of the Allies was also re-erected. Various Turkish ports, Constantinople, Smyrna, Alexandretta, etc., and the Maritsa river were to be placed under international control. *See* H. W. V. Temperley (ed.), *History of the Peace Conference at Paris,* vol. vi (1924). For the reversal of some of the terms of this treaty *see* LAUSANNE, CONFERENCES OF.

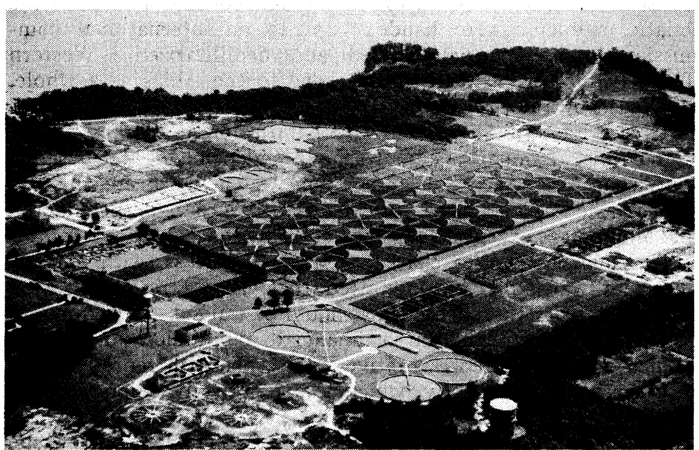
SEWAGE DISPOSAL constitutes one of the main barriers between disease organisms and man. To maintain this barrier the services of sanitary engineers, chemists, biochemists, civil engineers, aquatic biologists and many other technically trained people are required to build, supervise and operate waste-treatment facilities valued at millions of dollars. More than half of the population of the United States is served by sewers, and more than half of the sewage that is discharged to sewers is treated in municipal plants.

Every city, village and town is faced with the problem of disposing of the water-carried wastes from residences, business buildings and institutions. In most cities there are also industries that have wastes that must be disposed of in some way. The degree of purification that must be attained will be dictated by the amount of treatment that can be accomplished by the physical, chemical and biological processes that take place unaided in nature, without injury to the health and welfare of mankind. The relative volumes of treated sewage and the quantity of water in a stream, lake, sea or ocean into which the treated sewage is discharged and the use of the mixture for industrial water, recreation or as a water supply govern the degree of treatment that must be attained.

The methods of sewage disposal may be grouped broadly into (1) primary, such as sedimentation or passage through fine screens, to remove the grosser solids, and (2) secondary, such as trickling filters, sand filters or the activated-sludge method, by which the dissolved and colloidal organic matter in the sewage is collected by microorganisms and oxidized to stable forms that will not cause odour or nuisance.

Sewage is generally divided into two classes: domestic or sanitary sewage and industrial wastes, and storm water or storm sewage. In the more modern sewer systems the two classes of sewage are collected separately; however, in some of the older cities both classes of sewage are collected in one system. In the United States there is no attempt made to treat storm sewage unless it is mixed with the domestic sewage and in such cases it is only feasible to attempt treatment of a small portion of the combined sewages.

The average volume of domestic sewage is about 100 gal, per person per day. The measure of strength of the sewage is commonly based on the total and suspended solids and on the biological oxygen demand (BOD); the latter indicates the amount of oxygen required in the biological decomposition of the organic matter present, Both strength and volume may be markedly influenced bv industrial wastes.



BY COURTESY OF DORR-OLIVER INC.

LOW-RATE TRICKLING FILTERS. COVERING A 30-AC. AREA. USED AT BALTIMORE. MD.. BACK RIVER PLANT

Cities situated on large rivers are fortunate because they have a large quantity of water to dilute their waste waters. They are not required to achieve the high degree of sewage treatment that is required, for example, of a city that must discharge treated wastes into a lake and then obtain drinking water from the same lake.

Screening. — It is not uncommon to find pieces of wood, bundles of rags, pieces of wire and other sizable material in sewage. It is necessary to remove such material from sewage because it can damage the pumps. The screens used in most cases are bars spaced so that there are clear openings of about $1\frac{1}{4}$ in. Provision is made for mechanical cleaning, the cleaning mechanism being actuated by an electronic timing device. The screenings are only a small part of the total solids found in sewage, but in a large city they may amount to several truckloads per day. Disposal of the screenings may be accomplished by burial, incineration or by grinding and returning them to the sewage.

Grit Removal. — Materials such as sand, ashes and other gritty substances are found in all sewage and it is essential that they be removed so that there will be a minimum of wear of pump surfaces and no accumulation of the grit in parts of the treatment plant where they will be a nuisance. The grit is separated from the lighter sewage solids by regulating velocities of flow through channels so that the fast-settling grit will be deposited and the lighter solids carried on with the flowing sewage. The grit is removed from the channels and is buried or, if it has been freed of organic material by washing, it can be used as fill dirt. The equipment used in washing grit is the same type that is used in the mining industry to separate ore from debris.

Sedimentation. — Sewage that has had the screenings and grit removed still contains suspended solids, about one ton per 1,000,000 gal. of sewage, that make it look much like dirty dishwater. A city of about 500,000 persons has a sewage flow of nearly 100,000,000 gal. per day and consequently has the problem of disposing of approximately 100 tons per day of solids. Some of the solids in sewage will settle if the liquid is allowed to remain quiescent for a short period.

The standard method for primary treatment is sedimentation in a tank through which the sewage flows continuously. The period of retention in the tank is two to four hours. The units are eight to ten feet deep, and both round and rectangular tanks are used. The former employs a central feed and the settled sewage is discharged over a peripheral weir. Rectangular tanks have a length generally four or five times the width, with inlet at the one end and discharge at the other. Various methods are used for admitting the sewage and for removing the effluent to minimize currents that may interfere with the sedimentation.

The solids (or sludge) that settle are concentrated in a central hopper in the case of circular tanks, or in a hopper at the inlet end of rectangular tanks, by means of scrapers or collectors that are operated either continuously or several times a day.

Approximately 40%–55% of the suspended solids can be removed by sedimentation, and the biological oxygen demand will be reduced by nearly the same amount. Practically none of the dissolved solids can be removed by the process.

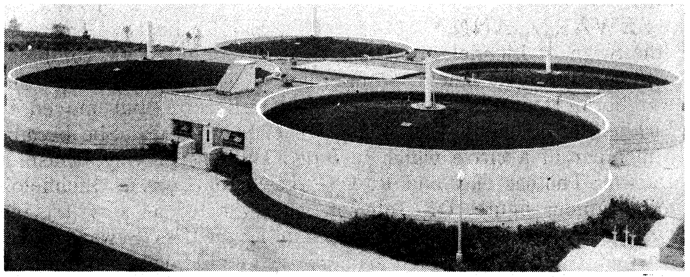
The German engineer Karl Imhoff developed a tank with an upper compartment for settling and a lower compartment where the solids are decomposed by bacteria that naturally grow in the environment provided.

The Imhoff tank is a simple device that contains no moving mechanical parts. It was used successfully in many parts of the world but in new plants was gradually replaced by settling tanks with mechanisms that permit more rapid handling of the sewage. Imhoff tanks were quite often used to provide settling prior to filtration through sand beds.

Chemical Precipitation. — Some cities on large rivers have been able to treat sewage sufficiently by primary sedimentation, disposal of the settled solids and chlorination of the effluent, the liquid remaining after sedimentation. Other cities have found it necessary to provide for chemical precipitation of the sewage during periods when the rivers are low. The chemicals coagulate some of the colloidal solids into particles of a size and weight that will settle. The chemicals are added to the sewage and quickly mixed with it in a small tank. The mixture then passes to a flocculating tank where gentle agitation is provided with stirring paddles. The floc is formed in 20–40 minutes and the flocculated sewage flows to a settling tank. Aluminum sulfate, ferric chloride and ferric and ferrous sulfates are the chemicals commonly used. The amount of chemical required depends upon the characteristics of the sewage. and will vary from 400 to 700 lb. per 1,000,000 gal. Addition of chemicals makes it possible to remove 80%–90% of the suspended solids and 65%–75% of the biological oxygen demand. The amount of dissolved organic solids removed by chemical treatment is very small.

Secondary Treatment. — The effluent from the primary settling processes contains some suspended and much dissolved and colloidal matter that will decompose if the body of water receiving the settled sewage is not large enough. Various methods are used for secondary treatment of the settled sewage. Trickling filters, the activated-sludge process and sand filters are the general methods used in secondary treatment.

Trickling Filters. — A trickling filter is a six to eight feet deep bed of stones two to four inches in diameter. Purification is accomplished by a film of bacterial slime and other organisms on the surfaces of the stones. The removal of materials from the sewage is not accomplished by mechanical filtering action, as might be surmised from the name given to the equipment. The sewage is applied to the stones in a thin sheet or spray, with short intervals between applications, and allowed to trickle down through the bed. Application is principally by means of rotating arms onto a circular bed, although some plants use fixed-spray nozzles that apply the sewage to square or rectangular beds. The standard rate of ap-



BY COURTESY OF PACIFIC FLUSH TANK COMPANY
SLUDGE DIGESTION TANKS AT TALLMAN'S ISLAND PLANT. NEW YORK CITY

plication is 300.000 gal. per acre per day per foot of depth, though some installations have been made which operate at rates twice as great. Trickling filters are usually enclosed in walls, generally of concrete. Openings in the walls or vents to the underdrains of the filters are provided to assure adequate ventilation, because the microorganisms on the filter stones must have an adequate supply of oxygen. The trickling filter is usually followed by a secondary settling tank because the organic matter that collects on the stones of the filter "unloads" or sloughs off, leaving solids in the effluent if they are not removed by sedimentation. Trickling filters, together with primary treatment and final sedimentation, will provide a removal of suspended solids and biological oxygen demand of 85%–95%.

High-Rate Trickling *Filters*.—These filters are so named because of the high rate of liquid load that is applied to their surfaces. The high rate of application, 10,000,000 to 30,000,000 gal. per acre per day, is attained by recirculating effluent over the filter along with the settled sewage. Application of the sewage and effluent to the stones is continuous and the rate is usually high enough to eliminate accumulations of large quantities of slime on the stones. The sludge that is accumulated in the settling tanks of both types of trickling filters must be removed and disposed of in some way.

Activated Sludge.—The activated-sludge method utilizes biologically active sludge mixed with the incoming sewage from the primary treated sewage and agitated in the presence of an ample supply of air in an aeration tank for four to ten hours. The suspended solids and many of the organic solids are quickly absorbed or adsorbed by the activated sludge. In the aeration period the organic matter is oxidized by the microorganisms in the sludge. The sludge, representing about 25% of the total volume, settles rapidly from the liquid in a secondary settling tank. The sludge is quickly returned to the incoming sewage and is passed through the aeration tanks again.

Aeration may be accomplished by means of compressed air blown through porous plates or tubes or admitted through specially designed jets, by means of mechanical agitators or by a combination of these methods. When plates, tubes or jets are used these are generally set in rows either across the aeration tank or along one side. In the mechanically aerated tanks, the most common arrangement is a revolving mechanism that agitates the sewage and sludge mixture and brings about aeration by throwing a portion of the mixed liquor through the air or by drawing air into a downdraft tube and discharging it under the surface in bubbles.

Advantages of the activated-sludge method include flexibility, permitting almost any desired degree of treatment by varying the period of aeration, and the high degree of removal of suspended solids, BOD and bacteria. About 95% of the bacteria are removed, more than 90% of the suspended solids and more than 90% of the organic matter as measured by the test for BOD. There is an accumulation of solids that must be removed from the system and disposed of in one of the several approved ways.

Sand Filters.—These are beds of sand, about 36 in. deep and underdrained, on which raw or settled sewage or the effluent from trickling filters is applied for final treatment. Sand beds are effective in producing a clear and sparkling effluent of high stability. Provision is made for backflushing the' beds for periodic cleanings.

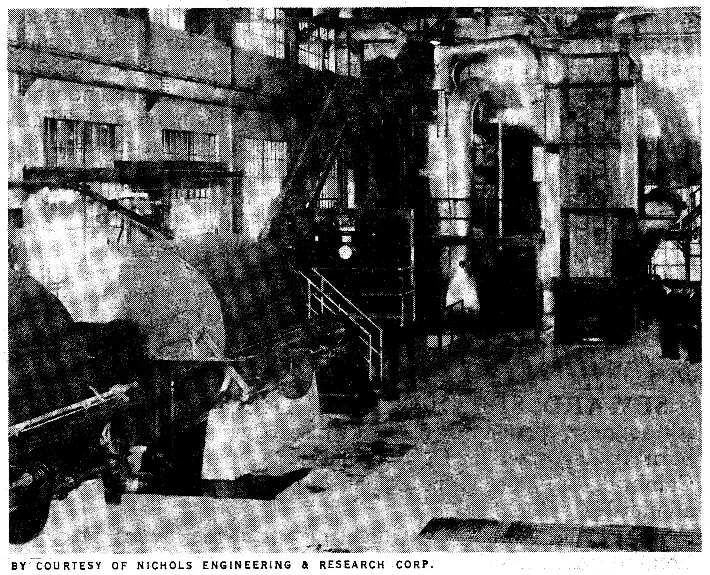
Sludge Disposal.—Sewage sludge is the accumulated settled solids deposited from sewage or industrial wastes, raw or treated, in tanks or basins and containing more or less water to form a semiliquid mass.

The various sludges that may originate in the several treatment processes are: (1) primary sludge; (2) chemically precipitated sludge; (3) trickling filter secondary sludge; (4) excess activated sludge; and (5) digested sludge.

The sludges may be hauled or pumped to sea, dewatered on vacuum filters and incinerated or sold for fertilizer immediately after removal from the sewage-treatment process, or they may be digested by microorganisms under controlled conditions to reduce the organic content prior to ultimate disposal. The digestion tanks are usually circular, 15 to 25 ft. in depth and with the diameter to provide the necessary capacity. Tanks are usually heated to a temperature of about 95° F. in order to provide the optimum temperature for the microorganisms that decompose the organic matter. With heated tanks, a standard design provides for two or three cubic feet of digestion tank per person contributing to the sewers; twice that volume is required for unheated tanks. A period of about 30 days ordinarily is required for complete digestion in a heated tank.

In the process of digestion the microorganisms produce carbon dioxide and methane—from 0.5 to 1.3 cu.ft. per day for each person contributing to the sewers. This gas is collected and used to heat the digestion tanks and buildings; it also may be used in gas engines that drive generators, sewage pumps and air compressors.

The sludge at the end of the digestion period may be used in liquid form as fertilizer, but the most usual procedure is to draw the sludge from the digestion tank and place it on sludge-drying beds. These consist of about 12 in. of sand supported on 6 to 8 in. of gravel, the whole being underdrained by open-joint tile spaced 8 to 10 ft. apart. The sludge can be removed from the beds by hand labour after a two- to three-week drying period. If properly digested, it is not objectionable and can be used for fertilizer or disposed of by dumping. It is excellent fertilizer for grass and shrubs, but should not be used to fertilize vegetables that are to be eaten raw.



BY COURTESY OF NICHOLS ENGINEERING & RESEARCH CORP.
VACUUM FILTERS (LEFT) AND SEWAGE SLUDGE INCINERATOR (BACKGROUND) IN DEARBORN, MICH. SEWAGE PLANT

Before sludge can be dried and sold as a commercial fertilizer or incinerated, a part of the water must be removed by vacuum filtration. Coagulating chemicals, lime, ferric chloride, ferric sulfate and chlorinated copperas are added singly or in combination to sludge prior to filtration with vacuum filters. Vacuum filters consist of a drum covered with a filtering medium, a vacuum being maintained inside a quadrant of the drum. As the drum is rotated through a tank containing sludge, the liquid is drawn into the drum while the solids are collected as a mat on the filtering media. The process is continuous, the sludge mat being peeled off as the drum revolves. The filters will dewater about five pounds of dry solids per hour per square foot of filter surface and the moisture content of the sludge cake will range from 70% to 85%. Vacuum filters will dewater either digested, raw, activated or partly digested sludge.

The digested sludge or the activated sludge filter cake can be dehydrated in heat driers and then bagged or sold in bulk as organic fertilizer. All sludge cake can be incinerated and there is usually sufficient heat value in the sludge to carry on the incineration process without the addition of fuel from outside sources, once the incinerator has been brought to operating temperature. Sludge may be hauled to dumping grounds at sea in boats and barges or pumped in suitable areas at sea. See also SEWER DESIGN AND CONSTRUCTION.

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SEWALL, SAMUEL (1652–1730), American jurist, was born at Bishopstoke, Eng., on March 28, 1652. He was taken to Newbury in New England in 1661; graduated at Harvard in 1671, receiving his master's degree three years later; studied divinity; and was resident fellow of Harvard in 1673–74 and keeper of the college library in 1674. He had apparently intended to enter the ministry, but his marriage to Judith Hull in 1678 caused him, like his father-in-law, to embark upon a mercantile and public career. In 1683 he mas deputy to the general court for Westfield; from 1681 to 1684 he managed the only licensed printing press in Boston; and in 1688 he went to England on business connected with land titles. He was a member of the New England council in 1692–1725, and in 1692 he was made one of the special commissioners to try persons accused of witchcraft in Suffolk, Essex, and Middlesex counties, Mass. This court condemned 19.

Sewall in Jan. 1697 stood in meeting while a bill was read in which he took "the blame and shame" of the "guilt contracted upon the opening of the late commission of oyer and terminer at Salem," and asked pardon; and till the end of his life he annually set apart a day of fasting, meditation and prayer in token of his offense. Later he was judge of probate for Suffolk county and a judge of the superior court, being its chief justice in 1718–28. He died in Boston, Jan. 1, 1730. Of his works the one which appeals most to modern readers, however, is his naive and delightful diary. The unconscious humour of such parts as the courting, the intimate revelation of a man of distinguished ability and sterling character and the minutely detailed record of the political, civic and social life of the time make it one of the most valuable and interesting documents left from colonial days.

The diary, like the letter book of Sewall, was published by the Massachusetts Historical Society in its *Collections*. Selections from it have been edited by Mark Van Doren (1927). *See* also G. E. Ellis, *An Address on the Life and Character of Chief Justice Samuel Sewall* (1885); N. H. Chamberlain, *Samuel Sewall and the World He Lived In* (1885).

SEWARD, SIR ALBERT CHARLES (1863–1941), British botanist, distinguished for his researches on fossil plants, was born at Lancaster on Oct. 9, 1863. As professor of botany at Cambridge (1906–36), he was an inspiring teacher and a capable administrator.

In 1921 he visited west Greenlaqd and made important collections of fossil plants. He was an authority on Mesozoic floras and author of several British museum catalogues. He was awarded the Royal and Darwin medals by the Royal society, and the Wollaston medal by the Geological Society of London.

In 1915 he was elected master of Downing college, Cambridge. Seward also was president of the Geological Society of London (1922–24), foreign secretary and vice-president of the Royal society, president of the International Botanical congress (1930) and president of the British association (1939). He died at Oxford on April 11, 1941. Seward's principal scientific publications include *Fossil Plants,* 4 vol. (1898–1919), and *Plant Life Through the Ages* (1931). (J. WN.)

SEWARD, ANNA (1747–1809), English poet, often called "the Swan of Lichfield." The rarity of women poets, combined with her cult of sentiment, brought her surprising popularity. She was born, Dec. 12, 1747, at Eyam, Derbyshire, but moved to Lichfield at 13, her father being prebendary there. She became a member of a circle which included William Hayley, Erasmus Darwin, Thomas Day and R. L. Edgeworth (*qq.v.*). Lichfield's most famous figure, Dr. Johnson, she admired as a writer but disliked as a man. Several times in love, Miss Seward never married. She wrote much bad poetry, including a sentimental poetical novel *Louisa* (1784), which went through five editions. She died in Lichfield, March 25, 1809. She had been a correspondent of Scott, and embarrassed him by making him her literary executor. He published her poetical works (3 vol., 1810) and her letters appeared in 6 vol. (1811).

See M. Ashmun, *The Singing Swan* (1931).

SEWARD, WILLIAM HENRY (1801–1872), U.S. statesman, was born on May 16, 1801, in the village of Florida, N.Y. He graduated from Union college, Schenectady, N.Y., in 1820, was admitted to the bar at Utica, N.Y., in 1822, and in the following year began the practice of law at Auburn, N.Y., his home for the rest of his life. He soon attained distinction in his profession, but drifted into politics, for which he had a greater liking, and early became associated with Thurlow Weed. He was at first an adherent of Daniel D. Tompkins in state, and a National Republican in national politics. After 1828 he became allied with the Anti-Masonic party, attending the national conventions of 1830 and 1831, and as a member of the organization he served four years (1830–34) in the state senate. By 1833 the Anti-Masonic movement had run its course, and Seward allied himself with the other opponents of the Jackson Democrats, becoming a Whig. In 1834 he received the Whig nomination for governor, but was defeated by William L. Marcy. Four years later he was renominated, was elected, was re-elected in 1840, and served from 1839 until 1843. As governor, Seward favoured a continuance of works of internal improvement at public expense. His administration was disturbed by the antirent agitation and by the M'Leod incident growing out of the Canadian rebellion of 1837. During this period he attracted much attention by his liberal and humane policy, promoting prison reform, and proposing to admit Roman Catholic and foreign teachers into the public schools of the state. Laws were passed during his term putting obstacles in the way of recovering fugitive slaves. Seward soon became recognized as the leader of the antislavery Whigs. He was one of the earliest political opponents of slavery, as distinguished from the radical Abolitionists, or the followers of William Lloyd Garrison, who devoted themselves to a moral agitation.

When the Whigs secured a momentary control of the state legislature in 1849 they sent Seward to the United States Senate. The antagonism between free labour and slave labour became the theme of many of his speeches. In his first set speech in the Senate, on March 11, 1850, in opposing the pending compromise measures, he attracted the attention of the whole country by his assertion that "there is a higher law than the constitution" regulating "our authority over the domain" (*i.e.,* the Territories). When the Democrats, however, declared such language incendiary he tried to explain it away, and by so doing offended his friends without appeasing his opponents. In a speech at Rochester, N.Y., in 1858 he made the famous statement that there was "an irrepressible conflict between opposing and enduring forces, and it means that the United States must and will, sooner or later, become either entirely a slave-holding nation or entirely a free-labour nation." Although this idea had often been expressed by others, and by Seward himself in his speech of 1848, yet he was severely criticized, and four days later he sought to render this statement innocuous also.

In the election of 1852 Seward supported Gen. Winfield Scott, but not his party platform, because it declared the Compromise of 1850 a finality. He naturally opposed the Kansas-Nebraska bill of 1854, which repealed the Missouri Compromise and established the principle of popular sovereignty in the Territories. Subsequently he actively supported in the Senate the free-state cause in Kansas. In 1854–55, when it became evident that the Whig party in the North was moribund, Seward helped to lead its scattered remnants into the Republican fold. As the recognized leader of the new party, his nomination by the Republicans for the presidency in 1856 and in 1860 was regarded as certain; but in each instance he was put aside for another. The heterogeneous elements of the new organization could not be made to unite on a man who for so many years had devoted his energies to purely Whig measures, and he was considered less "available" than Frémont in 1856 and than Lincoln in 1860. After Lincoln was elected in 1860 he chose Seward for his secretary of state. The new president was a man comparatively little known outside the state of Illinois, and many of his supporters, doubtful of his ability to deal with the difficult problems of 1861, looked to Seward as the most experienced man of the administration and the one who should direct its policy. Seward himself, apparently sharing these views, although not out of vanity, at first possessed an unbounded confidence in his ability to influence the president and his cabinet. He believed that the Union could be saved without a war, and that a policy of delay would prevent the secession of the border States, which in turn would gradually coax their more southern neighbours back into their proper relations with the Federal Government. In informal conferences with commissioners from the seceded States he assured them that Fort Sumter should be speedily evacuated. Finding himself overruled by the war party in the cabinet, on April 1, 1861, Seward suggested a war of all America against most of Europe, with himself as the director of the enterprise. Dangers from abroad would destroy the centrifugal forces at home, and the Union would be saved. When this proposal was quietly put aside by the president, and Seward perceived in Lincoln a chief executive in fact as well as in name, he dropped into his proper place, and as secretary of state rendered services of inestimable value to the nation. To prevent foreign states from giving official recognition to the Confederacy was the task of the hour, and in this he was successful. While he did not succeed in preventing the French occupation of Mexico or the escape of the confederate cruiser "Alabama" from England, his diplomacy prepared the way for a future adjustment satisfactory to the United States of the difficulties with these powers. While his treaty with Lord Lyons in 1862 for the suppression of the slave trade conceded to England the right of search to a limited extent in African and Cuban waters, he secured a similar concession for American war vessels from the British government, and by his course in the Trent affair he virtually committed Great Britain to the American attitude with regard to this right. On April 5, 1865, Seward was thrown from his carriage and severely injured. Nine days later, while lying ill at his home at Washington, he was attacked by Lewis Powell, alias Payne, a fellow-conspirator of John Wilkes Booth, at the same time that Lincoln was assassinated. The secretary's son, Frederick W. Seward, and three other persons who came to his assistance, were also wounded by the assailant. Seward's wife, an invalid, received such a shock that she died within two months, and his only daughter, who witnessed the assault, never recovered from the effects of the scene and died within the year. Seward gradually regained his health, and remained in the cabinet of President Johnson until the expiration of his term in 1869. In the struggle between the executive and congress over the method of reconstructing the southern States, Seward sided with Johnson and thus shared some of the obloquy bestowed upon that unfortunate president. His greatest work in this period was the purchase of Alaska from Russia, in 1867, for $7,200,000, a purchase which at that time was characterized by some as "Seward's folly." After returning to private life, Seward spent two years in travel and died at Auburn on Oct. 10, 1872.

The best biography of Seward is that by Frederic Bancroft, *The Life of William H. Seward* (1900); see also, *The Life and Works of William H. Seward* (1883), edited by George E. Baker; *William H. Seward: an Autobiography From 1801 to 1834, With a Memoir of His Life and Selections From His Letters* (1891), by his son, Frederick W. Seward; *William H. Seward's Travels Around the World* (1873), by his adopted daughter, Olive R. Seward; *Lincoln and Seward* (1874), by Gideon Welles; *William Henry Seward* (1899), by T. K. Lothrop, in the "American Statesmen Series"; *Seward and the Declaration of Paris*, by Charles Francis Xdams (1912); "Union Portraits: William H. Seward," *Atlantic Monthly*, vol. cxvi, pp. 322–334 (1915); *Recollections of a War-Time Statesman and Diplomat*, by Frederick W. Seward (1916); and "Seward's Far Eastern Policy," in *American History Review*, vol. xxviii, pp. 45–62 (1922).

SEWARD, a town of Alaska, U.S., at the head of Resurrection bay, about 1,800 mi. N.W. of Seattle, Wash. Transportation is the chief industry. Founded in 1903 as the terminus of a railway to the Yukon valley and named for William H. Seward, who as secretary of state negotiated for the purchase of Alaska by the U.S., Seward was chartered in 1907. In 1913 the federally owned Alaska railroad was created and took over the railway development. In the late 1950s the town had five docks for seagoing vessels, including facilities for handling bulk cement and explosives and for storing petroleum products. The small boat harbour and airfield are used extensively by chartered hunting and fishing parties. The August silver-salmon derby is a special attraction for fishermen. Hunting is varied; moose and bear, including the Kadiak, grizzly, brown and black varieties, mountain goats, small game and birds abound. The population in the early 1960s was approximately 2,000. (J. E. Cl.)

SEWER DESIGN AND CONSTRUCTION. The underground conduits constituting the system through which sewage is conveyed to the point of disposal are usually laid under public streets and form an intricate network of mains and branches. Sewers that carry only household and industrial wastes are called separate sewers; those that carry storm water from roofs, streets and other surfaces are known as storm-water drains; while those carrying both sewage and storm water are called combined sewers. House sewers connect the plumbing systems of buildings to lateral sewers in the streets. The sewage from laterals discharges into submain or main sewers, from which it discharges into trunk and outfall sewers.

Interceptors are generally laid transversely to the submain and trunk sewers to intercept the dry-weather flow of sewage and such additional surface and storm water as may be necessary. Relief sewers are provided to carry a portion of the flow from a district already served by sewers of insufficient capacity. and thus prevent overtaxing the latter. Storm-water overflow sewers are provided to carry flows in excess of the capacity of the main or intercepting sewers.

History.—The use of specially constructed sewers dates to the time of Babylon and ancient Greece, but only during the 19th and 20th centuries has the water-carriage system for removal of household and factory wastes been gradually adopted in the western world. Cities such as Paris, London, Boston and New York had sewers early in the 19th century. About the earliest application of engineering principles occurred at Hamburg, Ger., in 1842, at London in 1852 and at Brooklyn, N.Y., in 1857.

With the adoption of the water-carriage system, the transfer of wastes from home and factory to the nearest watercourse brought serious nuisance and health problems. Often the stream served the dual purpose of sewage-disposal and water supply, and hence there were frequent, disastrous epidemics of cholera, typhoid fever and other water-borne diseases. Gradually, corrective measures were devised, but at a slower rate than sewers were being built. Effective methods of sewage treatment had their beginnings only in the last quarter of the 19th century and the greatest development did not occur until the second quarter of the 20th.

Sewage.—Sewage is composed mainly of water, the proportion of solid matter: soluble and insoluble, to water being about 1 part per 1,000. In addition, it carries innumerable forms of microscopic life, and frequently contains bacteria hazardous to health. The prompt and inoffensive removal of sewage from its source to a suitable and convenient point of disposal is the basic purpose of sewer systems. The object of proper sewage disposal is to prevent nuisances from the decomposition of organic solids and health dangers from harmful bacteria.

Separate v. Combined Sewers.—Combined sewers have been used where disposal of sewage by dilution has been permissible. However, as population increases the receiving waters may become so seriously polluted as to require the installation of sewage-treatment plants; then it becomes necessary to ensure that the plants have adequate capacity to treat substantial quantities of both storm water and sewage. Moreover, combined sewers may have to be made much too large for the ordinary dry-weather flow of sewage alone; as a result, flow velocities may be too low to prevent formation of objectionable deposits of solids in the sewer.

Against these disadvantages, combined sewerage systems have the advantage of requiring only a single conduit in each street. In addition, the quantity of domestic sewage usually is no greater than the margin of error in estimates of the quantity of storm water; therefore, the combined sewer need not be appreciably larger than a storm-water drain for the same district. Consequently, there is a substantial saving in building the single conduit instead of two.

It is almost impossible to be sure of complete separation of domestic sewage and storm water. It is difficult to keep roof and cellar drainage out of separate sewers even when such connections are prohibited by local ordinances. The homeowner may connect the downspouts or gutter drains to his house sewer without the knowledge of the authorities.

Design. — The arrangement of a sewer system is governed by the topography of the area to be served and the relation of the point of disposal to various points in the system. Unlike water-distribution systems, which are under pressure, sewer systems must be laid out. within the limits imposed by the terrain, so that sewage can flow by gravity from the point of origin to the point of discharge. However, since economic and engineering factors control the depth to which sewers can be laid, it becomes necessary in flat terrain to provide numerous pumping stations in the system.

Estimates must be made of the volumes of sewage and storm water, in the case of combined systems, and the pipe sizes and slopes must be such as to provide sufficient capacity to handle maximum flows and at the same time give adequate scouring velocities at minimum flows to prevent deposits. Five factors determine the amount of liquid a sewer can convey: slope or fall; cross-sectional area and shape; character of interior walls; depth of sewage; and presence or absence of obstructions such as curves, air resistance and the like. Formulas for the mean velocity of flow are based upon the fundamental laws of fluid mechanics. Minimum velocities of design flows should be at least two feet per second and maximum velocities not over eight feet per second. The amount of sewage depends upon the water consumption of the contributing population and the amount of ground-water infiltration and storm runoff.

Sewer Pipe. — The pipe used in sewer systems is made of vitrified clay or concrete; it is usually circular in cross section, although for large combined sewers a variety of shapes may be used to meet special conditions. Clay pipe is generally used for sizes up to 42 in. in diameter and concrete pipe for larger sizes up to 108 in. Large pipe may be made of reinforced concrete cast on the site.

Miscellaneous Appurtenances. — Access manholes are provided at frequent intervals to permit inspection and cleaning. In the case of drains and combined systemb, catch basins at street curbs admit surface runoff and, in instances where high flow may at times exceed sewer capacity, regulating devices are provided to direct overflows to the nearest stream. Sometimes, to pass such obstacles as building foundations and rivers, sewers must be depressed for short distances; this is done in such a manner that the sewer flows under pressure, and the depressed sections are called inverted siphons. Under certain conditions special provision must be made for ventilating equipment to remove corrosive gases which may attack concrete pipe.

See also SEWAGE DISPOSAL; PLUMBING.

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SEWING, HOME. This article on home sewing is divided into two major sections: *Equipment, Fabrics and General Procedures* and *Hand Stitching*, the latter including a short subsection on repairing worn or torn fabrics.

EQUIPMENT, FABRICS AND GENERAL PROCEDURES

Before shopping for supplies, a list should be prepared of all items necessary for the completion of the sewing project. Swatches of the fabric that will be used may be attached to the shopping list to ensure selection of the right colour, weight and size of buttons, thread, slide fasteners, seam binding and findings. Extra thread should be purchased. Equipment such as sewing machine, ironing board and table should be placed close together and all supplies kept readily available. Before starting a project, the sequence of work should be planned so that the minimum number of changes of type of work need be made (*i.e.,* sew or press as many seams as possible at one time). All preshrinking of materials, cutting, marking and stay stitching should also be done at one time. Seams and darts that are unlikely to be altered during fittings should be permanently stitched and pressed.

EQUIPMENT

Scissors and Shears. — Shears are used for cutting heavy fabric. Pointed-tipped scissors are used for intricate cutting and trimming of threads and seams. Inaccurate cutting often results when shears and scissors are too heavy and long; shears should be seven to nine inches long, scissors four to five inches long. They should make slick cuts to the very tip and be of forged rather than cast steel. When blades are fastened with screws rather than rivets there is better tension and easier adjustment. A drop of sewing-machine oil should be put on the screw occasionally to keep scissors working easily. Differently shaped shears are available for right-handed and left-handed people. Shears with bent handles do not lift fabric from the cutting surface as much as those with straight handles.

Pinking shears are used to retard raveling on firmly woven fabrics. The notched blades make a zigzag or scallop cut that may also be used as a decorative edge on nonraveling fabrics. Pinking shears should be seven to nine inches long and have bent handles and notches deep enough to effectively retard raveling.

Scissors and shears may be sharpened and repaired by the manufacturer or in scissors-grinding shops.

Pins. — Brass pins approximately one inch long (sizes 16 or 17) are satisfactory for most home sewing. Unplated steel pins may cause rust or black marks. Slender silk pins should be used on light- and medium-weight fabrics as well as on resin-coated fabrics, which mar easily. Thicker dressmaker pins are desirable for stiffer fabrics.

Needles. — Coarser hand and sewing-machine needles should be selected for heavy fabrics, finer needles for light- and medium-weight fabrics and for use in places where inconspicuous stitching is desired. For ordinary hand sewing, medium-length needles such as sharps, sizes 7–10, with small round eyes, or crewel or embroidery needles, sizes 5–10, with long eyes, may be used.

Special needles are available for specific sewing tasks, among them extremely fine needles for beading; curved needles for upholstery and lamp-shade sewing; short betweens or tailor's needles for short stitches and fine handwork; cotton darners, wool darners and chenille needles with large eyes for heavy threads or yarns; blunt needles for canvas work; glover's needles with three-sided points for sewing fur and leather.

Needles should be kept in their packets; the black paper commonly used in the packets is treated to prevent corroding. Needles may be polished by slipping them through an emery bag several times, but they should not be left in the emery bag, which may cause rusting.

Thimble. — A thimble protects the finger and facilitates sewing. It should be worn on the middle finger of the sewing hand. A thimble should fit comfortably, be made of plastic or metal that is not bulky and have indentations deep enough to hold the needle in place while being pushed.

Marking Devices. — Tailor's chalk in cake or pencil form may be used to mark guides on fabric. The wax type of chalk is suitable for use on woolens, dry chalk for other fabrics.

A blunt or saw-tooth tracing wheel, run over dressmaker's carbon paper on fabric, will leave a path of small dots for sewing guides. Tailor's chalk and dressmaker's carbon paper are available in various colours. In general, all markings should be made on the wrong side of the fabric.

Measuring Devices.—An adjustable metal gauge or homemade cardboard gauge is useful for measuring short lengths. A 60-in. tape measure, preferably of plastic or plastic coated, is an essential item. A yardstick is useful for marking hems and long seamlines. Pin skirt markers, which guide pins into fabric, require the help of another person; chalk skirt markers can be used without help, but the powdered chalk does not always adhere to smooth fabrics and may rub off too easily.

Pressing Devices.—A three- or four-pound electric iron having steam- and dry-pressing features plus a heat-control dial is most useful. Damp, lint-free cotton or linen press cloths may be used for steam pressing. Organdy or tissue paper may be used for protecting fabric while pressing it on the right side.

Small narrow sleeveboards are useful in pressing sleeve seams or other seams that are difficult to press on a wider board.

The ironing board should have a clean, smooth covering. Covers made of unbleached muslin or drill should be laundered before use to remove sizing, which scorches easily and sticks to fabric and the iron.

Sharper creases are made when pressing on unpadded or tightly padded press boards or blocks. Seam markings are less likely to show on the right side if pressing is done on a thickly padded press board; strips of heavy wrapping paper may be placed under each side of a seam when pressing to prevent seam markings.

Darts and curved seams should be pressed on a curved surface such as a tailor's mitt, tailor's ham or tightly stuffed pillow. Needle or velvet boards are used to press pile fabrics, placing the pile side down and pressing on the wrong side of the fabric. Wool broadcloth and pile fabrics mar less when pressed over a piece of self-fabric, right sides against each other.

An iron will glide more easily if it is run over waxed paper occasionally. Burnt sizing (starch) should be removed from an iron with a soft cloth moistened with water or silver-polishing cream. An iron should never be cleaned with abrasives or scouring powder.

Sewing Machines.—Good machine stitching results when the machine tension is properly adjusted for the thread used (*i.e.,* loosened for heavy thread, tightened for fine thread); when a needle of correct size for the thread and fabric is selected; when the needle is sharp, not blunt or bent; and when the stitch of correct length for the fabric is used. Outside stitches look and wear better if they are shorter than inside seam stitches.

Fine fabrics are sewed with 16–20 machine stitches per inch; medium-weight fabrics with 12–16 stitches per inch; heavy fabrics with 10–14 stitches per inch; and very heavy fabrics with 8–10 stitches per inch. (*See* also SEWING MACHINES.)

FABRICS AND THEIR ACCESSORIES

Fabric Selection.—The inexperienced seamstress will have more success and less difficulty if she chooses fabrics that are of medium weight and firmly woven, do not stretch or ravel much, have a dull surface, are without nap and do not have check, stripe or plaid patterns. Uneven stitching is less noticeable on fabrics having textural variation or small- or medium-sized all-over prints. Widely spaced, large and one-way prints require special attention to balance and match the print. Some of the plastic, glazed, crease-resistant or resin-coated fabrics must be handled carefully because pin and needle holes show and the fabric may split where a stitching line has been removed.

A fabric best suited for the use and care the sewn item is expected to have should be selected. If the fabric label indicates a possible shrinkage of more than 1% (or has no indication) during laundering, it is best to purchase extra yardage and preshrink the fabric before cutting. In preshrinking, the fabric should be completely saturated in warm water, the water gently pressed out and the fabric hung lengthwise to dry.

Extra fabric is needed for matching stripes, plaids, large checks and prints. Additional napped or pile fabric also is required, because sections of the pattern must be laid in one direction (*i.e.,* all hemlines must be placed toward one end of the fabric). To estimate the amount of fabric needed, the fabric width and pattern alterations should be noted; sometimes it is more economical to purchase less yardage of a wide fabric than more yardage of a narrow width at a lower price.

See separate entries on fabrics, for example, BROCADE; CHIFFON; CORDUROY; CRASH; CREPE DE CHINE; CRETONNE; DAMASK; DENIM; FLANNEL; FLANNELETTE; GABARDINE; GINGHAM; LAWN; LIKEN AND LINEN MANUFACTURE; MOIRE; MUSLIN; PLUSH; PONGEE; POPLIN; SATIN; SERGE; SHANTUNG; SILK AND SERICULTURE; SYNTHETIC FIBRES; TAFFETA; TWEED; VELVET; VELVETEEN; VICUÑA; VOILE.

Thread.—Whenever possible, thread made of the same fibre as the fabric to be sewn, or of a fibre with similar properties, should be used; *i.e.,* nylon thread for sewing nylon and Orlon fabric; cotton thread for cotton and linen; silk thread for silk and woolen. Glossy thread produces a more conspicuous stitch than does dull-surface thread. For best results in sewing, thread designed for specific purposes should be used; *i.e.,* silk buttonhole twist for handworked buttonholes, fagoting or saddle stitching; button and carpet thread for extra strength when sewing rugs, buttons, tarpaulin or leather.

Threads may be made stronger, more slick and less likely to knot by rubbing against beeswax.

Fine basting thread should be used to prevent leaving holes in the fabric when removed. For basting, dark threads should be used on dark-coloured fabrics and light threads on light-coloured fabrics. Use of smooth thread (silk, nylon or Dacron [Terylene]) when basting pile or napped fabrics or when making stitches for gathering will prevent fibre adherence when the basting thread is removed. Use of strong, smooth thread (silk, nylon, Dacron) is desirable when gathers are to be made, since such thread draws easily through the material and is not likely to break. If basting remains in the fabric during pressing, pressed indentations from the thread are likely to occur unless fine thread is used.

Thread appears lighter after sewing than it does on the spool; hence in matching thread colour with fabric, thread that appears a shade grayer and darker on the spool than that which matches the fabric should be chosen.

Mercerized cotton thread (see MERCERIZING) is stronger and has more lustre than does untreated cotton thread. Heavy-duty thread should be used for strong stitching on heavy fabrics. The high sheen of silk thread emphasizes stitching lines; its strength and elasticity make it a good choice, however, when sewing areas where there is strain (*i.e.,* armholes) or when sewing bias sections. Dacron and nylon thread are affected by heat and are not desirable for use on cottons and linens that require high temperatures for pressing. Dacron thread may be used on Dacron, Orlon, nylon, acetate or wool fabrics. Nylon thread, which is very strong, may cut weaker fibres such as wool.

Silk, nylon and Dacron threads are strong and elastic; hence it is necessary to loosen the machine tension to prevent puckering.

Elastic thread may be used where elasticity and gathering of fabric are desired. When elastic thread is used in the sewing machine, it must be wound on the bobbin by hand, without stretching, and placed in the bobbin case but not slipped into the tension groove. The top of the machine is threaded with regular sewing thread. A long machine stitch should be used for full gathers.

Metallic threads are available for decorative stitching. Those that are guaranteed not to tarnish should be selected.

Tapes and Bindings.—Cotton twill and plain woven tape are used to strengthen seams and to prevent stretching. Plain woven tape may be sewn into the waistlines of dresses to prevent stretching. Rayon, silk or nylon straight seam bindings with woven edges are used to reinforce seams and as a finish on hems. Acetate tape with fused edges ravels with wear. Rayon tape should be used on cottons, linens, silks, wool and rayons; silk binding for silks and woolens; nylon binding for nylon, Orlon and Dacron (Terylene); acetate binding for acetate fabrics. Nylon or acetate binding should not be used on fabrics requiring high temperatures for pressing, because heat causes them to melt, stiffen, crack or shrink.

Bias binding is used to bind or encase seams in unlined coats and on fabric that ravels excessively or that has stiff fibres that might irritate the skin.

Bias skirt facing in two- or three-inch widths with one folded edge in cotton and rayon may be used to make false hems when inadequate fabric is left for a hem or when a less bulky, flat hem is desired.

Bias binding and skirt facings may be made from medium-weight fabrics by cutting the fabric on the true bias; it is usually more economical, however, to purchase them.

Grosgrain ribbon often is used as an inner belt attached to the waistline to prevent the waistline from stretching and to nip in the fabric. A snug-fitting inner belt (using hooks and eyes for opening and fastening) may be attached to the waistline of a dress with a heavy skirt to eliminate strain on the bodice.

Fasteners. — Slide fasteners should be chosen according to specific needs; they are available in fine, medium and heavy weights. The weight of the fabric and amount of strain to which the fastener will be subjected should influence selection. Slide fasteners are designed for skirts, dress plackets, neckline openings, trousers, foundation garments, removable linings, reversible garments, slip covers, garment bags, etc. In purchasing, the length and type of fastener and whether it is separable or nonseparable at one or both ends should be checked. Slide fasteners for slip covers, designed to withstand hard wear, may be purchased by the yard or inch. Foundation-garment fasteners are equipped with a fabric shield to protect the skin and have hook and eye fasteners to alleviate strain.

Snaps (press fasteners) provide a flatter closing than do hooks and eyes, but the latter withstand more strain. Snaps that withstand strain may be purchased in loose form to be hammered onto fabric; they also are available fastened to tape that can be sewn quickly to a slip cover. Thread-covered hooks and eyes are used on fur and fabric coats.

Small hooks and eyes and snaps should be used on fine fabrics, heavier ones on heavy fabrics or in areas subject to strain.

Nylon tape fasteners can be used in lieu of buckles, buttons, slide fasteners, snaps and hooks and eyes. These fasteners consist of two tapes, the inner side of one of which is covered with soft fine loops that become caught onto hooklike stiff nylon pile covering the inner side of the other. The fastener is secure even after repeated use and can readily be opened by pulling the strips of tape apart. The tapes are cut to any desired length with ordinary scissors and sewn by hand or machine stitches. This fastener is somewhat bulky, noisy while being unfastened and heat sensitive because it is made entirely of nylon fibres. Low or medium (up to 350° F.) iron temperatures are safely used. Nylon tape fasteners should not be used on items that will be subject to high temperatures in washing or ironing.

Cord. — Cord is placed inside bindings, buttonholes and looping to give a fuller appearance. The fabric cover should be cut on the bias to achieve a closer fit over the cord. Cable or piping cord, a moderately hard cord, is available in many sizes. For softer effects wool or cotton yarn with fewer twists may be used.

Padding. — Shoulder pads may be made with loose lamb's wool, which does not flatten down, with cotton sheet wadding or with tailor's cotton felt. Latex and plastic foam pads also may be used. Washable or removable pads must be used in washable garments. Commercial shoulder pads are fabric covered for unlined garments and unfinished for use in garments that will be lined. Pads with angular ends at the shoulder tip should be used for garments with set-in sleeves, pads with rounded shoulder tips for garments with kimono and raglan sleeves.

Tailor's cotton and wool felt and nonwoven bonded fabrics may be attached to the interfacing of tailored coats and jackets to fill hollows in the chest area, smooth the silhouette around the armhole and give shape to the hip curve.

For trapunto, wool yarn or loose lamb's wool, which does not pad down so quickly as cotton does, should be used. For quilted work cotton and Dacron (Terylene) sheet wadding, preshrunk cotton flannel and thin blankets may be used.

Stiffeners. — Bodices of strapless and sun-back dresses may be given support by attaching featherboning and very flexible metal stays to the seams or lining. For comfort, the boning and stays should be covered with fabric.

Belting with and without stays is sold for use in belts and for the insides of the waistlines of unbelted skirts and trousers. Belting with guaranteed durable stiffness should be selected.

Hems in sheer fabric that does not require laundering may be stiffened with horsehair braid, which is more or less transparent; it may be sewn either by hand or by machine over or inside the hem.

Flexible thread-covered wire and wire stays are sewn to sheer fabrics, such as lace, to give body to collars, cuffs and ruffles.

Stiffening (called heading) for the tops of draperies should be preshrunk, with a permanent stiff finish.

Interfacing. — Interfacing refers to the woven and nonwoven fabrics attached to the wrong side of a sewn item to give it more strength; to prevent seams from showing on the right side; to assure continued shape and fit during cleaning; to achieve a desired silhouette; and to give more body to fabric. Interfacing should reinforce and shape the item without adding unnecessary bulk, particularly at seams; therefore, thick interfacings usually are undesirable. The interfacing should not be too stiff for the outer fabric; satisfactory results usually are obtained when the interfacing is only as stiff as or less stiff than the outer fabric. Interfacing with permanent finish for crease resistance and stiffness should be used on garments requiring laundering or dry cleaning.

For items that will be laundered, colourfastness is essential; in addition, the interfacing must be thoroughly preshrunk before being cut and sewn. As a precaution, any interfacing should be shrunk at home unless it is guaranteed not to shrink; it should then be thoroughly dried before cutting.

Colour of interfacing should be considered, since sometimes the interfacing colour will show through the outer fabric. It is wise to have the outer fabric on hand when selecting the interfacing. Interfacing should not discolour when cleaned; if a white interfacing on a white garment turns yellow when laundered, it is likely to show through the outer fabric. Some brands of nonwoven bonded textiles tend to discoloration.

Interfacing used for reinforcing buttonhole sections should match the outer fabric.

Transparency or opaqueness of the interfacing also must be considered. In general, interfacing is not used on sheer fabrics, but sheer interfacing fabric such as marquisette, net or organdy may not show through a loose-woven or translucent outer fabric.

Interfacing materials are woven or nonwoven textiles. Woven interfacings can be molded and shaped through cutting, pressing and stitching. Nonwoven or bonded textiles are shaped by cutting and stitching but cannot be shrunk or stretched through pressing. Hence, woven interfacings are more suitable for use in collars, shoulders and chest sections of garments, where easing and molding of fabric are important.

Crease-resistant interfacings will retard wrinkling of the garment. Crease resistance of the interfacing is determined by the fibre used; nylon, wool and mohair fibres are least likely to wrinkle; cotton and rayon fibres will wrinkle more easily and retain wrinkles unless treated with a crease-resistant finish, at the time of manufacture. Garments having resilient interfacings crush less when packed. Interfacing must be able to tolerate (without melting, shriveling or splitting) the ironing temperature required by the outer fabric.

Nonwoven interfacing fabric made of nylon, acetate and cotton may be used with many types of outer fabric; it does not ravel and may be cut in any direction. Marquisette, net and tulle are used with filmy fabrics such as lace or where soft or slight reinforcement is needed. Marquisette and net often are used with wool and cotton jersey or as a reinforcement in areas where beads and sequins will be sewn. Batiste and lawn are used on all weights of fabric without affecting the suppleness of the outer fabric; they are used also as reinforcements in buttonhole areas. Taffeta as an interfacing provides stiffness and is not bulky. If the outer fabric is lightweight, self-fabric may be used as interfacing. Unbleached muslin should always be preshrunk in warm water prior to use. Hair canvas (hymo), made of mohair and linen or cotton, is used as a reinforcement in coats and jackets that are to be dry cleaned and occasionally in dresses or skirts when resiliency and stiffness are desired; hair canvas should always be preshrunk prior to use.

In general, interfacing is cut on the same grain as the section of the outer fabric to which it is to be attached. It may also be cut on the true bias.

Interlinings. — Fabric placed between the outer fabric and the lining of a garment for added warmth is called an interlining. Interlining, such as cotton flannel, also is placed between the lining and outer fabric of draperies for protection against sunlight and to give body.

Garment interlinings made of resilient fibres (*i.e.,* wool) will not pack down so quickly as those made of less resilient fibres (*i.e.,* cotton), and therefore are warmer. Cotton, glass fibre, plastic foam and wool quilting are bulkier than are woven interlinings.

Some garment linings — linings with quilted backs, napped fleece backs and backs coated with aluminum particles bonded with resins — are constructed to eliminate the necessity of a separate interlining. Chamois is used as a windbreaker in coats.

Linings. — Household items and clothes are lined to improve appearance and wearing qualities. Usually, fabrics specifically designated as lining fabrics are most satisfactory. Unless a bulky appearance is desired, lining fabrics should be flat. The degree of stiffness in the lining will affect the outward appearance of the finished garment. Outer fabric that falls limply is given body by use of stiff linings such as taffeta, satin or sateen. A soft effect is maintained with the use of soft fabrics such as crepe.

Lining materials for coats should be sturdy and of a smooth texture that makes it possible to slip in and out of the coat easily. Fabrics that will not change colour, lose stiffness or shrink when the finished item is cleaned should be selected.

Fabrics Requiring Special Treatment

Fabrics that ravel excessively should be cut with wide seam allowances. Raveling may be retarded by placing a row of machine stitches $\frac{1}{8}$ in. from the cut edge immediately after cutting the fabric. To stop raveling, seams may be finished by binding with bias binding; by folding back $\frac{1}{8}$ in. of the seam and machine stitching the fold; by using the zigzag attachment or zigzag sewing-machine stitch on the cut edge; or by overcasting with hand stitches.

Fabrics that shift a great deal during cutting may be pinned to thin paper, and the sections cut out and stitched through fabric and paper; then the paper sewn into the seams may be ripped off. Fabrics that are marred easily by the feed dog (the ridged surface under the pressure foot of a sewing machine) may be protected by placing a strip of paper under the seam during stitching, then ripping it off afterward.

Wool.—Wool fibres are stretched during the manufacture of cloth; when moistened they relax and the fabric shrinks. Because water is used in dry-cleaning solutions and for pressing, it is necessary before cutting woolen fabric to relax the fibres by a process called sponging. A presponged woolen may be labeled "sponged," "London shrunk" or "ready for sewing." If it has not been sponged the purchaser should buy an extra two or three inches of material for each yard required; it can then be sponged at home or by a commercial presser or dry cleaner before cutting. To sponge woolen fabrics at home, steam pressing on the wrong side, the steam being distributed uniformly, may be utilized. The fabric should not be pressed dry; rather it should be allowed to dry on a flat surface, not hung up. Steam pressing is the most satisfactory way to sponge felt, gabardine, crepe and knitted wools, and it may be used on all types of wool fabrics. For more complete sponging, the fabric, folded lengthwise, right sides together, may be placed within a sheet that has been immersed in warm water and wrung out. The fabric should remain in the moistened sheet until it feels slightly damp, then removed, wrinkles pressed out, and laid on a flat surface to dry. The wet-sheet method should not be used on felts, jerseys, crepes or gabardines because it may cause the fabric to shrink too much.

In steam pressing woolen, a little moisture should be left in the fabric and moderate heat used. High temperatures cause shine and scorching. A damp cloth must be used when pressing with a dry iron.

Home-sewn woolen items are given a more professional appearance by hand pressing by a tailor or presser in a dry-cleaning establishment. Coats and jackets should be so pressed before linings are attached.

Knitted Fabrics. — Fine needles and pins should be used; coarse pins and needles make holes, burst yarns and split fabric at seams. When cut edges curl, it is necessary to place pins closely together in pinning seams. To prevent bursting of machine stitches, knitted fabrics should be sewn with thread that has some elasticity and is smooth in texture (*i.e.,* mercerized cotton or silk) and the seam should be stretched slightly while stitching. Seams should be reinforced where there will be strain (as shoulder and waistline seams) by sewing bias or straight tape into the seam.

On knitted fabric the line created by the rib indicates the straight of the material; the garment will fall properly only if the straight of the pattern pieces is laid parallel to the ribline. To facilitate pattern layout, the line of the rib may be marked by laying a ruler on a continuous rib and then marking it with chalk or basting stitches. Tubular jersey is not always folded on a continuous rib; before laying out the pattern, the rib should be located and marked, then the fabric refolded or split directly on a continuous rib.

Interfacing material should be used to reinforce areas of knitted fabric where there will be strain; *i.e.,* buttonholes, snaps (press fasteners), hooks and eyes. It may also be used to prevent stretching.

For flat hems in knitted fabric items, a seam-binding finish should be used rather than a double fold.

Pile and Napped Fabric. — Velvet, velveteens and corduroy are examples of pile fabrics (see WEAVING: Piled Fabrics). Both napped fabrics (in which the fuzzy surface is produced by brushing, or teaseling, after the fabric is woven) and the pile fabrics must be cut with the nap going in one direction; otherwise the sewn sections will appear to have different colour values. Velvets and velveteens appear to have more depth and richness when cut with the pile direction upward; further, garments so cut will not shade differently where pressure has been applied to the fabric (*i.e.,* from sitting or wrinkling).

For most satisfactory results, pile fabric should be cut with the pile direction as follows: corduroy, down or up; velvet, up; very deep pile, down; white velvet, down; panne velvet, down; velveteen, up; plush, up.

Fine pins and needles should be used on pile fabrics so that the pile will not be pushed out of place, and basting should be done with slick thread to avoid catching pile on thread or pulling it out of position when basting is removed. Pile fabrics should be hand basted with short stitches to prevent the shifting and creeping of fabric that occurs when it is sewn by machine. It is wiser not to use machine basting, since the numerous punctures from the machine needle weaken the fabric. To retard creeping of pile fabric, some of the pressure on the presser foot bar should be released while stitching.

Long stitches are used on pile fabrics; short stitches tend to weaken fabric and may pucker seams.

Velvets should be sewn with glossy threads that have high elasticity (*i.e.,* silk, nylon, Dacron [Terylene]). Velvets that ravel easily or lose pile should be bound with bias rayon binding or net.

Satins and Sateens. — These fabrics must be cut with all sections of the pattern running lengthwise. The yarns on the right side of satin and sateen snag easily; hence in working with these fabrics the seamstress should not wear jagged jewelry, should cut and sew on a smooth surface and should make sure that hands and fingernails are smooth. Very fine pins and needles also should be used, and pins should be placed within the seam allowance. The pattern pieces may be weighted down instead of pinned to the fabric for cutting. Thread with a high lustre that will blend with the sheen of the fabric should be used. Long or medium-length machine stitches produce best results on these fabrics, since short machine stitches may sever too many yarns and cause weak seams. To prevent puckering of the seams, the machine tension should be loosened. To prevent marring of the fabric by the feed dog, seams may be sewn over a strip of thin paper which is gently removed after stitching.

Sheer Fabrics. — Such fabrics as lace, net, organdy and marquisette should be stitched with fine thread, fine needles and short stitches. Because seams show through on sheer fabrics, it is important that they be even, flat, neat and narrow. Fine $\frac{1}{8}$-in. French seams are often used for durability and neatness and to prevent fraying; a $\frac{1}{4}$ in. wide plain seam also is used. After stitching a plain seam, seam edges may be brought together and a row of machine stitching placed $\frac{1}{4}$ in. away from the seam, seam allowance then being trimmed off close to the second row of stitching; this seam finish is neat, flat and resistant to raveling.

If a sheer fabric is too limp or is more transparent than desired, it may be backed with another layer of fabric cut exactly like the sheer fabric section. Both layers should be basted together $ in. from the cut edge, and the basted fabric then handled as if it were one piece. An underlayer of self-fabric often is used to maintain characteristics of the fabric. Since many sheer and lace fabrics are fragile and tend to rip easily with strain, they may be reinforced with flesh-coloured silk or nylon marquisette or tulle. A sheer backing that blends with skin tones does not detract from the beauty of the outer fabric.

Changeable Fabrics. — All pieces cut from such fabrics—*i.e.,* chambray and changeable-coloured taffetas — should be cut on the lengthwise direction of the fabric; sections cut crosswise on the material will appear to be of a different colour.

Acetate and Rayon. — On these fabrics fine needles and pins should be used; coarse ones will leave holes. Mercerized cotton and silk thread are satisfactory for stitching; Dacron (Terylene) thread may be used on acetate fabrics. In stitching, these fabrics require loosened tension to prevent puckering of seams. Seams should be steam pressed on the wrong side. Rayon can tolerate more heat than can acetate; high temperatures can cause shine on rayon and melt acetate. Tissue paper or press cloths may be used as insulators while pressing, to prevent shine.

Nylon, Orlon, Dacron **(Terylene), Dynel.**—Because these fabrics may ravel easily, wide seam allowances should be made. The toughness of these fibres requires cutting with very sharp scissors and shears; dull shears gnaw the fabric. Fine pins and needles make sewing easier and do not leave unsightly holes. Since machine needles often become dull when stitching on these fabrics, the machine needle should be changed periodically.

Fabrics made of synthetic fibres should be sewn with thread of matching fibre; *i.e.,* Dacron thread on Dacron, nylon thread for nylon. The next best choice is to use nylon, Orlon or Dacron thread on any of these fabrics; failing this, silk or mercerized cotton may be employed. Machine tension should be loosened to eliminate strain on thread while stitching, and long stitches (eight to nine stitches per inch) should be used. While stitching, the fabric may be kept under slight tension by holding the machine-stitched line with one hand behind the presser foot and using the other hand to grasp the fabric in front of the presser foot. This may eliminate puckering at seamlines.

Plastic Film Fabrics. — To avoid making holes, weights should be used instead of pins to hold the pattern pieces in place on plastic film. For marking, crayon or soft lead pencil must be employed, and cellophane tape or paper clips used to hold sections together before stitching. Sections should not be basted, since the holes left may weaken or tear the fabric; seams requiring basting should be inserted between folds of cellophane tape and stitched through the tape, which then may be removed.

Plastic film should be sewn with fine mercerized cotton thread; strong thread cuts the film. Machine stitching should be done with a fine needle, long stitches and loosened tension. Backstitching or double stitching of seams should be avoided, since too many needle punctures split plastic. Thread ends should be tied. Gathers on plastic may be made with long machine stitches or with a ruffling attachment.

Before stitching, cellophane tape should be applied to the wrong side of film at points of strain (*i.e.,* tops of pockets), stitched through and left in place.

Wrinkles may be removed from plastic by smoothing with the hand or by allowing wrinkles to hang out. Plastics fuse and melt with heat. If an iron is employed, it should be used at the lowest temperature setting and unprinted heavy paper placed between iron and plastic.

Metallic Fabrics. — Lam6 and fabrics containing many metal yarns ravel easily; therefore pattern sections should be cut with a one- to two-inch seam allowance so that even if the seam allowance ravels before it is stitched sufficient fabric will remain in the seam allowance. Immediately after sections are cut, they should be machine stitched $\frac{1}{8}$ in. from the cut edge or overcast by hand or with a zigzag attachment. When no fitting alterations are expected, the edges of the seams may be bound with bias-cut chiffon or bias binding or may be picoted before they are sewn together. (A picoted edge is made by machine hemstitching close to the cut edge, then cutting through the holes created by the hemstitching.)

Fine pins and needles should be used so that the metallic yarns mill not be pulled out of position or broken. Sewing should be done with silk, nylon or Dacron (Terylene) thread with loosened tension and long stitches; short stitches will sever too many yarns and weaken the seamline. Exposed seams of metallic cloth clothing should be bound to prevent skin irritation from the fibres.

Prints. — Before pattern pieces are placed, a print fabric should be examined to determine the direction of print. If the print faces one direction, fabric should be cut logically; *i.e.,* flower stems should point downward, human figures should be upright. This precaution does not apply to prints having many directions.

If a design motif is placed in orderly sequence on the iabric, creating lines, the lines of the print should be matched at the seams.

Widely spaced, bold and large prints must be cut carefully so that the motifs will appear on the completed item where they look most appropriate and pleasing.

Striped, Checked and Tartan Fabrics. — If stripes, tartans or checks are very small, it may not be necessary to match the lines at the seam, but with medium-sized or large figures this must be done precisely. If lines are varied in colour or width, colours and widths also must be matched. In working with striped, checked or tartan materials having bold lines, it is necessary before cutting to consider the most pleasing placement of the bold lines on the finished item and then place the pattern on the fabric so that the bold lines will appear in the desired location on the finished garment.

Handling Fabric

Before Cutting. — Fabric should be examined for flaws, such as mismeaves, holes or discoloration, and such flaws marked with chalk or pins so that they may be avoided. If the fabric looks similar on both sides, large chalk X's should be marked on the wrong side so the sides may be distinguished. Wools and man-made fibre fabrics usually are folded with the right side inside, cottons and linens with the right side outside; usually, also, the selvage or woven edge of the fabric appears fuller on the right side. If the right side cannot be determined, one side may be chosen for the right side.

The filling yarns of the fabric should be perpendicular to the warp yarns, which are parallel to the selvage. If the fabric was ripped on removal from the bolt, the filling yarn is easy to see. If it nas cut, the filling yarn should be located and marked near the cut edge with chalk or a hand stitch. If the filling yarns are not at right angles to the warp yarns the fabric should be pulled to shift rhe yarns so that they do form right angles. Where this is not done, the material will twist and stretch out of position during use.

Cutting. — For accuracy, the fabric should be kept close to the cutting surface. Notches (triangular pattern guides for matching sections) should be cut outward, not inward toward the seam line; if they are cut inward, the seam cannot be let out. Weights should be used to keep the pattern pieces in place when cutting materials that are slippery or marred by pins.

Sewing. — To keep bias edges of fabric from stretching, a row of short or medium-length hand or machine stitches may be placed near the cut edge or near the seamline toward the cut edge; this is called stay stitching. If the fabric stretches a great deal, or might be stretched during fitting (*i.e.*, at neckline or armhole), straight woven tape may be basted to the bias-cut seam allowances.

It is easier to handle fabric while sewing if the bulk of the material is placed on the larger surface on the left side of the machine. It is wise, in using a new fabric, to experiment with scraps until the machine is adjusted properly and the best type of seam is determined.

Trimming Seams. — Concave curved seams (as at the neckline) need to be slashed so that the seam will lie flat. Notches should be cut from convex curved seams (as on scallops) so the seam will not be lumpy. Enclosed seams (as on the inside of the collar) should be trimmed evenly; if one layer is trimmed slightly narrower than the other, the seam will be flatter and less likely to show a ridge on the right side.

Pressing. — For best results, straight seams should be pressed on a flat surface, curved seams on a curved surface. Pressing should be done in the direction of the grain in woven fabrics and in the direction of the rib on knitted fabrics.

HAND STITCHING

Illustrations of hand stitches are devised for right-handed persons unless otherwise specified. Left-handed persons may ase these stitching diagrams by checking the reflection in a mirror. For most hand stitches (exceptions: catch stitch, blanket stitch) the right-handed person sews from right to left and toward the self (fig. 1 and 2).

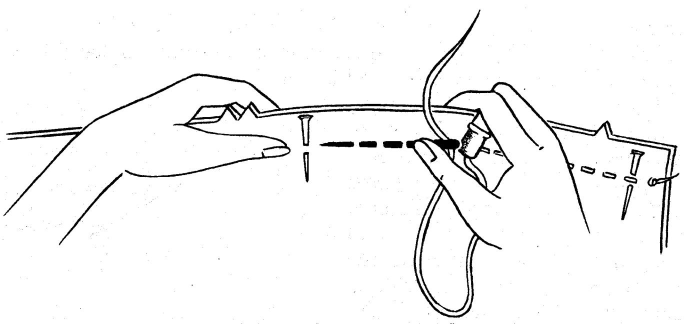

FIG. I.— POSITION OF HANDS WHEN SEWING SEAM

Left-handed persons sew from left to right and toward the self for most stitches. A properly fitted thimble should be worn on the middle finger of the sewing hand; while sewing, the needle is pushed with the thimble. A fine needle (but not so fine that it breaks easily) slips through fabric more readily than does a thick one, and a short needle is easier to control than a long one. A fine, small-eyed needle and a single thread are used for stitches that should not be conspicuous, double thread when strength is essential. See also NEEDLEWORK.

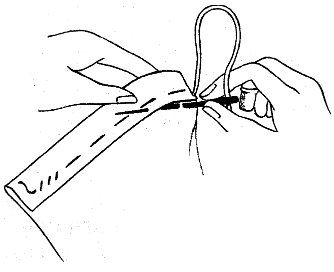

FIG. 2.—POSITION OF HANDS WHEN SEWING HEM (SLANT HEMMING)

BASIC HAND STITCHES

When two or more lavers of fabric are to be sewn together, it is best to pin the layers together to prevent shifting of fabric while sewing. Pins should be placed perpendicularly to the stitching line, pierced through the stitching line about three to five inches apart. A gathered or eased layer of fabric should be placed on top of the shorter layer so that distribution of the fabric may be checked. Pin basting, a method of holding sections of fabric together without thread basting, is satisfactory when checking the fit of loosely fitted garments, in basting long straight seams and items for the home. Pins should be placed rather close together and parallel to the stitching line.

To prevent twisting of thread while sewing, the needle should be threaded with the end just cut from the spool. If thread persists in twisting while sewing, it may be rubbed against beeswax. Too long a thread may knot while sewing. To fix the thread, it may be knotted at the end, or three backstitches mav be taken. Single thread is used for most hand stitching.

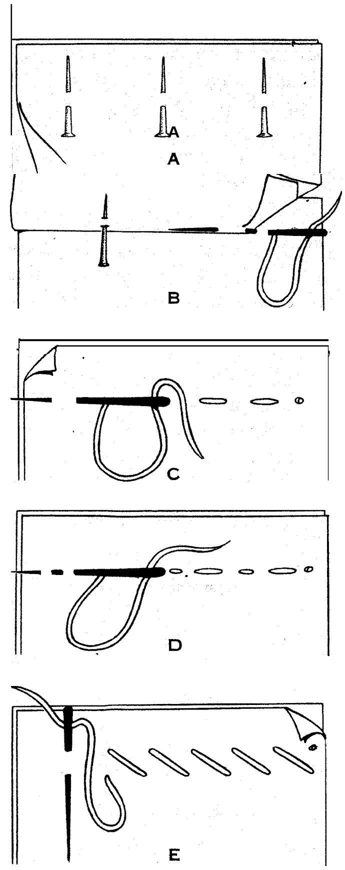

FIG 3.— METHODS OF BASTING

(A) Pin before basting; (B) slip basting; (C) even basting; (D) uneven basting; (E) diagonal or tailor's basting

Temporary Stitches. — Basting and tracing stitches are removed after permanent stitching has been completed. Before ripping them out, the thread should be snipped about every five inches to avoid distorting fabric while pulling on thread. Temporary stitching is ended with several oversewing or backstitches, leaving about $\frac{1}{2}$ in. cut end.

Basting. — Basting is used to hold layers of fabric together. Slip basting (fig. 3[B]), done on the right side of the fabric, is best used when matching stripes or designs and when basting after fitting alterations have been made. The seam allowance of one layer of fabric should be folded under, lapped over the topside of the other layer of fabric, matching design and seamline, and pinned in position. A small stitch is taken through the unfolded fabric, near to and parallel with the fold, the needle is then inserted into the fold and along inside it for about $\frac{1}{4}$ in., and needle and thread are pulled out; the process then is repeated. Even basting (fig. 3[C]), made with even stitches and spaces (about $\frac{1}{4}$ in. apart or more), is more secure but slower to do than uneven basting (fig. 3[D]) with alternating long and short stitches. Diagonal or tailor's basting (fig. 3[E]), using short vertical stitches placed parallel to one another, is used to keep interfacings, facings and linings from shifting.

Tracing. — Tracing stitches are sewn through one or more layers of fabric to outline the location of some detail (*i.e.*, pocket, folds forming a pleat). Stitches may be even or uneven, short or long.

Permanent Stitches. — If a knot is used, it should be hidden between layers of fabric. Stitching is usually completed by taking several whipping or oversewing stitches and pulling the thread through a loop formed by the last stitch.

Running Stitch. — The running stitch (fig. 4), with stitches and spaces of $\frac{1}{8}$ in. or less, is used in lieu of machine stitches on seams and tucks. The needle is slipped through the fabric to form several stitches before it is drawn out. A running stitch seam may be strengthened by taking one or two backstitches after every three or four running stitches. Easing of fabric and gathers are accomplished by making running stitches exactly on the seamline

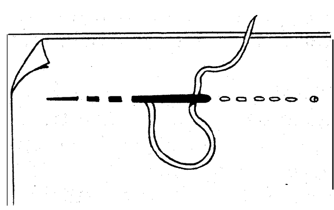

FIG. 4.— RUNNING STITCH

and then drawing up the thread. Shirring (fig. 5) is more likely to remain evenly distributed if three parallel rows of running stitches are made, one on the seamline, the second $\frac{1}{4}$ in. above it and the third row $\frac{1}{4}$ in, below it.

The three threads should be pulled simultaneously, the loose ends fastened by twisting them around a pin inserted at the end of the rows of stitching, and the fullness distributed evenly.

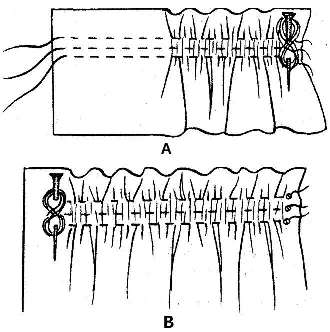

FIG. 5.— STEPS IN SHIRRING

Backstitch. — The backstitch (fig. 6) provides stronger but bulkier stitching than the running stitch. For seams, stitches should be about & in. long. After making a stitch, the needle is put through the fabric immediately behind the stitch and brought up in front of it at a distance equal to the stitch length. The process then is repeated. Beads may be sewn on in this way, the bead being slipped onto the thread before taking a backstitch equal to the length of the bead.

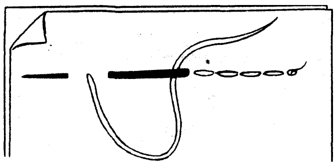
FIG. 6.— BACKSTITCH

Overcasting.—Overcasting (fig. 7) is used primarily to retard raveling of cut edges. It may be done through one or more layers of fabric. The needle pierces the fabric $\frac{1}{8}$–$\frac{1}{4}$ in. from the cut edge about every $\frac{1}{4}$–$\frac{1}{2}$ in. Deeper bight and closer stitches should be employed on loosely woven and easily raveled materials. Overcasting with embroidery thread or buttonhole twist on the edges of collars and cuffs and household linens provides a decorative stitch.

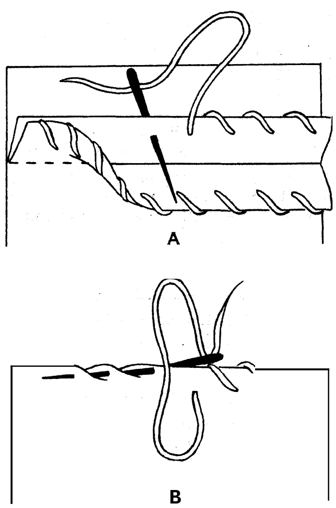

FIG 7.—TWO METHODS OF OVERCASTING

Oversewing. — Oversewing (fig. 8) is used to join edges of materials that are to be opened up flat after being sewn together (*i.e.,* sewn rips in fur, lace attachment or insertion). Edges sewn together must be finished so that they will not ravel (*i.e.,* folded back and picoted, or selvage utilized). Edges are pinned, right sides together, and pierced with the needle about $\frac{1}{16}$ in. from the edge; stitches should be kept close together. Tiny oversewn tucks are decorative when done in shiny or contrasting coloured thread.

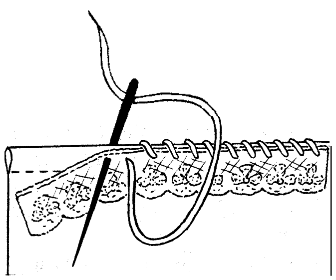
FIG 8 —OVERSEWING

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Buttonhole and Blanket Stitch. — Buttonhole and blanket stitches may be used as a decorative edging on finished edges; if stitches are placed sufficiently close together. they may be used also to finish cut edges. The buttonhole stitch is worked from right to left and a ay from the sewer as the cut edge is held taut over the finger.

The blanket stitch is worked toward the sewer, from left to right. The worked buttonhole illustration (fig. 9) demonstrates the buttonhole stitch along the sides of the buttonhole. The upraised purl created with the looping of thread should be noted. The bar end of the buttonhole is completed with blanket stitches, which are not purled.

Hand-worked buttonholes are made with buttonhole twist, heavy-duty or button thread or regular sewing thread. For best results a single thread should be used. Buttonholes are made with fan or bar ends or both. The fan end provides room for the button shank: the bar, which helps to keep the hole from gaping, is used on the end of the buttonhole that shows when buttoned. There are three methods which prevent shifting of fabric, retard raveling and provide a guide for making even stitches: (1) Before cutting the buttonhole, one to three rows of very small stitches may be made around the buttonhole marking; one row should be very close to the slash line, another may be $\frac{1}{8}$ in. away. After these reinforcing stitches are made (machine stitches are best) the fabric is slashed. (2) Very small stitches may be placed $\frac{1}{8}$ in. away from and around the slash marking. After the slash is made, the cut edges may be overcast. (3) On a thick or easily raveled fabric, a machine thread buttonhole may be made first and then the hand stitching done over it.

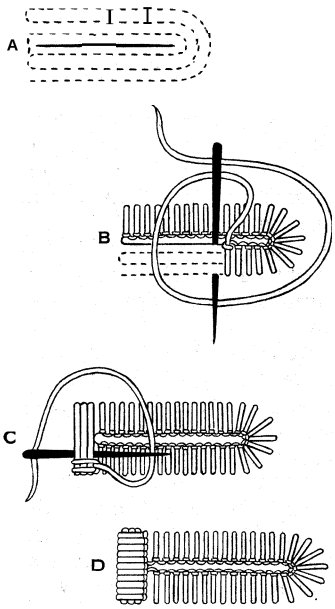

FIG. 9.—STEPS USED TO HAND STITCH BUTTONHOLE
(A) Fabric reinforced with stitches; (B) cut edges sewn over with buttonhole stitch, fanning out stitches at end; (C) bar end first satin stitched, then blanket stitched; (D) completed buttonhole

Slant Hemming Stitch. — The slant hemming stitch (fig. 10[A]) is commonly used to fasten the finished edge of a narrow hem or facing. The hem edge may be finished by turning under the cut edge $\frac{1}{4}$ in., wrong sides together; the fold lies flatter if edge stitched by machine or a running stitch. If the fabric is thick or springy, ribbon seam binding should be sewn on instead; binding is placed midway over the cut edge, over the right side of the fabric, and fabric and binding are stitched together by machine or hand running stitch near the edge of the binding.

The hem is then pinned in position. The knot is hidden under the edge of the hem, the needle slipped under one or two yarns of the underlayer next to the hem edge, the needle slanted and slipped under and through the hem edge and drawn through to form the stitch. The stitch may be made vertical and less noticeable if stitches on the hem edge and underlayer are placed opposite one another rather than diagonally.

Slip Stitch. — The slip stitch (fig. 10[B]) is used when attaching a lining; in applying appliqué, patches, braid or trimming to the right side of fabric; and in sewing together fabrics held taut, as in lamp shades, upholstery and hats. Slip stitching is made exactly like slip basting except that the stitches are closer together. Thread is less likely to show when the stitches are vertical rather than slanting.

Catch Stitch. — The catch stitch (fig. 10[C]) is used to secure the cut edge of a hem, seam, facing or interfacing. It retards

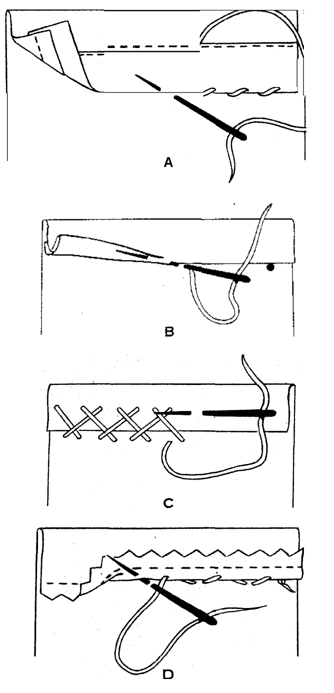

FIG. 10.— METHODS OF HEMMING
(A) Slant hemming on seam binding; (B) slip stitch; (C) catch stitch used on unfinished hem edge; (D) tailor's hemming stitch

raveling and is somewhat elastic. The stitch is worked from left to right. A small stitch is taken through the top layer of fabric, then another about $\frac{1}{4}$ in. diagonally across through the underlayer, close to the cut edge. The stitch forms a zigzag thread line.

Tailor's *Hemming* Stitch.—The tailor's or invisible hem (fig. 10[D]) is less likely to get caught in heels or fingernails when clothes are put on or off than is the slant hem. (1) If the fabric is not one that tends to ravel, the cut or pinked edge of the hem is left unfinished. (2) If the fabric ravels slightly, a row of machine stitches may be placed $\frac{1}{8}$ in. from the cut edge, or the edge may be overcast by hand or zigzagged by machine. (3) Ribbon seam binding may be sewn over the cut edge, half the width of the binding extending beyond the edge. To make this stitch, the hem is pinned in position. Then the cut edge or seam binding is folded back (right sides together) about & in. A very small stitch is taken through one or two yarns of the underlayer of fabric, the needle is slanted and slipped under and through the edge of the $\frac{1}{8}$-in. fold in the hem. When the hem is completed, the fold is pressed back to cover the stitches.

Padding Stitch.—The padding stitch is used to fasten interfacing to outer fabric with rows of stitching (about † in. apart) to achieve more stiffness and control the drape of fabric. In taflored garments the padding stitch is commonly used on the undercollar, cuffs and lapels. Interfacing is placed over the wrong side of the undercuff, collar or lapel of the garment. The needle pierces the interfacing, skims through a few yarns of the underfabric and is slipped up through the interfacing to form a small ($\frac{1}{8}$ in.) stitch. These small stitches are continued parallel to each other and about $\frac{1}{4}$ in. apart. No stitching should show on the outside (*i.e.*, underlayer) fabric. This stitch looks similar to tailor's basting (fig. 3[E]).

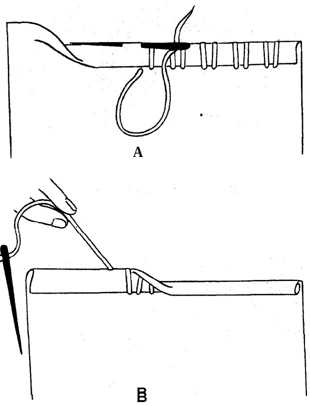

FIG 11—STEPS USED TO SEW ROLLED HEM

Rolled Hem.—A rolled hem (fig. 11) provides a dainty finish for the edges of sheer and fine fabrics. It is usually about $\frac{1}{8}$ in. deep when finished. With wrong sides together, $\frac{1}{8}$ in. of the cut edge is folded back and pressed (or fabric may be folded back while stitching is done, being held taut over the forefinger). With the fold facing upward, the knot is slipped inside the fold and a very small stitch taken on the underlayer next to the cut edge. Then the needle is slipped through the edge of the fold, directly opposite this stitch, for about $\frac{1}{8}$ in. and pulled through. After about an inch of such stitching, the thread is pulled taut. thereby forming a rolled hem. This procedure is repeated until the hem is completed.

Attaching Fasteners

Buttons.--If a button (fig. 12[A]) is sewn with a thread shank, the buttonhole will not spread too far apart and cause fabric bulging between buttonholes. The knot should be placed on the right side in the exact button position. To form a thread shank, a pin or match may be laid between the holes in the button and sewn over. When the button is securely sewn with several stitches, the pin is removed and the thread twisted around the shank under the button before being fastened.

Buttons that will be subjected to much strain or use should be sewn with strong heavy-duty or button thread. When much strain will be placed on the fabric, a small, flat button may be placed on the underpart of the fabric and sewn through simultaneously with the top button; a circle of sturdy fabric may be placed under the button position, between the two layers of fabric, and sewn through.

Snaps (Press Fasteners) and **Hooks** and Eyes.—The exact location of snaps and hooks and eyes (fig. 12[B] and 12[C]) should be clearly marked. The single-strand thread knot rests on the marked position, to be hidden between the fastener and fabric. A close oversewing stitch should be used in sewing. The only stitches showing should be those whipped around the fastener. When shifting from one place to another, the needle should be slid under the fastener. When sewing a hook, it should be first fastened under the bill with three or four stitches, then the two ends may be sewn on.

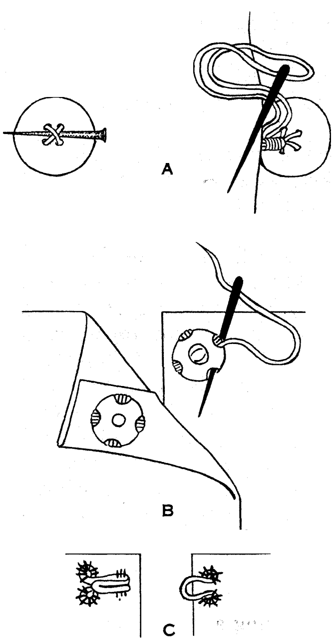

FIG. 12.— ATTACHING FASTENERS
(A) Button; (B) snaps (press fasteners); (C) hook and eye, bill of hook secured before loops are sewn down

Slide Fasteners.—Slide fasteners may be sewn by hand with an inconspicuous backstitch; machine stitching is stronger but more clearly visible. When sewing by machine, a zipper or cording foot should be used so that stitching may be placed close to the metal chain in the fastener. The machine foot should never ride over the metal.

The finished placket opening should be about $\frac{1}{4}$ in, longer than the metal slide (not the fabric tape). Seam allowance at the ends should be provided for if necessary, or if the fastener end is to be open. Stitching at the closed ends of the fastener should be placed about $\frac{1}{8}$ in. away from the metal ends to avoid a noticeable bulge.

Slide fasteners may be sewn in such a manner that they will be exposed. In this case the fabric is folded back, wrong sides together; the folded edges are placed almost next to the metal teeth and sewn close to the seam folds. More often, however, slide fasteners are sewn in such a way as to be inconspicuous. A channel or slot seam may be used to cover the fastener. To sew the

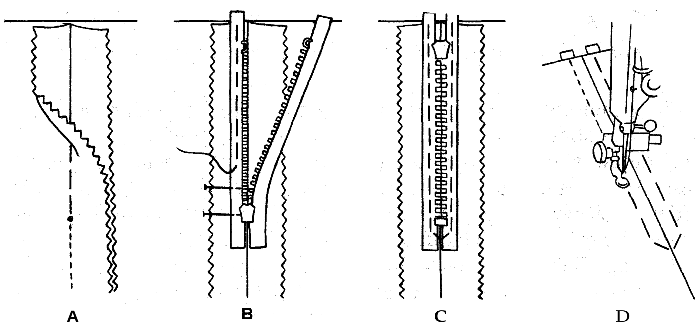

FIG. 13.— ATTACHING SLIDE FASTENER. SLOT PLACKET

slot placket, either of two techniques may be used: (1) Full seam allowances are folded back on both sides of the opening and pressed. pinned or basted to keep them in position. The fastener is positioned, face up, midway under the fold of one seam and pinned in place. Then the other seam fold is brought flush against the fold of the seam already pinned and also pinned in position. Basting follows, if necessary. With fabric right side up, the seam is stitched to the fastener at the same distance ($\frac{1}{4}$ in. more or less) on each side of the seam folds. (2) The seam opening is basted, right sides together, and pressed open (fig. 13[A]). The fastener is opened and its topside placed against the basted seam (on wrong side of fabric). The left side of the fastener is positioned, pinned and basted to the left side of the seam (fig. 13[B]). The fastener is then closed and the right side pinned and basted in position (fig. 13[C]). The fastener is stitched, parallel to, and on both sides equidistant from, the basted seamline (fig. 13[D]). Stitching across the end may be straight, perpendicular to the stitching lines on both sides of the fastener, or it may be forked with the point of the fork equidistant from both stitching lines. All basting threads, including that in the placket seam, are removed.

The slot-type opening is generally used in cushion and slip covers, long sleeves, centre backs of skirts and slacks and neck openings in clothes.

An overlapped placket may be used to hide the metal slide more completely than does the slot placket, which opens midway over the slide. The overlapped placket is usually used in side openings and long centre back openings in women's clothes, and in centre front openings in trouser-type garments. Skill can be developed in attaching the fastener without preliminary basting and with a few or no pins. The rapid technique for doing so is as follows: the seam allowances are folded back, wrong sides together, on each side of the placket, and creased or pressed. With the topside of the placket up, the placket overlap is positioned over the tab side of the slide fastener. The metal slide should be covered completely and the overlap fold should extend slightly beyond one side of the slide. It is pinned in position, or basted. The ends and side are attached close to the slide. The other folded edge is brought flush with the edge of the slide, over tape not covered by the overlap, pinned or basted and stitched very close to the edge of the fold.

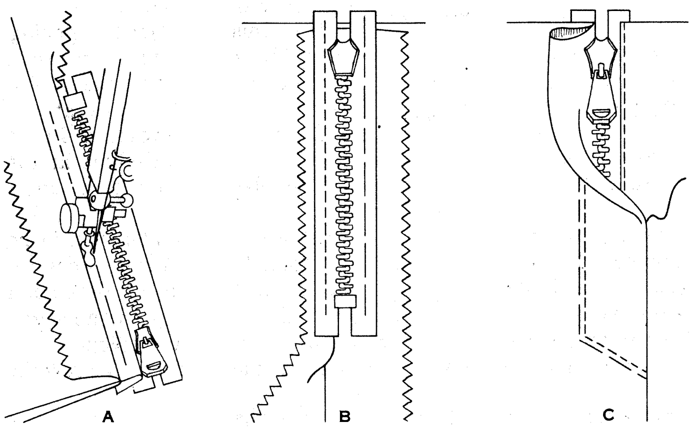

FIG. 14.— ATTACHING SLIDE FASTENER. OVERLAPPED PLACKET

A technique that provides for a wider overlap and hence conceals the slide even more effectively may be preferred. In this technique, about $\frac{1}{8}$–$\frac{3}{16}$ in. of underlap is created, with that much less of the underlap seam allowance folded back. With right sides together, the placket seams are basted together and pressed open (fig. 13[A]). The underlap seam then is folded back, wrong sides together, about $\frac{1}{8}$–$\frac{3}{16}$ in. from the basted seamline, and the fold creased or pressed and basted. With the wrong side of the placket facing upward, and the pressed overlap and tucked underlap showing, the tucked underlap is placed over one side of tape of the slide fastener (tab side upward). The folded edge is brought flush with the metal slide and stitching done close to the folded edge of the tuck (fig. 14[A]). The slide fastener and sewn underlap are moved onto the overlap seam allowance and pressed, pinned and basted into position (fig. 14[B]). With placket right side upward, the overlapped side of the placket is stitched to the tape of the fastener (fig. 14[C]) and basting threads removed.

Nylon Tape Fastener.— The exact locations of the two strips of tape should be marked so that when the overlapping and undersections of the opening are properly superimposed the tapes will latch onto each other. The fastener is cut the desired length, and the strips of tape separated. The soft, fleecy strip is placed face up onto the underside of the overlap. The stiff, burr strip is placed face up on the underlap. The tapes are sewn by hand or machine close to the edges.

Repairs

When it is expected that an area of clothing will be subject to enough abrasion to wear away the fabric (*i.e.*, elbow area of sleeve), or when such wearing has occurred, patches of press-on material, leather or matching fabric may be applied to the area. "Press-on" patches and tape are made of knitted or woven fabric treated with an adhesive that adheres to the basic fabric when the patch is pressed on it with a warm iron; no sewing is required. Other patches or reinforcements may be applied with running, hemming or machine stitches placed close to the edge of the patch. Leather patches are sewn over the right side; fabric patches are sewn on either right or wrong side. The cut edges of fabric patches to be applied to the right side are pressed under about $\frac{1}{4}$ in. (wrong sides together) before being sewn.

Threadbare and weakened fabric may be strengthened with close rows of running or machine stitches sewn across each other over and $\frac{1}{2}$ in. beyond the weakened area (fig. 15). Ripped and worn fabric also may be reinforced with a piece of fabric of matching colour held against the wrong side of the worn area and fastened down with close rows of padding, running or machine stitches.

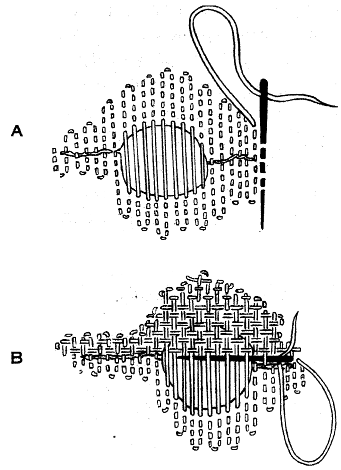

FIG. 15.—STEPS IN MENDING TEAR, HOLE OR WORN AREA

When mending a tear or hole with thread, the right side of the fabric should be held upward. Matching thread or yarns unraveled from matching fabric, as at a seam edge, should be used. Close rows of very small running or machine stitches are placed across the rip and about $\frac{1}{4}$–$\frac{1}{2}$ in. beyond each side of the cut edges. Then stitches are taken across the rows just completed. In repairing a hole, the needle should be woven alternately over and under the strands of thread lying across the hole; in effect, reweaving. A similar process is used in darning.

A hole also may be patched with matching fabric. Frayed yarns around the hole are cut away. With wrong sides together, the edges of the hole are turned under about $\frac{1}{8}$–$\frac{1}{4}$ in. (the corners being slashed) and the folded edge pressed or basted (fig. 16[A]). With right sides upward, the patch (at least $\frac{1}{2}$ in. larger than the opening) is centred and pinned or basted in position. The folded edge of the hole is slip stitched or sewn with hemming or machine stitches to the patch (fig. 16[B]). Machine-stitched patches are more conspicuous than hand-stitched patches. On the underside, the cut edge of the patch is secured with catch or padding stitches (fig. 16[C]); or the cut edge may be turned under and the folded edge hemmed or stitched to the fabric.

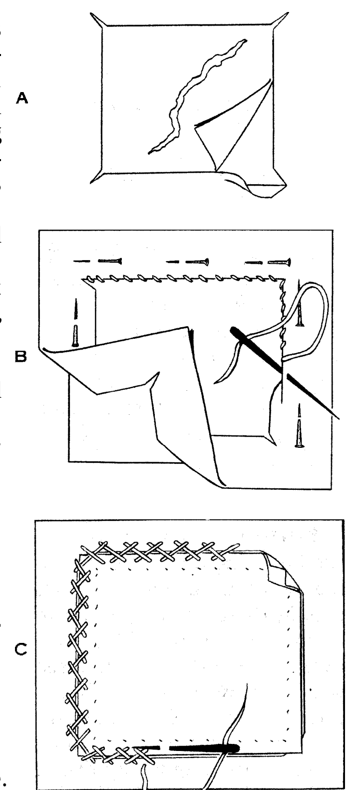

FIG. 16.— PATCHING

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Agriculture *Farmer's Bulletin* 1873 (1941) ; Ruth Cornstock, "**How to** Make Curtains and Draperies," *Cornell Miscellaneous Bulletin 24* (1955). (*F.* TA.)

SEWING MACHINES. The basic invention in machine-sewing was the double-pointed needle, with the eye in the centre, patented by Charles F. Weisenthal in 1755, with the object of avoiding the necessity for inverting the needle in sewing or embroidering. Many of the features of the sewing machine are distinctly specified in a patent secured in England by Thomas Saint in 1790, in which he described a machine for stitching, quilting or sewing; it appears to have been intended principally for leather work. Had Saint hit on the idea of the eye-pointed needle his machine would have been a complete anticipation of the modern chain-stitch machine.

The inventor who first devised a real working machine was a poor tailor, Barthélemy Thimmonier, of St. Étienne, who obtained letters patent in France in 1830. Though the machine was clumsy, made chiefly of wood, about 80 were being worked in Paris in 1841, making army clothing, when an ignorant and furious crowd wrecked the establishment and nearly murdered the unfortunate inventor. Thimmonier was not discouraged, for in 1845 he twice patented improvements on it, and in 1848 he obtained both in England and the U.S. patents for further improvements. The machine was then made entirely of metal, and vastly improved on the first model. But the troubles of 1848 blasted the prospects of the resolute inventor. His patent rights for Great Britain were sold; a machine shown in the Great Exhibition of 1851 attracted no attention, and he died in 1857 unrewarded.

Walter Hunt of New York constructed (about 1832–34) a machine having a vibrating arm, at the extremity of which he fixed a curved needle with an eye near its point. By this needle a loop of thread was formed under the cloth to be sewn, and through that loop a thread carried in an oscillating shuttle was passed, thus making the lockstitch of all ordinary two-thread machines.

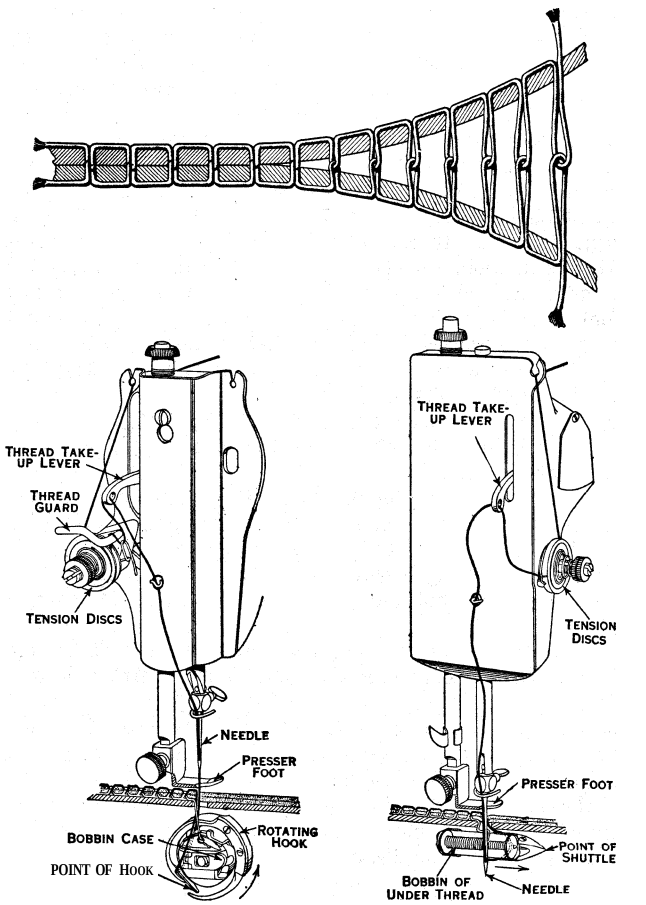


FIG. I.— LOCK STITCH AS FORMED ON SINGER SEWING MACHINES. FIG. 2.—THE LOCK STITCH IN FORMATION. THE NEEDLE THREAD IS DEFINED IN BLACK AND THE UNDER THREAD SHOWN WHITE. FIG. 3.— COURSE OF THE THREAD IN A VIBRATING SHUTTLE MACHINE

Apparently unaware of Hunt's invention Elias Howe, a native of Spencer, Mass., directed his attention to machine-sewing about 1843. In 1844 he completed a rough model, and in 1846 patented his sewing machine. Howe was thus the first to patent a lock-stitch machine. but his invention had the tao essential features —the curved eye-pointed needle and the under-thread shuttle —invented by Hunt twelve years previously. Howe's invention was sold in England to William F. Thomas of Cheapside, London, a corset manufacturer, for £250. Thomas secured in Dec. 1846 the English patent in his own name, and engaged Howe on weekly wages to adapt the machine for his manufacturing purposes. The career of the inventor in London was unsuccessful; and, having pawned his American patent rights in England, he returned in 1849 in poverty to America. There in the meantime the sewing machine was beginning to excite public curiosity, and various persons were making machines which Howe found to trench on his patent rights. The most prominent of the manufacturers, if not of inventors, ultimately appeared in Isaac Merritt Singer (1811–75), who in 1851 secured a patent for his machine. Elias Howe now became alert to vindicate his rights, and, after regaining possession of his pawned patent, he instituted suits against the infringers. An enormous amount of litigation ensued, but ultimately all makers became tributary to Elias Howe.

Allen B. Wilson also worked without knowledge of previous efforts. In 1849 he devised the rotary hook and bobbin combination, forming the special feature of the Wheeler and Wilson machine. Wilson obtained a patent for his machine, which included the important and effective four-motion feed for moving the work after every stitch, in Nov. 1850. In Feb. 1851 William O. Grover, a tailor, of Boston, patented his double chain-stitch action, which formed the basis of the Grover and Baker machine. In 1856 James A. E. Gibbs (1829–1902), a Virginia farmer, devised the chain-stitch machine, improved subsequently by J. Willcox and now known as the Willcox and Gibbs. These together —all American inventions—form the types of the various machines now in common use. Thousands of patents have been issued in the United States and Europe, covering improvements in the sewing machine; but, although its efficiency and usefulness have been greatly increased by numerous accessories and attachments, the main principles have not been affected thereby.

Chain Stitch.—In machine sewing three varieties of stitch are made—(I) the simple chain or tambour stitch, (2) the double chain stitch and (3) the lock stitch. In the first the machine works with a single thread, the other forms use two, an upper and an under.

The Modern Lock Stitch.—The lock stitch is that made by all ordinary two-thread sewing machines, and is a stitch peculiar to machine sewing. It consists of an upper or needle thread and an under thread locked together in the material which is being stitched; the lock being formed by passing the upper around the lower thread and tightening them together in the middle of the fabric, as shown in fig. 1. In fig. 2 the needle thread is shown as a thick black line and the under thread white, the fabric being stippled in order that each may be readily recognized. It shows the head of a lock stitch machine, rotary hook. The loop of needle thread has been taken by the point of the hook and is being passed round the bobbin case containing the bobbin of under thread, sufficient enlargement of the loop having been permitted by the descent of the thread take-up lever.

In fig. 3 is shown the head of a vibrating shuttle machine. The shuttle, containing the bobbin of under thread, has fully entered the loop of needle thread, sufficient enlargement of the loop having been permitted by the descent of the thread take-up lever. The shuttle travels to and fro in a carrier to which it is not fastened, but by which it is held in position. During the forward movement of the shuttle, the loop of needle thread slips between the shuttle and the carrier, then passes out between the heel of the shuttle and the rear part of the carrier. The shuttle thread is thus enclosed in the loop of needle thread and both threads are then drawn up by the action of the thread take-up lever.

There are over 2,000 varieties of modern sewing machines designed for stitching processes in the great sewing industries making up clothing, boots and shoes, corsets, hats, hosiery, etc. There are machines specially designed for sewing regular or fancy shank buttons on shoes; for sewing sweat leathers into stiff felt, soft felt or straw hats; for trimming scalloping and over-edging lace curtains; for sewing silk initials, monograms or floral designs upon material at one operation. There is a seven needle machine for making seven parallel rows of fine double chain stitching simultaneously. This machine is fitted with seven needles and seven loopers, and its capacity is over 20,000 stitches per minute.

The increasing use of electricity for domestic purposes has had its effect on the sewing machines. To adapt existing machines to electric operation, small motors are provided. There are also available sewing machines of various types with the motor incorporated in the body of the machine. Foot control or knee control is used. A small electric lamp directly over the work is often furnished.

SEX. Among the higher animals each individual is either male or female. In them maleness is the state associated with the production of spermatozoa; femaleness that associated with the elaboration of ova. A male is an individual that is efficiently equipped for the elaboration of functional spermatozoa and for the conveyance of these towards the site of fertilization; a female one efficiently equipped for the elaboration of functional ova, for the conveyance of these to the site of fertilization, and often, as in the mammals, for the prenatal care of the embryo and foetus and for the nurture of the offspring. In certain groups maleness and femaleness are exhibited by one and the same individual either concurrently or in succession: such groups are hermaphrodites.

Where the sexes are distinct, male is to be distinguished from female by differences in (1) the form and structure of the gonads or reproductive organs, those of the male being testes, those of the female, ovaries; (2) the accessory sexual apparatus of ducts and associated glands concerned with the transit of the products of the gonads; (3) the external organs of reproduction, and (4) certain skeletal, cutaneous and other less definite physiological, biochemical and psychological characters.

Sex-differentiation.—It is now established that the sex of the individual is decided at the time of the union of ovum and spermatozoon, *i.e.*, at the time of fertilization; and the mechanism which determines sex has been disclosed. At the beginning of this century it was generally accepted that at the time of fertilization the egg was sexually neutral and that the sex of the new individual was determined by the conditions incident to its development. But certain facts are now known which point directly to the conclusion that sex in higher animals at least is predetermined at fertilization. Identical twins are derived from a single fertilized ovum and are always of the same sex, whereas fraternal twins, originating in two distinct fertilized ova, may or may not be both of the same sex. There is no reason why, if purely environmental factors are at work in determining the sex of the offspring, those produced from one egg should always be of the same sex whereas offspring produced by separate ova may include both males and females.

In all higher bisexual animals so far as is known, and in certain plants, the sexes are to be distinguished by differences in the chromosomal content of the nuclei of the cells of which the body is built. *(See* CYTOLOGY.) In certain forms there is in one sex an unpaired chromosome in place of the equal pair in the case of the other sex. This difference is symbolized thus:—the sex with the unpaired chromosome is the XO; the other the XX. In other forms the number of chromosomes is the same in both sexes, but while in one sex, the XX, the members of one pair are identical in size and shape, in the other, the XY, the single X has an unequal mate, the Y-chromosome. (In still other forms the X-chromosome is represented not by one chromosome but by a group of from 2 to 8 which act together as a compound X-element.) These chromosomes, the X and the Y, since in respect of them the sexes differ, are known as the sex *chromosomes.*

Into each ripe germ cell, ovum and spermatozoon, there passes one or other member of each pair of chromosomes. If, as is the case in man, the female is XX, all ova will be alike in that each will contain an X-chromosome, but there will be two kinds of sperm elaborated by the XY male, one carrying the X-chromosome, the other the Y. The female in these groups is monogametic elaborating but one kind of gamete (marrying cell) in respect of chromosome content, the male, digametic. When egg and sperm unite, into the fertilized egg there will pass, by way of the sperm, one member of each pair of chromosomes, and, by way of the egg, the other member of each pair. There will thus be two kinds of fertilized ova, one that received an X-chromosome from each parent, to become an XX individual, *i.e.*, a female; the other, which received an X-chromosome from the mother and a Y from the father, to become an XY individual, *i.e.*, a male. This chromosomal difference between the sexes provides a simple yet sufficient mechanism for sex determination. Similar reasoning will apply to those species in which the X-chromosome in one sex has no mate, and also to those in which the X-element is compound.

In mamtnals and in most insects the male has the single X; in the butterflies, moths and birds, on the other hand, it is the female that is digametic.

SEX-LINKAGE

In those forms in which the male is digametic, being XO or XY in sex-chromosome constitution, a son receives his single X from his mother, whereas a daughter gets one X from each parent. If on the X-chromosome of the father is borne the hereditary factor for a recessive character (see HEREDITY) the track of the chromosome in inheritance can be followed, provided that in the T-chromosome there are no factors which affect the action of those borne upon the X. Moreover if the sex chromosomes are elements of the sex-determining mechanism and if factors for hereditary characters are borne upon them it will be seen that the mechanism that is determining whether the individual shall be male or female is also determining whether or not the individuals shall also exhibit some particular character—the character in its transmission from generation to generation will exhibit a sex-linked mode of inheritance.

For example, consider the inheritance of haemophilia (tendency to excessive bleeding). This appears to be a sex-linked recessive character; the interpretation which best fits the facts is as follows. Haemophilia is an hereditary character, the factor for which is X-borne. The male therefore, possessing but one X-chromosome, is either haemophilic or else is normal: the female on the other hand can be normal, a carrier (*i.e.*, with the factor on one of her X's only), or haemophilic (*i.e.*, with the factor on each of her X's). Let an italicized X indicate that on this particular X the factor for this recessive sex-linked character is borne. The following matings and results are possible:—

The marriage of a haemophilic man (XY) with a haemophilic woman (XX) can yield only haemophilic sons (XY) and haemophilic daughters (*XX*).

The marriage of a haemophilic man (XY) with a carrier woman (XX) can yield normal sons (XY); haemophilic sons (XY): carrier daughters (XX): haemophilic daughters (XX).

The marriage of a haemophilic man (XY) with a normal woman (XX) can yield normal sons (XY) and carrier daughters (XX).

The marriage of a normal man (XY) with a haemophilicwoman (XX) can yield haemophilic sons (XY) and carrier daughters (XX).

The marriage of a normal man (XY) with a carrier woman (XX) can yield normal sons (XU): haemophilic sons (XY): normal daughters (XX): carrier daughters (XX).

On the other hand the facts concerning the inheritance of certain characters in butterflies, moths and birds require that here the female shall be digametic. These facts can be illustrated by reference to the fowl. A black (nonbarred) cock mated with barred hens will throw barred sons and black (nonbarred) daughters. A barred cock mated with black hens will throw barred sons and daughters and if these are interbred they will in their turn produce barred and black offspring, but every black individual in this generation will be a female. These facts can only be explained on the assumptions that sex in this form is decided by the simplex or duplex condition of some element which when present in duplicate leads to the establishment of maleness and that the factors for the sex-linked characters are borne upon the X-chromosomes.

Nondisjunction.—So far the evidence derived from breeding experiments and also from microscopical examination of the cell is in entire agreement: it is exceedingly strong but it is indirect. But direct proof of the chromosomal determination of sex and of the location of the hereditary factors in the chromosomes is available, for it has been shown by Bridges (1916) that certain exceptions to the normal course of sex-linked inheritance in Drosophila depend upon abnormality in the distribution of the X-chromosomes.

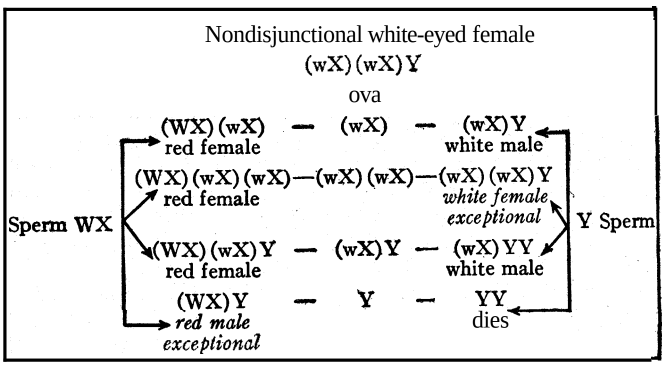
In *Drosophila melanogaster* white eye-colour is a sex-linked recessive character. Using the symbols w for the factor for this and W for the alternative dominant normal red eye and writing these as affixes to the X-chromosomes, the result of a cross between a red-eyed male and a white-eyed female can be shown.

Red-eyed male		(WX)Y x (wX) (wX)		white-eyed female
Spermatozoa	.	WX.Y	wX . wX	ova
Red-eyed daughters	.	(WX) (wX) .	(wX)Y	white-eyed sons

It is to be noted that during the process of the formation of the ova and spermatozoa the members of the pair of sex chromosomes (as do all the rest) disjoin so that only one passes into each gamete.

In a particular sex-linked experiment Bridges got unexpected results: there were some red-eyed sons and white-eyed daughters. On cytological examination of such exceptional white-eyed females Bridges found that their cells displayed a Y-chromosome in addition to the normal pair of X's. This is what would occur if, during the maturation of the egg in which such an individual had had its origin, the X-chromosomes had failed to disjoin so that instead of coming to possess but one X it would contain two and if this non-disjunctional egg had then been fertilized by a spermatozoon bearing a Y-chromosome. If a nondisjunctional female is used in experiments involving a sex-linked character such as white-eye, the mode of inheritance of such characters will be obscured, as can be shown in the following scheme. She will elaborate four sorts of eggs instead of one. These can be fertilized either by the (WX)-bearing or by the Y-bearing spermatozoon of the red-eyed male.

The exceptional white-eyed daughters are white-eyed because they do not get one of their X-chromosomes from their red-eyed



father: the exceptional red-eyed males are red-eyed because each gets his Y-chromosome from his mother and his X from his father.

The aberration in the chromosome distribution can explain the entire series of exceptional results. The evidence derived from breeding and from cytological investigation turned what seemed to be a direct contradiction of the chromosomal interpretation of sex-linked inheritance into a spectacular confirmation. The evidence confirms the conclusion that sex-linked characters are associated with the sex-determining mechanism because their factors are located in the sex-chromosomes and that sex is determined at the time of fertilization by the XX-XY mechanism. In Drosophila certainly the Y-chromosome has no influence upon sex determination, XXY and even X X W individuals develop into females of normal appearance while X individuals lacking the Y develop into unexceptional looking males (but are sterile). XXX individuals either die or else grow up into sterile females and Y individuals without an X never appear — they must be non-viable.

Gynandromorphism.—Another line of argument pointing to the same conclusion has been derived by Morgan and his associates from the study of gynandromorphism in Drosophila. A gynandromorph is an individuak of a bisexual species which exhibits a mosaic of male and female characters. Most specimens are lateral gynandromorphs, male on one side of the mid-line of the body, female on the other, with a sharp demarcation between the two kinds of tissue. In other instances one-quarter of the body is male, the other three-quarters female; in yet others the head is female and the rest of the body male. Morgan and Bridges (1919) have shown that if in the mating, which produces the gynandromorphs, sex-linked characters are involved and if the sex-linked characters of the two parents are dissimilar, then the sex-linked characters of the male parts are those either of the father or of the mother, whereas the sex-linked characters of the female parts are a combination of those of both parents. These facts point to the conclusion that gynandromorphism results from aberration in the distribution of the X-chromosomes. If it is assumed that the gynandromorph starts life as a female, X X in constitution, and that at some stage during the early divisions of the fertilized egg a daughter X-chromosome fails to enter one of the daughter cells, then this cell, unlike its sister, will contain one X instead of two, becoming XO instead of XX. It thus will come to possess the sex-chromosome constitution of male tissue. If the X-chromosome of paternal origin is lost the sex-linked characterization of the male part of the gynandromorph will be like the mother's.

BALANCE OF SEX-DETERMINING FACTORS

Since the difference in sex-chromosome content is the only apparent difference in the constitution of the sexes it follows that the X or something lodged in it is female-determining (in cases similar to man or Drosophila), while male-determination is an affair of the rest of the chromosomes (exclusive of the Y) or autosomes. If the female-determining factor in the X be symbolized as F and the sum of the male-determining factors in one set of autosomes as M, then while both male and female possess 2M, the females possess 2F, the males 1F. Thus 2F must be $>$2M and 1F must be $<$2M.

Triploid Forms.—Bridges found a strain of Drosophila which was triploid, *i.e.*, which possessed some or all of its chromosomes in triplicate instead of the normal duplicate. In the individuals produced by the triploid strain, three sets of autosomes (3A containing 3M) were in some individuals associated with 1X, in others with 2Xs, in others with 3Xs. Investigation revealed the following sex types. By representing the efficiency of the female-determining factors (X-borne) as 100 and that of the male-determining factor complex as 80, a series of sex indexes can be made.

Chromosome relation	Sex types	Numerical ratio X(100) A(80)	Sex index	Interval %	X = −6 A = +2
3X:2A	Super-female (triple-X) .	1.5:1	1.88	50	−14
4X:4A	4N female (N = the number of chromosomes in the gamete) . . .	1:1	1.25	..	−16
2X:2A	3N female . . .	1 :	1.25	..	−12
2X:2A	2N female (normal constitution) . . .	1:1	1	..	−8
1X:1A	1N female . . .	1:1	1.25	50	−4
2X:3A	Intersex, female type	1:1.5	.083	..	−6
2X.3A (= IV)	Intersex, male type .	1 : .	.083	33	−6
1X:2A	Male (normal constitution)	1:2	0.63	50	−2
1X:3A	Super-male (triple-A)	1:3	0.42		

Thus sex determination can not be the function of sex chromosomes alone; on the contrary, sex must be determined by the interaction of factors borne upon sex chromosomes and autosomes. The addition of more autosomal factors to the usual 2X:2A balance so disturbs this that femaleness is transformed into intersexuality. The difference in the sexual characters of individuals possessing 2X chromosomes associated with 3 of each autosome (2X:3A) and of those which have but two IV chromosomes instead of three (2X:3A—IV) is to be regarded as an indication that the IV chromosome carries, like the X-chromosome, a net balance of female-determining factors. Sex determination is thus a matter of the correct quantitative balance between the amount of male and of female determining factors of the fertilized egg and if one does not exceed the other by a certain amount intersexual forms result.

The monogametic female is a female because she has the constitution (FX)(FX)MM and because $2F>2M$, while a male is a male because he has the constitution (FX)Y MM and because $1F<2M$. In forms with digametic female the male-determining factors must be borne upon the X-chromosomes. Then a male is a male because his constitution is (MX)(MX)FF and because $2M>2F$, a female is a female because her constitution is (MX) YFF and because $1M<2F$. In either case when $M=F$, intersexuality will result. Of course, these formulae must not be taken too literally: they are but convenient symbolism. But it is clear that in *Drosophila* the effective factor in the establishment of maleness,' femaleness and intersexuality is the numerical ratio of X-chromosomes to autosomes.

The end-result of the interaction of male and female differentiating substances is the establishment of a particular physiological state, maleness or else femaleness, within the developing fertilized egg and in this or that internal environment the development of the individual proceeds. In *Drosophila* an individual is a male and develops the attributes of the male because in its beginning it had a chromosome constitution symbolised as XY; because in this XY individual the relation of male and female determining factors was such that an internal environment of maleness became established within the developing egg; because in this environment the structures pertaining to the XY sex equipment developed; and because the impress of the external environment did not or could not affect the developing individual so as to override the action of the sex-determining mechanism. For similar reasons the XX individual becomes possessed of typical female characterization.

Developmental Physiology. — So far this discussion has concerned itself with the location of sex-determining factors within the chromosomes and with their correlation with the adult sex characters. It is necessary to consider the methods by which the one becomes translated into the other during development.

Richard Goldschmidt made the first serious attempt to demonstrate the method by which the sex-determining factors in their action lead to the production of the sex characters of the adult. He started from the fact, long known to entomologists, that when species or even geographical races of moths are crossed, sexual abnormalities are commonly found among the hybrid offspring. For his material he chose the gypsy moth, *Porthetria* (*Lymantria*) *dispas*, which has a wide distribution and is very variable. If European specimens of this forest pest are bred among themselves the offspring are unremarkable in every way. The same is true of the Japanese variety, *Lymantria japonica*. But if a Japanese male is mated with a European female. normal male offspring and females which show a number of modifications in the direction of the male type are produced. When such female *intersexes* are mated with their brothers, of the females of the generation thus produced half are normal, half are intersexual. The reciprocal cross, European male Japanese female, produces normal females and males in the first hybrid generation, but if the individuals of this are then interbred they produce a certain proportion of males with female characters.

Further investigation demonstrated that there were many different subraces of European and of Japanese gypsy moths that were quite distinct in respect of intersexuality, in that the degree or grade of intersexuality was definite and typical for a particular mating. Goldschmidt classified strains as relatively "strong" or "weak." For example, a "strong" male mated to a "weak" female gives 50% normal males and 50% intersexual females. A "very strong" male mated to a "weak" female would give offspring all male. A mated to B gave a low grade of intersexuality, C×D a high grade, E×F a grade intermediate between these, and so on. If strong race A gave moderate intersexuality with weak race P, while with race Q it gave strong intersexuality, and if strong race B gave moderate intersexuality with Q, then it could be predicted that B with P would give only a slight grade. Similar males from one culture mated with females from different cultures gave intersexes that could be arranged in a series according to the degree of their abnormality and so on. It was possible, by calling on experience, to produce every stage from an almost complete male to an almost complete female intersex at will by making the appropriate mating. In fact, it was as possible to turn the "determined" females into fully equipped males as to ensure the regular production of normal males and females.

Influences of **Intersexuality.**—It was noticed that the condition of intersexuality did not affect all the structures of the sexual organization equally. Further investigation demonstrated that the different structures could be arranged in a definite series as regards degree of intersexuality in characterization and that this series was exactly the opposite of the order of the embryonic differentiation of these structures. Those organs which are first developed and differentiated are the last to be modified; those that appear last are the first to be changed. From these considerations there arose the Time-Law of Intersexuality. An intersex is an individual that has developed as a male (or female) up to a certain point in its life history and thereafter has continued its development as a female (or male). The degree of intersexuality is determined by the time at which this switch-over occurs.

Intersexual females start their development as females and then at a certain point in development change their differentiation and finish as males, and since the hard parts of an insect are external and composed of chitin any of them that have hardened before the switch-over remain unaltered by it. From an examination of the parts which are sexually dimorphic, it is possible to decide in the case of any particular individual exactly when the change-over took place. These intersexes are sex-mosaics in time.

From these facts Goldschmidt deduced the following conclusions:

(1) Each sex possesses the potentialities of the other since either can become intersexual.

(2) The type of sexual differentiation that the fertilized egg will pursue is determined at the time of, and by the mechanism of, fertilization. If the constituents of intersexuality are in the fertilized egg, then the individual will inevitably become an inter. sexual form.

(3) The normal determination of sex is bound up with the X:2X mechanism. But as this does not prevent the occurrence of intersexuality and sex reversal. it can not be the mere presence of these chromosomes or the factors contained within them that counts, but rather their quantitative effect during development.

(4) The mode of inheritance of this intersexuality shows that since the female in *Lynzantria* is XU, and since her single X-chromosome is received from her father, the male-determining factors in sex determination are transmitted in the X-chromosome.

(j) Other factors concerned in sex determination in *Lymantria* are purely maternal in inheritance, being resident in the Y-chromosome. A daughter receives her IT-chromosome from her mother. But since a male has no Y-chromosome, the factors in the Y-chromosome must have exerted their action on the unripe egg when this contained both X- and Y-chromosomes. If all eggs are to be alike in respect of the IT-borne genes, these must have acted and their products must have specifically affected the cytoplasm before the X and Y became disjoined.

(6) The fact that the females of similar constitution give different results when mated with males of dissimilar constitution shows that the sex-determining genes in the X-chromosome differ

quantitatively in the different races. The fact that males of similar constitution give different results when mated with females of dissimilar constitution shows also that the sex-determining factors resident in the Y-chromosome can be different quantitatively.

It will be seen that if both X-borne and Y-borne sex-determining genes can so vary quantitatively among themselves, an infinite variety of different combinations can be made, deliberately or by chance.

Goldschmidt infers with reason that the sexual characterization of any particular organ of the sex equipment depends on whether one or the other type of sex-differentiating substance is effectively in excess at the time when the organ arises in development. He interprets the mosaic character of the intersex on the assumption that the amount of sex-differentiating substances produced by virtue of the presence of the corresponding sex-determining factors is not constant throughout life: that at one time the male-differentiating substance is in excess, at another the female. In the male of the moth $M > F$ and the male-differentiating substance is effectively in excess until the period of development is complete. In the female $M < F$ and the female-differentiating sub. stance is effectively in excess during development. But if it should so happen that the sex-differentiating substances are produced at different rates, and if some genes possess the property of producing more sex-differentiating substance in a given time than others, then there exists the possibility that sex-mosaics in time will be produced.

A male of a race whose sex-determining genes work at a faster rate is crossed with a female of a race in which these factors work slower. The female-determining factor F is always inherited through the mother and in all the offspring there will be this factor F and the female-differentiating substance will be produced in all at the same rate. But the male offspring will receive one M from their mother, and the other, the quick-acting M, from their father, so that in a given time the male-differentiating substance will be effectively in excess during development. The female offspring will have only the paternal M, and therefore the amount of male-differentiating substance will increase relatively to the amount of the female-differentiating substance, overtake it, and finally supplant it, and from this point onwards any sex characters which still have to develop will be male. The individual will be a female intersex. It is not the absolute but the relative rates of production of male- and female-differentiating substances that control the modelling of the sex equipment. Sex reversal in these cases is due to genetic causes—the fertilized egg contains inevitably within itself the seed of its eventual transformation in the form of a quantitative disharmony of the sex-determining factors.

This work of Goldschmidt shows definitely that intersexuality in *Lymantria* depends upon variations in the relative rate of production of definite instances and that this again is correlated with differences in the sex-determining factors that can be interpreted in Mendelian terms. (See HEREDITY.)

In the case of the sexually abnormal types of *Drosophila* it is seen that the abnormality is the result of a disharmony in the *distribution* of the elements of the hereditary constitution of the individual. In the case of *Lymantria* intersexuality and sex reversal are due to a disharmony in the *composition* of the hereditary constitution. The sexually abnormal individuals of *Drosophila* are spatial intersexes; those of *Lymantria* and of the frog and of the small Crustacean *Gammarus* (Sexton and J. Huxley, 1927), are consecutive intersexes, sex-mosaics in time.

Prior to 1943 biologists for the most part regarded the control of sex differentiation, or the method of translating the sex-determining factors established at fertilization into the adult sex characters, on a somewhat different basis for vertebrates and invertebrates. Sex hormones, or secretions from the sex glands, while known to be clearly of first rate importance in the control of sex characters in vertebrates during postnatal life, appear to be largely nonexistent in invertebrates. Due largely to observations on the bovine "freemartin," the female of a pair of heterosexual twin calves, it was suggested that whereas the direct expression of the action of sex-determining factors carried development up to the stage of gonad formation, the further development of the remainder of the reproductive tract depended upon specific secretions produced by the gonads.

Each embryo of vertebrates produces early two sets of ducts—a male, or Wolffian duct, and a feinale, or Miillerian duct. The persistence of the male duct in mammals leads to the formation of the epididymis, ductus deferens, and certain accessory glandular structures such as seminal vesicles and prostate gland; the persistence of the female duct leads to the appearance of oviducts, uterus and a portion of the vagina. The selection of the appropriate duct system for persistence and development has been supposed to rest upon the type of hormone secreted by the developing gonad, hence the time of origin of the gonadal internal secretions has been projected back into embryonic life long before the gonads have completed their differentiation. Thus, in vertebrates, hormone secretion by developing gonads has been visualized as an important and necessary supplementary mechanism in the formation of secondary sex characters, especially the reproductive system, and atypical intersexual or hermaphroditic conditions have been interpreted as arising because of disturbances in the hormonal mechanism during embryonic development.

The application of chemical sex hormones to developing young of the opossum led to such modifications in the duct system as to raise some question relative to whether normal development could be thus controlled by gonadal secreted hormones (Carl R. Moore, 1941). All evidence suggested that the developing gonads did not begin to secrete hormones until after the proper duct system was a well-differentiated reproductive system. In 1943 the successful removal of gonads from both sexes in opossum pouch young, prior to differentiation of the embryonic male or female duct into the proper type of reproductive system, demonstrated the capabilities of normal differentiation of the proper duct during the total absence of gonads, and consequently of gonadal-secreted hormones (Moore, 1943). In the opossum it is clear that gonadal-secreted hormones are not required for differentiation of the reproductive system, but it is unknown whether similar conditions hold for other mammals. It is possible that in other cases also the sex hormones are produced and play a role in further development of the reproductive system only after it has progressed to a well-differentiated structure; it is suggested that intersexual or hermaphroditic conditions in vertebrates rests upon the original genetic composition, as in the invertebrates, and that sex hormones are not fundamentally involved in the original differentiation.

Abnormalities in the vertebrate sex equipment cover an almost complete range from normal conditions of one sex to that of the other. In man and other mammals we may encounter (1) testis on one side, ovary on the other, with complete or partial systems of both sexes—epididymis, ductus deferens, seminal vesicles of the male and oviduct, uterus and vagina of the female; (2) testes or ovaries may be present along with a reproductive system of the opposite sex; (3) alleged males may lack testes and exhibit atypical ovaries and a characteristic female tract; (4) alleged women, who have been wives, may lack entirely a female tract but exhibit testes containing a few atypical spermatozoa. The wider range of intersexual conditions may quite parallel those known in the invertebrates and it appears probable that in each of these large groups of animals the genetic composition, involving the quantitative balance of male- and female-determining factors, is the responsible basic condition upon which such differentiation depends.

THE BOVINE FREEMARTIN

Sex determination by virtue of the genetic complex established at the time of fertilization is not an irrevocable predestination since unusual conditions may override the specific determination and lead to development of a modified type. Intersexuality in cattle, especially that which almost invariably follows in a female developing as a twin to a male, constitutes an excellent example among mammals of the capability of modification in the individual during sex differentiation.

In cattle three combinations of twins occur—twin males, twin females and twins consisting of a male and a female. In keeping with the very long envelope of embryonic membranes (chorion and allantois) surrounding each embryo the membranes come in contact with each other and become fused together at a very early stage during development. Extra-embryonic blood vessels carried in the membranes of each embryo likewise become fused and permit of an interchange of blood between the two twin calves during development; this occurs in probably more than 90% of cases irrespective of the sexes of the embryos. Such fusion and interchange of embryonic blood between the twins is without undue consequence in the case of similar sexed twins but when it occurs in a male-female pair of twins the female experiences a modification in the development of her reproductive tract; as an adult she is incapable of reproduction. This female of the male-female twin pair has long been known as a "freemartin." During sexual differentiation her ovaries develop as testis-like bodies or remain poorly developed; her female ducts, instead of developing normally, undergo degeneration, and her male ducts are favoured during development. As a general consequence, this sexually-determined female undergoes such a modification in her sexual differentiation as to present much more of the characters of a male than of a female. External genitalia remain female in character but throughout life—and although an animal of large and relatively normal proportions—the freemartin never plays a role in reproduction.

The preferred interpretation of this overriding of the primary female determination and development in the male direction places responsibility on male hormones secreted by the developing testes of the male partner. Presumably testis secretion begins at a very early stage in development and the substances are carried through the fused blood vessel system of the embryonic membranes to the female partner. The male sex hormone has been considered to be both an inhibitor of the female duct and ovarian development and as a stimulating agent operating on the male duct of the embryo. This favoured interpretation of the genesis of the freemartin condition, while strongly indicated by a multitude of facts, has been brought into some question by observations and experimental analyses made on embryos of other mammals; in some cases female development has been studied while the embryo was being exposed to chemical male hormone substances. Typical freemartin conditions have never been realized in mammals by such experimental treatments of embryos of other species. While there appears to be no question that some humoral substance transported from the male twin to the developing freemartin introduces a modifying influence, the proof for its testis-secreted origin is not yet established. The apparent demonstration of the inability of testes in some other species to secrete detectable quantities of male hormones during the early developing stages, and the demonstration that typical sex differentiation of the reproductive system occurs after removal of the gonads prior to differentiation of the male and female ducts, raises anew the question whether the modifying influences are referable to male hormones secreted by the testes of the male co-twin.

THE CASE OF BONELLIA

The marine worm, *Bonellia viridis,* displays a remarkable degree of sex dimorphism. The female has a body about the size of a plum. The male is a microscopic pigmy whose internal organs, save those concerned with reproduction, are degenerate and who lives as a parasite within the body of the female. The fertilized eggs hatch out as free-swimming larvae. If a larva settles down upon the sea bottom, it becomes, with few exceptions, and after a short neuter period, a female; but if it settles upon the proboscis of a female it becomes a male. F. Baltzer (1914) took larvae at various periods after they had settled upon a female but before they had become completely male and forced them to lead an independent life, and as a result he obtained intersexes, the degree of intersexuality varying with the length of time the larva had been upon the female's proboscis. It has been shown that the larvae absorb material from the proboscis and that this is responsible for the arrest of growth and the direction of the sexual differentiation. The arrested pigmy male passes from the proboscis of the female into her mouth and thenemerges and ensconces himself in her reproductive duct.

An ingenious hypothesis has been advanced to cover the observed facts concerning the case of *Bonellia.* Goldschmidt (1923) supposed that in all the individuals there is at first an excess of male-differentiating substance, but that the production of female-differentiating substance after a time overtakes this. Further, he supposed that the secretion of the proboscis of the female of *Bonellia* has the effect of accelerating the processes of differentiation as opposed to the processes of growth, antedating, as it were, the period during development when sexual differentiation occurs. When differentiation is rapid, the sex organization matures under the influence of the male-differentiating substance; when it is not accelerated, under that of the female-differentiating substance. The mode of sex differentiation is determined by a varying physiological state in connection with varying environ. ment and secretions from other individuals.

F. Baltzer (1925) agrees in principle with this physiological interpretation of the case of *Bonellia* but holds that the cause of the intersexuality cannot be an acceleration of the rate of development but is rather a retardation. He points out that in experimental cultures of *Bonellia* there first appear normal females, then females with sperm and lastly intersexes and males; and that the male organization, compared with that of the female, is to be regarded as a lower grade of development, being characterized by the absence of various organs.

THE EFFECTS OF PARASITISM

Alfred Giard (1887) and later Smith (1906) described in detail the changes that occur in crabs parasitized by *Sacculina* and other parasitic crustacea. *Sacculina,* an internal parasite, is a cirripede crustacean, and part of its body projects to the exterior under the abdomen of its host, while rootlike processes ramify to all parts of the crab's body, avoiding the vital organs and absorbing nourishment chiefly from the blood. It attacks males and females and in both causes atrophy of the sex glands and consequent sterility. The only effect of this in females is an acceleration in assumption of adult sex characters. Parasitized males, however, gradually take on more and more of the female characters, their great claws become relatively smaller, the abdomen broader, the swimmerets enlarge and become fringed with the hairs to which, in females, the eggs are attached. Most of the affected crabs die, but in a few the parasite disappears and the reproductive organs are regenerated. In a female a normal ovary develops, in a slightly feminized male, a normal testis, but in some males a sex gland is regenerated, in which both ova and sperm are found; real male hermaphroditism is produced.

Geoffrey Smith (1906) who investigated this problem found that the blood of the normal female crab differs in chemical constitution from that of the male. It contains fatty substances which are used in the production of the yolk of the egg. These fatty substances form an important part of the food of the parasite *Sacculina.* That which *Sacculina* absorbs can not be used in yolk formation, and as the eggs can not develop, the ovary degenerates. In the male these fatty substances are present in but small quantities. The parasite demands more and the whole physiology of the male crab is altered to meet this demand; the male thus assumes the female type of metabolism, and consequently female characters.

The interest of this case is that it permitted Smith to question the validity of the conception that in all forms the gonads functioned as organs of internal secretion, contributing a peculiar product to the blood streams. Smith argued that the gonad, far from adding anything to the blood stream, removed something from it.

Sex Reversal.—It is somewhat difficult, when one first approaches this subject of the transformation of sex, to grant that reversal is possible in the higher forms in which the sexual differences, morphological, physiological and mental, are so sharply emphasized. But when one remembers that what is rare and exceptional in one form can be facultative in others, and that all forms have much in common, the difficulty vanishes. It is readily conceded that the oyster, for example, may regularly change its sex. The native oyster begins its life as a male and then, when one or two years old, may and indeed commonly does, become a female. But that is not all, for Orton (1921) has shown that such an oyster, after becoming "white sick," *i.e.,* after shedding its ova into the mantle cavity, and while still carrying its own embryos, can, within the space of a month, become equipped as a male once more. That which is usual in the oyster may be, under certain conditions, not rare in the more highly organized forms. Similar instances of facultative sex-transformation are those furnished by *Crepidula plana,* parasitized Cymotheids and Epicarids, the starfish, *Asterina gibbosa,* and the slug *Limax maximus.* In all these cases the direction of the transformation is male $\longrightarrow$ hermaphrodite $\longrightarrow$ female.

SEX REVERSAL AS DIRECT EXPRESSION OF GENETIC ACTION

If the genetic components of sex reversal are present in the hereditary constitution of an individual, if the physiological equilibrium of the embryo established by the action of the hereditary factors is not profoundly modified by the physiological influence of the glands of internal secretion during development, and if the impress of external agencies upon the embryo does not or can not override the hereditary constitution, *i.e.,* does not or can not profoundly alter the physiological state established by the hereditary factors, then sex transformation will occur as development and differentiation proceed.

Thus in the case of the moth, *Lynzantria,* and similarly constituted forms, the same general forces which lead to intersexuality lead also to sex reversal. Intersexuality is in such cases merely incomplete reversal. Complete reversal will occur when in a male the quantitative disharmony between the male and the female sex-differentiating reactions is such that the female reactions are in excess throughout the whole of the period of differentiation, or in the case of a female when the male reactions are in efficient excess throughout this time.

In the *Lepidoptera* Goldschmidt (1910, 1923), Ross Harrison, (1919), and others, obtained species hybrid broods that were largely or entirely of one sex. Harrison was able to show that in one of his cases the mortality was not sufficiently high to account for the results obtained; it was not a case of a sexually selective prenatal mortality, and both Goldschmidt and Harrison have presented evidence which strongly indicates that the results are due to a sex transformation of half the individuals concerned.

J. M. Essenberg (1925) recorded that sex reversal occurs in the viviparous teleost fish, *Xiphophorus helleri,* (the sword-tailed minnow), and that many instances of this have been reported by fish breeders and fanciers. In Essenberg's cases two females ceased to produce young when about three years old, and during the course of several weeks took on the sex characters of the male. Cytological examination revealed the presence of ripe sperm in all parts of the gonad which, however, was juvenile in relation to the size and age of the fish. Essenberg was able to show that there is a type of development in the female which readily provides a morphological basis for the change-over. He also shows that there is a complete reversal of the sex ratio in a population, males being rare among the immature and plentiful among the old. It would seem from Essenberg's observations that sex reversal is extremely common in this fish and that it is genetic in origin, there being a form which through genetic action is destined merely to pass through a female phase and later to proceed to a male type of sex differentiation.

W. Harms (1926) also observed the transformation of females of *Xiphophorus* into males at different ages, especially among old sterile females. He recorded that during this process of sex reversal the female when mated still produces young, though when the process is completed, the individual is a functional male, larger than the normal male, broader and heavier. Harms observed that the older the animal is at the time of the change-over, the more female the general body build remains. The process occupies about 3–4 months and in the case of old females may remain incomplete. The cause of the transformation was regarded by Harms as being a physiological exhaustion of the ovary with a consequent alteration in the general metabolism which invokes the differentiation of testicular tissue.

Harms bred from transformed females when they were functioning as males and got none but females, as would be expected if the female of the fish is monogametic (XX).

SEX REVERSAL AND HEREDITARY CONSTITUTION

Sex reversal can be the result of the overriding of the hereditary constitution by agencies which sufficiently disturb the general physiological conditions of the zygote at some stage or other of its development. It can result from a disturbance of the physiological condition within the ovum before fertilization. The work of R. Hertwig, S. Kushakevitch and E. Witschi showed that delayed fertilization and also the exposure of frogs' eggs before fertilization to high temperature (27° C.) lead to a profound disturbance of sex ratio. A male frog mas permitted to fertilize half the eggs of a female and then was removed, to be replaced after an interval to fertilize the remainder. After an interval of 89 hours none but male offspring were obtained. This result is not due to selective fertilization, to a sexually selective mortality among the embryos, or to the abnormal extrusion of an X-chromosome during the maturation of the eggs. The correct interpretation of the results would seem to be that some 50% of the eggs were fertilized by X-chromosome-bearing spermatozoa, females (XX) being produced, but that the conditions of the experiment were such as to transform these into functional males, the sex-chromosome constitution of the zygote being overridden by the effects of delayed fertilization upon the metabolism of the egg. The results obtained by Mrsić on the effect of over-ripeness upon trout eggs are probably to be explained in a similar fashion.

The observations of Adler (1920), who showed that the thyroids of individuals from these late fertilized eggs are markedly hypertrophied, would seem to be of significance. Adler suggested that in these individuals the thyroid comes into action earlier than does the gonad and so affects the internal environment that the gonads, when they do differentiate, become testes.

These observations are closely in line with those of Whitman (1919) and of O. Riddle, (1912, 1916) upon the pigeon. It was found by Whitman that the matings of birds belonging to the Columbidae with species of two distinct zoological families of birds resulted in the production of male offspring only, and that females alone were obtained from the eggs of doves which had been forced to lay excessively and at an abnormally rapid rate. Riddle carried these observations further and was able to show that the eggs that yield males can be distinguished from those which yield females, that maleness is associated with eggs of smaller size, higher water content, and less stored energy, and that the production of all males or of all females was associated with the production of eggs of one or of the other type. He was able to dismiss the possibility of selective fertilization and of differential maturation, and was driven to the conclusion that the conditions of the experiments were such as to induce sex reversal in the egg itself (1914, 1919).

It is a simple matter to interpret these results in terms of a metabolic theory of sex as elaborated by Riddle. Delayed fertilization implies an increased metabolic rate in the egg and a high metabolic rate implies maleness. Desiccation implies a decreased metabolic rate and femaleness. The hypertrophy of the thyroid implies an increased metabolism and an internal environment of maleness. The production of offspring all of one sex by matings of nide crosses is to be interpreted as the result of the pooling of hereditary factors which in their action lead to the establishment of one kind or the other of metabolic level in the zygote.

In this connection it should be noted that M. F. Guyer's (1909) data on species hybrids among birds show that there is a decided excess of males in the F_1 generation. O. Riddle (1916) recorded an excess of females in the cross *Streptopelia risoria* $\times$ *S. alba* (doves) under certain condition- and concluded that this excess was the result of a transformation of some of the males. It has been shown, however, that this conclusion is not justified, for the cross involved a sex-linked character and of the hybrids the males are dark, the females white in colour, and examination of the data for sex and also for colour shows that the only possible explanation of the excess of females is that which postulates that the conditions of the experiment were such as to cause the X-chromosome to pass into a polar body at the time of the reduction divisions more often than to remain in the egg.

Sex reversal can result from a disturbance of the general physiology of the individual during embryonic life.

R. K. Burns (1925) joined young embryos of *Ambystoma* in the tailbud stage in parabiosis and instead of getting the expected chance combinations of the sexes, 1♂♂, 1♂9, 1♀♂, 1♀♀, he obtained exclusively one sexed pairs. He suggested that the reason for this 44 89 : *36* ♀♂ or *1* : 1 ratio was that in one-half of the original ♂♀ and 96 associations the males became transformed into females, whereas in the other half the females became transformed into males.

Witschi (1927), using four different species of frogs, joined embryos 50–70 hours old, and shortly after the closure of the medullary tube, in parabiosis. The controls exhibited the first signs of sex differentiation during the third week of development; in the case of the parabiotic twins it was somewhat delayed. The twins were preserved at intervals during the larval period and the state of metamorphosis. The sex ratio among the controls was 96 66: 99 or 1 : 1. Among the 56 twins there would be expected the following sex combinations: 14♂♂, 14♂♀, 14♀♀. There was found on examination 1666, 17♂♀, (with 7 of the ♀♀ exhibiting some stage in sex reversal), 10♀♂ (with 4 of the ♀♀ undergoing sex reversal), 13♀9. The combination of a female with a male twin undergoing sex reversal was not encountered. Witschi therefore concluded that the male sex-differentiating agencies predominated and that sex reversal did not take place before the time of sex differentiation.

R. R. Humphrey (1931) replaced the primordial ovary on one side in the salamander *Ambystoma* with a primordial testis removed from a similar aged embryo. When the intact host ovary developed concomitantly with the graft testis the ovary became modified gradually into a testis and in some areas of the transformed organ typical testicular lobules contained spermatozoa. In 1945 Humphrey further demonstrated that in salamanders from which the testis graft responsible for transforming the host ovary into a testis nas removed, the germ cells (spermatozoa) formed in the converted ovary mere capable of fertilizing eggs.

Disharmonies in the development time-relationships of sex differentiation may provide opportunity for sex reversal. For example, in *Myxine* (Schreiner, 1904), growth would seem to proceed undirected to the stage when the individual is hermaphroditic, before the processes of sex differentiation set in to convert the individual either into a functional male or else into a functional female. In the young males of the stone fly *Perla* both ovarian and testicular tissues are to be found but the ovarian tissue undergoes atrophy, so that in the adult none but testicular remains (Junker, 1923). In such circumstances as these the morphological basis of a possible sex reversal is revealed and it becomes entirely conceivable how physiological disturbances during embryonic and early postembryonic life can change the course of differentiation and lead to the conversion of a genetic male into a functional female, and vice versa.

Sex reversal can result from a disturbance of the general physiology of the postembryonic individual. The conditions necessary for such sex transformation are (1) there must be a switch-over from one type of metabolism to the other, from the female to the male, or vice versa; (2) the component structures of the sex equipment must be capable of transformation or replacement, one kind of sex-gland tissue must be replaced by the other, ovary must become or be replaced by testis, or vice versa, the accessory sexual apparatus, the external organ of reproduction, the rest of the secondary sex characters must be remodelled or replaced.

Complete sex reversal therefore can not occur in any individual or form in which the internal and external organs of reproduction, being fashioned early in embryonic life, thereafter lose their plasticity and become unresponsive to any stimulus which, had it been exhibited at the time of their differentiation, would have controlled these processes. Nor can it occur in those cases in which the differences between male and female sex equipments are based upon the differential development of two different sets of structures, one of which, in either sex, undergoes complete atrophy. No more can it take place in those forms in which sex dimorphism involves a differential mode of development of one and the same set of structures, for if one plan of differentiation is pursued, the steps can not be retraced and the alternative route then followed.

Harms (1923) and E. Guyénot and K. Ponse (1923, 1925) showed that if young castrated male toads are fed on a diet containing an excess of fat, lipoids, and lecithin for a considerable period of time, the hind portion of Bidder's organ becomes differentiated as an ovary and the fore portion as a new organ of Bidder, and that oviducts and uteri are developed while the pointed head becames transformed into the blunted characteristic of the female. Ponse (1925) succeeded in rearing 9 metamorphosed offspring of one such transformed male functioning as a female and of these *6* mere males and *3* females. Harms raised 184 such offspring and of the 161 the sex of which could be identified there were 104 males and 57 females. If in the toad the male is digametic, and if the YY zygote is nonviable, the expected sex ratio is 2♂♂:1♀.

Charles Champy (1921) records that when a male triton (T. *alpestris*) was fed intensively after the winter's starvation period, he assumed the external characters of a female, and that within the pre-existing testicular tissue there were to be found immature, but unquestionable ova. He had previously shown that the annual process of spermatogenesis in tritons could be inhibited by starvation and that in the absence of spermatogenesis there was no development of external sexual characters, the animal exhibiting the "neuter" state characteristic of winter. In this "neuter" state there are to be found in the testes primitive gonocytes and spermatogonia. In animals killed in the spring, following starvation, the testis was represented by a longitudinal strip of fat. Two of these starved "neuter" tritons, when fed intensively, lost the dark blue coloration of the back and assumed a greenish shade mottled with distinct blue marks, as in the female, while the yellow dorsal line became more and more attenuated. One of these animals was killed in January and there was found the expected strip of fat with a few spermatogonia. The other was kept alive and in February was female in appearance. It was kept until April when post-morten examination revealed within each of the strips of fat an elongated organ of granular appearance resembling an ovary, together with an oviduct.

In addition to these experimental studies in sex reversal, the following cases have been observed. In the case of one of the frogs resulting from the "egg-overripeness" experiments, Witschi (1923) was able to show that indeed it was a transformed female, for when mated with a normal female it sired only female offspring. This is as would be expected, if in its fundamental chromosome constitution it still remained XX, for then all its spermatozoa would be X-chromosome-bearing and on fertilizing X-bearing eggs would yield none but XX zygotes. Crew (1921) had previously encountered a similar case in the frog.

Riddle observed a case of complete sex reversal in the ring-dove *(streptopelia risoria)* an adult female laid 11 eggs between January 17 and April 15, 1914. During the six months following she and a male mated three times, began sitting on a nest without producing eggs, and raised young of other parents. During the following 19 months her sex behaviour and mode of growing changed to that of a male, frequently forcing her male mate to act as a female in copulation. At 22 months after producing her last egg, this bird and mate were transferred to a pen with a few other spent inactive doves. The male of this pair died three and a half months later, and weights and dimensions of testes were obtained. Twenty-one months after transfer, the bird died, showing advanced abdominal tuberculosis. Two testes were found. removed and weighed. If any residue of the original ovary remained it was wholly included in a tuberculous mass, involving spleen and liver. At the time of autopsy this bird was supposed to be the original male of the pair, and therefore the testes were not saved for demonstration. The bird had lived $44\frac{1}{2}$ months after producing the last egg, became tuberculous, assumed male behaviour, the curve for the body weight during the three years undergoing a remarkable change, and at death it possessed two unmistakable testes. Riddle interprets this transformation as the result of the increased metabolism which followed the destruction of the ovarian tissue and the presence of tuberculosis.

F. A. E. Crew (1923) described the case of a buff Orpington hen, the reputed mother of many chickens, which when three years old was attacked by tuberculosis and developed male characters, to become a fecund male and the father of two chickens. Post-mortem examination revealed the presence of two functional testes and a highly degenerate mass of ovarian tissue destroyed by tubercular disease. This case alone could not be regarded as providing conclusive proof of sex reversal in the fowl, for during the earlier part of its life this bird had been in the possession of a private breeder concerning whose integrity there is no doubt but whose powers of critical observation can, of course, be held up to question. However, Crew (1923) and Fell (1923) examined a series of sexually abnormal fowls and were able to demonstrate that the condition found in these could logically be interpreted as stages in the process of transformation from a female type of sex organization to a complete male type.

The experiments of L. V. Domm (1927–29) on the brown leghorn fowl demonstrate with remarkable clarity the complete reversal of female to male condition. When the single left ovary of the female is removed by surgical means, the undeveloped and inconspicuous right ovary begins to grow and in approximately 90% of cases produces a testislike organ. Many of these female birds gradually assume the typical male feather patterns, instead of female, and their combs and wattles become typically male in character.

The microscopical condition of the right testislike organ, developed after removal of the left ovary, varies somewhat with relation to the time of ovarian removal. In cases where the single left ovary was removed at an age of three months or older the testislike organ displayed typical sterile seminiferous tubules. When, however, the operation was done within the first two weeks after hatching, a number of them were later found to possess the large testislike organ, in some areas of which typical spermatogenesis was in progress, and spermatozoa were shown to exhibit characteristic motility when they were suspended in a physiological salt solution. Thus, a normal female subjected to ovarian removal shortly after hatching proved capable of producing a testis on the right side, from the normally rudimentary right gonad, in which spermatozoa capable of motility were recovered; externally the head furnishings and feather pattern may be typically of the male type. It is presumed that for spermatogenesis to occur the operation must be performed while primordial germ cells still exist in the right rudimentary gonad, operations subsequent to degeneration of the primordial germ cells lead to the development of sterile testis.

In the mammal complete sex reversal can not occur in post-embryonic life, because of the differential mode of development of the internal and external sex organs.

A consideration of these instances of sex reversal will show that in the egg stage and in the post-embryonic stage of Amphibia and in the case of fish also, if Huxley's interpretation of Boulenger's results is correct, reversal can occur in either direction, female to male, and vice versa, whereas in the postembryonic stage of birds it has thus far been demonstrated in one direction only, from digametic sex to monogametic. In this connection it is of interest to note that in the instances of intersexuality in Lebistes observed by Winge (1927) the change occurred in old females which assumed male characters though still breeding as normal females. That this is so is provocative of thought. It is possible that the balance between male and female sex-differentiating reactions is more easily disturbed in the case of the sex which possesses but a single X-chromosome, a suggestion which is in line with the observation of Haldane (1921) that in the case of specific and wide varietal crosses if among the offspring one sex is absent, rare or sterile, that sex is the digametic.

In the case of Amphibia, fishes and birds, the conditions required for complete sex reversal are readily met. In the amphibians and birds it has been shown that it is possible experimentally to masculinize a female and to feminize a male by appropriate sex-gland implantation. Male and female accessory sexual apparatuses and external sex organs are very similar, the sexual differences commonly being nothing more than differences in the degree of development of common structures, or, in the case of such as are developed from different rudiments, the set appropriate to the alternative sex becoming completely atrophied. All that is required is that one kind of sex-gland tissue shall be replaced by the alternative kind. In the case of the Amphibia if, as seems the case, at the end of the breeding season the sex glands are physiologically exhausted, if the differentiated tissues undergo complete involution so that a new proliferation of germinal epithelium is required for the provision of gametes for the following breeding season, or if only a portion of the primordial germ cells develop each year, then the mode of differentiation of each season's crop can be determined by the impress of varying environmental agencies, if these are of such a nature as to disturb sufficiently the general metabolism of the individual. Such would appear to be the explanation of Champy's results. Surgical removal of the gonad will lead to the same result if following gonadectomy the general metabolism of the individual is influenced by special feeding (Harms, 1923).

It is to be emphasized that, although the processes of sex differentiation are reversible, the chromosome constitution of an individual is not thereby affected. The form and function of the gamete are not determined by its chromosome content: they are determined by the structure and function of the gonad in which the gamete is elaborated. In forms in which sex reversal is usual it seems that the physiological state established by the hereditary constitution is readily overridden through the environment. Reversal is an adaptive response to a changing environment—the individual is a female when it may be and a male when it must.

THE SEX RATIO

The sex ratio is the numerical proportion of the sexes within a group. In biological literature it is commonly recorded as the number of males per 100 females: in biometrical papers it is expressed as the percentage of males in the data examined. A third and somewhat elaborate method is one that shows the proportion of males as a decimal of unity. In any bisexual species there must be a sex ratio at all times after the sex-determining mechanism has operated. For purposes of discussion it is convenient to take conception, birth and maturity as the three salient points in the life history of the individual at which to compute the sex ratio of the species, and the proportions which obtain at these three stages are known as the primary, the secondary and the tertiary sex ratio respectively. Of these the secondary sex ratio has received most attention. In most animals only the tertiary sex ratio is known.

The Tertiary Sex Ratio.—The tertiary sex ratio will be identical with the secondary unless during the period birth-maturity sex reversal commonly occurs or unless a sexually selective mortality has been operating. Any difference between the secondary and tertiary ratios can simply be the result of a selective postnatal mortality and can serve as an indication of the relative postnatal survival value of the sexes.

The only material available for examination is the human The returns of the registrar-general for 1913 reveal the following facts. In the age groups 0–5 years the sex ratio of infantile mortality is 113.4; in the 5–10 group it is 100.7; in the 10–15 group it is 93.3. This period, 10–15, is, in fact, the only one during which more females than males die, and this is held to be the result of the exhaustion of puberty in the female and the incidence of tuberculosis (Schultz, 1918, and Stewart, 1910–1911). From 1j years on the sex ratio of mortality rises steadily to the age of 50, when a slight decline sets in. This excess of male mortality is probably mainly due to occupational stress. The effect of this selective mortality is seen in the swing of the sex ratio of the population; 104:100 at birth, it is reduced to 102:100 at the end of the first year, and to 101.5:100 at the end of the second. In the third to fifth years it falls to 101.3:100. From 5–10 it becomes 99.9:100; from 10–1j it becomes 94.2:100. During the 15–20 age period there is a rise following upon the increased mortality of females during the 10–15 age group.

From this point on there is a continuous drop, with the exception of a slight rise between 40 and 50 during which period there is an increased mortality of females from reproductive disorders during the period 40–45 years. In old age (85 years) the sex ratio is only 55.2:100.

It is impossible as yet to define the causes of this postnatal sexually selective mortality. The action of semilethal factors, differences in occupational risks, and such like, can not explain all the facts, and all that can be said at present is that for reasons as yet unknown the male exhibits an inherently inferior resistance to the stresses of the acts of living.

The Secondary **Sex** Ratio. — The secondary sex ratio in a group will be the same as the primary unless during the period conception-birth (hatching) sex reversal is common, or else a sexually selective mortality among male and female embryos operates. Any differences between primary and secondary ratio will suggest that the sexes possess different prenatal survival values.

It is known that while the secondary sex ratio of a species is fairly constant and not far from equality it is distinctly variable. It varies with the species.

Man	103–107		*Mammalia*
Horse	98.3	100	"
Dog	118.5	100	"
Cattle	107.3	100	"
Sheep	97.7	100	"
Pig	111.8	100	"
Rabbit	104.6	100	"
Mouse	100–118	100	"
Fowl	93.4–94.7	100	*Aves*
Pigeon	115.0	100	"
Cottus	188.0	100	*Teleostei*
Lophius	385.0	100	"
Loligo	16.6	100	*Cephalopoda*
Octopus	33.3	100	"
Latrodectes	819.0	100	*Arachnoidea*
Lucilia	95.13	100	*Diptera*
Drosophila	100.0	100	"
Macrodactylus	131.0	100	*Coleoptera*

It varies with the race, breed and strain.

Sex Ratio of Entire Populations

Country	Males per 100 females	Country	Males per 100 females
Great Britain	93.5	Belgium	98.4
Norway	94.0	Italy	99.0
Denmark	94.5	Poland	100.5
Sweden	95.3	Greenland	101.5
Spain	95.3	Japan	102.0
Austria	96.6	India	104.1
Germany	96.9	Bulgaria	104.5
European Russia	97.2	Serbia	106.0
Switzerland	97.2	Siberia	106.0
Hungary	97.7	Caucasus	
France	97.9	Korea	113.0
Holland	98.2	Asiatic Russia	117.5
Ireland	98.3	China	125.0

It varies among differentraces living under the same conditions.

Locality	Authority	Ratio for whites	Ratio for coloured
U.S.A.	Jastrzebski	105.7	100.0
Cape Colony	"	105.4	102.6
Columbia	"	105.0	100.0
New York	"	104.j	101.6
New Orleans	"	102.0	98.2
U.S.A. (1st births)	Little (1920)	115.51	93 61
Columbia	Nichols (1907)	106.2	103.0
Cuba	Heape (1909)	108.42	101.2

It is possible by selection to obtain strains differing widely in respect of their secondary sex ratios. King (1918) found that in the case of the albino rat it was possible, starting with two pairs of rats from the same litter, to found two strains, one of which produced a high proportion of males, the other a preponderance of females. The progeny of one pair (pair A) were bred brother to sister without selection for six generations in order to build up a homozygous and uniform race. After this, selection was practised, the brothers and sisters being chosen from litters which showed a preponderance of males. In line B the selection after the sixth generation was made from litters showing a preponderance of females. After 15 generations of such inbreeding and selection, the sex ratio at birth in line A was 125:100, in line B 83:100. The habitual production of an unusual sex ratio can be the expression of the hereditary constitution of a stock. It is possible to breed for a preponderance of one sex. If this process can be developed successfully in the case of domestic animals, breeding for sex preponderance will assume economic importance.

It varies with the seasons of the year. It is not improbable that the breeding season is one in which the general physiological condition of the individual is above the average, and it is of interest therefore to compare the secondary sex ratio following conception during the breeding season with that following conception at other times. The human birth rate actually shows a slight variation in spite of the fact that nearly all traces of the primitive breeding season have been obliterated by social habits. It is found that the sex ratio is low for birth resulting from conceptions at the seasons of greatest fertility and high at the time of lowest birth rate. In the case of the fowl there is evidence to show that there is a swing in the secondary sex ratio with the chronological order of the egg. Jull (1923), using a sex-linked cross in order to preclude errors, recorded the sex of the chickens hatched from eggs of 45 hens during their first year of production. The observations were repeated for three years and the secondary sex ratio was found to be 48.41 expressed as a percentage. Analysis of the figures gave the follo ing table:

Eggs	Secondary sex ratio
0 to 20	62.91 ± 1.44
11 " 40	57.46
41 " 60	45.00
61 " 80	44.61
81 " 100	37.65
101 " 120	32.53 ± 1.15

The secondary sex ratio is profoundly disturbed as a result of interspecific and intervarietal crosses. Haldane (1922) has pointed out that in any such cross the sex that is absent, rare or sterile is the digametic sex.

The effects of hybridization upon the sex ratio is a subject of considerable anthropological interest. Three types of hybridization are possible: (1) between white races, (2) between coloured races and (3) between white and coloured races. As a result of an investigation of the effect of hybridizatios, C. C. Little (1920) concluded that a higher preponderance of males resulted from hybrid white matings than from pure white matings, and that hybrid coloured matings gave a higher preponderance of females than did pure coloured matings. This is in agreement with Lewis' results in the Argentine (1906). Powers (1877) states that, in the case of black and white hybrids, there is a large excess of girls among half-breeds in California and Kohl (1859) notes that in the northern parts of the United States females preponderate in the progeny of French men with Indian women. Starkweather (1883) found in the mulatto a 12 to 15% excess of females, while in the whole population males were in excess. An excess of females is reported by Gortz and Waitz among the offspring of Dutch men and Malay women in Java (1859). Jastrzebski states that for the years 1910–15 the ratios of males to 100 females in New York were: whites, 104 0; Negroes, 99.9; and mulattoes, 97.9. Bugnion (1910) states that in a hybrid race formed by settlers in a colony of Negroes there was a marked preponderance of females. It seems therefore possible to conclude (1) that crosses between white races produce an

Mother	Father	Males	Females	Author
Insects (in *Lepidoptera* the female is digametic; in *Drosophila*, the male)				
Nyssia graecoria	*Lycia hirtaria*	65	0	Harrison (1916)
N. zonaria	" "	208	0	" (1919)
"	*Poecilopsis isabellae*	32	0	"
"	" *pomonaria*	90	0	"
"	" " (inbred)	71	7	"
"	" *lapponaria*	93	0	"
"	" " (inbred)	62	3	"
Lycia hirtaria	" *pomonaria*	86	75	" (1916)
" "	" "	190	14	"
Poecilopsis isabellae	*Lycia hirtaria*	38	32	"
P. lapponaria	*Poecilopsis pomonaria*	38	39	" (1917)
Oporabia diltrtata	*Oporabia autumnata*	6	0	" (1920a)
Tephrosia bistortata	*Tephrosia crepuscularis*	378	12	" (1920b)
Drosophila melanogaster	*Drosophila melanogaster*	..	..	Lynch (1919)
(fused)	(normal)	0	823	"
(fused XXY)	"	9	744	"
(rudimentary)	"	10	923	"
(rudimentary XXY)	"	93	649	"
Drosophila melanogaster	*Drosophila melanogaster*	2	3552	Sturtevant (1920)
Birds (female digametic)				
Turtur orientalis	*Columba livia*	13	1	Whitman and Riddle (1919)
Streptopelia risoria	" "	38	0	
S. alba-risoria	" "	11	0	
S. risoria	*Zenaidura carolinensis*	16	0	
Gallus domesticus	*Phasianus colchicus*	100	..	Lewis Jones (quoted by Haldane)
Phasianusreevesi	" *torquatus*	161	6	Smith and Thomas (1913)
" "	" *versicolor*			
Tetrao urogallus	*Tetrao tetrix*	40	8	Suchetet (1897)
Gallus domesticus	*Pavo nigripennis*		0	Trouessart (1907)
Mammals (male digametic)				
Bos taurus	*Bison americanus*	6	39	Boyd (1914)
" "	*B. bonasus*	1	3	Ivanov (1913)

excess of males over pure white matings; (2) that hybridization between coloured races produces an excess of females above pure coloured matings; and (3) that hybrids of white and coloured races show an excess of females above the pure matings of either race.

The secondary sex ratio varies with the parity, *i.e.,* the chronological number of the pregnancy. In the case of the human, the dog, and the mouse, it has many times been noted that there is a continuous drop in the sex ratio at each succeeding pregnancy (Wilckens, Punnett, Bidder, Copeman and Parsons). King and Stotsenburg found that the same rule obtained in the rat.

A. S. Parkes points out, however, that most of the second and higher births occurred at the end of the breeding season when the sex ratio is at its highest, and that too much must not be inferred from his figures until the experiment has been repeated.

It has been suggested that the sex ratio varies with the time relation of successive conceptions. Rumley Dawson (1921), for instance, maintained that in the case of the female producing one young at a time the right ovary elaborated only male-producing ova, the left only female-producing, and that the ovaries function alternately, ovulation occurring in one ovary at one oestrous period, in the other at the next. This view can not be brought into harmony with established facts, and therefore can not be accepted on its present-day evidence. The theory is supported by a collection of selected statistical data applied without proper statistical treatment, and those cases which do not fit into the scheme are airily dismissed, while the great body of established facts which supports other theories and can not support this particular one is neglected. Variations of this theory are numerous, and like it are based upon the conception that in the human, horse and cattle, the female is digametic. Many believe that offspring of either sex can be obtained at will by persuading the semen of the male to flow to the right or the left of the body of the female, toward the left ovary or to the right, that is. This is ensured by the female lying on one side or the other after coitus, or standing on a slope. The matter has been tested experimentally and found wanting. Doncaster and F. H. A. Marshall (1910) have shown that unilateral ovariotomy in the rat does not result in the production of offspring of one sex only, and the cogency of these experimental results can not be dismissed by the statement that it is too far a cry from the rat to the human female. If the breeder really desires to have this theory tested, the way is simple, for it can readily be shown that unilateral ovariotomy in the horse or in the cow is not followed by the production of offspring of one sex only, and that the production of both male and female progeny is not to be explained by any regeneration of the imperfectly removed ovary.

Statistical evidence has been presented, sometimes supporting, at other times contradicting, the suggestion that the sex ratio is affected by the relative ages of the parents, the offspring being mostly of the same sex (or of the opposite sex) as the older (or as the younger) parent. Hofacker (1828) and Sadler's (1830) law—that the sex of the offspring is that of the older parent—finds no support in the result of critical inquiry: it is contradicted by the work of Schultze (1903) on mice, for example. According to some data, the age of the mother has a relation to the sex of the offspring, younger mothers producing a preponderance of males (or of females). In the majority of cases the data upon which these theories are based have not been collected by biometrical experts, nor can their genuineness be absolutely guaranteed. Other data seems to suggest that the sex of the offspring tends to be that of the more (or the less) vigorous parent. For example, the theory of Starkweather (1883) suggested that the "superior" parent tended to beget offspring of the opposite sex, but since it is impossible as yet to define "vigour" and "superiority" in accurate physiological terms, such theories are not suitable for scientific discussion. There is no experimental basis for such conceptions.

It has been suggested that the sex ratio varies with the time of service during the oestrous period. This is not supported by the elaborate data of Raymond Pearl (1917).

It has often been stated that as a result of war more males are born. Savorgnan (1921) and others have supported this contention. *(See* SEX RATIO.)

Causes of Inequality of Secondary Sex Ratio.—The secondary sex ratio is probably always above 100, whereas the tertiary is almost invariably below 100. If the sex ratio of still-births is examined it will be found to be higher than that of live births. If the sex ratio of abortions is next examined it will be found to be considerably higher than that of still-births. The empirical data only extend back to about the third month of pregnancy, but it is well established that the relative male mortality increases the nearer conception is approached so that the primary sex ratio must be considerably higher than that encountered in the latter part of pregnancy. Gunther (1923) has calculated that the early wastage of males must be very considerable indeed.

It is seen, then, that there exists a very considerable prenatal sexually selective mortality. Far more males than females are conceived in those forms *in which* the male is the digametic *sex,* and far more males than females perish prenatally so that the secondary sex ratio approaches equality.

It is highly probable that much of this sexually selective mortality is due to the action of hereditary sex-linked factors, lethal or semilethal in their effects in that they lead to the development of characters which render the further development or the continued existence of the individual impossible. Since the male is digametic any recessive factors borne in the X-chromosome will take effect in all males carrying them whereas in females both X-chromosomes must carry the factor before the corresponding character can appear. It is well known that many recessive characters in animals are harmful to their exhibitors: when markedly so they may not permit the organism to live; when slightly so they may yield but a slight reduction in viability. If such recessive characters are sex linked then the male embryo and foetus will suffer far more often than will the female. It is reasonable to assume that such recessive sex-linked factors should in man, as in other forms, frequently reduce viability. If so, a complete formal explanation of the excess of male infant mortality is provided.

This selective elimination is also affected by favourable and unfavourable conditions during pregnancy. Savorgnan concluded from an examination of his data concerning the sex ratio and the war that it was not privation but absence of husbands which determined the rise in the sex ratio. He explains the relatively low sex ratio of still-births by suggesting that long absences of husbands imply less frequent pregnancies and therefore healthier mothers. It is not improbable that the lower male ratio in still-births and the increase in still-births are but reflections of privation during the latter part of pregnancy.

The same explanation can be applied to the fact that the secondary sex ratio among illegitimate children is lower than that among legitimate—the lack of prenatal care and hygiene resulting in an intensification of the forces that always make it relatively difficult for the mammal to beget male offspring and for the bird to produce as many females as males. The secondary sex ratio is highest among those people and those herds in which the highest degree of prenatal hygiene is practised. It is probable that among the coloured people there is a higher prenatal mortality and that this is the case also among the hybrids of coloured races and of white and coloured, whereas the mortality of hybrids of two white races is relatively very low in consequence of the hybrid vigour or heterosis that results from such a mating.

The Primary Sex Ratio.—If the two forms of gametes elaborated by the digametic sex are produced in equal numbers, if the two forms are equally viable and functional and if fertilization is at random, then the primary sex ratio will be equality.

But in certain forms the two forms of gamete elaborated by the digametic sex are not produced in equal numbers. In the case of bird and moth the egg contains the X- and Y-chromosomes in conjugation before the polar bodies are formed. Into the first polar body goes either the X or the Y. If it is but a matter of chance which way this chromosome pair lies on the spindle, then equal numbers of X-bearing and Y-bearing eggs will result. But if in a particular line this pair should habitually be so orientated on the spindle that the X passes into the polar body more often than the Y, then in this line a preponderance of female offspring (XY) would be observed. Such a differential production can be obtained experimentally, as is shown by the work of Seiler (1920) on the Psychid Talaeporia tubulosa in which the female is the heterogametic sex. Seiler was able to show that the ratio of the eggs in which the X-chromosome passed into the polar body to those in which it remained in the egg, was exactly the same as the sex ratio. Moreover, since in the course of these observations it was possible to detect the moment of the disjunction of the sex-chromosomes, it became possible to attempt to influence this disjunction experimentally and so to disturb the sex ratio. Seiler by varying the temperature during the period of maturation division obtained the following highly interesting and significant results:

Temperature	X-chromosome remained in the egg	X-chromosome passed into the polar body	Sex ratio
18 C.	61	45	136:100
35–37 C.	52	84	62:100
3.5 C.	48	31	155:100

The fact that there is competition between sperm is illustrated in the results of an experiment by Cole and Davies (1914). A rabbit was served by two bucks, and it was found that the majority of the offspring claimed one of these bucks as their sire. In repeated matings this was always so. But when the sperm of this buck was alcoholized it could not compete with that of the other buck, though it was shown that when employed alone it could and did fertilize ova. It is reasonable to assume that if differences in the size of the sperm are associated with differences in motility, activity or resistance to unfavourable conditions within the genital passages of the female, then chance would favour fertilization by one rather than by the other kind of sperm.

Sex in Plants.—In plants sex is generally less rigidly expressed than in the higher animals, and there is wider and more general variation in the manner of its expression. Partly for this reason the sexual nature of plants was not generally recognized until the 18th century (see C. Zirkle, 1935, for a detailed historical account). Conditions in the lower plants are even more variable and in some of them reproduction does not involve the union of gametes. The vast literature on this subject was effectively summarized by Hans Kniepp in his Die Sexualitat der *niederen Pflanzen.*

A small minority of the higher plants are dioecious (bisexual); the whole plant bearing flowers of one kind only, either staminate or pistillate, and these are often referred to as male and female respectively (*e.g.,* hemp, hops). At the other extreme are hermaphroditic plants with staminate and pistillate parts in the same flower, it then being known as "perfect" (*e.g.,* the rose). Among the various intermediate conditions are (1) the silver maple with staminate and pistillate flowers mostly on separate trees but with twigs or even whole branches of flowers of the opposite sex; (2) the honey locust with perfect and staminate flowers on the same plant; (3) the boxwood with separate staminate flowers set in a cluster beneath the pistillate ones; (4) maize with staminate and pistillate inflorescences in different parts of the plant. C. Yampolsky and H. Yampolsky (1924) have attempted to classify these and the various other forms of sex expression in the higher plants in a logical and comprehensive system.

A few of the higher plants resemble the higher animals in having sex quite sharply determined for each individual. Some of these species have been the objects of intense experimentation. Early genetical study showed that in certain of them the "male" is the heterozygous sex (Carl Correns, *Bryonia* dioica, 1907; G. H. Shull, Melandrium [Lychnis], 1910–11). Beginning in 1924 cytological evidence confirmed and extended these conclusions (Ö. Winge and also Kathleen Blackburn, Melandrium; H. Kihara and T. Ono, *Rumex* acetosa). All workers were in agreement that the sex determining mechanism in *Melandrium* was of the XX-XY type but an involved dispute as to whether the X- or the Y-chromosome was the longer was not definitely settled until the experimental production of polyploids (*see* below) made it possible to confirm the greater length of the Y-chromosome by experimental methods.

There is one type of sex-determining mechanism in plants which is not known in animals. In the liverworts and kindred forms the gametophyte generation is the conspicuous one. C. E. Allen (1917) found in *Sphaerocarpus* that the male gametophyte has a Y-chromosome, the female gametophyte an X, whereas the sporophyte has the 2N number of chromosomes, including the very unequal XY pair.

Sex reversal has been reported frequently in dioecious plants (J. H. Schaffner, 1918–23). The transformation is conditioned by age, nutrition, length of day, etc. C. Correns (1918–22) has investigated aberrant sex ratios in *Lychnis dioica* and explained the excess of females on the basis of a more rapid growth of the pollen-tubes from grains bearing the X-chromosome.

R. A. Emerson (1924) has adduced evidence showing that in maize as in *Drosophila,* it is the genic balance which is the effective factor in sex determination. Artificially induced polyploids of *Melandrium* have made it possible to study the sex balance in plants experimentally. M. Westergaard (1940), T. Ono (1940), and H. E. Warmke and Albert F. Blakeslee (1940) working independently, showed that the sex of the male plants is determined by the balance between extremely strong male-determining elements in the Y-chromosome and female determining genes in the X-chromosomes and the autosomes. There is some evidence that the sex genes vary in strength between different races. Askell Löve (1944) demonstrated that the sex balance tn *Rumex Acetosella* is similar to that in *Melandrium.* However in *Rumex acetosa* he found no evidence for determiners in the Y-chromosome and the balance is between the X-chromosomes and the autosomes as in *Drosophila.* He included both these types in a generalized theory ("Cytogenetic Studies on *Rumex Acetosella,*" *Hereditas* 30, p. 123, 1944) of the evolution of sex in the higher plants.

Chemical Tests and Sex Identification.—A chemical test for the identification of sex was introduced by Manoiloff (1922–23). The method is based upon the assumption that there are specifically different chemical substances in the blood of male and female. Subsequent work by others has seemed to show that different concentrations of serum proteins in the blood can explain the Manoiloff reaction. E. Schratz (1926) concludes that the reaction does not show a greater accumulation of oxides in female blood and that the reaction of Bernatzki (1924) is of greater value. Galwialo and others (1926) are of opinion that the test is not specific but is dependent entirely upon the protein content of the substance investigated. Luttge and v. Mertz (1926) describe a technique for the serological identification of sex, which, judging on the basis of early investigations, apparently gives satisfactory results.

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SEXAGESIMAL FRACTION: *see* Fraction.

SEXBY, EDWARD (d. 1658), English soldier, "leveller" and conspirator. About 1657 he wrote the apology for tyrannicide entitled *Killing No Murder,* under the pseudonym William Allen. In July 1657 he was arrested and he died in the Tower of London on Jan. 13, 1658.

SEXPARTITE VAULT, six part vault, in architecture, a type of vault used in late Romanesque and early Gothic structures, in which each bay of the vault is divided by ribs into six portions. The form was one of many attempts to solve the problem of vaulting a church nave without too great difference in the heights of the cross, diagonal and wall ribs. This was accomplished by making two bays of the aisle equal to one bay of the nave, thus creating an almost square bay which was given the normal cross and diagonal ribs. Then an additional cross rib was carried across the nave at the intermediate piers, crossing the diagonal ribs at their intersection. The wall ribs over the clerestorey windows were only as wide as the side aisle bay, thus giving two on each side, and the ridges of the cross vaults, instead of running at right angles to the main ridge, ran at an angle from the apex of the wall arches to the common intersection of the diagonals and the central cross rib. The sexpartite vault appears in an awkward and transitional form in the Abbaye aux Hommes at Caen (nave vaulting 12th century) and in another experimental form with one semicircular wall arch on each side, the intermediate cross rib merely carrying web walls up to its ridge, in the Abbaye aux Dames at Caen (same period). In a fully developed form it is found in the cathedrals of Senlis (1150–65), Sens (1143–68), Noyon (1150–1200), Laon (1160–1205), Notre Dame at Paris (1177–1223), Bourges (begun *c.* 1200) and in England in that portion of Canterbury cathedral begun by William of Sens, 1174–80. (*See* Gothic Architecture; Vault.)

SEX RATIO. The hereditary sexual mechanism (*see* Sex) provides that, as a general rule in animals with well-differentiated sexes, there shall be approximately equal numbers of males and females. But even in man and other mammals the ratios are not exactly equal, and in some of the lower vertebrates and invertebrates the disparity is very great. In all races of mankind more boys than girls are born. The excess of males differs somewhat in different races, in different nationalities and in different years, but is seldom more than 107 or less than 104 males to 100 females. For all races combined, there are born an average of approximately 105.5 boys to 100 girls. (For mammals and birds, see *Livestock;* for human, see *Human, at Birth and Death.*)

W. T. Russell (1936) states that the highest ratios (113 males to 100 females) are reported from Greece and Korea and the lowest (104.3) from England and Japan. The ratios are considerably lower among Negroes. The average ratio at birth, exclusive of stillbirths, in the United States from 1915–42 was about 105.6, the white ratio being computed as 106.3 and the Negro ratio was 103.3. As compared with the preceding decade, there was a tendency for the ratio to decline slightly during 1930–39. The tabulations by A. Ciocco (1938) indicate that no significant differences are found between the various states, in spite of diverse national origins of the populations and varied environmental conditions. Nor are there significant differences in the month or season of birth or the time during the sexual cycle when fertilization takes place. The ratios in Germany, the Netherlands and Italy average about 106, with slightly higher ratios in Norway and Sweden and slightly lower in France. High ratios are usually reported for Jews.

The ratios at birth, *secondary* sex ratios, differ considerably from the *primary* ratios which refer to the proportion of males at the time of conception or at the earliest period of embryonic development. In man the primary ratio must be even higher than the ratio at birth, since more males than females die during prenatal development. The sex ratio of prenatal deaths in the United States during 1926–29 is stated by Russell (1936) to range from 142.6 at the fourth to sixth month of gestation to 129.3 at the seventh to ninth month, with an average of 134.5, as compared with a ratio of 105.6 for living births during the same years.

No satisfactory explanation can yet be given for the disparity of the primary sex ratio, which is probably at least as high as 115 males to 100 females, but the following suggestions have been made: (a) that more male-determining than female-determining sperm are produced; (b) that the former have greater motility than the latter or are otherwise more likely to be successful in fertilization; (c) that the response of the egg to the entrance of a male-determining sperm is more likely to lead to normal embryonic development; and (d) that more female-determined embryos die in the earliest stages of development, or before sexual differentiation can be recognized, presumably owing to the influence of sex-linked lethal genes which affect only the homozygous (female) sex. (See Livestock.)

The higher mortality of males which prevails before birth continues throughout life. In the United States the mortality ratio for infants less than one year of age averages about 133 males to 100 females. At the ages of 13 to 19 years the two sexes are approximately equal in numbers and thereafter there are more women than men. Hence the life expectancy of males is always less than that of females. As a consequence of this differential mortality the ratio of males to females in the total population of a country will often be less than parity except as it may be influenced by migration. In the United States the sex ratio of the total population in 1940 was 100.6 males to 100 females; for the white race it was 101.2 to 100. Aside from the greater industrial and social hazards to which the males are commonly exposed in civilized life, this differential mortality must be ascribed to some fundamental physiological difference between the two sexes, since the same condition is found in some of the lower vertebrates and in many invertebrates.

The fact that males have a higher basal metabolism than females may make the former more susceptible to unfavourable conditions. Consequently any condition, such as impaired vitality of the mother, which tends to increase the prenatal mortality, tends to decrease the proportion of boy babies. And conversely the ratio of boys will be higher from reasonably early marriages, since prenatal deaths are relatively less frequent with young mothers than with women more than 30 years of age. For the same reason the first-born children have a slightly greater chance of being boys than those born later in the same families, but there seems to be no satisfactory praof that either the absolute age or the relative age of the father influences the sex ratio. The question as to whether there is a significant increase in the ratio of male births as a consequence of prolonged wars or other social upheavals has not yet been satisfactorily answered. Statistics indicate that a slight increase did follow World War I in all the belligerent and most of the neutral nations of Europe, but not in the United States (see section on Influence of War). It is not improbable that where an increase occurred it may have been due to conditions favourable to early marriage and the resulting low prenatal mortality.

The proportion of prenatal deaths is usually somewhat lower in rural communities than in cities, and the ratio of living male births slightly higher. The union of different racial stocks sometimes results in a high male ratio, either as the influence of hybrid vigour or the suppression of defective genes. In other hybrids the reverse is true. In certain mammals inheritable divergence in sex ratios has been demonstrated and selection for high and low sex ratios has established family lines with the corresponding characteristics. It is not improbable that human families may have similar traits.

In reptiles, fishes and many invertebrates, including insects, crustaceans and molluscs, males are usually smaller than females as well as shorter lived. In some of these a selection of either the largest or the oldest individuals in the population will contain few if any males, although there may have been equality in the primary sex ratio. In many species, including even some of those in which the male is homozygous, males throughout life are more susceptible to adverse conditions, such as deficiency of oxygen, abnormal temperature, poisons and various diseases and succumb more readily than females. In various species of reptiles and fishes there are generally about equal numbers of males and females or an excess of males when young but the proportion of males decreases with increasing age until there may be only 20 to 30, or even fewer, males to 100 females. In some species of molluscs in which each individual retains the same sex throughout life, the males die when relatively young and the population of old and large individuals consists exclusively of females.

These sexual differences in susceptibility and mortality may also be due in part to the influence of sex-linked lethal or semi. lethal genes which would affect principally the heterozygous (heterogametic) sex (See HEREDITY.) Such genes are known to be operative in both animals and plants. Families or races having few or none of these genes would be expected to have a high ratio of males. Colour blindness and defective blood-clotting (haemophilia) are the two best-known sex-linked defects in man.

A good example of the influence of such lethal genes may be found in the fly *Drosophila* melanogaster. In this fly, which has a normal sex ratio of about 98 males to 100 females, certain genetic strains have been obtained whereby it is possible to arrange matings which will produce $66\frac{2}{3}\%$, $87\frac{1}{2}\%$ or 100% female progeny, since one-half, three-fourths or all the males die before or soon after hatching. In other stocks the ratios may be highly variable. Another strain carries a sex-limited lethal gene and produces only males.

In a considerable number of invertebrates, in a few fishes and in certain plants, the sexuality changes during the individual's lifetime. Such individuals are usually, but not invariably, protandric, functioning as male when young and later changing to the opposite phase of sexuality. In any such populations the ratio of male-phase to female-phase individuals will depend entirely upon the proportion of young as compared with older individuals. In some other species each individual experiences several alternations of male and female phases.

EXPERIMENTAL

It seems safe to assert that not one of the many methods which have yet been proposed for obtaining the desired sex in prospective human offspring has been proved to have any merit whatever. Nevertheless the sex ratio can be changed slightly by conditions which tend to increase or decrease the prenatal mortality. It is also theoretically possible to increase the chances of male or female offspring by choosing a mate from a family stock, if such there be, with the desired hereditary characteristics. (See Livestock.) In man, and in many animals and plants, maleness or femaleness is so definitely determined in the fertilized egg that no known external influence can completely reverse it. In others, on the contrary, the male-determining and female-determining factors are so nearly balanced that the sex can be controlled by relatively slight changes in the environmental conditions. In a few species of animals and plants such environmental, or phenotypic, sex control operates regularly in nature.

The environmental conditions, which in certain organisms may influence the sexuality of the individual, and hence the sex ratio of the population, may be grouped in eight categories, namely: mutilation (removal of portion of body), nutrition, chemical alteration, temperature, sunlight, delayed fertilization, association and hybridization. Not infrequently any one of several of these may have the same effect or several may operate conjointly but it is not to be assumed that any of them, except as specially noted, are applicable to man.

The annelid worm *Ophryotrocha puerilis,* found along the seacoasts of both Europe and North America, may be mentioned as an example of this sexual instability. All the young of this species normally function as males but, on reaching a certain age and size, change to the female phase. Under favourable conditions the female phase may continue through life; but when the worm in the female phase has her posterior segments removed, or lacks sufficient food or oxygen, or is subjected to abnormal temperatures or to slightly poisonous substances, she returns to the juvenile male phase. If favourable conditions are then restored, the female phase is again resumed, but is retained only as long as such conditions continue. There are other cases in which the removal of a part of the body reverses the sexuality, both in animals and plants. Extirpation of the left gonad of the young female chicken may cause the prospective hen to develop into a cock by stimulating the otherwise rudimentary right gonad to form a testis.

Nutrition.—Both the quantity and quality of the food, as well as chemical and temperature changes, influence the sexuality of rotifers and cladoceran crustacea. Unfavourable conditions lead to the production of males from cultures of parthenogenetic females, as is also true of aphids. There is some evidence that deficient or faulty nutrition in pregnant women may be a contributing cause of abortion and thus lead to a slight decrease in the normal ratio of male births, since, as has been mentioned, the proportion of prenatal deaths, including stillbirths, is greater for males than for females.

Chemical Alterations.—Male production in cladocerans and rotifers may be elicited from their own excretions. Chemical changes in the sea water, such as the addition of a small amount of a copper or potassium salt or a trace of acid, as well as a decrease in the normal amount of magnesium, may determine whether certain worms (*e.g., Bonellia*) shall develop into males or females. Sex hormones administered to certain fishes and amphibia may likewise reverse the prospective sexuality more or less completely. In some of the amphibia such partial sex reversal may be effected by the surgical union, or parabiosis, of pairs of larvae with opposite sexuality so intimately that sex-differentiating substances may pass from one individual to the other. Grafts of heterosexual gonads may be equally effective.

Temperature may be a potent factor in sex differentiation in both animals and plants. Highly aberrant sex ratios result from temperature changes applied to the eggs of moths and other animals. If certain races of frogs are reared at a relatively high temperature, all or nearly all of the genetic females may transform into males (E. Witschi, 1942). The high temperature activates the male portion of the primary ambisexual gonad and inhibits the female portion.

Sunlight may influence the sexuality of certain plants, since improved nutrition has a tendency to initiate female development in hermaphroditic individuals.

Delayed fertilization may be influential in changing the prospective sexuality of certain amphibians and fishes. When fertilization is delayed until the eggs have become overripe, the majority or all of the resulting embryos usually develop into males.

Association in overcrowded conditions leads to male production in cladocerans. A period of attachment to the proboscis of an adult female usually causes the young, sexually undifferentiated, *Bonellia* worms to develop into males by inhibiting female development in individuals with genetic tendencies toward consecutive sexuality. In snails of the genus *Crepidula* opportunity for mating causes the accentuation and retention of the male phase in an individual which would otherwise have transformed to the female phase.

Hybridization of diverse races or species frequently results in highly aberrant sex ratios, owing in some cases to the abnormal development and death of the heterozygous sex and in other cases to the partial or complete reversal of the initial sex during development. Aberrations which may take place during the formation of the gametes may lead to the production of only one, or predominantly one, of the normally two sexual types of gametes by the heterozygous sex.

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LIVESTOCK

The proportions of the two sexes at birth (secondary sex ratios) in the various farm animals approximate equality, as is the case in man and other mammals and in birds. Significant deviations from equality may be characteristic of the different species, but similar deviations may occur within the same species when different breeds, strains or families are considered. The stated ratio for any form, therefore, depends to some extent on the proportions in which these different elements enter into the tabulation. Combined and weighted sex ratios (expressed as per cent males) from various authors for some of the principal farm animals are:

Cattle	51.2	Goat	50.1	Rabbit	51.1	Turkey	49.2
Horse	49.7	Sheep	49.2	Dog	52.4	Pigeon	51.5
Mule	44.3	Pig	51.2	Chicken	49.4		

The secondary sex ratio is the result of the primary or initial sex ratio and any differential mortality with respect to sex in the interval to birth. The primary sex ratios are unknown, but, as in man, there is evidence, at least in cattle and swine, that the early prenatal ratios are higher than those at birth. If this trend is continued back to conception, primary sex ratios of 60% or even higher would he indicated. On the other hand, some results in mice and chickens, where every egg produced was accounted for, suggest an initial equality of sexes. The question must be considered still open.

The tertiary sex ratio. that is the ratio at any period after birth, has little biological meaning in domestic animals, since it is for the most part determined arbitrarily by the husbandman But even when there is no artificial adjustment, there is usually a differential survival rate with respect to sex. Thus F. A. E. Crew reported in swine a sex ratio of 51.2 at birth, which at weaning had dropped to 49.3, indicating a higher mortality of male pigs during this early life period.

For particular purposes the breeder often desires animals all of one sex, or at least to have one or the other sex greatly in excess. In polygamous animals fewer males than females are needed, hence in breeding groups the ratio of males is kept much lower. The number of males to breeding females maintained is ordinarily only 1 male to 10 or 20 females, or even more. With the advent and increasing use of artificial insemination, it may be anticipated that the ratio of males maintained will be considerably lower. The producer of dairy cattle places a premium on heifer calves and the chicken farmer who supplies an egg market prefers pullet chicks. He therefore adjusts the proportions of the sexes in his herds or flocks to meet his economic needs. In some instances this adjustment occurs very early, in other cases at a later age. The excess male calves are usually eliminated from the dairy herd as vealers at a very few weeks of age. In intensive poultry production the male and female hatchery-produced chicks are separated immediately after hatching, the latter going into egg-production flocks, while the former, except such as may be saved for reproduction, are raised for meat purposes as fryers, broilers or roasters.

In the farm mammals sex is recognizable at birth, making selective elimination an easy matter. Such is not ordinarily the case in the birds, however, and here special methods have to be employed. There are differences in the rudimentary sex organs of the newly hatched chick which may be distinguished by a skilled worker. This is known as the Japanese method of sexing chicks and is employed rather extensively. An accuracy of 85% or greater is claimed. Advantage may also be taken of sex-linked characters which occur in certain breeds. By making appropriate crosses, crossbred chicks will be produced in which the males have one colour of down and the females another, and the two sexes may be easily separated. This method involves the disadvantage that the parental breeds have to be maintained separately in order to make the crosses. More recently certain so-called *autosexing* breeds have been established in which the male and female chicks regularly differ with respect to a sex-linked character, thus obviating the necessity of crossbreeding to obtain 100% accuracy in sex-recognition. Such are the Cambar and Legbar in England and the Oklabar in the United States. This method is also being used to some extent with pigeons.

In hybrids between species there is commonly a considerable disparity in the secondary sex ratio, which is ordinarily greater the less closely the parent species are related. Usually females are in excess in mammals and males in birds. The only species hybrid of great economic importance is the mule, from mating of the ass and horse, with a resulting male ratio of 44.3. Certain wide crosses in pigeons produce almost 100% males, presumably due to the death of the female embryos at an early embryonic stage. The almost complete infertility of species hybrids precludes using them for further breeding.

The breeder has always been interested in the possibility of controlling the sex of the offspring before birth and innumerable means of doing this have been suggested, none of which has proven reliable. Recently much publicity has been given to a method of predetermining the sex of the offspring, particularly of farm animals, by controlling the acidity of the vagina at time of mating. An alkaline reaction was supposed to result in more males and an acid condition in more females. Careful experiments on rats, rabbits and swine have failed to substantiate these claims.

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HUMAN, AT BIRTH AND DEATH

There is a very extensive and somewhat conflicting literature on the sex ratio at birth. One thing is definite, that in most populations males are born in excess of females in a ratio somewhere around 1,050 to 1,000. Comparative data which have been quoted for different races must be viewed with some reservation, since these ratios are easily disturbed by any inaccuracies, incompleteness or variations in methods of registration. Indeed, some very high figures occasionally cited may be fallacious, being coloured in part by a tendency among certain peoples to hold females in low esteem. With due allowance for these facts, the following reported figures may be cited as examples. In the congeries of peoples making up the former empire of Austria were to be found political divisions inhabited by populations of which the majority had more or less clearly differentiated racial characteristics. An investigation into the births for the three years 1904, 1907 and 1910 showed that among the Jews inhabiting the whole of the empire there were 1.091 males born to 1,000 females. In Dalmatia, with a preponderating Serbo-Croat population the male plurality was only 1,037. Bohemia and Moravia (Czechs) had a ratio of 1,056; Galicia (Poles) one of 1,060 and the coastlands (Italians) one of 1,065. The figures thus quoted relate to racial rather than political divisions, and to populations living under strictly comparable conditions. Going farther afield. data from the different provinces of India and from different parts of the Japanese empire show similar and sometimes extreme variations in the sex ratio at birth seemingly attributable to racial differences, though the statistics in these cases may be very unreliable.

Urbanization.— The general impression, gained from studies by a variety of authors in different countries, is that the sex ratio is somewhat higher in rural than in urban districts. This also appears for most items in Table I. The United States, however, in recent years forms an exception, and for the period 1930–34, the figures for the urban and rural ratios were 1055 9 and 1053.9 respectively, so that here the rural ratio was actually below the urban.

TABLE I —*Births by Sex—Urban and Rural Areas*

Country	Period	Number of births	Males to 1,000 females	
			Urban	Rural
England and Wales	1911–15	4,300,000	1,038	1,043
England and Wales	1936	605,292	1,053	1,058
Ireland	1906–14	600,000	1,048	1,052
Austria	1904–7–10	2,800,000	1,057	1,062
Setherlands	1911–15	850,000	1,045	1,055
U.S.A.	1915	2,800,000	1,054	1,058
U.S.A.	1925–29	13,417,000	1,058	1,058
U.S.A.	1930–34	12,077,000	1,056	1,054
Uruguay	1912–16	170,000	1,044	1,068
South Africa (Wh.)	1912–16	200,000	1,037	1,075
Cape Colony (Bl.)	1906–08	100,000	1,023	1,033

Order of Birth.— There seems little doubt that the sex ratio is higher among the first born than in subsequent births. In the United States in 1925–29, the sex ratio among the first born was 1063.2; for the fourth child 1053.3 and for the fifth and higher children 1051.0. Related to this phenomenon is the fact that there seems to be a tendency for a relatively high sex ratio among the children of very young mothers. So, in the United States 1917–24, the following were the sex ratios observed among the children born of mothers of successive ages.

Age of mother	Sex ratio
Under 15 years	1.229
1; to 34 years	1.060
35 to 54 years	1.055

Influence of War.—There is a popular belief that the proportion of males to females born increases after wars. The question has been much debated. The figures shown in Table II seem to indicate that World War I was indeed followed by an increase in the ratio of male to female births in Great Britain, Belgium, France, Germany, and in the two nonbelligerent countries most closely affected, namely the Netherlands and Switzerland, both of which had large bodies of troops under arms. Finland was less affected by the war in every way, and Italy is the only other belligerent showing no increase. For World War II, figures for the United States show practically no appreciable increase in masculinity, the figures for the years 1939–43 running as follows: 1054; 1055; 1054; 1058; 1055. Thus the only year to show possible evidence of a slight increase is 1942. The figures for England and Wales, on the other hand, do show a definite increase during the progress of the war. The figures for 1939–44, inclusive, are as follows: 1050; 1059; 1054; 1060; 1065; 1062.

TABLE 11.—*Sex Ratio at Birth*

Period	England and Wales	Scotland	Belgium	Bulgaria	Finland	France
1876–1905	1,035	1,050	1,045	1,075	1,053	1,044
1906–14	1,039	1,042	1,042	1,054	1,061	1,045
1915–20	1,048	1,053	1,054	1,072	1,061	1,054
1921–25	1,047	1,051	1,049	1,062	1,063	1,049

Period	Germany	Italy	Netherlands	Norway	Sweden	Switzerland
1876–1905	1,053	1,059	1,053	1,060	1,055	1,048
1906–14	1,055	1,056	1,051	1,060	1,061	1,036
1915–20	1,068	1,056*	1,059	1,059	1,058	1,049
1921–25	1,068	1,053	1,056	1,055	1,059	1,048

*1916–19.

Other Factors.— Many other factors have been alleged to affect the influence of masculinity at birth, among them being crossbreeding and illegitimacy. As to crossbreeding, in British Guiana, the masculinity of children of mixed parentage for the decade 1903–12 was lower than that of the East Indians or blacks, while in Rio de Janeiro from 1910–15, the ratio was whites 1049, mulattoes 979 and blacks 999. It is very probable that the effects of crossbreeding are determined by the nature of the cross. So, for instance, Ciocco, in studying conditions in the United States, found that when one parent was of foreign birth and the other native born, the sex ratio of the children tended to be greater or less than that among purely native born, according as the foreign-born parent belonged to a nationality with greater or less masculinity than the native-born U.S. population. For illegitimacy, the evidence is conflicting, though in the majority of countries illegitimate births show a preponderance of males. The figure for the United States as a whole is misleading, because it is strongly influenced by illegitimate births among the coloured people, where illegitimacy is much higher than among the white. When the illegitimate white births are segregated, it is found that the sex ratio among these was 1056 4 in 1926–29, and 1060.1 in 1930–34. It may be remarked that, to be of real value, figures on masculinity in illegitimate births should relate, not to numbers born out of wedlock, but to those resulting from casual unions. A certain proportion of the births classified as illegitimate is the result of unions which, though not recognized by the law or the church are, from the physiological point of view, marriages.

Sex Ratio at Death.— In speaking of the sex ratio at birth, it is unnecessary to specify the age, since this is necessarily zero. But in discussing the sex ratio at death the age is an important factor and must be specifically taken into account. To speak merely of the sex ratio of all deaths in a population is rather meaningless, since this ratio depends on the prevailing age distribution, and this in turn depends on the past history of the population, on the sex ratio at birth and on other factors.

A comparison of the sex ratio at death for males and females at every tenth year of life is shown in Table III for England and Wales and for the United States (white population). Practically throughout life the mortality of the male exceeds that of the female, and this is true even at the ages where women are exposed to special risks related to childbearing. The advantage in favour of females is undoubtedly due primarily to an underlying physiological superiority, as is clear from the fact that this advantage shows itself even in infancy. In the most productive period of life men, on the other hand, are exposed to greater risks than women in special occupational hazards, and the final picture is the composite of these various tendencies.

TABLE III —*Mortality Rates and Sex Ratio of the Same at Decennial Ages, United States, 1943, and England and Wales, 1930–32*

Age	United States, 1943			England and Wales, 1930–32		
	Mortality rate per 1,000		Ratio: White males to white females	Mortality rate per 1,000		Ratio: Males to females
	White males	White females		Males	Females	
0	42.30	32.91	1.29	71.86	54.55	1.32
10	.89	.61	1.46	1.46	1.34	1.09
20	2.62	1.23	2.13	3.16	2.68	1.18
30	2.77	1.91	1.45	3.40	3.19	1.07
40	4.96	3.41	1.45	5.62	4.40	1.28
50	11.59	7.26	1.60	11.28	8.16	1.38
60	25.67	16.55	1.55	24.15	17.70	1.36
70	55.30	41.54	1.33	60.35	44.51	1.36
80	126.95	108.95	1.17	145.00	118.58	1.22

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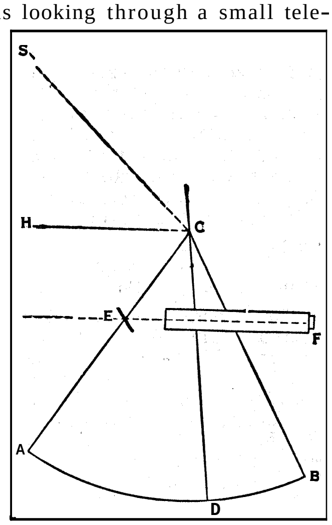
SEXTANT, a sixth part of a circle. The name is applied especially to an optical instrument for measuring angular distances, invented by John Hadley in 1731. Hadley's original instrument was, strictly, an octant, employing a graduated arc of one-eighth of a circle. The arc was enlarged to one-sixth, to meet the needs of navigation, by Capt. Campbell in 1757.

The instrument is mainly used at sea, and the angle that is measured is the altitude of the sun (or a star) above the horizon (*see* NAVIGATION). A familiar sight on an ocean steamer is the officer on the bridge "shooting the sun" at noon, in order to determine his latitude. The officer is looking through a small telescope straight at the sea horizon; but he sees also an image of the sun (dimmed by an interposed dark glass) which has been reflected into his field of view by an arrangement of mirrors described below. He is slowly moving an arm which turns one of the mirrors until the solar image appears just to touch the sea-horizon.



The figure shows the construction of the sextant. ABC is a light framework of brass in the shape of a sector of 60°, the limb AB having a graduated arc of silver inlaid. It is held in the hand by a small handle at the back, either vertically in a position in front of the eye to measure the altitude of an object, or in the plane passing through two objects the angular distance of which is to be found. It may also be mounted on a stand. CD is a radius movable round C, where a small plane mirror of silvered plate-glass (called the "index glass") is fixed perpendicular to the plane of the sextant and in the line CD. At D is a vernier read through a microscope, also a clamp and a tangent screw for giving the arm CD a slow motion. At E is another mirror "the horizon glass," also perpendicular to the plane of the sextant and parallel to CB. F is a small telescope fixed across CB, and pointed to the mirror E. As only the loaer half of E is silvered, the observer can see the horizon in the telescope through the unsilvered half, while the light from the sun or a star S may be reflected from the index glass C to the silvered half of E and thence through F to the observer's eye. If CD has been moved so as to make the image of a star or of the limb of the sun coincide with that of the horizon, it is seen that the angle SCH (the altitude of the star or solar limb) equals twice the angle BCD. The limb AB is graduated so as to avoid the necessity of doubling the measured angle, a space marked as a degree on AB being in reality only 30'.

If the sextant is used on land an "artificial horizon" is required instead of the sea horizon. This consists of a trough containing a shallow layer of mercury, which gives a truly horizontal reflecting surface. The telescope F is now pointed downwards so as to view the sun's image reflected in the mercury trough; an image of the sun reflected by the sextant mirrors appears as before, and the two images are made to touch. The reading now gives the angle between the sun and its image in the mercury trough, which is double the angle between the sun and the horizon. In the air, however, the visible horizon is of no use, since its "dip" (below the truly horizontal direction) is large and unknown. The mercury trough is obviously unsuitable for use in an aeroplane. Hence some form of "bubble sextant" (see NAVIGATION) is used, in which a spirit level is reflected into the field of view in such a way that the centre of the bubble indicates the true horizon.

SEXUAL BEHAVIOUR. Definitions and Points of View.—Sexual behaviour could be discussed in terms of its ethical, sociological and biological aspects, but to consider the subject from every possible point of view would involve much more space than is available here. The sociological angle of approach presumably would deal on a descriptive level with the sexual mores and practices found in various human cultures; but, valuable as such data undoubtedly are, they are limited in the sense that they apply only to one of the thousands of species that inhabit the earth. Treatment of the ethical features of this subject would be extremely difficult and of questionable value, for moral standards change from generation to generation and vary widely from one society or culture to another. The biology of sexual behaviour, in contrast, is a basic part of natural science which can be considered objectively, without reference to moral values; and the zoological approach permits description of the behaviour of any animal, including man, in strictly factual terms.

The following discussion will deal with the sexual behaviour of many different kinds of organisms, and activities of the human animal will be treated in the same fashion as those of any other species. The mating responses of insects and other invertebrates are worthy of study, but because of space limitations only vertebrate animals can be considered here. The term "mating" will be applied exclusively to bodily activities directly associated with fertilization of the eggs. "Mating" thus becomes synonymous with "coition" when used in reference to those species which copulate, and, as applied to other organisms, it signifies behaviour accompanying release of eggs by the female and ejaculation of sperm by the male.

Behaviour Preceding Mating.—In many vertebrates the act of mating is preceded by various types and amounts of behavioural interaction between the male and female. Naturalists have lumped such activities together under the heading of "courtship" (see COURTSHIP, ANIMAL), and we shall follow this precedent although the term is poorly chosen, for it implies too close a similarity to human courtship. Generally speaking, the courtship of men and women involves highly complex patterns of social behaviour whereby mutual favour is established and emotional bonds are strengthened, and the eventual goal is the establishment of a marital relationship in which sexual activities represent only one of several equally important elements. Whether or not human courtship includes any behaviour which is sexual in the biological sense depends to a large degree upon the cultural setting in which it occurs, but certainly many patterns of courtship are removed from the biological plane. In other animals, ho ever, the actions belonging under this rubric serve several very important physiological functions.

(1) The attainment of a completely fertile condition in some animals depends upon courtship. Some sea birds nest in very large colonies of several hundred or many more individuals and indulge in mass displays and courting reactions for several days or even weeks before pairs are established. It appears that stimuli derived from the group courtship produce physiological changes in every bird in the colony. One important alteration is a gradual increase in the hormones of the pituitary gland which are essential to reproduction; but, if the colony is so small that communal courtship is markedly restricted, a high proportion of individuals fail to reach fertility.

(2) In many seasonally-breeding species males and females are fertile when the sexes congregate. but even in such cases courtship frequently is essential to reproduction. Many female fishes lay their eggs in previously prepared nests, and sperm are released directly above the fresh spawn by the male who follows close behind his mate. If a species is to be perpetuated by this type of mating, it is necessary that the behavioural responses of both partners occur at the proper place and in exact sequence; and in many species the essential behavioural integrations are brought about by a protracted courtship which leads gradually to the act of spawning. The synchronizing function of premating courtship is further illustrated in the sexual behaviour of certain salamanders which reproduce without laying eggs and without copulating. Walking slowly ahead of the female, the male deposits "spermatophores," small stump-shaped structures of jelly, each surmounted by a cap of sperm. The female straddles over each spermatophore, securing the sperm with the lips of her cloaca (sexual opening), and the eggs are then fertilized within her body. In salamandrian species with this mating pattern, integration of the behaviour of the male and female appears to depend upon the prolonged courtship activities which always precede a successful mating.

(3) Certain types of premating behaviour contribute to the establishment of oppositely-sexed pairs and decrease the likelihood that males will attempt to mate with males and females with females. When they attain breeding condition, male fishes, birds and reptiles of several species establish "sexual territories," and any intruder is vigorously attacked by the resident individual. If the newcomer is another male and does not withdraw before the advances of the resident animal, a fight ensues and the winner drives the loser out of the territory (see BIRD: Reproduction: Territory and Breeding Habits). Invading females are at first attacked as if they were males, and any female that does not have ovaries with maturing eggs beats a quick retreat. A female that is ready to breed does not retaliate as would a male nor attempt to escape in the manner of a nonreceptive female, and her passive toleration of the male's aggression results in a decrease in the frequency and intensity of his attacks. Gradually, as the male's fighting responses are replaced by courtship activities, the pair is established and mating follows.

(4) In addition to inducing physiological preparedness or fertility, facilitating the integration of separate responses into a biologically effective pattern and assisting in the establishment of heterosexual pairs, the courtship of animals appears in many instances to serve yet another function—namely, the generation of a temporary state of intense excitement which is essential, in some species at least, to the occurrence of a complete mating. To the uninitiated observer copulation by a pair of minks resembles a fight, for the female periodically resists her mate, and in his efforts to achieve intromission the male makes full use of his superior size and strength. This is, however, not an example of rape, for it is physically impossible for the most powerful male

to achieve sexual union with a nonreceptive female; in fact, the violent physical exertions of both animals are essential to fertile mating. Males often refuse to mate with a female that submits too easily, and the release of ripe eggs from the female's ovaries to the Fallopian tubes where fertilization takes place depends upon stimulation derived from her struggles with the male. Egg release may occur in the female after a protracted sexual chase or fight, even though copulation does not occur, and, in contrast, matings which take place with very little activity usually are infertile.

The forms of physical contact which engender sexual excitement differ from species to species. An important element in the courtship of the common pigeon is the act of "billing," during which the female inserts her bill within that of the male (or vice versa) and the birds bob their heads up and down in a pumping motion. Copulation usually occurs directly after a sequence of billings, and coition rarely takes place in the absence of this preparatory behaviour. Direct investigation and stimulation of the external genital organs forms a fundamental segment in the premating behaviour of many fishes, amphibians, birds and mammals. The characteristic licking and nibbling with which male mammals of many domestic species investigate the genital region of the female in heat is well known, and the resulting sensations seem in many cases to serve an important function. Just before mating, the male skunk scratches at the female's vulva with his claws, and in response the female assumes the coital posture which is essential to successful copulation. The female cat in heat is induced to display the sexual crouch when the male grips the loose skin of her neck in his teeth and probes her external genitalia with the erect phallus.

The coition of all primates, including man, tends to be preceded by various forms of stimulation which serve to evoke or intensify sexual excitement. Female monkeys and apes invite the male's advances by executing the "sexual presentation," which consists of bending forward sharply at the hips and exposing the buttocks and genitalia. A very similar behaviour pattern occurs in a few human cultures in which open sexual solicitation by women is countenanced. The investigatory responses with which the female chimpanzee greets the male sometimes include handling of the penis and scrotum, and the resultant sexual excitement often culminates in coition. Almost every region of the partner's body is explored and stimulated in the course of the precopulatory activities of apes, but the male's attention is focused particularly upon the female's genitalia. The female's vagina is thoroughly investigated with the male's fingers and often with his tongue and lips, and the excitatory value of such stimulation is revealed by the fact that it often produces erection and pulsation of the clitoris.

The sexually-exciting function of certain forms of stimulation in humans is indicated by the almost universal occurrence of particular types of bodily contact before coition. The complexity and duration of precopulatory behaviour may be influenced by the mores of the social group, but in the absence of cultural prohibitions the premating activities of the human species resemble in many respects those of other primates. Mutual masturbation and mouth-genital contact appear regularly in the sexual behaviour of some cultures, and the stimulation of specific erotic zones such as the female breast is practised in many societies. The similarity of the precoital activities of humans and other primates suggests the existence of an underlying biological pattern common to the order, and the belief that such widely distributed responses as mouth-genital contact are "abnormal" or "perverted" is probably incorrect from the strictly zoological point of view.

Behaviour During Mating. — For descriptive purposes the types of mating shown by different vertebrates can be divided into two major classes, depending upon whether fertilization is external or internal. If the eggs are fertilized after they leave the female's body, mating can occur — and in many species does occur — without any union of male and female sexual organs. In fact, the bodies of the pair may never come in contact during the emission of eggs by the female and of sperm by the male. This type of mating is characteristic of those species of fishes in which the female deposits the eggs and the male releases sperm as he swims behind her.

In other species which reproduce by external fertilization, the eggs and sperm are released simultaneously and the meeting of male and female germ cells depends upon the fact that the sexual openings of the pair are in close proximity at the moment of emission. The mating of some fishes occurs as the male and female swim side by side with their bodies pressed tightly together in such a way that the genital pore of the male is held very near to that of his mate while the eggs and sperm are being released. Approximation of the genitalia is achieved in a different fashion during the mating of frogs and toads, which also depend upon external fertilization. The male swims or climbs upon the back of the female, clasping his forelimbs about her body in the region of the chest; and the male's sexual ejaculations are timed to coincide with the abdominal contractions by means of which the female expels her eggs. When oviposition is completed, the mating clasp is relaxed and the pair separates.

The eggs of many vertebrates are fertilized within the female's reproductive tract, and the mating pattern associated with internal fertilization nearly always culminates in direct contact between the sexual organs of the pair. This is not true in a few species like the salamanders described above, but such exceptions are relatively rare. Transfer of sperm from male to female is achieved through one of two types of genital union: simple contact of the male and female cloacae suffices for species in which the male lacks an intromittent organ; and in all other vertebrates the male's copulatory organ is inserted within the female's cloaca or vagina.

The copulation of most birds involves only cloacal contact. Having been prepared for mating by the preceding courtship, the sexually receptive female stoops or squats, holding her body more or less parallel to the substrate, and the male stands upon her back, maintaining an upright position by vigorous wing flapping. The female's tail feathers are diverted and copulation occurs as the male lowers his rump, pressing his genital opening tightly against that of the female. Sperm transfer is effected in a matter of seconds and the male dismounts with relatively little delay.

Sexual intromission occurs in the mating of some fishes, reptiles and birds and in all mammals. In the male fish of many viviparous species the anal fin is transformed into a movable "gonopod" which may be inserted in the female's genital pore at the moment of sperm release. The masculine sexual organ of most reptiles consists of a bifurcated, saclike structure which is retained within the body cavity save during the time of mating. The copulation of snakes is achieved while the bodies of the male and female are closely intertwined and the sexual parts are in contact or juxtaposition. The male lizard usually grips the neck of the receptive female in his jaws and straddles her body with his legs. Bending the hind parts of his body to one side and downward, he gradually inverts his tail until its under surface is brought against the under side of the female. In this position the male's hemipenis is everted and enters the female's cloaca. The duration of intromission may vary from several minutes to an hour or more.

A few male birds, notably ganders, drakes and others of the order Anseriformes, possess an erectile copulatory organ similar in several respects to the mammalian penis. In such species the outward form of the mating pattern is like that of other members of the class, but the male's organ is inserted within that of the female prior to the emission of sperm.

The copulatory actions characteristic of quadrupedal mammals are relatively stereotyped and well known. The essential elements in the female's pattern consist of standing still, flattening or depressing the back and exposing the elevated genital region. The male always mounts from the rear with his forelimbs resting upon the female's back or encircling her sides. Anecdotal reports of species which copulate with the female in a reclining position and facing the male almost certainly are in error and seem to be based upon pure speculation or upon ignorance of the true nature of the behaviour under observation.

The copulation of monkeys takes place while the standing female bends sharply forward at the hips and the male achieves intromission from the rear, holding himself erect by grasping the hips or waist of his mate. The coital pattern of apes is similar to that of lower primates, and adult pairs apparently do not copulate in a face-to-face position, although this variation may occur occasionally in the sexual play of very young chimpanzees. The possibility of successful "ventro-ventro" copulation would seem to be limited to species, like man, in which structural modifications accompanying the assumption of an upright posture have brought the vaginal opening to the front of the body. Even among humans, however, preferred coital positions vary from society to society, and the bodily relationship common to European cultures (reclining posture, face-to-face, male usually uppermost) is far from universal.

Females of most mammalian species display relatively little activity during copulation, although in a few cases the hindquarters may be moved from side to side or pushed steadily against the male. The coital response of the male involves a variable number of pelvic thrusts which assist in insertion of the penis or serve to move the male organ back and forth within the vagina, producing stimulation which contributes to the occurrence of ejaculation. Ejaculation in most human males is accompanied by a release of tension and may be followed by a period of relative impotence. The subjective aspects of this phenomenon can not be studied in lower animals, but behavioural criteria suggest that something similar to orgasm occurs in at least a few species. The male rabbit, for example, utters a sharp cry and falls off the female just after ejaculation; and in the male rat the emission of sperm is accompanied by mild convulsive reactions followed by a period of lowered sexual responsiveness. Whether or not female animals below the human level experience any orgasmic sensations during intercourse is not known.

Self-Stimulation. — Different human cultures impose varying degrees of social restraint upon the exercise of autoerotic behaviour, but it can hardly be doubted that in every culture at least some men and women practise various methods of self-stimulation leading to intense degrees of sexual arousal The moral or sociological implications of such behaviour are irrelevant from the biological point of view, but studies of other primates indicate that autoerotic responses may be regarded as a common element in the sexual pattern of the entire order.

Male apes and monkeys use the hands and the mouth to stimulate their own sexual organs and ejaculation frequently is produced by either means. This response has been observed not only in caged animals but in wild monkeys living with females under natural conditions, and therefore it can not be regarded as "abnormal" behaviour produced by the artificial conditions of captivity. Autoerotic activities appear less frequently in the behaviour of female primates, but female chimpanzees occasionally stimulate their own genitalia, using their fingers, foreign objects such as twigs, or projections of larger objects such as the corner of a box or the spigot of a water faucet.

Animals belonging below the primates upon the evolutionary scale show little behaviour which can definitely be described as autoerotic but it may be noted that in many mammalian species copulation is preceded or followed by vigorous licking of the genitals in both sexes.

Sex **Play** Before Adulthood. — In many vertebrates certain elements of the adult mating pattern tend to occur long before reproductive maturity is attained. For example, young rats which have just been weaned indulge in mock fighting and wrestling in the course of which mounting with pelvic thrusts occasionally appears; and similar responses have been observed in the behaviour of other rodents. The sexual play of immature primates is more varied than that of lower mammals and resembles more closely the mating of adult animals. Both heterosexual and autoerotic responses occur quite early in the life of monkeys and apes. Male monkeys practise masturbation and employ rubber playthings in a sexual fashion as early as two years after birth. Although chimpanzees are not capable of reproduction until the eighth year or later, male and female infants two years of age indulge in highly complex sexual play which sometimes progresses as far as the achievement of intromission and the execution of pelvic thrusts.

With such a biological background it is not surprising that members of the human species exhibit sexual activity during childhood. The restraints and inhibitions imposed upon this type of behaviour in most societies probably reduce its frequency to some extent; but it is doubtful that sex play is ever totally prevented, although in the presence of strong social taboos it is very difficult to reach any completely satisfactory estimate of the form and frequency of such activity. More reliable information is obtainable in cultural settings which do not restrict sexual activities during childhood, and under such conditions nearly every element in the adult sexual pattern appears several years before puberty.

Effects of Experience. — The widespread occurrence of sex play in juvenile members of many mammalian species naturally raises the question as to whether sexual experience gained during infancy and adolescence has any effect upon mating behaviour in adulthood. Reliable data bearing on this question are not numerous, but it is clear that the answer varies for different species.

No previous sexual experience is necessary for completely normal mating in most of the lower mammals. Males and females which are reared to adulthood in total isolation from all others of their species, and then put together at a time when the female is in heat. mate promptly in a manner indistinguishable from that of experienced breeders.

The situation is somewhat different in primates. Reproductively mature male monkeys which have never mated sometimes experience difficulty in making the essential coital adjustments during initial contacts with a receptive female. No such inadequacy is apparent in the performance of the sexually inexperienced female. Adult male chimpanzees completely lacking in copulatory experience rarely succeed in achieving sexual union with the female, no matter how co-operative she may be.

Erotic arousal is easily evoked in the naïve male ape. but a great deal of experience and practice must take place before this generalized sexual excitement leads smoothly into a well-integrated and complete copulatory pattern.

The mating responses of most sexually inexperienced female chimpanzees stand in striking contrast to those of the unsophisticated male. If she is placed with an experienced consort, the receptive young female often assumes her proper role with very little awkwardness or hesitation, and intercourse is accomplished without difficulty or delay. If both the male and female are inexperienced, the female not only performs all of the responses necessary for her part of the act, but she may even try to assist the male in the execution of his responsibilities.

We have no direct knowledge concerning the importance of learning in human sexual behaviour. Vicarious experience made possible through language might well replace at least part of the trial-and-error behaviour which seems necessary in the, case of subhuman primates. However, the zoological evidence makes it appear probable that in the absence of such vicarious experience, and perhaps even when it is present, a considerable amount of preliminary experimentation and practice is essential to biologically effective sexual intercourse in adult human beings.

It appears that in the course of mammalian evolution, particularly during the appearance and specialization of the higher primates. the mating behaviour of the male (and possibly in humans that of the female as well) has come to be more and more dependent upon individual experience and learning. This implies, of course, a complementary decrease in the adequacy of the purely instinctive elements of the pattern.

"Bisexual" **Behaviour.**—Under certain conditions male and female animals display mating responses which are typical of the opposite sex. Thus, sexually-receptive females of several mammalian species respond to other females which are in heat by mounting them in masculine fashion and executing pelvic movements suggestive of the male's copulatory thrusts. This display of malelike reactions is not "abnormal" in the biological sense; instead, in several species such as cattle, pigs, guinea pigs and rabbits, these responses constitute a regular element in the female's mating pattern, and their appearance is a reliable sign that she is in heat and ready to receive the male. Since nearly all normal females of such species show the complete feminine pattern in addition to portions of the masculine pattern, their behaviour is best described as "bisexual"; and it should be noted that, when a choice is offered, the female mates with the male instead of executing masculine responses toward another female.

Male mammals which are sexually excited sometimes mount other males, treating them as though they were females. Behaviour of this type probably arises from failure to discriminate the sex of the partner under conditions of high excitement and should not be regarded as indication of a preference for sexual relations with members of the same sex.

Support for the first interpretation is seen in the fact that, when both males and females are available, females are always selected as the mate. Occasionally a male that is mounted by other males responds with the temporary display of feminine mating reactions. Such individuals are rare, but their behaviour should probably be regarded as "bisexual," for they inevitably respond in typical masculine fashion to receptive females.

The behaviour of male and female animals thus reveals that the inherited neuro-muscular constitution of both sexes includes mechanisms capable of mediating many of the responses which make up the mating pattern of the opposite sex. However, we do not find any convincing examples of true "homosexuality" among subhuman forms.

The individual incapable of responding to any member of the opposite sex, but experiencing full arousal and satisfaction in contacts with his or her own sex, appears to be primarily if not exclusively a product of human society.

Effects of **Sex** Hormones on Mating **Behaviour.**—In addition to producing sperm or eggs, the male and female gonads (sex glands) manufacture and secrete into the blood stream testicular and ovarian hormones—complex organic compounds which have been analyzed and synthesized in the laboratory.

The fact that gonadal hormones control the mating behaviour of some species is revealed by observations of the reproductive cycle in animals which breed only once each year. With the approach of the breeding season the ovaries and testes increase markedly in size and begin to release the sex hormones which are primarily responsible for the obvious behavioural changes that characterize animals during the rut.

If seasonal recrudescence of the gonads fails to occur, the behavioural changes do not appear. In some species, growth of the sex glands can be experimentally induced at any time of year; and artificially produced activity of the gonads is accompanied by the unseasonal appearance of courtship and mating behaviour.

Males of some mammalian species are sexually active throughout most of the year, while the female becomes fertile and is "in heat" at regular intervals unless pregnancy intervenes. Under such circumstances, the ovaries secrete large amounts of the hormone or hormones responsible for the female's mating behaviour, just at the time that ripe eggs are ready to leave the ovary and pass into the oviduct, where fertilization will occur if mating takes place. The effective hormone concentrations thus are present to produce sexual receptivity only during the limited period that fertile mating, and therefore perpetuation of the species, is possible; and during all other stages of the female's reproductive cycle she is infertile and will not permit mating.

This generalization holds true for nearly all mammals which stand below the primates on the evolutionary scale, but it is not applicable to monkeys, apes or humans. The sex glands of female primates show a periodicity of function resembling in all essential details the ovarian rhythm of lower mammals. Eggs mature and are extruded from the ovaries at fairly regular intervals, and the secretion of sex hormones rises and falls in close relationship with the resultant fluctuations in fertility.

The sexual behaviour of the female primate is not, however, entirely restricted to any single phase of the gonadal cycle. Wild female monkeys have been caught in the jungle immediately after they were observed in copulation, and examination of the ovaries and uterus has shown that, although nearly all matings are restricted to the fertile period, coition does occasionally occur when the ovaries are not secreting large amounts of the hormones ordinarily associated with sexual receptivity.

The mating behaviour of female apes shows a much greater degree of emancipation from control by sex hormones. Chimpanzees may indulge in sexual intercourse during any stage of the female's reproductive cycle, although her eagerness to copulate is most obvious and intense near the time of ovulation. Social factors often take precedence over physiological condition. For example, during their infertile periods females sometimes divert an impending attack by the male by inviting and permitting copulation. In the course of various psychological experiments female apes have been observed to obtain food from the male by proffering sexual services and then seizing and devouring the choice morsel while the male's attention was diverted.

The relaxation of hormonal control over sexual excitability reaches its apex in the human female. Most of the published attempts to identify a cycle of sexual desire in women indicate one or two peaks of erotic responsiveness which come either immediately before or after menstruation in different individuals and at both times in others. It is significant that very few investigators have reported maximal responsiveness during the midmenstrual period when concentrations of the "heat-producing" hormones are highest and most women are fertile.

These observations suggest the interesting hypothesis that within the zoological class Mammalia, advancing evolutionary status is accompanied by progressive reduction of hormonal dominance over the female's sexual behaviour. This interpretation is supported by comparisons of the effects of removal of the ovaries in various species. Spayed females of lower mammalian species never come into heat or show any willingness to receive the male. However, if such animals are injected with ovarian hormones, mating behaviour appears promptly. although of course pregnancy does not occur since there are no eggs to be fertilized. Loss of the sex glands usually eliminates all mating behaviour in female monkeys, but upon rare occasions a few weak signs of receptivity may appear. Administration of ovarian hormones induces full sexual activity in the spayed monkey.

Some female chimpanzees continue to cohabit with the sexually active male despite removal of the ovaries. It is nevertheless obvious that hormonal effects are important in this species, for when ovariectomized apes are injected with the appropriate ovarian secretions their sexual behaviour becomes much more vigorous and frequent. Loss of the ovaries does not necessarily produce a change in the human female's capacity for sexual performance. Scientifically admissible evidence is so scanty that generalizations must be made with extreme caution, but there are many reasons to believe that if general health is not impaired and if the mental attitude is favourable, loss of the woman's sex glands need not interfere with mutually satisfactory intercourse. Differences between individuals are pronounced, however, and in some instances ovarian removal is followed by a definite reduction in sexual responsiveness. The effectiveness of administering sex hormones to such cases is at present subject to controversy; but it is quite clear that the results are less consistent and predictable than they are in the case of other primates. This fact further substantiates the conclusion that the sex life of the human female is not influenced by gonadal hormones to the same degree as is that of lower species.

Males of constantly-breeding mammalian species do not exhibit sex cycles, and therefore our knowledge of the role of testicular hormone in the male's mating behaviour is based chiefly upon the effects of castration and subsequent hormone administration. If the testes are removed before adolescence, males of most of the lower mammalian species show very little sexual behaviour when they reach adulthood; but normal mating performance can be elicited by the administration of testicular hormone. Castration in adulthood usually is followed by gradual loss of sexual responsiveness and ability to mate; and these changes can be prevented or reversed by the proper hormone treatment.

There are indications that castration during infancy does not prevent male chimpanzees from showing some copulatory behaviour in adulthood. Despite such operation, some chimpanzees may perform coitus frequently, although ejaculation does not occur. Administration of testicular hormone evokes the appearance of this final element in the normal male's mating pattern.

The effects of removal of the testes in young boys are variable, but in the majority of individuals the sexual development which normally occurs at the time of puberty never takes place, and the capacity for intercourse in adult life is extremely limited. In many cases of this sort, treatment with testicular hormone during adulthood has induced delayed puberty and produced significant increases in sexual ability.

Loss of the testes after the attainment of maturity seems to have very little effect upon some men and to cause pronounced changes in others. Some patients have reported undiminished sexual desire and capacity continuing for as long as 30 years after complete castration; but most individuals experience a reduction in erotic excitability and coital ability which becomes apparent from several months to a few years after operation and proceeds gradually to a point where intercourse is possible only at infrequent intervals. If testicular hormone is administered to castrated men, it usually restores the capacity for normal sexual behaviour.

Although the data are too few to justify any final conclusions, it may be suggested that while the sexual behaviour of all male mammals is clearly influenced by testicular hormone. the degree of dependence may be somewhat less marked in primates than in lower species, and in at least some humans considerable sexual activity is possible in complete absence of testis secretions. See also references under "Sexual Behaviour" in the Index volume.

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SEXUAL DEVIATIONS are ways of sexual behaviour which replace normal copulation. This article will be confined to certain practices which either do not terminate in normal intercourse or involve some degree of physical injury. Normal sexual desire has (1) as its object a person of the opposite sex of more or less the same age as the person feeling the desire; and (2) as its mode of expression the loveplay and intercourse necessary for the fertilization of the female. In the sexual deviations, the object may be unbiological (for instance a person of the same sex, a child or an animal) or the mode of expression only may be at fault.

Deviated conduct occurs in animals as well as in human beings; it is apparent sometimes in the immature, but more often in animals deprived of a normal outlet for their instincts. Conditioning may have a great deal to do with causing it, although much arises spontaneously. In human beings it may be regarded as caused either by some biological residue (apes appear to pass through a stage of undefined sexual activity) or. according to Sigmund Freud, by a fixation of the individual libido resulting from a traumatic experience during an early stage of development. Environment, however, appears to be important as a possible cause.

Sexual deviations may lead to unhappiness in marriage, either because they often result in impotence or because of the very nature of the deviation. They are also a major factor in the demand for prostitution and may further lead to crime. Medically, however, they are regarded as psychosexual diseases, and the law is becoming more and more willing to allow deviant offenders to be treated rather than punished. Some deviations are definitely curable; some can be alleviated. Since glandular and other physical conditions play only a slight part in causation, treatment must be mainly by psychotherapy. This may be easy or take a long time, according to the nature of the cause. Patients should not be encouraged to marry until there is strong evidence of cure. Those who cannot be cured should avoid drinking alcohol, as it may release deviant behaviour and lead to criminal charges. Treatment by conditioning has been tried but not proved satisfactory. In this the patient is shown objects associated with his perversion and given an emetic such as apomorphine at the same time. More useful is the prescription of stilbestrol or estrogens which suppress the libido in males, simultaneously causing atrophy of the genitalia. This treatment should be used in patients unsuitable for psychotherapy or in whom it has failed.

Homosexuality. — Homosexuality (*q.v.*), the female form of which is known as lesbianism (*q.v.*), is the most important sexual deviation. In it the object of desire is unbiological, so that the mode of expression is perforce at fault.

Sodomy.—This expression may be understood in a number of senses: (1) as denoting any homosexual practices between men, in allusion to the story of Sodom, in Gen. xviii–xix; (2) as denoting anal intercourse; (3) as synonymous with bestiality (see below); and (4) as comprehending a number of activities ranging from hand-genital contacts with minors to mouth-genital contacts between persons of the opposite sex. In this article it is understood in the second sense.

Anal intercourse has been observed in apes and is often accepted as normal between men and boys in preliterate societies, notably during initiation rites. In civilized communities it occurs between male homosexuals (though far less frequently than is commonly supposed) and also between men and women. Between men the passive partner as well as the active one may experience pleasure, but if the act is committed by force he may suffer painful injuries. The man who plays the active role with one partner may assume the passive with another.

The desire for anal intercourse has been explained (1) as arising from lack of opportunity for vaginal intercourse, an explanation which cannot be maintained in view of men's committing it on women; (2) as caused by Pavlovian conditioning, which may be of some importance in the case of boys habituated to the passive role; (3) as caused by fixation of the libido at the stage where sexual interest, after being centred on the mouth, is centred on the anus, from which it would normally, but for the fixation, proceed to the genitalia; and (4) as a dominance phenomenon, a view which receives some support from the behaviour of apes (when a weaker one turns to be mounted sexually if a stronger one threatens to steal its food) but does not account for human behaviour in all its aspects.

"The abominable crime of buggery," meaning either anal penetration or intercourse with animals, was punishable by death in England under a 16th-century act (25 Henry VIII c.6). The Offences Against the Person act (1861) reduced the penalty to penal servitude for life or for a term not less than ten years. Attempts are punishable under section 62 of the same act by imprisonment for between three and ten years.

Bestiality. — Intercourse between human beings and animals (Lat. bestiae) is tolerated and even approved by some primitive societies, but many races condemn it and some even punish it with death. In some parts of the United States it was estimated by A. C. Kinsey that between 40% and 50% of boys brought up on farms have some sexual relation with an animal, vaginal intercourse being commoner than anal. The cause of the desire for it is not known for certain; sometimes, however, there may be some inhibition against relations with another human being, or the animal may symbolize a loved human in the deviant's subconscious mind.

Sadism. — Named after the marquis D. A. F. de Sade (*q.v.*), sadism is the obtaining of sexual pleasure from acts of cruelty. Sometimes sadism and masochism (see below) are regarded as correlative aspects of a single deviant tendency, sado-masochism. Sadism appears to shade off into nonsexual cruelty and may be classified in degrees as (1) cruel or destructive acts performed with pleasure but not appreciated as sexual in nature, including certain sports, arson and lynching; (2) cruel acts without erection or ejaculation but with some sexual satisfaction; and (3) acts of outrage accompanied by full sexual satisfaction and associated with erection and ejaculation, including necrophilia (intercourse with the dead) and rape.

Sadism is the association of the aggressive instincts with sexual arousal. Freud (Psychoanalyse, 1917) suggested that this was caused by the fixation of the libido at some early stage when aggression was manifested by biting, scratching, soiling or some such act. L. Bender and F. J. Curran suggested that rivalry was important, deprivation of love and parental aggression being other factors. The sadist uses hate as the emotional currency where the normal man uses love. He injures the parts of the woman a normal man wishes to caress. There is often an obsessional element present, and B. Karpman (*The* Sexual Offender and His Offenses, 1954) states, "The abnormal expression of sadism represents inner tension and anxiety for which the act is attempted relief. He relieves fear by doing to another what he fears might be done to him."

Sadism is most dangerous when the sadist is also a psychopath and therefore has no inhibitions against antisocial conduct. Murders and violent assaults are then done repeatedly until the sadist is caught. Characteristic of the sadistic murder are (1) periodicity; (2) cutting, stabbing and sometimes biting, sucking the blood and even eating the flesh; (3) concomitant sexual excitement; (4) the occasional revisiting of the scene of the crime; and (5) normal behaviour until the next occasion.

There is no separate legislation against sadists, but they may offend against the laws covering assault if the victim does not die, or those covering murder if death results. Their mental abnormality in most cases does not amount to insanity and is no excuse for their crimes, but when sadism shades off into schizophrenia the individual may be regarded as irresponsible.

Masochism. — Masochism. the converse of sadism in the sadomasochistic deviation, is named after the Austrian novelist Leopold von Sacher-Masoch (1835–95), whose writings are centred on it. It is the seeking of what would normally be painful to oneself to induce sexual pleasure. Often associated with fetishisms, it may take the form of a desire to be dominated, humiliated, degraded, enslaved, bound and even castrated and may also appear unrelated to sexual pleasure, as in the practice of religious flagellation.

Masochism appears to be the impulse to hurt others reversed onto oneself. Freud suggested that it was a manifestation of being beaten in infancy. He also believed that the girl's discovery that she had no penis was a strong factor in feminine masochism. K. Horney suggests conditioning as the cause.

Masochism is less important than sadism socially. It does not inspire murders or assaults, but sometimes the masochist is injured so severely as to need medical care or even to die. Thus anyone co-operating with a masochist may lay himself open to charges of assault, manslaughter or murder.

Voyeurism. — Voyeurism, or scoptophilia, is the reverse of exhibitionism (see below), just as masochism is the reverse of sadism. Thus it is often called scoptophilio-exhibitionism. It is the obtaining of pleasure by watching other people undress or by watching sexual intercourse. Voyeurs who are not satisfied by vaudeville acts such as strip tease may go to immense trouble to spy on other people and have been known to fall from buildings and trains in doing so.

Voyeurism appears to be derived from the infantile desire to look. Young monkeys. for instance, are absorbed by the sight of their mother's genitals, and children are intensely curious about sexual matters. Psychoanalysts believe that the voyeur has repressed experiences of the primal scene (*i.e.*, observation of parental intercourse) and is trying to overcome a fear of castration. In normal men the wish to look is a sign of sexual attraction and preliminary to further advances, but in voyeurism all the sexual pleasure comes from looking at nakedness or intercourse. Probably those who watch mating couples show considerable empathy, or imaginative involvement in the act. A. C. Kinsey and his associates pointed out that voyeurism and exhibitionism form an important part of preadolescent sex play. This suggests that, like all deviations, it stems from immaturity.

Voyeurs are called "Peeping Toms." from the legend of Godiva (*q.v.*) and are prosecuted for behaviour contrary to common law and, in England. to the Justices of the Peace act of 1361.

Exhibitionism. — Exhibitionism, or sexual exposure. is exposing the genitalia to obtain sexual pleasure. It usually occurs in males. In exhibitionism the mere showing of the genitals is not sufficient. some emotional reaction is sought from the person to whom exposure is made, viz., disgust or horror. Ejaculation may occur at or after exposure, or the patient may masturbate.

The psychoanalyst believes that exhibitionism is the denial of castration and that the shocked reaction of the onlooker proves to the exhibitionist that his own unconscious fears are unfounded. This explanation is not altogether satisfactory. Psychoanalysts also believe that the castration shock is greater in women than in man, and if this is so one would expect women to be more sexually exhibitionistic than men. Men with castration fears are not necessarily exhibitionistic. Biologically, exhibitionism is the seeking of love. It can be seen in the love dances of many animals, including apes, and in the sexual dances of primitive tribes. Clinically it is often seen, as N. K. Rickles suggested, in men who live in a female-dominated environment. Where a man is subservient to an assertive wife or mother he sometimes goes to some place where he exhibits himself as a means of proving his virility. This desire to assert his masculinity may be uncontrollable.

Exhibitionism (indecent exposure) is an offense under common law and under the Vagrancy act of 1924 and Town Police Clauses act of 1847.

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(C. A.)

SEXUAL SELECTION: see SELECTION: Sexual Selection.

SEYCHELLES, an archipelago in the Indian ocean, including islands and islets, between 4° and 10° S. latitude and 46° and 57" E. longitude. With the Amirante Isles, Cosmoledo group, Aldabra Islands and other islands they form the British colony of Seychelles. The outlying islands lie southwest of the Seychelles group and between that archipelago and Madagascar. The 92 islands under the Seychelles government have a total area of 156 sq.mi. There are in addition 40,000 to 50,000 sq.mi. of coral banks within the bounds of the colony.

The Seychelles lie, with two exceptions, toward the centre of a large submarine bank and are all within the 50-fathom line. Mahé, the largest island, is 600 mi. from Madagascar, 934 mi. from Mauritius and 970 mi. from Mombasa. The other chief islands form two principal groups: (1) Praslin, with La Digue, Félicité, East Sister, West Sister, Curieuse and Aride; (2) Silhouette and North Island. The most easterly island is Frigate, the most southerly Platte; on the northern edge of the reef are Bird and Denis islands.

Mahé Island, 16 mi. long and 4 mi. wide, has an area of 55 sq.mi. There are small areas of lowlands, chiefly at the mouths of the rivers, but most of the island is mountainous and in general the hills rise abruptly from the sea. The highest peaks are Morne Seychellois, 3.008 ft., and Trois Frères, 2,510 ft. The main ridge runs north and south and from the heights descend many torrents, the whole island being well watered. The capital and principal port, Victoria, is on the northeast coast and is approached by a deep channel through the coral reef which fringes the entire eastern side of the island. Of the small islands close to Mahé, the chief are St. Anne and Cerf, off the east, and Conception and Thérèse off the west coast.

Praslin Island is 8 mi. long and from 1 to 3 mi. wide, and its highest point is 1,260 ft.; La Digue covers 3.9 sq.mi., and its greatest height is 1,175 ft.; Silhouette, roughly circular, covers 8 sq mi and culminates in Mon Plaisir, 2,473 ft. Aldabra, the outlying island farthest from the main group, is 630 mi. from Mahé.

Geology.—Most of the islands are of granite (hornblende or hornblende-biotite variety), in places fringed by coral reefs; Silhouette and Long islands are of typical syenite, while there are dikes and sheets of a younger vogesite, dolerite, porphyrite suite. Bird and Denis islands are of coral limestones, while the basement rocks are represented by clay slates on Silhouette Island and hornstones on Stag's Island. The group is probably a detached and partially submerged portion of Gondwanaland. Inland cliffs indicate a recent uplift of about 200 ft.

Climate. — The climate is equable, and the temperature varies on the coast from about 68" to 88° F., falling at night in the higher regions to 60° or 55° F. The mean coast temperature exceeds 79° F. The southeast monsoon blows from May to October. which is the dry season, and the west-northwest monsoon from December to March During April and November the winds are variable. The average annual rainfall on the coast is 90 in.; it increases to about 120 in at a height of 600 ft., and at heights exceeding 2,000 ft. is about 150 in. The Seychelles lie outside the track of the hurricanes which occasionally devastate Réunion and Mauritius The public health is good.

Vegetation and Animal Life.—Both flora and fauna include species and genera peculiar to the Seychelles. Of these the best knoan is the *Lodoicea sechellarum,* a palm tree indigenous only in Praslin Island, but introduced into Curieuse—noted for its fruit, the so-called Maldive double coconut or *coco de mer*. Another tree found only in the islands is the capucin *(Northea sechellarum)*, ravaged badly by an introduced green beetle. Characteristic of the forests of the coastal belt are the mangrove and *Pandanus,* and. a little inland, the banyan *(Ficus), Pisonia* and *Hernandia.* The coconut is a characteristic feature of the coast. The forests of the granitic land have the characteristics of a tropical moist region, palms. shrubs, climbing and tree ferns growing luxuriantly, the trees on the mountain sides, such as the *Pandanus sechellarum,* sending down roots over the rocks and boulders from 70 to 100 ft. Of timber trees the bois gayac has disappeared, but bois de fer *(Stadtmannia sideroxylon)* and bois de natte *(Mnbn sechellarum)* still flourish on Silhouette Island. Besides cutting for building, the jungle was largely cleared for the planting of vanilla; a multitude of other tropical plants have been introduced. The most important of the trees introduced since 1900 are various kinds of rubber, including Para *(Hevea brasiliensis),* which grows well. *See* also *Agriculture and Industries,* below.

The indigenous fauna resembles that of Madagascar. The only varieties of mammals are the rat and bat. The dugong. which formerly frequented the waters of the islands, does so no longer. The reptiles include certain lizards and snakes; the crocodile, once common, has been exterminated. Land tortoises have also disappeared; a fresh-water tortoise *(Sternothaerus sinuatus)* is still found The giant tortoise. *Testudo elephantina,* is found only in the Xldabra Islands; and the adjacent seas contain many turtles. Three coecilians, three batrachians (including a mountain-frequenting frog) and three fresh-water crustaceans are also indigenous. and there are about 26 species of land shells. The islands are the home of a large number of birds, including terns, gannets and white egrets.

Dependencies.—The outlying islands forming part of the colony of Seychelles consist of several uidely scattered groups. The Amirante Isles are situated on a submarine bank west and southwest of the Seychelles, the nearest island being about 120 mi. from Mahé. The archipelago consists of a number of coral islets and atolls comprising the African Islands (4). the St. Joseph group (8), the Poivre Islands (9) and the Alphonse group *(3)*. Farther south and uithin 170 mi. of Madagascar is the Providence group (3) formed by the piling up of sand on a surface reef which is of crescent shape. The Farquhar group lies to the south of these. The Cosmoledo group, 12 in number, lies about 210 mi W. of Providence Island, while 70 mi. farther west are the Aldabra Islands *(q.v.)*. Assumption Island lies to the south of the Aldabra. The chief island in the Cosmoledo group is 9 mi. long by 6 mi. broad. South of this group of islands lies Astove. Coetivy (transferred from Mauritius to the Seychelles in 1908) lies about 100 mi. S.S.E. of Platte. The majority of the outlying islands are extremely fertile, coconut trees and maize growing luxuriantly. Several of the islands contain valuable deposits of guano and phosphate of lime, and their waters are frequented by edible and shell turtle. Like the Amirantes, all the other islands named are of coral formation.

History and Government.—The Seychelles are marked on Portuguese charts dated 1502. The first recorded visit to the islands was made in 1609 by an English ship. The second recorded visit, in 1742, was made by Capt. Lazare Picault, who, returning in 1743, formally annexed the islands to France. Picault, uho acted as agent of Mahé de La Bourdonnais, governor of Mauritius, named the principal island Mahé and the group Îles de La Bourdonnais, a style changed in 1756, when the islands were renamed after Moreau de Séchelles, at that time *contrôleur général des finances* under Louis XV. The first permanent settlement was made in 1768. Soon afterward Pierre Poivre. intendant of fle de France, seeing the freedom of the Seychelles archipelago from hurricanes, set up spice plantations there. with the object of wresting from the Dutch the monopoly of the spice trade they then enjoyed. The existence of these plantations was kept secret, and it was with that object that they were destroyed by fire by the French on the appearance in the harbour in 1780 of a vessel flying the British flag. The ship. however, proved to be a French slaver which had hoisted the Union Jack fearing to find the British in possession. The islands were occupied in 1810 by the British. to whom they were ceded by the treaty of Paris in 1814. J. B. Quéau de Quincy (1748–1827), governor under the monarchy, the republic and the empire. was appointed agent-civil by the British. He governed the islands for 38 years until his death in 1827. Mauritius and Seychelles were administered as a single colony until 1872 when a board of civil commissioners was appointed and the finances of Seychelles were separated from those of Mauritius. In 1889 the post of administrator was created with a nominated executive and legislative council. In 1897 the administrator was given full powers as governor and in 1903 Seychelles was constituted a separate colony.

The executive council consists of the governor as president with three ex officio and three unofficial members, and the legislative council has six ex officio, two nominated unofficial and four elected members. The electorate comprises about 10% of the population. The civil law is based on the French *code civil* and *code de commerce* as modified by local enactment. The only bank is the government savings bank. In order to facilitate trade, the government treasury purchases and sells drafts and undertakes the collection of documentary bills for London and foreign banks. The monetary unit is the Indian silver rupee of 100 cents (Seychelles) ; currency notes are issued by the government of Seychelles.

Population.—The Seychelles were uninhabited when first visited by Europeans and the islands were colonized by Mauritian and Bourbon Creoles. The first planters introduced slaves from Mauritius, and the African element was increased by the introduction of freed slaves from east Africa. There has also been an immigration of Chinese and, in larger numbers, of Indians (mainly from the Malabar coast). The bulk of the retail trade is in the hands of the Indians and Chinese. A Creole patois, based on French but with a large admixture of Indian. Bantu and English words, is in general use. The Seychellois are excellent sailors. The population was 41,425 in 1960. Of the 92 islands, 33 are inhabited, but 81% of the total population lives on Mahé. Nearly 90% of the population are Roman Catholics. Malarial fever is unknown in the Seychelles, but hookworm is common. There is a leper settlement on Curieuse Island. The only town of any size is the capital, Victoria, on Mahé, picturesquely situated at the head of an excellent harbour 3 mi. wide. Many of the houses are built of massive coral, *Porites gamardi,* hewn into square building blocks, which at a distance glisten like white marble. About one-third of the total population lives in Victoria, the rest being scattered in hamlets which lie along the seashore or in estates on the hills. Education is free but not compulsory.

Communications.—Principal steamer connection is with Mombasa and Bombay. There are no air services. Seychelles is an important cable station. A radio telephone provides communication between Praslin and Mahé and, in conjunction with the Cable and Wireless company, a regular broadcasting service is maintained, which also serves as a means of communication with outlying islands. There are about 75 mi. of motor roads on Mahé.

Agriculture and Industries.—Unproductive lands which cover about one-third of the acreage of the colony comprise outcrops of granite following erosion, and coral reefs still in their position of growth. More than 3,500 ac. of land are under forest, about one-fourth being commercial timber. About a third of the adult population is engaged in agriculture. Copra is the most important export and essential oils, of which cinnamon leaf oil is the most important, are next in value. Breadfruit is the staple food and the tree flourishes on all the granitic islands. Quantities of cassava, yams, sweet potatoes and plantains are also grown. Salted fish is exported, also tortoise shell, green turtle shell and tripangs. There are no exploitable minerals in the colony except phosphatic guano, and no manufactures. There is a small and flourishing production of straw mats, hats and baskets. tortoise-shell cigarette cases, brooches and toilet sets for sale to tourists.

The chief imports are cotton goods! kerosene and petrol, rice, maize, sugar and flour. Imports come principally from the Cnited Kingdom and India. Two-thirds of the exports go to the Cnited Kingdom and most of the remainder to India and the United States.

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SEYDLITZ, FRIEDRICH WILHELM, FREIHERR VOK (1721–1773), Prussian soldier, one of the greatest cavalry generals of history, was born on Feb. 3. 1721, at Kalkar. in the duchy of Cleve. At the age of 13 he went as a page to the court of the margrave of Schwedt, who had been his father's colonel. There he acquired a superb mastery of horsemanship, and many stories are told of his feats, the best known of which was his riding between the sails of a windmill in full swing. In 1740 he was commissioned a cornet in the margrave's regiment of Prussian cuirassiers. He served through the first and second Silesian Wars. and in 1753 became lieutenant colonel of the 8th cuirassiers. Under his hands this regiment soon became a pattern to the rest of the army. The Seven Years' War gave Seydlitz his opportunity In 1757, regardless of the custom of keeping back the heavy cavalry in reserve, he took his regiment to join the advanced guard; at Prague he nearly lost his life in attempting to ride through a marshy pool, and at Kolin. at the head of a cavalry brigade, he distinguished himself in checking the Austrian pursuit by a brilliant charge. Two days later the king made him major general and gave him the order pour le *mérite*. In reply to Zieten's congratulations he said: "It was high time, Excellency, if they wanted more work out of me. 1 am already thirty-six " Four times in the dismal neeks that followed the disaster of Kolin. Seydlitz asserted his energy and spirit in cavalry encounters, and on the morning of Rossbach, Frederick, superseding two senior generals. placed Seydlitz in command of the whole of his cavalry. The result of the battle was the complete rout and disorganization of the enemy, and in achieving that result only seven battalions of Frederick's army had fired a shot. The rest was the work of Seydlitz and his 38 squadrons. The same night the king gave him the order of the black eagle, and promoted him lieutenant general. Seydlitz was wounded, but rejoined the king in 1758, and at the battle of Zorndorf his cavalry again won the victory. At Hochkirch with 108 squadrons he covered the Prussian retreat, and in the great disaster of Kunersdorf he was severely mounded in a hopeless attempt to storm a hill held by the Russians. During his convalescence he married Countess Albertine Hacke. In 1761 he reappeared at the front. He now commanded a wing of Prince Henry's army, composed of troops of all arms. and many doubts were expressed as to his fitness for this command, as his service had hitherto been with the cavalry exclusively. But he answered his critics by his conduct at the battle of Freiburg (Oct. 29. 1762), in which, leading his infantry and his cavalry in turn. he decided the day.

After the peace of Hubertusburg he was made inspector general of the cavalry in Silesia, where 11 regiments were permanently stationed and whither Frederick sent all his most promising officers to be trained by him. In 1767 he was made a general of cavalry. But his later years were clouded by domestic unhappiness. His wife was unfaithful to him. and his two daughters, each several times married. were both divorced, the elder once and the younger twice. His formerly close friendship with the king was brought to an end by some misunderstanding, and it was only a few weeks before his death that they met again. Seydlitz died at Ohlau on Aug. 27, 1773.

SEYMOUR or ST. MAUR, the name of an English family in which several titles of nobility have from time to time been created. and of which the duke of Somerset is the head. See HERTFORD. EARLS AKD MARQUESSES OF; and SOMERSET: EARLS AND DUKES OF.

SEYMOUR, HORATIO (1810–1886), U.S. statesman, was born in Pompey, Onondaga county, N.Y., on May 31. 1810. He studied at Geneva academy (afterward Hobart college) and at a military school in Middletown, Conn., and was admitted to the bar in 1832. He was military secretary to Gov. W. L. Marcy in 1833–39, was a member of the New York assembly in 1842, 1844 and 1845. and was speaker in 1845, mayor of Utica in 1843, and in 1852 was elected governor of New York state. He vetoed in 1854 a bill prohibiting the sale of intoxicating liquors, which was declared unconstitutional almost immediately after its re-enactment in 1855. and in consequence he was defeated in 1854 for re-election as governor. Seymour was a conservative on national issues, and supported the administrations of Pierce and Buchanan; he advocated compromise to avoid secession in 1860–61; but when war started he supported the Union. In 1863–65 he was again governor of New York state.

His opposition to President Lincoln's policy was mainly in respect to emancipation. military arrests and conscription. Although he responded immediately to the call for militia in June, he thought the Conscription act unnecessary and unconstitutional and urged the president to postpone the draft until its legality could be tested. During the draft riots in July he proclaimed the city and county of New York in a state of insurrection. but in a speech to the rioters adopted a tone of conciliation—a political error which injured his career. He was defeated as Democratic candidate for governor in 1864. In 1868 he was nominated presidential candidate by the Democratic national convention, but carried only eight states (including New York, New Jersey and Oregon), and received only 80 electoral votes to 214 for Grant. He died on Feb. 12, 1886, in Utica.

The Public Record of Horatio Seymour (1868) includes his speeches and official papers between 1856 and 1868.

SEYMOUR OF SUDELEY, THOMAS SEYMOUR, BARON (*c.* 1508–1549), lord high admiral of England. was fourth son of Sir John Seymour of Wolf hall. Wiltshire. and younger brother of the protector Edward Seymour. 1st duke of Somerset. His sister Jane Seymour became the third wife of Henry VIII in 1536 and another sister, Elizabeth, married Thomas Cromwell's son. Seymour was employed in the royal household and on diplomatic missions abroad. For a short time in 1544 he commanded the English army in the Netherlands. In the same year he received the post of master of the ordnance for life. becoming admiral of the fleet a few months later. in which capacity he was charged with guarding the channel against French invasion. In 1547 he was created Baron Seymour of Sudeley and appointed lord high admiral. From this time forward he mas mainly occupied in intrigue against his brother the protector; and he aimed at procuring for himseli the position of guardian of the young king, Edward VI. The lord high admiral tried to secure the princess (afterward queen) Elizabeth in marriage; and when this project was frustrated he secretly married the late king's widow, Catherine Parr (1547). He ingratiated himself with Edward, and proposed a marriage between the king and Lady Jane Grey. He entered into relations with pirates on the western coasts, whom it was his duty as lord high admiral to suppress, with a view to securing their support; and when the protector invaded Scotland in the summer of 1547 Seymour fomented opposition to his authority in his absence. On the death of his wife in September of the next year he made renewed attempts to marry the princess Elizabeth. Somerset strove ineffectually to save his brother from ruin, and in Jan. 1549 Seymour was arrested and sent to the Tower. He was convicted of treason, and executed on March 20, 1549.

See also SOMERSET, EDWARD SEYMOUR, 1ST DUKE OF.

See Sir John Maclean, *Life of Sir Thomas Seymour* (London, 1869); A. F. Pollard in *Dictionary oj National Biography*.

SFAX, a city of Tunisia, 78 mi. due south of Sousse, on the Gulf of Gabès (Syrtis Minor) opposite the Kerkenna Islands, in

34° 43' N., 10° 46' E. It consists of a European quarter, with streets regularly laid out and fine houses, and the Arab town, with its kasbah or citadel, and tower-flanked walls pierced by three gates. Many of the private houses, mosques and *zawias* are good specimens of native art of the 17th and 18th centuries. Sfax is the market for the phosphates of the Gafsa region. with which it is connected by a railway; other railways and good roads link it also with Sousse and Tunis on the one hand and with Gabès on the other. Olive oil is manufactured, and the fisheries are important, notably those of sponges and of octopuses. The prosperity of the town is largely due to the export trade in phosphates. esparto grass. oil, almonds, pistachio nuts, sponges, wool, etc. There is. in the Gulf of Gabès, a rise and fall of 5 ft. at spring tides, which is rare in the Mediterranean. A harbour. to which a channel 1.8 mi. long and of varying width gives access, was built in 1895–97, and has since been deepened at different times. The harbour, which was an important axis base from Nov. 1942, was almost entirely destroyed by Allied air raids. It was captured April 10, 1943, by the British 8th army after covering 75 mi. from Wadi Akarit in four days. The 1956 municipal population was 65,635, of whom 52,707 were Moslems, 3,168 Jews and 9,760 Europeans (8,168 French and 1,1j8 Italians). About 50,000 Moslems live in the outskirts and in the gardens in the neighbourhood of Sfax. Sfax is on the site of a Roman settlement called Taparura, of which few traces remain. The Sicilians under Roger the Norman took it in the 12th century, and in the 16th century the Spaniards occupied it for a brief period. The bombardment of Sfax in 1881 was one of the principal events of the French conquest of Tunisia.

SFORZA, the name of a famous Italian dynasty, descended from the Attendoli of Cotignola (Romagna), a wealthy and war-like family.

MUZIO ATTENDOLO (1369–1424), nicknamed "Sforza" for his strength, became a distinguished mercenary captain in the wars of Italy. Like other *condottieri,* he served many masters and aspired to the possession of a patrimony if not a principality. He was most prominent in the wars of the Neapolitan succession at the time of Joanna II (*q.v.*) in which finally he lost his life.

Muzio was certainly successful in acquiring lands and titles, in Romagna and in Naples! but it was reserved to two of his sons, FRANCESCO (1401–66) and ALESSANDRO (1409–73), likewise *condottieri,* to achieve the status of princes. In 1445 Alessandro acquired possession of Pesaro, in the papal states, where he was subsequently made vicar by the pope; his descendants retained the city until 1512, when Pope Julius II expelled them. Francesco had to wait longer and strive harder before winning himself a state. His first attempt, directed likewise against the states of the church, where for 14 years (1433–47) he held the March of Ancona, ended in failure and dispossession; and success, when it came, lay in the north of Italy in the duchy of Milan. which had long been one of the greatest Italian states. After his father's death, Francesco had. entered the service of the last Visconti duke, Filippo Maria, a morose, suspicious and unpredictable prince, and for more than 20 years had fought now with him, now against him. During the periods of uneasy harmony Franceaco had succeeded in getting himself betrothed (1433) and then married (1441) to Filippo Maria's illegitimate daughter. Bianca Maria, receiving as dowry Pontremoli and Cremona; and he had attained also some promise of succession in the duchy itself. But Filippo Maria did not nominate Francesco as his successor when he died (1447), and it was primarily by right of conquest that Francesco triumphantly entered Milan in March 1450, overthrowing the unstable republic that had been proclaimed at Filippo Maria's death. For 16 years Francesco ruled as duke in Milan, though without the formal recognition of the emperor Frederick III, whose price (in money) for a "legitimate" title was too high. His government, which in the March of Ancona had been burdensome because of the expense of perpetual war, seems in Milan to have been enlightened though despotic. He himself was frugal, retaining the manners of a soldier, but his court conformed to the lavish fashion of the time and his children were raised under leading men of letters in the humanist education then coming into fashion.

Francesco left several sons, among them ASCANIO (1455–1505), who became a cardinal, worldly, magnificent and lettered, and Galeazzo Maria and Ludovico il Moro, who in turn ruled the duchy.

GALEAZZO MARIA (1444–76), who married Bona of Savoy, sister to Queen Charlotte of France, in 1468 and who desired the emperor to raise his duchy to a kingdom, was in many ways a capable ruler (for example, he introduced the cultivation of rice into the territory); he was also an active patron of letters and the arts. But the character traditionally given him was very different from his father's, showing him vain, extravagant, dissolute and often cruel. He was murdered on Dec. 26, 1476, by three citizens of Milan, who hoped thereby to free their city from despotism; but no popular rising followed to endorse their deed, and the duke was rather mourned in his dominions, which in the past had several times stirred against his harsh taxation. Even so the murder did prepare the way for the end of Sforza rule by raising the problems and divisions of a regency. Galeazzo Maria's son GIAN GALEAZZO (1469–94), who in 1476 was only seven years old, never proved himself strong in mind or body, and after a period of conspiracy and violence, effective power passed (1479–80) to his uncle, LUDOVICO IL MORO (1451–1508), whose main concern thereafter was to retain control of the duchy. Ludovico il Moro, who in 1491 married Beatrice d'Este, a brilliant personality and no less ambitious than himself, is both celebrated and ill-famed in Italian history: celebrated for his court and for his patronage of such men as Leonardo da Vinci; ill-famed, though perhaps unjustly, for having encouraged Charles VIII of France to invade Italy and so begin a series of devastating wars. This was the effect of his design to rule perpetually in Milan and to displace Gian Galeazzo for good; in 1489 Gian Galeazzo had married Isabella of Aragon, granddaughter of Ferdinand I of Naples, and it was to conquer Naples that Charles VIII entered Italy, with Ludovico's reluctant connivance. In Sept. 1494 Ludovico was secretly invested with the duchy of Milan by the emperor Maximilian I, to whom he married his niece Bianca; and in October, after the timely death of Gian Galeazzo, he was chosen duke by the Milanese. His triumph, however, lasted only until 1499, when he was driven from power by Louis XII of France. Reinstated for a short time by the Swiss, he was eventually delivered by them to the French (April 1500) and died a prisoner in the castle of Loches.

The two sons of Ludovico, MASSIMILIANO (1493–1530) and FRANCESCO MARIA (1495–1535), took refuge in Germany; the former was restored to Milan by the Swiss in 1512 but, after the overwhelming defeat of his allies at Marignano (1515), surrendered his rights to Francis I and died in Paris; the latter was put in possession of Milan after the defeat of the French at La Bicocca in 1522. His death (Oct. 24, 1535) marked the extinction of the ducal male line of the Sforza. The duchy went to the emperor Charles V.

The dukes Sforza-Cesarini (Rome) are descended from Bosio, a younger brother of Francesco, the first duke of Milan; the counts Sforza (Lunigiana) from Sforza Secondo, one of Francesco's younger sons. Gian Galeazzo's daughter Bona married Sigismund I of Poland.

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(P. J. J.)

SFORZA, COUNT CARLO (1873–1952), Italian statesman. born at Montignoso di Lunigiana on Sept. 25, 1873. Having entered the diplomatic service in 1896, Sforza mas minister to China (1911–15) and to Serbia (1916–18) and high commissioner in Turkey (1918) before becoming a senator and undersecretary of state for foreign affairs (1919) and then foreign minister (1920–21); he negotiated the treaty of Rapallo with Yugoslavia (Nov. 1920). Appointed ambassador to France in Feb. 1922, he resigned two months later, refusing to serve the Fascist government.

He then became a leader of democratic opposition in Italy. In voluntary exile after 1928, he went to the United States in 1940, still making anti-Fascist propaganda. He was named leader of the Free Italian movement at the Montevideo conference (Aug. 1942), returned to Italy (1943), served as minister without portfolio under Pietro Badoglio and Ivanoe Bonomi (1944), became president of the consultative assembly (Sept. 1945–May 1946) and was elected to the constituent assembly as a Republican (Sept. 1946). Appointed foreign minister under Alcide de Gasperi (Feb. 1947), he was largely responsible for Italy's ratification of the peace treaty and adherence to the North Atlantic treaty but resigned because of ill-health in July 1951. He died in Rome on Sept. 4, 1952. English translations of his works include Makers of *Modern Europe* (London. 1930), *Fifty Years* of *War* and Diplomacy in *the* Balkans (New York, 1940), Contemporary Italy (New York, 1944) and Italy and the Italians (London, 1918).

SGAMBATI, GIOVANNI (1841–1914), Italian pianist, conductor and composer. was born in Rome on May 28, 1841. After studying music in Naples, he settled in 1860 in Rome. where he became famous for his recitals of works by German composers, who had previously been neglected in Italy. In 1866 he founded an orchestra and conducted the first Italian performance of such works as Beethoven's *Eroica* symphony and Emperor concerto and Liszt's *Dante* symphony. Meanwhile his own compositions began to attract attention and when Wagner visited Rome in 1876 he was so impressed with two piano quintets and some songs that he helped to get them published. Of Sgambati's other works, the most important are the Symphony in D (1881), the Quartet for Strings in D flat (1883) and *Messa* da *Requiem* (1896). He is best remembered, however, as a teacher. He died on Dec. 14, 1914.

SHACKLETON, SIR ERNEST HENRY (1874–1922), British explorer who led two Antarctic expeditions, was born in Kilkee, Ire., on Feb. 15, 1874. Educated at Dulwich college, he entered the mercantile marine service. He joined Capt. R. F. Scott's British National Antarctic ("Discovery") expedition (1901–04) as third lieutenant and took part, with Scott and Edward Wilson. in the sledge journey over the Ross Ice shelf when latitude 82" 16' 33" S. was reached. His health suffered and he was invalided out on the supply ship "Morning" in March 1903. In Jan. 1908 he returned to Antarctica as leader of the British Antarctic ("Nimrod") expedition (1907–09). The expedition, prevented by ice from reaching the intended base site in Edward VII peninsula, wintered on Ross Island, McMurdo sound. A sledging party, led by Shackleton, reached within 97 mi. of the south pole. and another! under T. W. Edgeworth David! reached the area of the south magnetic pole. Victoria Land plateau was claimed for the British crown. On his return Shackleton was knighted and was made a companion of the royal Victorian order. In 'larch 1914 the British Imperial Trans-Antarctic expedition (1914–16) left England under his leadership. He planned to cross Antarctica from a base on the Weddell sea to McMurdo sound. via the south pole, but the expedition ship "Endurance" was beset off Caird coast and drifted for 10 months before being crushed in the pack ice. The expedition then drifted on ice floes for a further five months and finally escaped in boats to Elephant Island in the South Shetland Islands. Shackleton and five others sailed 800 mi. to South Georgia in a whale boat, and then made the first crossing of the island, to seek aid. We led four relief expeditions before succeeding in rescuing his men from Elephant Island. A supporting party, the Ross Sea party led by A. E. Mackintosh, sailed in "Aurora" and laid depots as far as latitude 83° 30' S. for the use of the Trans-Antarctic party; three of this party died on the return journey. Shackleton died on Jan. 5. 1922, at Grytviken, South Georgia, at the outset of the Shackleton-Rowett Antarctic expedition in "Quest"; his exertions in raising funds to finance his expeditions, and the immense strain of the expeditions themselves, wore out his strength. He was ambitious both for himself and for the honour of his country, but his outstanding characteristic was leadership. Courage, optimism and endurance, coloured by a streak of romanticism, earned him the trust and devotion of all his men under the most difficult circumstances.

Shackleton's publications are *The* Heart of the Antarctic (1909), and South (1919).

See H. R. Mill, *The* ***Life*** *of* ***Sir*** *Ernest Shackleton* (1923); Margery and James Fisher, *Shackleton* (1957). (L. M. Fs.)

SHAD, common name of fishes of the genus Alosa, belonging to the herring family, with the upper jaw notched in front. found in the Mediterranean and on both sides of the North Atlantic. They enter rivers to breed, generally from April to June. and the fry live for a year or two in fresh water. The Allis shad. A. alosa, of the coasts of Europe has numerous long, slender gill rakers; it attains a length of 30 in. and a weight of 8 lb. The twaite shad (A. *finta)* is smaller, and has fewer and shorter gill rakers; the Mediterranean form *(A. f.* nilotica) is distinct, and the species also includes some well-marked forms permanently resident in fresh water, one from Killarney, two from lakes in northern Italy. The American shad (A. *sapidissima)* is a valued food fish. and has been successfully introduced on the Pacific coast. The shad of the Black and Caspian seas (*Caspialosa*) have teeth on the vomer, like the herring. Another important related genus of anadromous fishes is Hilsa, with six species, ranging from east Africa to China.

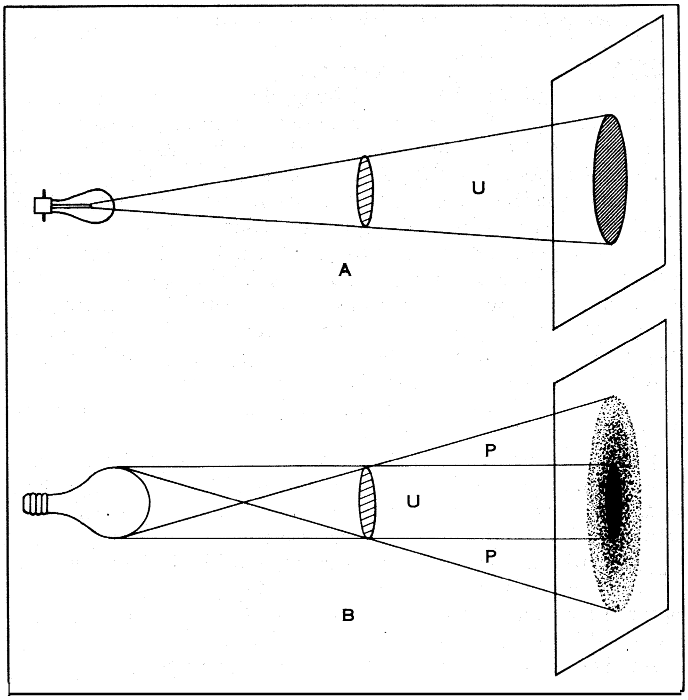
SHADDOCK, or pummelo (Citrus grandis), a tree. 20 to 40 ft. in height, allied to the orange and the lemon, presumably native to the Malay and Polynesian islands. The leaves are like those of the orange, but have broadly winged petioles and are downy on the undersurface, as are also the young shoots. The flowers are large and white, and are succeeded by very large subglobose or subpyriform fruits: closely resembling grapefruit, lemon yellow in colour, and with a pungent, subacid but agreeable flavour. The pulp segments are either pallid or red, and shell out easily. The fruit is highly prized in the orient. The name "shaddock" is asserted to be that of a captain who introduced the tree to the West Indies. The shaddock is considered the parent type from which the grapefruit probably originated. See GRAPEFRUIT.
(L. D. B.)

SHADOW, a term usually meaning that region of an illuminated surface from which the oncoming light rays are shielded by an opaque object. More generally, it can refer to any local changes in the intensity of radiation caused by placing some form of matter in the path of the rays. There are many interesting examples of the latter type, some of which will be mentioned below. First, however, let us consider the characteristics of the simpler kinds of shadow.

If the source of light is small as, for example, the filament of an automobile headlight lamp illustrated in part (A) of the figure, the rays effectively emanate from a point and the shadow has a sharp boundary between light and darkness. Its shape evidently will he that of the object producing it. If, on the other hand, the source has an appreciable size, as in part (B) of the figure, there is a region, U, of the total darkness called the umbra and also another, P. called the penumbra, in which there is a gradual transition from dark to light in going from the inner boundary to the outer. When one looks toward the source from the region of the penumbra, he sees only part of it, the rest being covered by the obstacle.

Pronounced shadows are not formed if there is more than one light source, except when one of these is much brighter than any other, as in sunlight. Shadows cast by the sun are not sharply bounded because there is always a perceptible penumbra. This is relatively unimportant for shadows cast at small distances: it is possible to read a sundial with fair accuracy. The umbra and penumbra assume vast proportions. however, for the shadows of the moon and of the earth. During an eclipse of the sun, the moon's shadow falls on the earth, and the penumbra covers the wide area n-here the eclipse is partial. An eclipse of the moon. on the other hand, occurs when the moon moves into the earth's shadow. The shadow of the moon on its own surface may render a good part of its sphere invisible, so that it appears. to us as a crescent. Another type of shadow occurs when sunlight penetrates to the ground through very small spaces between the leaves of a tree, or to the wall of a room through a hole in a window shade. One observes small circular or elliptical patches of light. which are actual images of the sun's disk. They are caused by the fact that from each part of this disk essentially only one ray can pass through the hole to the shadow. The faithfulness of this image becomes apparent during a partial eclipse of the sun, when the patches of light become crescent shaped.

The nature of a shadow may be modified when the rays are deflected from their straight line paths by the process called refraction. Thus, when the moon lies in the umbra of the earth's shadow



PERSPECTIVE DRAWINGS OF THE SHADOW CAST BY AN OPAQUE DISK USING (A) A SMALL LIGHT SOURCE. AND (B) AN EXTENDED SOURCE SUCH AS A FROSTED LIGHT BULB

during a total lunar eclipse, it is still visible by a faint copper-coloured light. This is light which has been bent inward by refraction as it traverses the mantle of air surrounding the earth. The light has a hue similar to that of a sunset because in both cases the light traverses a great thickness of air. Refraction by the atmosphere also has the effect of delaying the time of sunset, that is, the time when the shadowing effect of the horizon is complete. As a result of the downward deflection of its rays, the sun appears to be higher than it actually is by an amount almost equal to its own diameter. Thus, if it were not for refraction, the sun would have completely disappeared at about the time when we see it first touch the horizon.

It is possible for shadows to form even without the presence of any object to screen off the rays. A transparent substance may, by reflection or refraction, concentrate the light in certain places and deflect it away from others. The commonest example occurs when sunlight is reflected onto the ceiling by a liquid whose surface is disturbed. The shifting patterns of light and shade are caused by the irregularities in the surface contour acting like curved mirrors to focus the light to a greater or less degree. Similar effects caused by refraction may be seen on the bottom of a clear pond when the sun shines through the waves. The air itself, when it contains turbulent regions and irregularities of temperature, can act in the same way. Here the deflections of the rays are so slight that the effects are only apparent when the source of light is a bright one of very small dimensions. For example. at the instant before a solar eclipse becomes total, darker areas called shadow bands are observed rushing across the landscape, an effect which is attributed to refractive effects of the upper atmosphere. On a laboratory scale. the same principle has been put to highly practical use in studying the flow of air around objects in wind tunnels by what is known as the Schlieren method.

One occasionally speaks of shadows formed by radiations other than light. X-ray photographs are shadowgrams caused by absorption of the rays coming from a tiny spot in the X-ray tube *(see* X-RAYS). Sounds, especially those of high pitch, may be almost completely screened off by large obstacles. Even when the source has small dimensions, the resultant acoustical shadows do not have sharp boundaries. The reason lies in an effect called diffraction, exhibited by all types of waves. It becomes more pronounced for longer waves, but exists even for the minute waves of light, where the crest-to-crest distance is only about $\frac{1}{20,000}$ cm.

If we examine the edge of an apparently sharp shadow with a magnifier, the transition from dark to light is found not to be abrupt, and bordering the edge there are several faint bands. These "diffraction fringes" are completely explained as a wave phenomenon, as are some other curious effects such as the existence of a minute bright spot at the centre of the shadow of a circular disk.

A spectacular observation of diffraction fringes has been made when the edge of the moon passes in front of a star. The fringes sweep across the observing telescope at a rate corresponding to the frequency of audible sound, and may be recorded photoelectrically. From the clearness of these records, it is possible to deduce the diameter of the star's disk, provided it is greater than the apparent size of a one-cent piece at a distance of 750 km.

See also ECLIPSE; LIGHT: *Diffraction; Refraction and Double Refraction.*

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SHADOW PLAY or SHADOW SHOW is drama performed by flat, articulated puppets on a translucent paper or cloth screen illuminated from behind.

Shadow plays originated in the Orient. In India, subjects were drawn from the Hindu national epics *Mahabharata* and *Ramayana (see* SANSKRIT LANGUAGE AND LITERATURE). These passed to Java where they developed into a popular theatre which performed for all ceremonial occasions. Themes from Javanese legendary history and new ones introduced in the 15th century when Java became Moslem were also used. The figures, made-from buffalo hide. were highly ,stylized, perforated and painted. The narrator *(dalang)* operated the puppets (usually by thin bamboo rods). spoke their lines and directed the orchestra. Bali received the shadow play from Java, gave the figures a characteristic stylization, and preserved the Indian themes. In Siam similar stories were presented, and the shadow theatre was also found in Malaya, Burma and Cambodia.

The shadow play in China, for which a legendary origin in the Han dynasty is claimed, became a favourite entertainment for court ladies. The figures were made from thin donkey skin, dyed to cast brilliant colours on the screen.

Shadow plays spread westward by way of Persia to Turkey. where the witty and vulgar characters Karagöz and his companion Hadjivad became the heroes of a popular theatre. The puppets were made of camel hide. perforated and coloured to present types such as the opium addict and the idiot. as well as regional characters including the Persian, the Albanian and the Jew. These plays became popular in Greece. where such showmen as Xntonios Mollas gave them a Greek interpretation. Shadow plays were also found in various forms in the Moslem countries of north Africa.

In the 17th century the shadow theatre was known in Italy; from there it spread to other western European countries. The French called them *ombres chinoises,* although they were black silhouettes, instead of coloured like those of the Chinese. Dominique Séraphin opened a shadow show in Versailles in 1774, later moved it to the Palais Royal in Paris. Until 1859 his descendants presented especially written plays. such as *The Broken Bridge.* Sophisticated plays were produced by a group of artists. musicians and writers who regularly met at the Chat Noir cabaret in Montmartre. Paris. Other cabarets imitated them: and shows were given until 1923.

Shadows were popular in America during the 18th century, declined toward its end and were revived around 1850. At the Chicago world's fair in 1893. Léon-Charles Marot presented the *Théâtre des Ombres Parisiennes,* similar to the performances of the Chat Noir. Greek emigrants brought the Karagoz plays to the U.S. where they were seen in Chicago and Detroit coffeehouses.

In modern times Pauline Benton produced shows in the U.S. with authentic Chinese shadows. After World War I, Lotte Reiniger developed in Germany a number of films in stop motion, using black silhouettes against backgrounds of varying tones of gray. Although showmen in Europe and the U.S. occasionally used them, shadow plays were less popular in mid-20th century than in the past. *See* also PUPPETS AND MARIONETTES.

(M. B. McP.)

SHADWELL, THOMAS (c. 1642–1692), English playwright and miscellaneous writer, was born about 1642, at Santon hall, Norfolk, according to his son's account. He was educated at Bury St. Edmund's school and at Caius college, Cambridge, where he was entered in 1656. He then joined the Middle Temple. Shadwell's best plays are *Epsom Wells* (1672), for which Sir Charles Sedley wrote a prologue, and the *Squire of Alsatia* (1688). For 14 years from the production of his first comedy to his memorable encounter with Dryden, Shadwell produced a play nearly every year. These productions display a genuine hatred of shams and a rough but honest moral purpose. They are disfigured by indecencies, but present a vivid picture of contemporary manners.

Shadwell is chiefly remembered—rather unjustly—as the unfortunate MacFlecknoe of Dryden's satire, the "last great prophet of tautology," and the literary son and heir of Richard Flecknoe:

> The rest to some faint meaning make pretence,
> But Shadwell never deviates into sense.

Dryden had furnished Shadwell with a prologue to his *True Widow* (1679), and in spite of momentary differences, the two had been apparently on friendly terms. But when Dryden joined the court party and produced *Absalom and Achitophel* and *The Medall,* Shadwell became the champion of the true-blue Protestants and made a scurrilous attack on the poet in *The Medal of John Bayes: a Satire Against Folly and Knavery* (1682). Dryden immediately retorted in *MacFlecknoe, or a Satire on the True Blue Protestant Poet, T.S.* (1682), in which Shadwell's personalities were returned with interest. A month later he contributed to Nahum Tate's continuation of *Absalom and Achitophel* satirical portraits of Elkanah Settle as Doeg and of Shadwell as Og. In 1687 Shadwell attempted to answer these attacks in a version of the tenth satire of Juvenal. At the Whig triumph in 1688 he superseded his enemy as poet laureate and historiographer royal. He died at Chelsea on Nov. 19, 1692.

SHAFI'I, AL- (ABU ABDALLAH MOHAMMED IBN IDRIS AL-SHAFI'I) (767–820), one of the greatest jurists of Islam and the founder of the Shafi'i school of canon law, was born in A.H. 150 (A.D. 767) at Gaza or Ascalon, and was brought up by his mother in poor circumstances at Mecca. There, and especially in intercourse with the desert tribe of Hudhail, he gained a knowledge of classical Arabic and old Arabian poetry for which he was afterward famous. About 170 he went to Medina and studied canon law under Malik ibn Anas.

After the death of Malik in A.H. 179 legend takes al-Shafi'i to Yemen, where he is involved in an 'Alid conspiracy: carried prisoner to Baghdad, but pardoned by Harun al-Rashid. He was certainly pursuing his studies, and he seems to have gone to Baghdad in some such way as this and then to have studied under Hanafi teachers. He had not yet formulated his own system. After a journey to Egypt, however, he is reported in Baghdad again, as a teacher, between A.H. 195 and 198. There he had great success and turned the tide against the Hanafi school. In 198 he went to Egypt in the train of a new governor, and this time was received as the leading orthodox authority in law of his time. There he developed and somewhat changed the details of his system, and died in A.H. 204 (A.D. 820). He was buried to the southeast of what is now Cairo, and a great dome (erected c. A.D. 1211–12) is conspicuous over his tomb.

The "classical" theory of Islamic law, by which is meant the view that the law is based upon four sources (Koran, *sunna, ijma, qiyas*), was, according to Joseph Schacht in his *Origins of Muhammadan Jurisprudence* (1950), the creation of Shafi'i. The classical theory does not fully explain the facts as unearthed by modern research. Whether the opinion of Schacht, in its full import, is correct has yet to be proved; but his researches are worthy of the most serious consideration, and give an insight into the system developed by a master jurist. Imam Shafi'i was the founder of one of the "four" schools of Sunnite law, the others being Hanafi, Maliki and Hanbali. *See* also ISLAMIC LAW.

See *Shorter Encyclopaedia of Islam,* pp. 512–515 (1953).

(A. A.-A. F.)

SHAFT (IN ARCHITECTURE): *see* ORDER.

SHAFT, DRIVING. A driving shaft is a cylindrical, rotating member which transmits motion or power, usually both, from one point to another. The shaft may be made of any material strong enough for the purpose, but nearly all shafts are made of metal, especially steel. Motors, engines and machines of all kinds have shafts, often of a specialized kind, such as the camshaft and crankshaft in an automotive engine. In general, the input to or the output from a shaft may be through a shaft coupling, of which there are various kinds, or through belt-driven pulleys, chain drives! gears, etc. The crankshaft of an automotive engine receives power from the work done by the expanding gases in the cylinder; the camshaft is driven from the crankshaft by gears or a chain and delivers power through the cams that operate the valves.

A line shaft drives more than one machine and is itself driven by a prime mover, the power being taken off via belts or chains, usually at several points along the shaft. Shafts intermediate between a line shaft and a driven machine are variously called countershafts, jackshafts or headshafts. In highly industrialized areas where electricity is readily available the use of individual motor drives for each machine is generally favoured over line shafts. It is common practice to speak of short shafts on machines as spindles, especially shafts that carry cutting tools on metal-working machines. The word axle strictly refers to a stationary member carrying rotating wheels, pulleys, etc.. as the axle on a wagon or wheelbarrow; but the drive shafts to the rear wheels of an automobile are also called axles, no doubt a carry-over from horse-and-buggy days.

A shaft is designed to carry without failure or without excessive deformation the forces which act upon it. These forces may cause the shaft to bend. inducing what are called bending stresses within the material, or cause the shaft to twist, inducing twisting or torsional stresses; more often than not, shafts are subject to both bending and twisting forces. Sometimes a force acting in the axial direction causes a tensile or compressive stress. In accordance with theory, these stresses combine and if the resultant combination is too large, the strength of the material will be exceeded and the shaft mill fail. Most shafts break because the resultant of the combination of stresses at some point repeatedly exceeds the fatigue strength of the material. The stress at a point is increased by discontinuities such as fillets; etc.

It is quite likely that the breaking strength of a shaft is not the significant criterion. In a large percentage of situations, it is a matter of keeping the deflection of the shaft at a specified minimum. For example, in machine tools, rigidity or resistance to deflection is most important if the machine is to cut metal to close tolerances. This is often true even if the amount of deflection involved is much too small for the unaided eye to perceive. The torsional deflection of most machinery shafts will be less than 0.1° per foot of length. The transverse or bending deflection may be from a few ten-thousandths of an inch, depending upon the requirements. If the transverse deflection is large enough, a shaft may tend to bind in its bearings.

Any rotating shaft has a critical speed at which the shaft vibrates noticeably, perhaps violently. It might be said that at the critical speed the shaft is undecided whether to rotate about its geometric axis or about the axis through its centre of mass and it attempts to do both. This speed can be fairly accurately computed for a given situation; in any case, the shaft must be designed to run either well above or well below the critical speed.

Flexible shafts will bend around obstructions, as a cable bends, or will transmit small amounts of power in a curved form. They are used in dentists' grinding tools, portable drilling and polishing machines, etc.

Shafts are manufactured by cold-rolling or cold-drawing, processes which leave a relatively hard, strong, smooth surface on steel.. Because of the residual stresses left within the metal after cold-working, cold-finished shafts will warp when a keyway is cut and must later be straightened. Larger shafts are made from hot-rolled steel, turned on a lathe and polished or ground.

(V. M. F.)

SHAFTESBURY, ANTHONY ASHLEY COOPER, 1ST EARL OF (1621–1683), English politician who was one of the most prominent and skillful opponents of Charles II's pro-Catholic policy, was born at Wimborne St. Giles, Dorset, on July 22, 1621, and succeeded his father, Sir John Cooper, as 2nd baronet on March 23. 1631. Largely through his mother, Anne, daughter and heiress of Sir Anthony Ashley, who herself died on July 20, 1628, he inherited great estates in the southwest of England, and although much was lost during his long minority he always remained a wealthy man. Educated partly by tutors, partly at Exeter college, Oxford, and partly at Lincoln's Inn, he early showed evidence of a restless and acute intelligence, which led to his return to the Short parliament of 1640 as member for Tewkesbury and to the succeeding Long parliament as member for Downton. As he was still under age, however, and as his election to the Long parliament was the subject of a dispute which was not determined until 1660, it may be doubted whether he played any effective part in either of these assemblies.

By his first marriage, on Feb. 25, 1639, to Margaret, daughter of Thomas, 1st Baron Coventry, the lord keeper of England, he formed a close association with the lord keeper's sons: Henry and William, and confirmed his natural inclination to take, like them, the royalist side in the Civil War serving the king as captain of a troop of horse, colonel of a regiment of foot, governor of Weymouth and high sheriff of Dorset. Early in 1644, however, he went over to the side of parliament, was given command of all the parliamentary forces in Dorset and took an active part on their behalf in the concluding stages of the war in the southwest. Thereafter he devoted himself mainly to the problems of local government until appointed a member of the Barebones parliament in 1653 and returned for Wiltshire to its more legitimate successors in 1654, 1656 and 1659.

Appointed a member of the council of state on July 14, 1653, and of its successor, the lord protector's council, on Dec. 16 of the same year. he acted for some time as a supporter of Oliver Cromwell and in opposition to the more extreme reformers. At the very end of 1654. however, alienated by the protector's increasing neglect of parliament, he broke away from him, and in consequence was one of the members denied the certificate from the 'council without which they could not take their seats in the parliament of 1656. Against this exclusion he. along with others. strongly protested, and the certificates were soon afterward abolished; but even then he was not elevated. as in other circumstances he probably would have been, to the new "house of lords" created in 1657. When his criticisms of that house and of the protector's autocratic methods proved unavailing, he continued his opposition, not merely for the remainder of Oliver Cromwell's life but under Richard Cromwell as well.

After the fall of Richard and the restoration of the Rump of the Long parliament he was reappointed to the council of state and came under increasing suspicion of being in the interest of the exiled king. Against the power of the army he supported the authority of parliament; but it was a genuine parliament that he had in mind, and in consequence he lent all his weight to secure first his own right to sit in virtue of his election in 1640. then the readmission of the members excluded by Pride's Purge in 1648 and finally the dissolution of the Long parliament and the election of a new one. To that new parliament or convention he was again returned as member for Wiltshire on March 27, 1660, and in it he exerted himself to the utmost to secure the recall of Charles II. On May 7 he was appointed one of the 12 commissioners directed by the commons to go over to Breda and invite Charles to return, and after the landing of the king at Dover on May 25 he waited on him at Canterbury and was well received.

Offices and titles were immediately conferred upon him. Admitted to the privy council on May 27 and to the committee for plantations on July 4, 1660, he was created Baron Ashley of Wimborne St Giles on April 20, 1661, and appointed chancellor of the exchequer on May 13 of the same year. In the general settlement which followed the return of the king he advocated a policy of moderation, urging lenity as regards the former king's judges, opposing the more extravagant provisions of the Corporation act, the Act of Uniformity and the Five Mile act and supporting Charles II's declaration of 1662 in favour of toleration This naturally commended him to Charles. who was also impressed by his industry and ability, and on the death of the earl of Southampton, the lord treasurer, in May 1667 he was appointed one of the commission which took his place, becoming in a short time its most influential member.

During these early years he developed to a high degree that interest in the problems of commerce and colonization which was to be one of his leading characteristics as a statesman. Part owner of a plantation in Barbados, and member of several committees dealing with colonial affairs under the Commonwealth, he had served a long apprenticeship in the colonial field even before the Restoration, and was regularly included thereafter in the various committees to which such affairs were entrusted. On March 24, 1663, he was given a grant, along with seven others, of the vast province of Carolina, and found in it an ideal field for experimentation. Making the acquaintance, three years later, of the philosopher John Locke, he entrusted him with the task of drawing up a constitution for the province based upon aristocratic predominance, religious toleration and other principles which he would have liked to see recognized in England. In Oct. 1673 he secured for Locke the position of secretary to the recently established council of trade and foreign plantations. of which he himself had been appointed president.

Meanwhile Ashley's position at court had first improved and then suddenly declined. On the dismissal and impeachment of the earl of Clarendon in 1667 he had chosen to attach himself, among the ministers who rose to prominence in Clarendon's place, to the duke of Buckingham, with whom he had a common interest in the support of religious toleration; as early as 1670 he became so impressed by the danger of the Catholic duke of York's succeeding to the throne as to give his support to schemes for securing a divorce for the king or legitimizing his bastard son, the duke of Monmouth. In these circumstances he was naturally excluded from the secret of the real treaty of Dover, which aimed at the reconversion of England to the Roman Catholic faith, but he approved of the sham treaty, which provided only for an Anglo-French alliance to reduce the commercial supremacy of the Dutch, and readily signed it, along with other members of the so-called Cabal, on Dec. 21, 1670. He also gave his support to the Declaration of Indulgence which the king issued on March 15, 1672, but disapproved of the Stop of the Exchequer, by which an attempt was made to secure the necessary funds for the whole design.

As a reward he was appointed lord lieutenant of Dorset on Jan. 20. 1672. created earl of Shaftesbury on April 23, and appointed lord chancellor on Nov. 17. As chancellor he was, by general admission. a success; but in his capacity of adviser to the king he nas now in a false position, for he was advocating a policy half of which was concealed from him. When parliament assembled in Feb. 1673 he delivered his famous "*Delenda est Carthago*" speech, justifying the attack on the Dutch as the commercial rivals of England; but as he watched the rising tide of opposition to the king's policy, and began to suspect that there was more in that policy than he had been given to understand. his attitude inevitably changed. Later in the same year he supported the first Test act, designed to exclude Roman Catholics from office under the crown. and did his best in parliament to put obstacles in the way of the duke of York's marriage with the Catholic Mary of Modena On Nov. 9 he was summarily dismissed from the chancellorship and went into opposition. On May 19, 1674, he was also dismissed from the privy council and from his local offices.

It is as a leader of opposition to the court that Shaftesbury is chiefly remembered. but real leadership of the malcontent elements in parliament and the country long evaded his grasp. His frequent changes of policy and his inclination toward extreme courses. increasing rather than diminishing with age. were regarded with disfavour by responsible men, and even among his own associates some preferred the leadership of Lord Holles. Successful in obstructing Lord Danby's nonresisting test bill in the spring of 1675, he failed in the autumn of the same year, even with the assistance of the duke of York, to carry in the lords an address in favour of a dissolution of the Cavalier parliament. He then sought supporters among discontented elements in the City of London, elaborated an argument that in accordance with a statute of Edward III's reign requiring annual parliaments a prorogation for 15 months pronounced on Nov. 22, 1675, was in effect a dissolution, and advanced this contention in the lords when the houses reassembled on Feb. 15, 1677. He was immediately sent to the Tower by the lords themselves for his reflections on parliament, and was not released until Feb. 26, 1678.

The event which gave him his real chance was the appearance of Titus Oates in the autumn of the same year with his story of a vast Jesuit conspiracy against the king and government. Shaftesbury was in no sense the originator of the tale told by Oates, and indeed began by regarding it with suspicion as a fable inspired by government supporters with the object of rallying the nation round the king; but at an early stage he realized what a useful weapon it might prove in his hands: and thereafter he supported it to the utmost. In the midst of the nationwide panic which it engendered, moderate leaders and counsels were forgotten and he was able to secure widespread acceptance as the only man with the courage and skill to ride the storm. By developing an elaborate party organization, based on the famous Green Ribbon club. he exercised great control over elections, built up a large following both in the lords and in the commons and in three successive parliaments endeavoured to secure the exclusion of the duke of York from the succession to the throne. To his efforts at this time was largely due the passing of the Habeas Corpus act, perhaps his greatest and most creditable achievement.

With the object of silencing him by office Charles on April 21, 1679, remodeled the privy council, admitted many of the leading members of the opposition to it and appointed Shaftesbury president; but the failure of the king to follow the advice of his new council soon led Shaftesbury to withdraw his support, and on Oct. 15 of the same year he was dismissed. On Nov. 15, 1680, the Exclusion bill, which had passed without a division in the commons, was rejected, in spite of some brilliant speeches on his part, by the lords; but this only inspired him to more violent courses than he had yet contemplated, and to the succeeding parliament, which met at Oxford on March 21, 1681, he and his associates rode up with an armed following. confident that the king, in his need of money, could not withstand the pressure of the house of commons any longer. Charles, however, who had just strengthened his financial position by an agreement for a subsidy from the king of France, dissolved parliament within a week, and Shaftesbury suddenly found himself practically helpless. Cnfortunately for him the policy by which he had secured his acceptance as the oracle of the nation had almost inevitably been marked by extravagance rather than by statesmanship. and as the panic caused by the "popish" plot declined his credit had correspondingly diminished. Complete exclusion of the duke of York was a hazardous device which could have been accepted, if at all, only during a moment of panic. The substitution of the duke of Monmouth. at which he aimed, probably could not have been accepted at any time. and was only too obviously inspired by his desire to have an the throne a mere puppet of his own. On the unexpected dissolution of the third Exclusion parliament, accordingly. his following simply disintegrated. and he himself came into a position of considerable danger.

For the short remainder of his life his chief efforts were directed toward providing for his own safety. On July 2. 1681, he was seized, committed to the Tower and kept there for four months while every effort was made to find or suborn evidence on which to base a charge of high treason against him. So gloomy did his prospects appear that he offered. if released, to retire to Carolina. When he was brought to trial on Nov. 24, however, the Whig grand jury selected by the Whig sheriffs of London rejected the indictment, and on Dec. 1 he had to be admitted to bail, from which in turn he was released on Feb. 13, 1682. But in spite of the jubilation with which the failure of the prosecution was received, the court was now in the ascendant, and at the midsummer election contrived to secure the return of two Tory sheriffs for London. Thus deprived of all prospect of protection from a favourable jury at a future trial. Shaftesbury made desperate efforts to organize a rising against the government, and when these proved vain left the country on Nov. 28. Reaching Amsterdam early in December he was granted asylum there and admitted a burgher; but imprisonment and privations had aggravated the diseases from which he had long suffered. and after a short final illness he died on Jan. 21, 1683. His body was brought back to England, and was buried at Wimborne St. Giles.

Shaftesbury was undoubtedly a very clever man, and particularly adept at turning to his own advantage the weaknesses of others; but he failed to realize that in English politics cleverness alone is not enough, and that men are not composed exclusively of weaknesses. He has been credited with few genuine principles beyond a sincere belief in parliament and in the desirability of toleration in religious matters. His methods are difficult to defend, involving as they usually did not merely an assumption that the end justifies the means but also a reckless disregard of future consequences in the prospect of immediate gain. Especially toward the close of his life he repeatedly embarked on courses which men much less acute than he was could see were bound to lead to disaster. It is typical of his whole career that he ended his life under the protection of the Dutch, the nation which he had done his best, when at the height of his power, to ruin.

BIBLIOGRAPHY.—The Shaftesbury Papers in the Public Record Office, consisting of autobiographical fragments, letters, speeches and documents connected with Shaitesbury's colonial ventures, have been extensively used by historians, but have not proved as illuminating as might have been expected. Many of them are printed in W. D. Christie, *A Life oj Anthony Ashley Cooper, First Earl of Shaftesbury*, 2 vol. (1871), which is still the standard biography. H. D. Traill, *Shaftesbury* (1886), and O. Airy's article in the *Dictionary* of *National Biography* are useful sketches, one unfavourable and the other favourable in its interpretation of Shaitesbury's conduct. Louise Fargo Brown, *The First Earl of Shaftesbury* (1933), devotes attention to his connection with commercial and colonial developments. (A. Bg.)

SHAFTESBURY, ANTHONY ASHLEY COOPER, 3RD EARL OF (1671–1713), English politician and philosophical writer. was born on Feb. 26. 1671, at Exeter house, London. the residence of his grandfather. the famous 1st earl of Charles II's reign. His early education was directed by the philosopher John Locke; but in Nov. 1683 he was sent to Winchester college. and in 1686 embarked under the care of a tutor on a tour of France, Italy and Germany, from which he did not return until shortly after the English revolution. On May 21, 1695, he was returned to parliament at a by-election for the borough of Poole, and on Nov. 4 of the same year he was re-elected at the general election for the same constituency; but his health. never robust, broke down under the strain imposed by the house of commons, and after the dissolution of 1698 he did not stand again.

During his second period of service in the commons he was the central figure in a well-known incident which has done almost as much as his writings to perpetuate his memory. Having carefully prepared a speech in favour of a bill the main object of which was to allow the assistance of counsel to those accused of high treason. he found himself, when the time arrived, too overcome by the importance of the occasion to be able to recollect the points he had intended to advance, and yet contrived to make out of his own confusion a powerful argument in support of the bill. "If I." he declared, "who rise only to speak my opinion on the bill now depending, am so confounded that I am unable to express the least of what I proposed to say. what must the condition of the man be who is pleading for his life without any assistance. and under apprehensions of being deprived of it?" The bill passed, and became the famous Trials for Treason act of 1696.

On Nov. 2. 1699. occurred the death of his father, the 2nd earl, which enabled him to take his seat in the house of lords on Jan. 19. 1700; and in the quieter atmosphere of that house he found it possible to attend with regularity for the short remainder of William III's reign. In neither house, however. did he make himself quite at home, for he insisted on pursuing a completely independent policy. supporting such measures as he considered to be for the general welfare rather than those dictated by the party situation of the moment. Yet his general outlook, as might have been expected from his ancestry. was that of an advanced Whig, and at elections he did not hesitate to exert all his very considerable influence on behalf of Whig candidates. Under William he was more than once ofiered high office, but doubtful health combined with his love of independence to prevent him from accepting. On the accession of Anne, and the rise of the Tories to power, he was deprived of the vice-admiralty of Dorset, the only official position he held, and this slight was instrumental in inducing him to retire altogether from public affairs. and then to seek quiet and the opportunity for the studies he loved on the continent.

As early as 1699 he had spent nearly the whole of the year in Holland. where the climate suited him better than that of any other place. Now he embarked on a further visit, and from Aug. 1703 to Aug. 1704 resided mainly at Rotterdam. But the improved health with which he returned to England soon gave way before advancing consumption, and for the remainder of his life he was a confirmed invalid. Nevertheless. on Xug. 29, 1709, he married Jane. daughter of Thomas Ewer of Bushey hall, Hertfordshire, and with the birth of a son on Feb. 9, 1711, could feel that he had duly provided for the future of his family. In July of the same year declining health once again forced him to go abroad, and on Feb. 14, 1713, he died at Naples.

During his lifetime his fame was comparatively slight; for he lived much in seclusion and published scarcely anything before 1708. The next few years. however. were years of great literary activity on his part. and his *Characteristics of Men, Manners, Opinions and Times*, in which all his chief works were gathered together, appeared in a first edition in 1711 and in a second edition, enlarged and corrected under his own directions, in 1714. The effect was immediate. and was felt not merely in England but also on the continent, where French and German speculations were deeply influenced by his writings.

This was largely the result of the fidelity with which he reflected the spirit of the age in which he lived. The enthusiasms and conflicts of the 17th century were over: and a sober rationalism or even scepticism was taking their place in church and state. Shaftesbury was strongly opposed to fanaticism, which he maintained was best counteracted, not by argument. but by raillery and good humour. Though never an atheist he was highly critical of revealed religion. The capacity to distinguish between right and wrong was. he believed, due to a "moral sense." inborn in human nature, and was thus independent of theology, custom and law in much the same way as is the capacity to distinguish between what is beautiful and what is ugly. This idea was later developed by Shaftesbury's disciple. Francis Hutcheson (*q.v.*), and became a characteristic feature of the Scottish school of philosophy which derived from him.

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SHAFTESBURY, ANTHONY ASHLEY COOPER, 7TH EARL OF (1801–1885), son of Cropley, 6th earl (a younger brother of the 5th earl; succeeded 1811), and Anne. daughter of the 3rd duke of Marlborough, was born on April 28. 1801. Be was educated at Harrow and Christ Church. Oxford, and entered parliament in 1826. Hc succeeded his father as earl in 1851. Although giving a general support to the Conservatives, his parliamentary conduct was greatly modified by his intense interest in the improvement of the social condition of the working classes. his efforts in behalf of whom have made his name a household word. He opposed the Reform hill of 1832, but was a supporter of Catholic emancipation. and his objection to the continuance of resistance to the abolition of the corn laws led him to resign his seat for Dorset in 1846. In parliament his name. more than any other. is associated with the new factory legislation. He was a lord of the admiralty under Sir Robert Peel (1834–35), but on heing invited to join Peel's administration in 1841 refused. having been unable to obtain Peel's support for the Ten Hours' bill. Chiefly by his persistent efforts a Ten Hours' bill was carried in 1847, but its operation was impeded by legal difficulties. which were only removed by successive acts, instigated chiefly by him, until the law was consolidated by the Factory act of 1874.

The part which Shaftesbury took in the legislation bearing on coal mines was equally prominent. In 1846. after the resignation of his seat for Dorset, he explored the slums of the metropolis, and not only gave a new impulse to the movement for the establishment of ragged schools, but was able to make it more widely beneficial. For 40 years he was president of the Ragged School union. He was also one of the principal founders of reformatory and refuge unions, Young Men's Christian associations and workingmen's institutes. He took an interest in foreign missions, and was president of several philanthropic and religious societies of London. He died on Oct. 1. 1885. By his marriage (1830) to Lady Emily (d. 1872), daughter of the jth Earl Cowper, he left a large family, and was succeeded by his eldest son Anthony, who committed suicide in 1886.

See J. L. and B. Hammond, *Lord Shaftesbury* (1923); and J. W. Bready, *Lord Shaftesbury and Industrial Progress* (1926).

SHAFTESBURY, a market town and municipal borough in the North Dorset parliamentary division of Dorsetshire, Eng., 20 mi. W.S.W. from Salisbury by road. Pop. (1961) 3.366. Area 1.7 sq.mi. It lies high on a hill, on the edge of Cranborne Chase. above a rich agricultural district. Although traces of British and Roman occupation occur in the neighbourhood, the site of Shaftesbury (Caer Palladur, Caer Septon. Seaftonia, Sceafstesbyrig. Shafton) was probably first occupied in Saxon times. Matthew Paris speaks of its foundation by the mythical king Rudhudibras, while Asser ascribes it to Alfred. who made his daughter Ethelgeofu the first abbess. It is probable that a small religious house had existed there before the time of Alfred, and that it and the town were destroyed by the Danes, both being rebuilt about 888. The foundations of the Saxon abbey and nunnery have been laid bare. In 980 Dunstan took St. Edward's hody there from Wareham for burial, and there Canute died in 1035. The relics of St. Edrr-ard were discovered in 1931 during excavation.

In 1252 the burgesses received their first charter from Henry III. There is no evidence that Elizabeth granted Shaftesbury a charter as has been asserted. but she confiscated the common lands in 1585, the town only recovering them by purchase. This probably led to the granting of a new charter by James I in 1604. Yet another charter was granted to the town in 1684. Shaftesbury returned two members to parliament from 1294 to 1832, when the representation was reduced to one. and it was lost in 1885.

SHAFT SINKING. A shaft is a throatlike excavation which has been so formed as to penetrate downward into the earth's crust, either in a vertical or somewhat inclined manner. Although shafts sometimes may be used as intermediate accessways along the courses of railway and vehicular tunnels, or for making deep footings of large buildings and dams and for establishing bridge piers, subways and similar structures, by far the greater number are sunk for underground mining of mineral deposits. The process of shaft sinking has been pursued in one way or another ever since man first began to do underground mining.

Subsurface mineral deposits are notably distinctive and often peculiarly unique so far as their mode of occurrence is concerned (*see* ORE DEPOSITS) and these characteristics frequently introduce important modifying elements in the nature and type of shaft that is made for their exploitation. That is, the shaft may prove to be the limiting "bottleneck" of a given mining operation if it has not been properly designed as to shape, size, depth and inclination to meet the particular environmental conditions that affect the ore body in question. Such situations often transpire because it is through the more or less constricted shaft opening that not only must the ore be moved but, also. all supplies. men and mining equipment must be transported. Shafts may range in general type from the most crude warrenlike openings to highly specialized and well-constructed excavations, and the several ways of shaft sinking may be of various degrees of complexity and engineering refinement.

The basic cycle of the shaft-sinking operation is similar to that which obtains to most mining ventures, namely: (1) drilling and blasting (breaking); (2) loading (mucking); (3) placing of timbers or other types of wall-support materials; and (4) hoisting.

These activities are interrelated in their application and, to be followed efficiently, they require the energy of co-ordinated mining crews. The several individuals forming a crew must have the faculty of working in close and safety-conscious co-operation, not only with each other but also with supporting associates whose function is to give service to the endeavour as a whole. The physical effort that must be expended ordinarily is great and the space within which the work must be performed is constricted. It often is very wet and of rather high temperature.

A typical total labour unit (exclusive of supervisory and engineering personnel) employed for shaft sinking commonly is composed as follows: a sinking crew of 12 miners; 3 or 4 cagers; 3 hoistmen; 1 mechanic; and 2 or more surface labourers.

At about the beginning of the 20th century, the "breaking" stage of the mining cycle was marked by the progressive perfection and adoption of rock-drilling machines (see DRILLING MACHINERY) and this trend, accompanied as it was by the development of better explosives. contributed appreciable progress to the practice of shaft sinking. Most drilling machines are motivated by compressed air and during operation they either are hand-held or more commonly are mounted on a frame known as a "jumbo."

A typical drill hole pattern usually is composed of numerous downward directed holes. The explosives that are employed for blasting generally are water-repellant varieties of high-strength dynamites.

The arduous and expensive procedures of hand-loading and of "mucking off the rough" were practised for many years after the advent of air-driven drilling machines and therefore the operational cycle of shaft sinking in reality showed but little refinement of consequence until about the time of World War II. That is, from the time when man first began to burrow extensively into the earth until the late 1930s, shafts to be used for mining purposes were sunk almost wholly by hand-labour methods or by a borehole drill rig of some form. In fact, sinking by borehole drilling was not used to noteworthy degree until about 1925.

However: mechanized mucking procedures have been pronouncedly advanced and few shafts are sunk without employing some type of mechanical means of loading. The more widely used and generally accepted types of equipment would fit into the following classification: scraper with 2- or 3-drum hoist (inclined shafts); reverse-action bucket or scoop on sliding boom (inclined shafts) (fig. 1); positive-action power shovel (fig. 2); overshot loader or "rocker shovel!' (fig. 3); free-moving clamshell or orange-peel bucket loader; positive-action clamshell unit; and positive-action "backhoe" loader.

Most loading devices discharge into a pan or directly into a car or sinking-bucket sometimes called a "can" and the broken rock thus may be moved at will from the shaft chamber. Except for a few cases, shafts are lined with wood timbering (fig. 2) or with steel or concrete or masonry bricking. The shaft linings are so placed as to serve as protective walls to inhibit the infall of rock from the sides of the excavation and, also, they tend to reduce or to control the inflow of water. In addition, they afford means whereby running guides for the cages can be affixed and aligned.

In giving consideration to the adoption of a shaft-sinking process there are a number of factors that require analysis. First is the question of whether the shaft is to serve chiefly as a means of

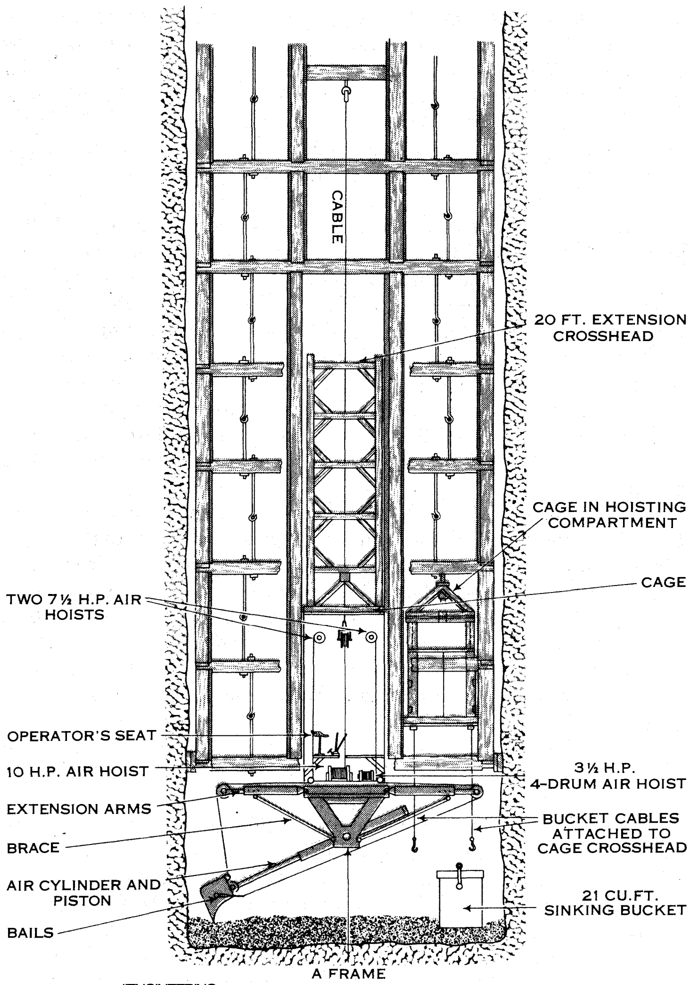

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FIG. 2.— SHAFTMUCKER USING POWER SHOVEL PRINCIPLE

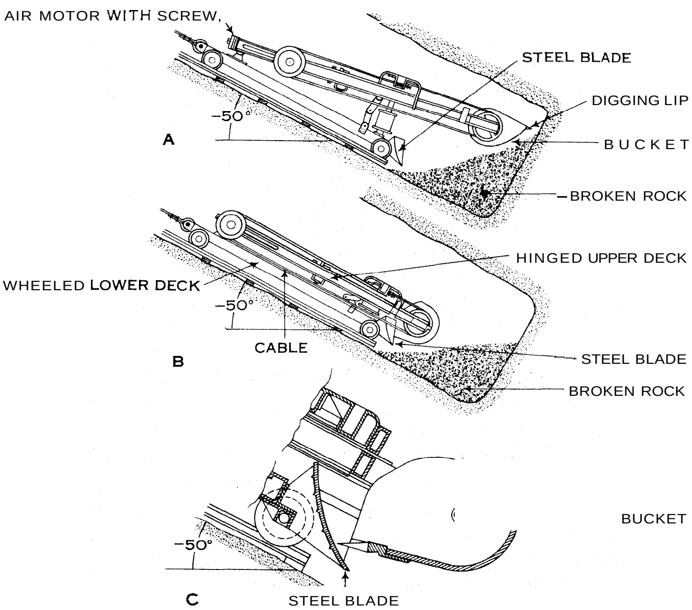

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FIG. 1.— SCHEMATIC DRAWING OF MUCKING MACHINE

(A) As extended boom is drawn back, bucket loads itself by digging into broken rock. (B) After digging lip of bucket has closed against steel blade, machine is ready to be hoisted. (C) Detail of digging head shown in (B) exploration and prospecting or is to be a large excavation dug so that a major ore body can be mined. Other factors which may bear consequential influence are: (1) availability and degree of skill of man power; (2) location, such as accessibility to sources of power and other supplies; (3) character of surface-plant site, especially with regard to the disposal of muck and the installation of the hoisting engine; and (4) prevailing geologic features and other conditions of the rock environment. This latter factor is particularly pertinent with reference to the shape and general attitude of the body to be exploited. Also, it is related to the existence of possible structures and other ground conditions which, by their influence on rock stability, may tend to induce problems bearing directly on the actual sinking operation.

There are usually other more incidental elements that must be analyzed. For example, if abnormally heavy water flows are encountered, they often will require the installing of exceptional pumping units or, at least, the building of eavelike ducts called "water rings" at intervals within the shaft. In addition, if the temperature gradient of the earth is steep, it is frequently necessary to furnish cooling and ventilating in a manner and to a degree that otherwise would not be needed.

Where the rock material to be penetrated is loose soil or gravel it may be grouted (cemented) or even frozen before sinking is begun.

In some cases, it is necessary to progress downward by lowering steel caissons or to push or drive wooden planks. called "spiles" or "forepoles," into the rock mass ahead of and beyond the actual excavation. These several practices have the general effect of inhibiting sloughing when the shaft is being made and, also, they usually serve to reduce the lateral percolation and undesirable inflow of subsurface water.

When hard rocks are being excavated, the normal or downward sinking cycle of drilling, blasting, mucking and hoisting ordinarily is followed. However, as before noted, the development of some shafts by various means of borehole drilling or, in some special cases! by "raising," which is a mining process carried upward from below, has proved to be outstandingly economic and efficient.

The operational plant unit needed to accomplish the shaft-sinking work usually is comprised of a hoisting engine and headframe, several buckets or skips, one or more sinking pumps, a satisfactory complement of drilling machines, ventilating fans, a selected loading machine and other accessory items of equipment and structure

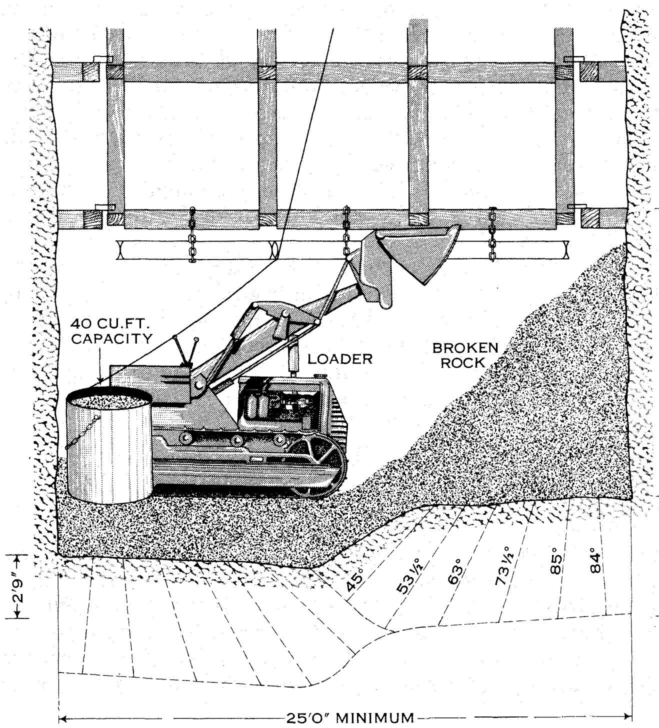

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FIG. 5.— MUCKING WITH HIGH-LIFT LOADER

BY COURTESY OF INTERNATIONAL NICKEL COMPANY

FIG. 4.— DRILLINGBY SHAFT-SINKING CREW

such as a change house and warehouse.

Shaft-sinking costs may run to several hundred dollars a foot. An example of the items involved in costs in a typical U.S. case is given in the listing below.

Labour	Insurance expense
Bits and rods	Shop and payroll expense (on outside labour)
Compressed air	Taxes—social security
Drill repair	Workmen's compensation
Explosives	Electric power
Hoisting	
Pumping	
Shaft mucking machine—maintenance royalty	Shaft-sinking equipment (purchased)
Ventilation—maintenance	Blasting mat
Shait sets—complete	Drill machines
Surface	Sinking cage
Engineering and surveying	Portable blower
General expense	Shait mucher

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SHAGREEN. A species of untanned leather with a roughened. granular surface. The word is the English form; *cf.* Ger. *Schagrin*, Fr. *chagrin*, Ital. *zagrin, zigrino;* these are usually referred to Turkish and Persian *saghri*, "the back of a horse," and so applied to leather made from this part. The skin of the wild ass aas especially used. The method of preparing the skins to secure the rough. granular surface is as follows: The seeds of a plant, usually some species of *Chinopodium*, are embedded in the skin while soft; the surface is then shaved down and soaked in water, when the edges of the indentations swell up. The leather is then dyed, green being a favourite colour. Shagreen is now commonly made of the skins of sharks and rays; the placoid scales of the shark skin giving the necessary roughened surface. Shagreen is used as an ornamental leather for making pocketbooks, small cases and the like, and for the handles of swords, daggers, etc.

SHAHABAD, a district of Bihar, India. Area 4.404 sq.mi. Pop. (1951) 2,688,440. To the north is an alluvial flat constituting about three-fourths of the district, closely cultivated and thickly populated. The southern part is occupied by the Kaimur hills, a branch of the great Vindhyan range. These hills consist of an undulating plateau largely covered with jungle, about 800 sq.mi. in area; at Rohtasgarh they attain a height of 1,490 ft. above sea level. The chief rivers are the Ganges and the Son, which unite in the northeastern corner of Shahabad, and the Karamnasa, which divides it from Uttar Pradesh. The chief crops are rice, millets, wheat, pulses, oilseeds and sugar cane. The northern part of Shahabad is known as Bhojpur, which has given its name to a dialect of the Bihari language. Its inhabitants, the

Bhojpuri, were formerly notorious for turbulence and predatory habits. Before 1857 many were recruited for the army, but during the mutiny they broke out into a rebellion which was not put down till the end of 1858. The district's administrative headquarters are at Arrah, 31 mi. W. of Patna. Pop. (1951) 64,205. The town contains one of the undergraduate colleges of Bihar university. Sixty miles southwest of Arrah is Sasaram, with the domed tomb of the emperor Sher Shah (1540–45) and that of his father.

SHAH ALAM (1728–1806), Mogul emperor of Delhi, son of Alamgir II, was born on June 15, 1728, and was originally known as the Shahzada Ali Gohar. Being proclaimed a rebel by his father, he fled to Shuja-ud-Dowlah, wazir of Oudh, and on the death of his father in 1759 assumed the name of Shah Alam. He joined Shuja-ud-Dowlah against the British, but after his defeat at the battle of Buxar he sought British protection. In 1765 he granted the diwani (superintendence of the revenue) of Bengal to Lord Clive for the East India company in return for a payment of 26 lakhs a year.

In 1771 he fell into the power of the Marathas, was installed emperor of Delhi and lost the British subsidy. In 1788 the Rohilla chief Ghulam Kadir seized Delhi and put out Shah Alam's eyes. Sindhia restored him to the throne, and after the Maratha War of 1803 he was again taken under British protection. He died on Nov. 10, 1806.

See also INDIA: *History*.

See W. Francklin, *History of the Reign of Shah-Aulum* (1798).

SHAH JAHAN (fl. 1627–1658), Mogul emperor of Delhi, the fifth of the dynasty. After revolting against his father, Jahangir, as the latter had revolted against Akbar, Shah Jahan succeeded to the throne on his father's death in 1627. It was during his reign that the splendour of the Mogul court reached its zenith.

The chief events of his reign were the destruction of the kingdom of Ahmadnagar (1636), the loss of Kandahar to the Persians (1653) and a second war against the Deccan princes (1655). Shah Jahan fell ill in 1658 and was confined by his son Aurangzeb in the citadel of Agra until his death in 1666. The period of his reign was the golden age of Indian architecture. Shah Jahan erected many splendid monuments. the most famous of which is the Taj Mahal at Agra, built as a tomb for his wife Mumtaz Mahal; while the Pearl mosque at Agra and the palace and great mosque at Delhi also commemorate him. The celebrated Peacock throne, said to have been worth £6,000,000, also dates from his reign. For his city of Shahjahanabad, *see* DELHI.

See B. P. Saksena, *History of Shahjahan of Dihli (1932).*

SHAHJAHANPUR, a city, with *tehsil* (administrative subdivision) and a district of Uttar Pradesh, India. The city is on the left bank of the Deoha river, 95 mi. N.W. of Lucknow and is a military cantonment. Pop. (1951): city 104,835; municipal 98,949; cantonment 5,886; *tehsil* (395 sq.mi.) 307,735. The city was founded in 1647 during the reign of Shah Jahan by Nawab Bahadur Khan, a Pathan. His mosque is the only building of antiquarian interest. One of the colleges of Agra university is in the city.

SHAHJAHANPUR DISTRICT has an area of 1,762 sq.mi. It consists of a long, narrow tract running up from the Ganges toward the Himalayas, and is for the most part level. The principal rivers are the Gumti, Khanaut, Garai and Ramganga. To the northeast waste and forest preponderate. Between the Gumti and the Khanaut the country varies from a rather wild and unhealthful northern region to a densely inhabited tract in the south, cultivated with sugar cane and other crops.

From the Ramganga to the Ganges in the south is a continuous low country of marshy patches, alternating with a hard clayey soil that requires much irrigation in parts. In 1951 the population was 1,004,378. Shahjahanpur was ceded to the English by the nawab of Oudh in 1801.

SHAHPUR, a small city with *tehsil* (administrative subdivision) and a district in the Rawalpindi division of West Pakistan. The town is near the left bank of the Jhelum river. 48 mi. S.S.W. of Rawalpindi. Pop. (1951): city 5,330; *tehsil* 175,397.

SHAHPUR DISTRICT (4,788 sq.mi.) is bounded by the Salt range in the north. The Jhelum flows through the middle of the district, the eastern half of which, in the Chaj Doab, is well irrigated by the Lower Jhelum canal. There also is the district headquarters, Sargodha: pop. (1951) 78,447. West of the Jhelum are undulating sand hills, part of the Thal desert. The submontane strip has however been reclaimed. New townships and villages have grown up. In 1951 the population was 1,162,988. The chief commercial centre is Bhera (16,644). Shahpur passed into English hands. with the rest of the Punjab, in 1849. The climate is hot and dry but healthy. Wheat, gram, cotton and bajra are the chief crops. (K. S. AD.)

SHAKER HEIGHTS, a city of Ohio, U.S., is an attractive residential suburb of Cleveland (*q.v.*). Planned and developed by the Van Sweringen brothers after 1900 in an area once held by the North Union Shaker community, Shaker Heights was incorporated as a village in 1912 and as a city in 1931. After 1920 it was accessible to downtown Cleveland by rapid transit railroad. now city owned. Population increase, after the initial rush of the 1920s, was due to large apartment developments. In the 1960s little vacant land remained and building codes were rigid. There are no industries in the community. Shaker Heights has a top-ranking public-school system. excellent private schools, a public library and a Shaker historical museum. Shaker lakes, once the site of the Shaker community grist and woolen mills, furnish a distinctive setting for the suburb. For comparative population figures *see* table in *OHIO*. Population. (V. B. S.)

SHAKERS, an American celibate and communistic sect, known as the "United Society of Believers in Christ's Second Appearing" and as the "Millennial Church." Some of the leaders prefer the name "Alethians," for they consider themselves children of the truth. The society had its beginning in a Quaker revival in England (1747) which resulted in the organization of a sect of which Jane and James Wardley were the leaders. They were succeeded by Ann Lee. The distinctive merit of celibacy became an original tenet of the Shakers in England. They did not prohibit marriage but refused to accept it as a Christian institution and considered it less perfect than the celibate state.

Under stress of persecution and in response to a revelation, "Mother" Ann led a band of six men and two women to America. They arrived in New York city on Aug. 6, 1774, and after two years' stay there, settled in the woods of Watervliet, not far from Albany, N.Y. In 1780 there was a religious revival in New Lebanon, N.T., and some of the converts became disciples of Ann Lee. At this place, in 1787. the first Shaker society in the United States was organized; the society at Watervliet was organized immediately afterward. Ann Lee went from place to place preaching her new doctrine and became known as a faith healer. At the time of her death (1784) she had disciples in New York, Massachusetts and Connecticut. A group of Shakers came out of the Kentucky revival of 1800–02. The community at Mount Lebanon, N.Y., sent three of their number to Kentucky to bear witness to the people.

Though at first bitterly opposed, these Shaker preachers made a sufficient number of converts to found five societies, "two in Ohio, two in Kentucky and one in Indiana." In 1894 the Mount Lebanon society founded a colony at h'arcoosee, Fla., called the Union Village society. In 1910 it went into the hands of a receiver.

The Shakers held that God was both male and female, that Adam, having been created in the image of God, had in him the nature of both sexes, that even angels and spirits are both male and female. Christ, they believed, was one of the superior spirits and appeared in Jesus, the son of a Jewish carpenter, representing the male principle. In Mother Ann, daughter of an English blacksmith, the female principle in Christ was manifested, and in her the promise of the Second Coming was fulfilled. Christ's kingdom on earth began with the establishment of the Shaker Church.

The practical ideals of the community were the common possession of property, a life of celibacy, confession of sin, without which no one could become a member of the community, power over physical disease and separation from the world. Disease they regarded as a sin against God. Their separateness from the world was indicated by their manner of living in families of 30 to

90 individuals. Each family had its own house, the stories being divided between the men and women. They made no room for adornments in the way of pictures or other works of art. In their prescribed mode of dress for men and women, they also protested against the fashions of a vain world. For a time they made their own clothing and wove their own cloth. They made leather in New York for several years; but were more successful in selling herbs and garden seeds, and in making apple sauce, weaving linen and knitting underwear. Many of them, however, considered it a mistake to have left agriculture and entered into manufacturing.

In 1874 there were 58 Shaker communities with 2,415 members, owning 100,000 ac. of land; in 1905 the membership was reduced to about 1,000. By mid-20th century there were fewer than 100 members in five surviving communities.

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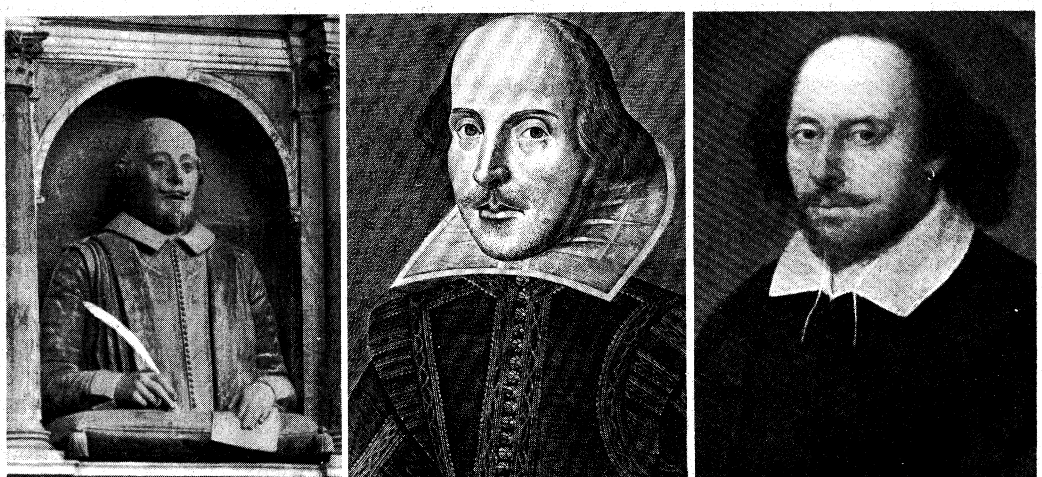
SHAKESPEARE, WILLIAM (1564–1616), English poet, player and playwright, was baptized in the parish church of Stratford-on-Avon (*q.v.*) in Warwickshire on April 26, 1564. The exact date of his birth is not known. Two 18th-century antiquaries, William Oldys and Joseph Greene, gave it as April 23, but without quoting authority for their statements, and the fact that April 23 was the day of Shakespeare's death in 1616 suggests a possible source of error. In any case his birthday cannot have been later than April 23, since the inscription upon his monument is evidence that on April 23, 1616, he had already begun his 53rd year.

Family and Youth.—His father, John Shakespeare, was a burgess of the recently constituted corporation of Stratford (it received its charter in 1553), and had already filled certain minor municipal offices. From 1561 to 1563 he had been one of the two chamberlains to whom the finance of the town was entrusted. John Aubrey (1681) called him a butcher and Nicholas Rowe (1709) a wool dealer, but it is clear from formal documents that by occupation he was a "whittawez," or glover, although he appears to have dealt from time to time in various kinds of agricultural produce, such as barley, timber and wool. He is also described as a yeoman, and it is possible that he combined a certain amount of farming with the practice of his trade. He was living in Stratford as early as April 1552, when he was fined for having a dunghill in Henley street, but he does not appear to have been a native of the town, in whose records the name is not found before his time; and he may reasonably be identified with a John Shakespeare of Snitterfield, who administered the goods of his father, Richard Shakespeare, in 1561. Snitterfield is a village in the immediate neighbourhood of Stratford, and there Richard Shakespeare had been settled as a farmer since 1529. He may have come from Hampton Corley in Budbrooke, where a Richard Shakespeare is on the subsidy roll for 1525. It is probable that John Shakespeare carried on the farm for some time after his father's death, and possible that by 1570 he had acquired a small holding called Ingon in Hampton Lucy. But the Snitterfield farm seems to have passed subsequently to his brother Henry, who was buried there in 1596. There were also at Snitterfield a Thomas Shakespeare and an Anthony Shakespeare, who seems to have moved to Hampton Corley; and these may have been of the same family. A John Shakespeare, who dwelt at Clifford Chambers, another village close to Stratford, is clearly distinct. Strenuous efforts have been made to trace Shakespeare's genealogy beyond Richard of Snitterfield, but so far without success. Certain drafts of heraldic grants of the Shakespeare arms speak, in one case of John Shakespeare's grandfather, in another of his great-grandfather, as having been rewarded with lands and tenements in Warwickshire for service to Henry VII. No such grants have been traced; statements about "antiquity and service" in heraldic preambles were, even in the 16th century, looked upon with suspicion.

The name Shakespeare is extremely widespread, and is spelled in an astonishing variety of ways. Competent paleographers hold that Shakespeare himself, in the extant examples of his signature, generally wrote "Shakspere" in full or in an abbreviated form, but possibly, in the main signature to his will, "Shakspeare." In the printed signatures to the dedications of his poems, on the title pages of nearly all the contemporary editions of his plays that bear his name and in many formal documents it appears as Shakespeare or Shake-speare. This may be in part due to the martial derivation which the poet's literary contemporaries were fond of assigning to his name, and which is acknowledged in the arms that he bore. Certain forms often used at Stratford, however, such as Shaxpere and Schackspere, suggest a short pronunciation of the first syllable, and thus tend to support Henry Bradley's derivation from the Anglo-Saxon personal name, Seaxberht. It is interesting to record that in 1487 Hugh Shakspere of Merton college, Oxford, changed his name to Sawndare, because his former name *vile reputatum est* ("was basely regarded"). The earliest record of a Shakespeare that has yet been traced is in 1248 at Clapton in Gloucestershire. The name also occurs during the 13th century in Kent, Essex and Surrey, and during the 14th in Cumberland, Yorkshire, Cheshire, Nottinghamshire, Essex, Warwickshire and as far away as Youghal in Ireland. Thereafter it is found in London and most of the English counties, particularly those of the midlands; and nowhere more freely than in Warwickshire. There were Shakespeares in Warwick and in Coventry, as well as around Stratford; the clan appears to have been numerous in a group of villages about 12 mi. N. of Stratford, which includes Baddesley Clinton, Wroxall, Rowington, Haseley, Hatton, Lapworth, Packwood, Balsall and Knowle. William was in common use as a personal name, and Williams from more than one other family have from time to time been confounded with the dramatist. Many Shakespeares are upon the register of the guild of St. Anne at Knowle from about 1457 to about 1526. Among these were Isabella Shakespeare,



BY COURTESY OF (CENTRE AND RIGHT) THE NATIONAL PORTRAIT GALLERY, LONDON; PHOTOGRAPH, (LEFT) HAROLD BAKER

PORTRAITS OF SHAKESPEARE

Left, bust and monument erected in the north wall of the choir of Holy Trinity church, Stratford-on-Avon. Believed to have been executed by Gerard Johnson (Gheerart Janssen, Flemish) before 1623; centre, the Droeshout print prefixed to the First Folio edition of Shakespeare's plays in 1623; right, the Chandos portrait attributed to Richard Burbage (*c.* 1567–1619)

prioress of the Benedictine convent of Wroxall, and Jane Shakespeare, a nun of the same convent. Shakespeares are also found as tenants on the manors belonging to the convent, and at the time of the Dissolution in 1534 one Richard Shakespeare was its bailiff and collector of rents. Attempts have been made to connect the ancestors of this Richard Shakespeare with a family of the same name which held land by military tenure at Baddesley Clinton in the 14th and 15th centuries, and to identify him with the poet's grandfather, Richard Shakespeare of Snitterfield. But Shakespeares are to be traced at Wroxall nearly as far back as at Baddesley Clinton, and Richard the bailiff seems to have retired to a farm at Haseley, which he had held since 1523. Probably he died there about 1558 It is not likely that he had also been farming land at Snitterfield since 1529

With the breaking of this link, the hope of giving Shakespeare anything more than a grandfather on the father's side must be laid aside. On the mother's side he nas connected with a family of some distinction. At least part of Richard Shakespeare's land at Snitterfield was held from Robert Arden of Wilmcote in the adjoining parish of Aston Cantlow, probably a younger son of the Ardens of Parkhall, who counted among the leading gentry of Warwickshire. Robert Arden married his second wife. Agnes Hill, formerly Webbe. in 1548, when he was already the father of eight daughters by his first wife. To the youngest. Mary Arden he left in 1556 a freehold in Aston Cantlow. a farm of about 50 or 60 ac.. knonn as Asbies. He had possibly already settled other property in Wilmcote upon her. Mary Arden. at some date later than Nov. 1556, probably before the end of 1j57, married John Shakespeare. John Shakespeare had, in Oct 1556. bought two freehold houses; one in Greenhill street. the other in Henley street The latter. known as the wool shop, was the easternmost of the two houses now combined in the so-called Shakespeare's birthplace The western house, locally regarded as the birthplace proper, may already have been in John Shakespeare's hands, as he seems to have been living in Henley street in 1552. It has sometimes been thought to have been one of two houses purchased in 1575, but there is no evidence that these were in Henley street at all.

William Shakespeare was not the first child A Joan was baptized in 1558 and a Margaret in 1562. Margaret was buried in 1563 and Joan must have died young. though her burial is not recorded, as a second Joan was baptized in 1569. A Gilbert nas baptized in 1j66, an Anne in 1571, a Richard in 1574 and an Edmund in 1580 Anne died in 1579; Edmund (who. like his brother, became an actor) in 1607; Gilbert in 1612; Richard in 1613 Tradition has it that a relative of Shakespeare used to visit London in the 17th century as quite an old man. One form of this tradition makes him a brother, which is impossible

During the years after his marriage, John Shakespeare became prominent in Stratford life, In 1565 he was chosen as an alderman, and in 1568 he held the chief municipal office, that of high bailiff. This carried with it the dignity of justice of the peace. John Shakespeare seems to have contemplated the assumption of arms, and usually appears in corporation documents as "Master" Shakespeare, whereby he may be distinguished from another John Shakespeare, a "corviser" or shoemaker, uho dwelt in Stratford about 1586–92 In 1571 as a former bailiff he began another year of office as chief alderman.

Shakespeare in his boyhood, therefore, may be thought of as the son of a leading citizen of an important market town. Stratford had its own vigorous life, probably not much unlike the life of a similar town today, despite dunghills; the stately buildings formerly belonging to its college and its guild, both suppressed at the Reformation, were reminders of its past. The town stands in agricultural country throughout which, in those days, enclosed orchards and meadows alternated with open arable fields; not far distant was the wilder wooded district of the forest of Arden. Among Stratford's medieval heritages was a free grammar school, and here it is natural to suppose that William Shakespeare obtained a sound enough education, with a working knowledge of "Mantuan" and Ovid in the original, even though to such a thorough scholar as Ben Jonson it might seem no more than "small Latin and less Greek." In 1577, when Shakespeare was about 13, his father's fortunes began to take a turn for the worse. He became irregular in his contributions to town levies. and had to give a mortgage on property of his wife at Wilmcote as security for a loan from her brother-in-law. Edmund Lambert. Money was raised to pay this off. partly by the sale of a small interest in land at Snitterfield which had come to Mary Shakespeare from her sisters. partly perhaps by that of the Greenhill street house and other property in Stratford outside Henley street, none of which seems to have ever come into William Shakespeare's hands. Lambert, however. on the plea of older debts, refused to surrender the mortgage, and an attempt to recover the Wilmcote property by litigation proved ineffectual. John Shakespeare's difficulties increased. He had long ceased to attend the meetings of the corporation, and as a consequence he uas removed in 1586 from the list of aldermen. In this state of domestic affairs it is not likely that Shakespeare's school life was unduly prolonged. The chances are that he was apprenticed to some local trade.

Marriage.--Whatever his circumstances, they did not deter him at 18 from the adventure of marriage. Rowe recorded the name of Shakespeare's wife as Hathanay. and Joseph Greene succeeded in tracing her to a family of that name dwelling in Shottery, one of the hamlets of Stratford. Her monument gives her first name as Anne. and her age as 67 in 1623. She must. therefore, have been about eight years older than Shakespeare. Various small trains of evidence point to her identification nith the daughter Agnes mentioned in the will of a Richard Hathaway of Shottery, who died in 1581, being then in possession of the farmhouse known as "Anne Hathaway's cottage."

Agnes was legally a distinct name from Anne, but there can be no doubt that ordinary custom treated them as identical. The principal record of the marriage is a bond dated Nov. 28, 1582, and executed by Fulk Sandells and John Richardson, two yeomen of Strstford who also figure in Richard Hathaway's will. as a security to the bishop for the issue of a licence for the marriage of William Shakespeare and "Anne Hathwey of Stratford." upon the consent of her friends. with one asking of the banns. There is no reason to suppose, as has been suggested, that the procedure adopted was due to dislike of the marriage on the part of John Shakespeare, since, the bridegroom being a minor. it would not have been in accordance with the practice of the bishop's officials to issue the licence nithout evidence of the father's consent. The explanation probably lies in the fact that Anne was already pregnant. and in the nearness of Advent, nithin which marriages were prohibited, so that the ordinary procedure by banns would have entailed a delay until after Christmas A kindly sentiment has suggested that some form of civil marriage, or at least contract of marriage, had already taken place, so that a canonical marriage was really required only in order to enable Anne to secure the legacy left her by her father "at the day of her marriage." But such a theory is not rigidly required by the facts It is remarkable that, on the day before that on which the bond was executed. an entry was made in the bishop's register of the issue of a licence for a marriage between William Shakespeare and "Annam Whateley de Temple Grafton." Of this it can only be said that the bond, as an original document, is infinitely the better authority, and that a mistake of "Whateley" for "Hathaway" is a possible solution. Temple Grafton may have been indicated in the licence as the place of marriage, although Worcester licences usually named the place of residence of the bride. There are no contemporary registers for Temple Grafton. and there is no entry of the marriage in those for Stratford-on-Avon. Such a record seems to have been seen during the 19th century in the registers for Luddington, a chapelry within the parish, which are now destroyed. Shakespeare's first child, Susanna, was baptized on May 26. 1583, and was followed on Feb. 2, 1585, by twins, Hamnet and Judith.

Departure From Stratford.— In or after 1584 Shakespeare left Stratford. An 18th-century story of a drinking bout in a neighbouring village is of little importance. There is a stronger tradition that he got into trouble through poaching on the estates of a considerable Warwickshire magnate, Sir Thomas Lucy, and found it necessary to leave Stratford in order to escape punishment. It is added that he afterward took his revenge on Lucy by satirizing him as the Justice Shallow of *The Merry Wives of Windsor.* From this event until he emerges as an actor and rising playwright in 1592 his history is a blank. and it is impossible to say what experience may not have helped to fill it. Much might indeed be done in eight years of cronded Elizabethan life Conjecture has not been idle and has assigned him in turn to the occupations of a scrivener. an apothecary. a dyer, a printer a soldier and the like The suggestion that he saw military service rests largely on a confusion with another William Shakespeare of Rowington. Aubrey had heard that "he had been in his younger years a schoolmaster in the country." The mention in *Henry 11'* of certain obscure yeomen families. Visor of Woncote and Perkes of Stinchcombe Hill. near Dursley in Gloucestershire. has been thought to suggest a sojourn in that district. where indeed Shakespeares were to be found from an early date. Ultimately of course, he drifted to London and the theatre. where. according to the stage tradition he found employment in a menial capacity. perhaps even as a holder of horses at the doors, before he was admitted into a company as an actor and so found his nay to his true vocation as a writer of plays. Edmund Malone thought that he might have left Stratford with one of the traveling companies of players which visited the town Later biographers have fixed upon Leicester's men. who were at Stratford in 1586–87. and have held that Shakespeare remained to the end in the same company. passing with it on Leicester's death in 1588 under the patronage of Ferdinando, Lord Strange and afterward earl of Derby. and on Derby's death in 1594 under that of the lord chamberlain. Henry Carey. Lord Hunsdon This theory hardly takes account of the shifting combinations and recombinations of actors, especially during the disastrous plague years of 1592 to 1594. It is not possible to establish a contmuity betneen Strange's company and Leicester's, and nhile the names of many members of Strange's company in and about 1593 are on record, Shakespeare's is not among them It is at least possible. as will be seen later. that he was in contact with the earl of Pembroke's men about this time. or with the earl of Sussex' men, or with both.

Earliest **Writings.**—What is clear is that by the summer of 1592, when he nas 28, he had begun to emerge as a playnright and had evoked the jealousy of at least one of the group of scholar poets who in recent years had claimed a monopoly of the stage This was Robert Greene, nho, in an Invective on behalf of the playmakers against the play actors which forms part of his *Groats-worth of Wit*, speaks of "an upstart Crow, beautified with our feathers, that with his *Tygers heart wrapt in a Players hide,* supposes he is as well able to bumbast out a blank verse as the best of you. and being an absolute *Iohannes fac totum,* is in his owne conceit the onely Shake-scene in a countrie" The play upon Shakespeare's name and the parody of a line from *Henry VI* make the reference unmistakable. The London theatres were closed, first through riots and then through plague from June 1592 to April 1594. with the exception of about a month at each Christmas during that period, and the companies were dissolved or driven to the provinces Even if Shakespeare had been connected with Strange's men during their London seasons of 1592 and 1593, it does not seem that he traveled with them. Other activities may have been sufficient to occupy the interval. The most important of these was probably an attempt to win a reputation as a nondramatic poet. *Venus and Adonts* was published about April 1593. and *Lucrece* about May 1594. These books were printed by Richard Field, who had come to London from Stratford. Each has a dedication to Henry Wriothesley. earl of Southampton. a brilliant and accomplished favourite of the court. who was not yet of age. A possibly supersubtle criticism discerns an mcreased warmth in the tone of the second dedication, which is supposed to argue a marked growth of intimacy. The fact of this intimacy is vouched for by the story handed down from Sir William Davenant to Roue (uho published in 1709 the first regular biography of Shakespeare) that Southampton gave Shakespeare £1,000 "to enable him to go through with a purchase which he heard he had a mind to" The date of this generosity is not specified, and there is no known purchase by Shakespeare which can have cost anything like the sum named. The mention of Southampton leads naturally to the most difficult problem which a biographer has to handle, that of the *Sonnets*. But this will be more conveniently taken up at a later point. and it is necessary here only to record the probability that the earliest of the sonnets belong to this period. There is a surmise. not too implausible and supported by much ingenious argument, that Shakespeare's enforced leisure enabled him to make of 1j93 a *Wanderjahr*, and in particular that the traces of a visit to northern Italy may be seen in the local colouring of *Lucrece* as compared with *Venus and Adonis,* and in that of the group of plays nhich may be dated in or about 1594 and 1595 as compared with those that preceded. It must, honever. be kept in mind that. while Shakespeare may perfectly well. at this or at some earlier time have voyaged to Italy. and possibly Denmark and even Germany as well. there is no direct evidence to rely upon. and that inference from internal evidence is a dangerous guide when a writer of so assimilative a temperament is concerned

Connection With the Chamberlain's Company of Actors.—From the reopening of the theatres in the summer of 1594 onward. Shakespeare's status is in many ways clearer. He had certainly become a leading member of the Chamberlain's company by the following winter. when his name appears for the first and only time in the accounts of the treasurer of the chamber as one of the recipients of payment for their performances at court: there is every reason to suppose that he continued to act with and write for the same associates to the close of his career. The history of the company may be briefly told. At the death of the lord chamberlain on July 22, 1596, it passed under the protection of George, 2nd Lord Hunsdon, and once more became "the Lord Chamberlain's men" when he was appointed to that office on March 17, 1597. James I on his accession took this company under his patronage as grooms of the chamber. and during the remainder of Shakespeare's connection with the stage they were "the King's men." The records of performances at court show that they were by far the most favoured of the companies, their nearest rivals being the company known during the reign of Elizabeth I as "the Admiral's," and afterward as "Prince Henry's men." From the summer of 1594 to March 1603 they appear to have played almost continuously in London. although they undertook a provincial tour during autumn. 1597. when the London theatres were closed because of the interference of some of the players in politics. They traveled again during 1603 when the plague was in London. and during. at any rate, portions of the summers or autumns of most years thereafter. In 1594 they were playing at Newington Butts, and probably afterward at the Cross Keys in the city. It is natural to suppose that in later years they used the Theatre in Shoreditch. since this was the property of James Burbage, the father of their principal actor, Richard Burbage. The Theatre was pulled down in 1598; after a short interval during which the company may have played at the Curtain (also in Shoreditch). Richard Burbage and his brother Cuthbert rehoused them in the Globe on Bankside, built partly out of the materials of the Theatre. There the profits of the enterprise were divided between the members of the company as such and the owners of the building as "housekeepers," and shares in the "house" were held by Shakespeare and some of his leading "fellows." About 1608 another playhouse became available for the company in the "private" or winter house of the Blackfriars. This was also the property of the Burbages, but had previously been leased to a company of boy players. A somewhat similar arrangement with profits was made.

Shakespeare is reported by Aubrey to have been a good actor, but Adam in *As You Like It* and the Ghost in *Hamlet* indicate the type of part he played. As a dramatist, however, he was the mainstay of the company for at least 15 years. during which Jonson, Dekker, Beaumont and Fletcher, and Cyril Tourneur also contributed to their repertory. On an average he must have written about two plays a year for them, although he seems to have been most productive during the opening years of the period. He occasionally took his plots from earlier plays, but theories which represent him as largely a "patcher" of the work of other men, or of his own, seem to be generally abandoned. Similarly, while the texts of his plays contain some theatrical interpolations. there is no reason to suppose that they were substantially revised by other hands before the Restoration. Occasionally he may have entered into collaboration. as, for example. at the end of his career. with Fletcher.

Stratford Affairs. — In a worldly sense he clearly flourished, and about 1596. if not earlier he was able to resume relations as a moneyed man n-ith Stratford-on-Avon. There is no evidence to show whether he had visited the town in the interval. or whether he had brought his wife and family to London. His son Hamnet died in 1596. During the last ten years John Shakespeare's affairs had remained unprosperous. He incurred debts. partly through becoming surety for his brother Henry. and in 1592 his name was included in a list of recusants dwelling at or near Stratford. with a note by the commissioners that in his case the cause was believed to be the fear of process for debt. There is no reason to doubt this explanation or to seek a religious motive in John Shakespeare's abstinence from church. William Shakespeare's purse must have made a considerable difference. The prosecutions for debt ceased. and in 1597 a fresh action was brought in chancery for the recovery of the Wilmcote property from the Lamberts. It seems to have been without result. Another step was taken to secure the dignity of the family by an application in 1596 to the heralds for the confirmation of a coat of arms said to have been granted to John Shakespeare while he was bailiff of Stratford. The bearings were *or* (gold)on a bend *sable* (black) a spear *or* steeled *argent* (silver), the crest a falcon. his wings displayed *argent* supporting a spear *or* steeled *argent*, and the motto *Non sanz droict* ("Not without right"). The grant was made. and in 1599 there was a further application for leave to impale the arms of Arden. in right of Shakespeare's mother. No use, hon-ever. of the Arden arms by the Shakespeares can be traced. In 1597 Shakespeare made an important purchase for £60 of the house and gardens of New Place in Chapel street. This was one of the largest houses in Stratford. Presumably John Shakespeare ended his days in peace. A visitor to his shop remembered him as "a merry-cheekt old man" always ready to crack a jest with his son. He died in 1601. and his wife in 1608, and the Henley street houses passed to William. Aubrey records that William paid annual visits to Stratford, and there is evidence that he kept in touch with the life of the place. The correspondence of his neighbours. the Quineys, in 1598 contains an application to him for a loan to Richard Quiney upon a visit to London.. and a discussion of possible investments for' him in the neighbourhood of Stratford. In 1602 he took, at a rent of 2s. 6d. a year, a copyhold cottage in Chapel lane. perhaps for his gardener. In the same year he invested £320 in the purchase of an estate of 107 ac. in the open fields of Old Stratford. together with 20 ac. of pasture and common rights: in 1605 he spent another £440 in the outstanding term of a lease of certain tithes in Stratford parish. which brought in an income of about £60 a year.

London Associations. — He continued meanwhile to live near the theatres. There is evidence that in 1 j96 he was living in Southwark. Payments of subsidy were due from him in 1597 and 1599 in the parish of St. Helen's. Bishopsgate. and an arrear was ultimately collected in the liberty of the Clink. He had no doubt migrated from Bishopsgate when the Globe upon Bankside was opened by the Chamberlain's men. There is evidence that about 1604 he "lay," temporarily or permanently, in the house of Christopher Mountjoy, a tiremaker of French extraction. at the corner of Silver street and Monkwell street in Cripplegate. A note by Aubrey, if it really refers to Shakespeare (which is almost certain), is of value as thron-ing light not only upon his abode, but upon his personality. Aubrey seems to have derived it from William Beeston the actor. It is as follows: "The more to be admired q[uod] he was not a company keeper. lived in Shoreditch, wouldn't be debauched. & if invited to court; he was in paine." Against this evidence of the correctness of Shakespeare's morals are to be placed an anecdote of a tiring-house amour picked up by a Middle Temple student in 1602 and a Restoration scandal which made him the father, by the hostess of the Cron-n tavern at Oxford where he stayed en route to Stratford. of Sir William Davenant. who was born in Feb. 1606. His credit at court is implied by Jonson's references to his flights "that so did take Eliza and our James." and by stories of the origin of *The Merry Wives of Windsor* in Elizabeth I's desire to see Falstaff in love, and of an autograph letter written to honour him by King James. It was noticed by Henry Chettle that his "honied muse" dropped no "sable tear" to celebrate the death of the queen. Southampton's patronage may have introduced him to the brilliant circle around the earl of Essex. but there is no reason to suppose that he or his company were held responsible for the performance of *Richard II* at the command of some of the followers of Essex as a prelude to the disastrous rising of Feb. 1601. The editors of the First Folio speak also of favours received by the author in his lifetime from William Herbert. earl of Pembroke. and his brother Philip Herbert, earl of Montgomery.

He appears to have been on cordial terms with his fellows of the stage. One of them. Augustine Phillips. left him a small legacy in 1605, and in his own will he paid a similar compliment to Richard Burbage. and to John Heming and Henry Condell, nho afterward edited his plays. His relations with Jonson, whom he is said by Rowe to have introduced to the world as a playwright! have been much discussed. Jests are preserved which, even if apocryphal, indicate considerable intimacy between the two. This is not inconsistent with occasional passages of arms. The anonymous author of *The Return From Parnassus* (2nd part: 1602), for example. makes William Rempe, the actor, allude to a "purge" which Shakespeare gave Jonson, in return for his attack on some of his rivals in *The Poetaster*.[1] It has been conjectured that this purge was the description of Ajax and his humours in *Troilus and Cressida*. Jonson, on the other hand, who was criticism incarnate, did not spare Shakespeare either in his prologues or in his private conversation. He told William Drummond of Hawthornden that "Shaksperr wanted arte." But the verses which he contributed to the First Folio are generous enough to make all amends, and in his *Discoveries* (1623–37), while regretting Shakespeare's excessive facility and the fact that he often "fell into those things, could not escape laughter." he declares him to have been "honest and of an open. and free nature." and says that, for his own part. "I lov'd the man and do honour his memory (on this side idolatryj as much as any." According to a memorandum book (1661–63) of the Rev. John Ward (who became vicar of Stratford in 1662), Jonson and Michael Drayton, himself a Warwickshire poet. had been drinking with Shakespeare when he caught the fever of which he died: and Thomas Fuller (1608–61), whose *Worthies* was published in 1662, gives an imaginative description of the wit combats which took place between the two.

Contemporary Reputation. — Of Shakespeare's literary reputation during his lifetime there is ample evidence. He is probably neither the "Willy" of Edmund Spenser's *Tears of the Muses,* nor the "Aetion" of his *Colin Clout's Come Home Againe.* But from the time of the publication of *Venus and Adonis* and *Lucrece* allusions in praise of his work both as poet and dramatist, and often to himself by name, come thick and fast from writers of every kind and degree. Perhaps the most interesting of these from the biographical point of view are contained in the *Palladis Tamia,* a kind of literary handbook published by Francis Meres in 1598, for Meres not only wrote of him as "the most excellent in both kinds (*i.e.*, comedy and tragedy) for the state," and one of "the most passionate among us to bewaile and bemoane the perplexities of Love." but also took the trouble to give a list of 12 plays already written, which serves as a starting point for all modern attempts at a chronological arrangement of his work. It is, moreover, from Meres that we first hear of "his sugred sonnets among his private friends." Two of these sonnets were printed in 1599 in a volume of miscellaneous verse called *The Passionate Pilgrim.* This was ascribed upon the title page to Shakespeare, but probably, so far as most of its contents were concerned, without justification. The bulk of Shakespeare's sonnets remained unpublished until 1609.

[1]Kempe (speaking to Burbage), "Few of the university men pen plays well. They smell too much of that writer Ovid and that writer (sic) Metamorphosis, and talk too much of Proserpina and Jupiter. Why here's our fellow Shakespeare puts them all down; aye, and Ben Jonson too. O that Ben Jonson is a pestilent fellow. He brought up Horace giving the Poets a pill, but our fellow Shakespeare hath given him a purge that made him beray his credit."

About 1610 Shakespeare seems to have left London, and to have finally settled in his house at New Place. Stratford. There he lived the life of a retired gentleman. on friendly if satirical terms with the richest of his neighbours. the Combes. and interested in local affairs. such as a bill for the improvement of the highways in 1611. or a proposed enclosure of the open fields at Welcombe in 1614. which might affect his income or his comfort. He had his garden with its mulberry tree, and his farm in the immediate neighbourhood. His brothers Gilbert and Richard were still alive. His sister Joan had married William Hart, a hatter, and in 1616 was dwelling in one of his houses in Henley street. In 1607 his eldest daughter. Susanna. had married John Hall (d. 1635), a physician of some reputation. They lived in Stratford and had one child. Elizabeth, born in 1608. The younger daughter. Judith, married Thomas Quiney, a vintner, also of Stratford, two months before her father's death. The last few of the plays may have been written at Stratford. but it is reasonable to suppose that Shakespeare's connection with the King's company ended when the Globe was burned down during a performance of *Henry VIII* on June 29, 1613. Certainly his retirement did not imply an absolute break with London life. In 1613 he devised an *impresa,* or emblem. to be painted by Richard Burbage, and worn in the tilt on .Accession day by the earl of Rutland, who had been one of the old circle of Southampton and Essex. In the same year he purchased for £140 a freehold house in the Blackfriars. near the Wardrobe, once a gatehouse to the lodging of the prior of Blackfriars. This was conveyed to trustees, apparently in order to bar the right which his widow would otherwise have had to dower. In 161j this purchase involved Shakespeare in a lawsuit to obtain the surrender of the title deeds. Richard Davis. a Gloucestershire clergyman of the late 17th century, reports that the poet "died a papist." There is little to corroborate this; the alleged "spiritual testament" of John Shakespeare: an 18th-century discovery, cannot in fact be confidently connected with the poet's father at all. and Davis' own words suggest a late conversion rather than a hereditary faith. On the other hand. there is little to refute it beyond an entry in the accounts of Stratford corporation for drink given in 1614 to "a preacher at the Newe Place."

Will and Death. — Shakespeare made his will on March 25, 1616. apparently in some haste. as the executed deed is a draft with many erasures and interlineations. There were legacies to his daughter Judith Quiney and his sister Joan Hart, and remembrances to friends both in Warwickshire and in London; but the property was left to his daughter Susanna Hall under a strict entail which points to a desire on the part of the testator to found a family. Shakespeare's wife. who had of course dower in most of the property. is mentioned only in an interlineation. by which the "second best bed with the furniture" was beaueathed to her. Much nonsense has been written about this. but it seems quite natural. The best bed was an important chattel. which would go with the house. The estate was after all not a large one. Aubrey's estimate of its annual value as £200 or £300 a year sounds reasonable enough, and John Ward s statement that Shakespeare spent £1.000 a year must surely be an exaggeration The sum total of his known investmepts amounts to £960 Sir Sidney Lee's calculation that his theatrical income must have reached £600 a vear is a considerable overestimate; it can hardly have been more than about £200. It must be remembered that the purchasing value of money in the 17th century was many times greater than at present. Shakespeare's interest in the "houses" of the Globe and Blackfriars probably ended on or before his death.

A month after his will was signed Shakespeare died, on April 23 (old style: May 3. new style), 1616. and as a tithe owner was buried in the chancel of the parish church. Some doggerel upon the stone that covers the grave has been assigned by local tradition to his onn pen A more elaborate monument with a bust by the sculptor Gerard Johnson was in due course set up on the chancel wall Anne Shakespeare followed her husband on hug 6. 1623 The family was never founded Shakespeare s granddaughter, Elizabeth Hall made tno childless marriages the first nith Thomas Nash of Stratford the second nith John (afternard Sir John) Barnard of Abington Manor, Northamptonshire His daughter Judith Quiney had three sons! all of whom had died unmarried by 1639. There were, therefore, no direct descendants of Shakespeare in existence after Lady Barnard's death in 1670. Those of his sister, Joan Hart. could, however, still be traced in 1864. On Lady Barnard's death the Henley street houses passed to the Harts, in whose family they remained until 1806. They were then sold, and in 1847 were bought for the public. They are now held with Anne Hathaway's cottage at Shottery as the Birthplace trust. Lady Barnard had disposed of the Blackfriars house. The rest of the property was sold under the terms of her will, and New Place passed. first to the Cloptons, who rebuilt it, then to the Rev. Francis Gastrell, who pulled it down in 1759. The grounds of the site are now open to the public, and nearby is the Shakespeare Memorial theatre (burned, but rebuilt and opened in 1932) in which performances of Shakespeare's plays are given annually. Both the Memorial theatre and the Birthplace contain museums, in which books. documents and portraits of Shakespearean interest, together n-ith relics of greater or less authenticity, are stored.

No letter or other writing in Shakespeare's hand can be proved to exist, with the exception of three signatures upon his will, one upon a deposition (May 11. 1612) in a lawsuit with which he was remotely concerned. and two upon deeds (March 10 and 11, 1613) in connection with the purchase of his Blackfriars house. Aubrey records that he was "a handsome, well-shap't man." and the lameness attributed to him by some writers has its origin only in a too literal interpretation of certain references to spiritual disabilities in the *Sonnets*.

THE PLAYS

Editions.—A collection of *Mr. William Shakespeare's Comedies, Histories and Tragedies* was printed at the press of William and Isaac Jaggard. and issued by a group of booksellers in 1623. This volume is known as the First Folio. It has dedications to the earls of Pembroke and Montgomery, and to "the great Variety of Readers." both of which are signed by two of Shakespeare's "fellows" at the Globe. John Heming and Henry Condell, and commendatory verses by Ben Jonson. Hugh Holland. Leonard Digges and an unidentified I.M. The Droeshout engraving forms part of the title page. The contents include, with the exception of *Pericles,* all of the 37 plays now ordinarily printed in editions of Shakespeare's works. Of these 18 were published for the first time. The other 18 had already appeared in one or more separate editions. known as the quartos.

The following list gives the date of the First Quarto of each such play, and also that of any later quarto which differs materially from the first.

The Quarto Editions

Titus Andronicus (1594)
2 *Henry VI* (1594)
3 *Henry VI* (1595)
Richard II (1597, 1608)
Richard III (1597)
Romeo and Juliet (1597, 1599)
Love's Labour's Lost (1598)
1 *Henry IV* (1598)
2 *Henry IV* (1600)
Henry V (1600)
A Midsummer Night's Dream (1600)
The Merchant of Venice (1600)
Much Ado About Nothing (1600)
The Merry Wives of Windsor (1602)
Hanzlet (1603, 1604)
King Lear (1608)
Troilus aad Cressida (1609)
Othello (1622)

Entries in the *Register* of copyrights kept by the Company of Stationers indicate that editions of *As You Like It* and *Antony and Cleopatra* were contemplated but not published in 1600 and 1608 respectively.

The quartos vary much in quality. Some of them contain texts which are practically identical with those of the First Folio; others show variations so material as to suggest that some alteration, generally by way of shortening for stage purposes, took place. A group of First Quartos. including 2 *Henry VI*, 3 *Henry VI*, *Romeo and Juliet*, *Henry V*, *The Merry Wives* of *Windsor* and *Hamlet,* are labeled "bad quartos"; it is practically certain that *Richard III* and *King Lear* should be added to this list, and it is highly probable that there was a (no longer extant) bad quarto of *Love's Labour's Lost.* The bad quartos tend to shortness; they are textually corrupt and are generally believed to have a surreptitious origin in "memorial reconstruction" by an actor or actors, or a prompter.

Theories formerly held that they represent "early versions" of the plays or that they derive from shorthand reports of performances in the theatre no longer appear to find supporters. Most of them must have been printed without the consent of the theatrical companies which owned the plays. and the phenomenon is to be observed also in connection with plays by authors other than Shakespeare. Shakespeare's name or initials were printed on the title pages of *Locrine* (1595), *Sir John Oldcastle* (1600), *Thomas Lord Cromwell* (1602). *The London Prodigal* (1605), *The Puritan* (1607). *A Yorkshire Tragedy* (1608) and *Pericles* (1609). It is not likely that, with the exception of *Pericles,* he wrote any part of these plays, some of which were not even produced by his company. They were not included in the First Folio of 1623, or in a reprint of it in 1632, known as the Second Folio; but all seven were appended to the second issue (1664) of the Third Folio (1663) and to the Fourth Folio of 1685. Shakespeare is named as joint author with John Fletcher on the title page of *The Two Noble Kinsmen* (1634), and with William Rowley on that of *The Birth of Merlin* (1662); there is no reason for rejecting the former ascription or for accepting the latter. Late entries in the Stationers' *Register* assign to him *Cardenio* (with Fletcher). *Henry I* and *Henry II* (both with Robert Davenport), *King Stephen, Duke Humphrey* and *Iphis and Ianthe;* none of these plays is extant. Conjecture has attempted to trace his hand in other plays. of which *Arden of Feversham* (1592), *Edward III* (1596), *Mucedorus* (1598) and *The Merry Devil of Edmonton* (1608) are the most important; he may possibly have had a share in *Edward III.* A play on *Sir Thomas More,* which has been handed down in manuscript. contains passages interpolated in various handwritings. and a theory that one is in that of Shakespeare, and gives indications of his orthography and methods of composition, would appear to have won general acceptance.

An attempt to publish a collected edition of the plays seems to have been made in 1619. It was apparently planned to bring out ten plays—The *Merchant of Venice* and *A Midsummer Night's Dream,* the bad quarto versions of the *Henry VI* plays. *Merry Wives, King Lear* and *Henry V,* two of the spuriously attributed plays, and *Pericles.* There is a possibility that undated quartos of *Romeo and Juliet* and *Hamlet* (not in bad quarto versions) were connected with the venture. Official intervention hampered the enterprise and the first ten plays came. separately, surreptitiously and, some of them. with false dates and imprints, from the press of William Jaggard. later the printer of the First Folio; the other two were printed without dates by William Stansby for the owner of the copyright, John Smethwick, later a First Folio shareholder.

Chronology.—The First Folio, unfortunately, does not give the dates at which the plays in it were written or produced; the endeavour to supply this deficiency has been one of the main preoccupations of Shakespearean scholarship: since Edmund Malone's *An Attempt to Ascertain the Order in Which the Plays of Shakespeare Were Written* (1778). The investigation is not a mere piece of barren antiquarianism, for on it depends the possibility of appreciating the work of the world's greatest poet. not as if it were an articulated whole like a philosophical system, but in its true aspect as the reflex of a vital and constantly developing personality. A starting point is afforded by the dates of the quartos and the entries in the Stationers' *Register* which refer to them. and by the list of plays already in existence in 1598 which is inserted by Francis Meres in his *Palladis Tamia* of that year. and which, while not necessarily exhaustive of Shakespeare's pre-1598 writing. includes *The Two Gentlemen of Verona, The Comedy of Errors, Love's Labour's Lost, A Midsummer Night's Dream, The Merchant of Venice, Richard II, Richard III, Henry IV, King John, Titus Andronicus* and *Romeo and Juliet,* as well as a mysterious *Love's Labour's Won,* which must be considered to be a play once printed in quarto and now no longer surviving in a single copy. There is a mass of supplementary evidence, drawn partly from definite notices in other writings or in diaries, letters. account books and similar records, partly from allusions to contemporary persons and events in the plays themselves, partly from parallels of thought and expression between each play and those near to it in point of time, and partly from considerations of style: including the so-called metrical tests, which depend upon an analysis of Shakespeare's varying feeling for rhythm at different stages of his career. The total result is certainly not a demonstration, but in the logical sense a hypothesis which serves to colligate the facts and is consistent with itself and with the known events of Shakespeare's external life.

The following list is an attempt to arrange the original dates of production of the plays according to the theatrical seasons. from autumn to autumn, in which they may have fallen. It is framed on the assumption that. as indeed John Ward tells us was the case. Shakespeare ordinarily wrote two plays a year; but some slackening of production in the later years seems probable.

This chronology is taken from Sir Edmund Chambers' *William Shakespeare.* It will be understood that neither the order in which the plays are given nor the distribution of them over the years lays claim to more than approximate accuracy. Later scholarship has found a tendency to push back the dates of the earlier plays. to date 1 *Henry VI* before the second and third parts, and to argue for numerous minor alterations. As, however. Chambers' book remains the standard scholarly life of Shakespeare, it is convenient to retain his order and chronology.

Chronology of the Plays

1590–91
(1, 2) 2, 3 *Henry VI*

1591–92
(3) 1 *Henry VI*

1592–93
(4) *Richard III*
(5) *Comedy of Errors*

1593–94
(6) *Titus Andronicus*
(7) *Taming of the Shrew*

1594–95
(8) *Two Gentlemen of Verona*
(9) *Love's Labour's Lost*
(10) *Romeo and Juliet*

1595–96
(11) *Richard II*
(12) *Midsummer Night's Dream*

1596–97
(13) *King John*
(14) *Merchant of Venice*

1597–98
(15, 16) 1, 2 *Henry IV*

1598–99
(17) *Much Ado About Nothing*
(18) *Henry V*

1599–1600
(19) *Julius Caesar*
(20) *As You Like It*
(21) *Twelfth Night*

1600–01
(22) *Hamlet*
(23) *Merry Wives of Windsor*

1601–02
(24) *Troilus and Cressida*

1602–03
(25) *All's Well That Ends Well*

1604–05
(26) *Measure for Measure*
(27) *Othello*

1605–06
(28) *King Lear*
(29) *Macbeth*

1606–07
(30) *Antony and Cleopatra*

1607–08
(31) *Coriolanus*
(32) *Timon of Athens*

1608–09
(33) *Pericles*

1609–10
(34) *Cymbeline*

1610–11
(35) *Winter's Tale*

1611–12
(36) *Tempest*

1612–13
(37) *Henry VIII*
(38) *Two Noble Kinsmen*

Composition and **Sources.**—A more detailed account of the individual plays may now be attempted. The figures here prefixed correspond to those listed in the chronology.

1, 2. The relation of *The Contention of York and Lancaster* to 2, 3 *Henry VI* and the extent of Shakespeare's responsibility for either or both works have long been subjects of controversy. The extremes of critical opinion are to be found in a theory which regards Shakespeare as the sole author of 2. 3 *Henry VI* and *The Contention* as a shortened and surreptitious version of the original plays. and in a theory which regards *The Contention* as written in collaboration by Christopher Marlowe. Robert Greene and possibly George Peele, and 2. 3 *Henry VI* as a revision of *The Contention* written, also in collaboration, by Marlowe and Shakespeare. A comparison of the two texts leaves it hardly possible to doubt that the differences between them are to be explained by reporting rather than by revision; scholarly opinion has tended more and more to regard the plays as coming from the unaided pen of Shakespeare. Greene's parody. in the "Shake-scene" passage of his *Groats-worth of Wit* (1592). of a line which occurs both in

The Contention and in 3 *Henry VI,* while it clearly suggests Shakespeare's connection with the plays, is evidence neither for nor against the participation of other men, and no sufficient criterion exists for distinguishing between Shakespeare's earliest writing and that of possible collaborators on grounds of style. But the blank verse style of 2. 3 *Henry 1'1* may quite well be an earlier stage of that found more fully developed in *Richard III*, and it is difficult to assign to anyone except Shakespeare the humour of the Jack Cade scenes. Views which exclude Shakespeare altogether may be left out of account. *Henry VI* is not in Meres's list of his plays, but its inclusion in the First Folio is an almost certain ground for assigning to him some share in the work.

3. It has been argued that such variety and poor quality of style are found in I *Henry VI* that it is difficult to regard Shakespeare as its sole author, even at the earliest stage of his development. It is assuredly unlikely that the text of the First Folio represents that of its original performances. The Temple Gardens scene (ii, 4), which is that most obviously Shakespeare's, was probably a later addition. Thomas Nashe refers to the representation of Talbot on the stage in his *Pierce Penilesse, His Supplication to the Divell* (1592), and it is probable that I *Henry I'1* is to be identified with the "Harey the vj" recorded in Philip Henslowe's *Diary* as having been acted on March 3, 1592, by Lord Strange's men, probably at the Rose theatre.

4. The *Henry VI* series leads directly up to *Richard 111,* and this relationship, together with its style as compared with that of the plays of 1594–96, suggests the short winter season of 1592–93 as the most likely time for the production of *Richard III*. There is a difficulty in that it is not included in Henslowe's list of the plays acted by Lord Strange's men during that season. But it may quite n-ell have been produced by the only other company which appeared at court during the Christmas festivities. Lord Pembroke's. The mere fact that Shakespeare wrote a play. or more than one play, for Lord Strange's men during 1592–94 does not prove that he never wrote for any other company during the same period; and indeed there is plenty of room ior guesswork as to the relations between Strange's and Pembroke's men. The latter are not known to have existed before the latter part of 1592, and many difficulties would be solved by the assumption that they originated out of a division of Strange's. who had amalgamated with the Admiral's. and may have found their numbers too much inflated to enable them to undertake as a whole the autumn tour of that year. If so, Pembroke's probably took over the *Henry VI* series of plays, since part of *The Contention,* under the name of the *True Tragedy of Richard Duke of York,* was published as performed by them, and completed it with *Richard 111* at Christmas. It will be necessary to return to this theory in connection with the discussion of *Titus Andronicus* and *The Taming of the Shrew*. The principal historical source for *Henry VI* was Edward Hall's *The Union of the Noble and Illustre Families of Lancaster and York* (1542), and for *Richard III,* as for most of Shakespeare's later historical plays, the second edition (1587) of Raphael Holinshed's *Chronicles of England, Scotland and Ireland* (1577). An earlier play, *The True Tragedy of Richard the Third* (1594), seems to have contributed little if anything to *Richard III*.

5. To the winter of 1592–93 may also be assigned with fair probability Shakespeare's first experimental comedy. *The Comedy of Errors,* and if his writing at one and the same time for Pembroke's and for another company is not regarded as beyond the bounds of conjecture, it becomes tempting to identify this with "the gelyous comodey" produced. probably by Strange's men, for Henslowe as a new play on Jan. j, 1593. The play contains a reference to the wars of succession in France which would fit any date from 1589 to 1594. The plot is taken from the *Menaechmi* and to a smaller extent from the *Amphitruo* of Plautus. William Warner's translation of the *Menaechmi* was entered in the Stationers' *Register* on June 10. 1594. A performance of *The Comedy of Errors* by "a company of base and common fellows" (including Shakespeare?) is recorded in the *Gesta Grayorum* as taking place in Gray's Inn hall on Dec. 28. 1j94

6. Many scholars have been loath to see the hand of Shakespeare in *Titus Andronicus;* the double testimony of its inclusion in Meres's list and in the First Folio makes its total rejection hazardous. A stage tradition was recorded by Edward Ravenscroft, a late 17th-century adapter of the play, that Shakespeare did no more than give a few "master touches" to the work of a "private author." The share of a collaborator has, however, been much whittled down in accordance with the general departure from "disintegrationist'; theories and many authorities are prepared to regard the play as Shakespeare's throughout. It remains. however, extremely difficult to produce a convincing and coherent hypothesis about its early stage history. The play was entered in the Stationers' *Register* on Feb. 6. 1594, and was published in the same year with a title page setting out that it had been acted by the companies of Lords Derby (*i.e.,* Strange, who had succeeded to his father's title on Sept. 25, 1593), Pembroke and Sussex. It is natural to take this list as indicating the order in which the three companies named were concerned with it. Henslowe records the production by Sussex' company of *Titus Andronicus* as a new play on Jan. 23, 1594, only a few days before the theatres were closed by plague. For the purposes of Henslowe's financial arrangements with the company a rewritten play may have been classed as new. Two years earlier he had appended the same description to a play of *Tittus and Vespacia* (as used in Henslowe's *Diary;* more generally *Titus and Vespasian*), produced by Strange's men on April 11 1592. At first sight the title suggests a piece founded on the lives of the emperors Titus and Vespasian, but there are some grounds. although far from conclusive. for supposing the play to have been an early version of *Titus Andronicus*. It is difficult to explain the company names on the title page unless there had been some version earlier than that of 1594. Pembroke's men are known from a letter of Henslowe's to have been ruined by Aug. 1j93. and it is to be suspected that Sussex'. who appeared in London for the first time at Christmas 1593, acquired their stock of plays and transferred these to the Chamberlain's men when the companies were again reconstituted in the summer of 1594. The Chamberlain's men were apparently playing *Andronicus* in June. The stock of Pembroke's men probably included. as well as *Titus and Vespasian,* both *Henry VI* and *Richard 111,* which also thus passed to the Chamberlain's company. The source of the plot is unknown; there are only slight hints for it in Byzantine chronicles. The relationship between the play and a chapbook version of the story. extant only in an 18th-century printing, remains obscure. It is not impossible that the chapbook represents Shakespeare's source material.

7. A play of *The Taming of a Shrew,* which can be traced back as far as 1589, was published in 1594 as acted by Pembroke's men. In June 1594 it was being acted by the Chamberlain's. There is little agreement among scholars concerning the relationship between *a Shrew* and Shakespeare's *The Shrew.* There are considerable differences between the two texts. One doctrine is that Shakespeare's play is his adaptation of the other; another is that *A Shrew* is a bad quarto of *The Shrew* (it shows all the signs of being a bad quarto of something); supporters of the latter view are forced to date *The Shrew* extremely early. It has been suggested in the past that the hands of two authors are to be seen in *The Shrew;* the evidence for this is not notably cogent. The origins of the play, which is to be classed as a farce rather than a comedy, are to be found ultimately in widely distributed folk tales, and more immediately in Ariosto's *I Suppositi* (1509) as translated in George Gascoigne's *The Supposes* (1566). Those who regard *The Shrew* as an adaptation of *A Shrew* suggest that it may have been Shakespeare's first task for the newly established Chamberlain's company of 1594 to refurbish the old farce. Thenceforward there is no reason to think that he ever wrote for any other company.

8. No very definite evidence exists for the date of *The Two Gentlemen of Verona,* other than the mention of it in *Palladis Tamia.* It is evidently a more rudimentary essay in the genre of romantic comedy than *The Merchant of Venice,* with which it has other affinities in its Italian colouring and its use of the interrelations of love and friendship as a theme; and it may be roughly assigned to the winter of 1594–95. The plot is drawn from various examples of contemporary fiction, especially from the story

of the shepherdess Filismena in Jorge de Montemayor's *Diana* (1559). A play of *Felix and Philiomena* had already been given at court in 1585.

9. *Lose's Labour's Lost* used to be regarded as the first of Shakespeare's plays. and has sometimes been placed as early as 1589. So early a date is extremely improbable. The characters of *Love's Labour's Lost* are evidently suggested by Henry of Navarre, his follon-ers Biron, Longueville and D'Aumont. who has probably been confused with the Catholic league leader, the duc de Maine. These personages would have been familiar at any time from 1591 onward, but Navarrese history of 1578 has also been drawn upon. and the channel of transmission to Shakespeare is unknown. The absence of the play from the lists in Henslowe's *Diary* does not leave it impossible that it should have preceded the formation of the Chamberlain's company. but certainly renders this less likely; and its lyric character perhaps justifies its being grouped with the other lyric plays of 1594–96. No entry of the play is found in the Stationers' *Register;* it is most likely that the present First Quarto of 1598 was not really the first edition, but replaces a lost bad quarto edition. The title page professes to give the play as "corrected and augmented" and as given at the Christmas of 1597. It was again revived for that of 1604 No literary source is known for its incidents.

10. Romeo and Juliet, which was published in 1597 as played by Lord Hunsdon's men, was probably produced somewhat before *A Midsummer Night's Dream,* as its incidents seem to have suggested the parody of the Pyramus and Thisbe interlude. An attempt to date it in 1591 is hardly justified by the Nurse's reference to an earthquake 11 years before and the fact that there was a real earthquake in London in 1580. The text of the First Quarto is surreptitious, and was "corrected, augmented and amended" in the Second Quarto of 1599. There had been an earlier play on the subject, but the immediate source was Arthur Brooke's narrative poem *Romeus and Juliet* (1562).

11. Richard II can be dated with some accuracy by a comparison of the two editions of Samuel Daniel's narrative poem on *The Civil Wars Between the Two Houses of Lancaster and York,* both of which bear the date of 1j gj and were therefore issued between March 25, 1595, and March 24. 1jg6 (new style). It is possible that a performance was given before Sir Robert Cecil in Dec. 1595. The second edition. but not the first: contains some close parallels to the play. From the first three quartos of *Richard II,* one published in 1597 and two in 1598, the deposition scene was omitted, although it was clearly part of the original structure of the play, and its removal leaves an obvious mutilation in the text. There is some reason to suppose that this was due to a popular tendency to draw seditious parallels between Richard and Elizabeth, and it became one of the charges against the earl of Essex and his fellow conspirators in the abortive outbreak of Feb. 1601 that they had procured a performance of a play on Richard's fate to stimulate their followers. As the actors were the Lord Chamberlain's men, this play can hardly have been other than Shakespeare's. The deposition scene was not printed until after Elizabeth's death, in the Third Quarto of 1608.

12. *A Midsummer Sight's Dream,* with its masquelike fairy scenes and the epithalamium at its close. has all the air of having been written less for the public stage than for some courtly wedding. and the compliment paid by Oberon to the "fair vestal throned by the west" makes it possible that it was a wedding at which Elizabeth was present. Many more or less plausible occasions have been suggested. The wedding of Mary, countess of Southampton. with Sir Thomas Heneage on hlay 2, 1594, would fit the setting of the plot; but a widowed countess hardly answers to the "little western flower" of the allegory, and there are allusions to later events and in particular to the rainy weather of 1594–95. The wedding of William Stanley, earl of Derby. brother of the Lord Strange for whose players Shakespeare had written?and Elizabeth Vere, daughter of the earl of Oxford. which took place at Greenwich on Jan. 26. 1595, would meet the conditions. But that of Thomas Berkeley and Elizabeth Carey, granddaughter of the company's patron Lord Hunsdon, on Feb. 19, 1596, is at least as likely. It has been fancied that Shakespeare was present when "certain stars shot madly from their spheres" in the Kenilworth fireworks of 1575, but if he had any particular recorded entertainment in mind it is more likely to have been the more recent one given to Elizabeth by the earl of Hertford at Elvetham in 1591. There appears to be no special source for the play beyond Chaucer's *Knight's Tale* and the fairy lore of western Europe.

13. *King John* has no very clear indications of date, but 1596 seems likely because of the style. in spite of the a priori improbability of a play on an independent subject drawn from English history being interpolated in the middle of the Lancastrian series. It would seem that Shakespeare had before him an old play of the Queen's men. called *The Troublesome Reign of King John.* This was published in 1591 and again. with "W. Sh." on the title page. in 1611. For copyright purposes *King John* appears to have been regarded as a revision of *The Troublesome Reign,* and in fact the succession of incidents in the two plays is much the same. Shakespeare'~dialogue. however, owes little or nothing to that of his predecessor. The early-date supporters argue for *The Troublesome Reign* as being some kind of bad quarto version of a Shakespeare *King John* which must be earlier than 1591. Their case cannot be regarded, in the present state of knowledge. as convincing.

14. The Merchant of Venice, certainly earlier than July 22. 1598, when it was entered in the Stationers' *Register,* and perhaps inspired by the alleged poison plots of Roderigo Lopez. Queen Elizabeth I's Jewish physician who was executed in 1594, shows considerable advance in comic and melodramatic pon-er over any of the earlier plays. and is assigned by a majority of scholars to about 1596. The various stories of which its plot is compounded are based upon common themes of folk tales and Italian *novelle.* It has been suggested that Shakespeare had before him a play called *The Jew,* of which there are traces as early as 1579, and in which motives illustrating "the greedinesse of worldly chusers" and the "bloody mindes of usurers" appear to have been already combined. Marlowe's *Tite Jew of Malta* may also have contributed something to the play.

15, 16. The first part of *Henry IV* was published in 1598, the second not until 1600. but both parts must have been in existence beiore the entry of the first part in the Stationers' *Register* on Feb. 25, 1598, since Falstaff is named in this entry. and a slip in a speech-prefix of the second part. which was not entered in the *Register* until Xug. 23, 1600, betrays that it was written when the character still bore the name of Sir John Oldcastle. Richard James, in his dedication to *The Legend of Sir John Oldcastle* about 1625, and Rowe in 1709 both bear witness to the substitution of the one ,personage for the other; Rowe ascribes this to the intervention of Elizabeth, and James to that of some descendants of Oldcastle, one of whom was probably Lord Cobham. There is an allusion to the incident and an acknowledgment of the wrong done to the famous Lollard martyr in the epilogue to 2 *Henry IV* itself. Probably Shakespeare found Oldcastle. with very little else that was of service to him, in an old play called *The Famous I'ictories of Henry the Fifth,* which is said to have been acted by Tarlton and the Queen's men at least as far back as 1588, and of which an edition was printed in 1598. Falstaff himself is a somewhat libelous portrait of the 15th-century leader Sir John Fastolf. who had already figured in *Henry VI;* but presumably Fastolf had no titled descendants alive in 1598.

17. A note in the Stationers' *Register* during Xug. 1600 shows that *Much Ado About Nothing* was in existence, although its publication was then directed to be "stayed." It may plausibly be regarded as the earliest play not included in Meres's list. In 1613 it was revived before James I under the alternative title of *Benedick and Beatrice.* Dogberry is said by Aubrey to have been taken from a constable at Grendon in Buckinghamshire. There is no very definite literary source for the play. although some of its incidents are to be found in Xriosto's *Orlando Furioso* and Bandello's *novelle,* and attempts have been made to establish relationships between it and two early.German plays. Jacob Ayrer's *Die Schöne Phänicia* and the *Vincentius Ladiszlaus* of Duke Henry Julius of Brunswick.

18. The completion of the Lancastrian series of histories by

Henry V can be placed in or about 1599, since there is an allusion in one of the choruses to the military operations in Ireland of the earl of Essex, who crossed on March 27 and returned on Sept. 28. 1599. The First Quarto, which, in spite of the fact that the play was "stayed" with *Much Ado About Nothing*, was published in 1600, is a surreptitious text, and does not include the choruses. A genuine version was first published in the First Folio.

19. That *Julius Caesar* also belongs to 1599 is shown, not only by its links with *Henry V*, but also by an allusion to it in John Weever's *Mirror of Martyrs*, a work written two years before its publication in 1601, and by a notice of a performance on Sept. 21, 1599, by Thomas Platter of Basel in an account of a visit to London. This was the first of Shakespeare's Roman plays, and, like those that followed, was based upon Plutarch's *Lives* as published by Sir Thomas North in 1580.

20. *As You Like It* was one of the plays "stayed" from publication in 1600, and cannot therefore be later than that year. Some trifling evidence suggests that it is not earlier than 1599. The plot is based on Thomas Lodge's romance of *Rosalynde* (1590), and this in part on the pseudo-Chaucerian *Tale of Gamelyn*.

21. *Twelfth Night* may be placed about 1600–01, since it quotes part of a song included in Robert Jones's *First Book of Songs and Airs* (1600), and is recorded by John Manningham to have been seen by him at a feast in the Middle Temple hall on Feb. 2, 1602. The principal source of the plot was Barnab Rich's "History of Apolonius and Silla" in his *Farewell to Military Profession* (1581).

22. A play of *Hamlet* was performed. probably by the Chamberlain's men, for Henslowe at Newington Butts on June 9, 1594. There are other references to it as a revenge play, and it seems to have been in existence in some shape as early as 1589. It was doubtless on the basis of this that Shakespeare constructed his tragedy. There is an allusion in *Hamlet* to the rivalry between the ordinary stages and the private plays given by boy actors, which points to a date not earlier than the revival of the plays at Paul's. probably in 1599; and another to an inhibition of plays because of a "late innovation" may also be explained by the revival rather than by the Essex rising of 1601, since the play is mentioned in a manuscript note by Gabriel Harvey, probably written before the death of Essex. The play was entered in the Stationers' *Register* on July 26, 1602. The First Quarto was printed in 1603 and the Second Quarto in 1604. These editions contain texts whose differences from each other and from that of the First Folio constitute one of the most difficult of Shakespearean problems. The First Quarto is certainly surreptitious. Its title page records performances in the universities of Oxford and Cambridge and elsewhere, as well as in London. The source of the plot is to be found in Scandinavian legends preserved in the *Historia Danica* of Saxo Grammaticus and transmitted to Shakespeare or his predecessor through the *Histoires Tragiques* (1570) of François de Belleforest (*see* HAMLET).

23. It is reported by John Dennis! in the preface to *The Comical Gallant* (1702), that *The Merry Wives of Windsor* was written at the express desire of Elizabeth, who wished to see Falstaff in love, and was finished by Shakespeare in the space of a fortnight. A date at the end of 1599 or the beginning of 1600, shortly after the completion of the historical Falstaff plays. would be the most natural one for this enterprise, and with such a date the evidence of style agrees. The play was entered in the Stationers' *Register* on Jan. 18 1602. The First Quarto of the same year gives a surreptitious text. which was replaced by that of the First Folio. The Windsor setting makes it possible that *The Merry Wives* was produced within the castle. and perhaps with the assistance of the children of Windsor chapel in the fairy parts. The plot has its analogies to various incidents in Italian *novelle* and in English adaptations of these.

24. Few of the plays present so many difficulties as *Troilus and Cressida*, and it cannot be said that its literary history has as yet been thoroughly worked out. A play of the name. "as yt is acted by my Lord Chamberlens men." was entered in the Stationers' *Register* on Feb. 7, 1603, with a note that "sufficient authority" must be got by the publisher, James Roberts! before he printed it. This can hardly be any other than Shakespeare's play but it must have been "stayed," for the First Quarto did not appear until 1609, and on Jan. 28 of that year a fresh entry had been made in the *Register* by another publisher. The text of the quarto differs in certain respects from that of the folio, but not to a greater extent than the use of different copies of the original manuscript might explain. Two alternative title pages are found in copies of the quarto. On the earlier is a statement that the play was printed "as it was acted by the Kings Maiesties seruants at the Globe"; from the other these words are omitted; and a preface is appended which hints that the "grand possessors" of the play had made difficulties about its publication, and describes it as "never staled with the stage." Attempts have been made, mainly on grounds of style. to find another hand than Shakespeare's in the closing scenes and the prologue, and even to assign widely different dates to various parts of what is ascribed to Shakespeare. But the evidence does not really bear out these theories, and the style of the whole must be regarded as quite consistent with a date in 1602. It has been thought that the description of Ajax and his humours in the second scene of the first act is Shakespeare's "purge" to Jonson in reply to the *Poetaster* (1601), alluded to, as already mentioned, in the *Return From Parnassus*, a Cambridge play acted probably at Christmas 1601–02. It is tempting to conjecture that *Troilus and Cressida* may have been played, like *Hamlet*, by the Chamberlain's men at Cambridge, but may never have been taken to London, and in this sense "never staled with the stage." The only difficulty of a date in 1601 is that a parody of a play on Troilus and Cressida is introduced into *Histriomastix* (*c.* 1599, but not printed until 1610), and that in this Troilus "shakes his furious speare." But Henslowe had produced another play on the subject, by Dekker and Chettle, in 1599, and probably, therefore, no allusion to Shakespeare is intended. The material for *Troilus and Cressida* was taken by Shakespeare from Chaucer's *Troilus and Criseyde*, Caxton's *Recuyell of the Historyes of Troye* and Chapman's Homer.

25. Stylistic arguments have led to the dating of *All's Well That Ends Well* in 1602–03. It has been urged, as in the case of *Troilus and Cressida* (and with little justification), that parts of the play are of a considerably earlier date. The story is derived from Boccaccio's *Decameron* through the medium of William Paynter's *Palace of Pleasure* (1566).

26. *Measure for Measure* was played at court on Dec. 26, 1604. The evidence for this is a list of plays in one of the account books of the office of the revels. This was formerly thought to have been forged, but is now satisfactorily rehabilitated. The play was probably produced when the theatres were reopened after the plague in 1604. The plot is taken from a story already used by George Whetstone. both in his play of *Promos and Cassandra* (1578) and in his prose *Heptemeron of Civil Discourses* (1582), and borrowed by him from Giraldi Cinthio's *Hecatommithi* (1566).

27. A performance at court of *Othello* on Nov. 1, 1604, is noted in the same list as that recording *Measure for Measure*, and the play may be reasonably assigned to the same year. An alleged performance of Harefield in 1602 certainly rests upon a forgery. The play was revived in 1610 and seen by Prince Louis of Württemberg at the Globe on April 30 of that year. It was entered in the Stationers' *Register* on Oct. 6. 1621, and a First Quarto was published in 1622. The text of this is less satisfactory than that of the First Folio, and omits a good many lines found therein and almost certainly belonging to the play as written. It also contains profane expressions which have been modified in the folio, and thereby points to a date for the original production earlier than the Act to Restrain Abuses of Players in spring 1606. The plot, like that of *Measure for Measure*, comes from the *Hecatommithi* (1566) of Giraldi Cinthio.

28. The entry of *King Lear* in the Stationers' *Register* on Nov. 26. 1607, records its performance at court on Dec. 26, 1606. This suggests 1605 or 1606 as the date of production, and this is confirmed by the publication in 1605 of the older play, *The True Chronicle History of King Leir*, which Shakespeare used as his source. Two quartos of *King Lear* were published in 1608, and contain a text rather longer, but in other respects less accurate, than that of the First Folio. The material of the play consists of fragments of Celtic myth which found their way into history through Geoffrey of Monmouth. It was accessible to Shakespeare in Holinshed and in Spenser's *Faerie Queene*, as well as in the old play.

29. *Macbeth* cannot. in view of its obvious allusions to James I, be of earlier date than 1603. The style and some trifling allusions point to about 1605 or 1606. and a hint for the theme may have been given by Matthew Gwynne's entertainment of the *Tres Sibyllae*, n-ith which James was welcomed to Oxford on Aug. 27. 1605. The play was revived in 1610 and Simon Forman saw it at the Globe on April 20. The only extant text. that of the First Folio. bears traces of shortening and has been interpolated with additional rhymed dialogues for the witches. possibly by the hand of Thomas Middleton. But the extent of Middleton's contribution has been exaggerated. A ballad of *Macdobeth* is mentioned in the Stationers' records during 1596, but is not known. It is not likely that Shakespeare had consulted any Scottish history other than that included in Raphael Holinshed's *Chronicle;* he may have gathered witch lore from Reginald Scot's *Discoverie of Witchcraft* (1584) or King James's own *Demonologie* (1599).

30. It is not quite clear whether *Antony and Cleopatra* was the play of that name entered in the Stationers' *Register* on May 20. 1608. for no quarto is extant. and a fresh entry was made in the *Register* before the issue of the First Folio. Apart from this entry there is little external evidence to fix the date of the play. but it is in Shakespeare's later. although not his last. manner and may very well belong to 1607. It is possible that it guided some changes introduced by Samuel Daniel into a new edition of his *Cleopatra* issued in 1607.

31. In the case of *Coriolanus* the external evidence available is even scantier, and all that can be said is that its closest affinities are to *dntony and Cleopatra*, which in all probability it directly followed in order of composition. Both plays, like *Julius Caesar*, are based upon North's *Plutarch*.

32. There is no external evidence as to the date of *Timon of Athens*, but it may safely be grouped on the strength of its internal characteristics with the plays just named. and there is a clear guli between it and those that follow. It may be placed provisionally in 1607, although some critics put it next after *Lear*. The estraordinary incoherencies of its action and inequalities of its style have prevented modern scholars from accepting it as a finished production oi Shakespeare, but there agreement ceases. It is sometimes and perhaps most reasonably regarded as an incomplete draft for an intended play; sometimes as a Shakespearean fragment worked over by a second hand either for the stage or for printing in the First Folio; sometimes, but not very plausibly, as an old play by an inferior writer which Shakespeare had partly remodeled. It seems to have no relation to an extant academic play oi *Timon* which remained in manuscript until 1842. The sources are partly in Plutarch's *Life of Marcus Antonius*, partly in Lucian's dialogue of *Timon or Misanthropos* and partly in William Paynter's *Palace of Pleasure* (1566).

33. Similar difficulties, equally unsolved, cling to *Pericles.* It was entered in the Stationers' *Register* on May 20, 1608. and published in 1609 as "the late and much admired play" acted by the King's men at the Globe. The title page bears Shakespeare's name, but the play was not included in the First Folio and was added to Shakespeare's collected works only in the Third Folio. in company with others which, although they also had been printed under his name or initials in quarto iorm, are certainly not his. In 1608 was published a prose story, *The Painful Adventures of Pericles Prince of Tyre*. This claims to be the history of the play as it was presented by the king's players, and is described in a dedication by George Wilkins as "a poore infant of my braine." The production of the play is therefore to be put in 1608 or a little earlier. It can hardly be doubted on internal evidence that Shakespeare is the author of the verse scenes in the last three acts. with the possible exception of the doggerel choruses. It is probable. although it has been doubted, that he was also the author of the prose scenes in those acts. The poverty of the first two acts has been fairly convincingly accounted for by the theory that the play is a bad quarto, a memorial reconstruction by two reporters, the reporter of the last three acts having an efficiency greater than that of his colleague. It seems reasonable to allow R'ilkins some connection with the play: other dramatic work by him was produced about 1607. The writing oi the play cannot much have preceded publication. for the close resemblances of the style to that of Shakespeare's latest plays argue for its lateness. Unless there was an earlier Shakespearean version now lost. Dryden's statement that .'Shakespeare's own Muse her Pericles first bore" must be held to be an error. The story is an ancient one which exists in many versions. In all of these except the play, the name of the hero is Apollonius of Tyre. The play is directly based upon a version in Gower's *Confessio Amantis*, and the use of. Gower as a "presenter" is thereby explained. But another version in Laurence Twine's *Patterne of Painefull Adventures* (*c.* 1576), of which a new edition appeared in 1607, may also have been consulted.

34. *Cymbeline* shows a further development than *Pericles* in the direction of Shakespeare's final style. and can hardly have come earlier. A description of it is in a notebook of Simon Forman. who died in Sept. 1611; other plays seen by him in 1610 and 1611 are described in the same book. But these were not necessarily new plays. and *Cymbeline* may perhaps be assigned conjecturally to 1609. The masquelike dream in act v, sc. 4 has been thought to be an interpolation by another hand. This play also is based upon a widespread story. probably known to Shakespeare in Boccaccio's *Decameron* (day 2, novel 9), and possibly also in an English book of tales called *Westward for Smelts*. The historical part is, as usual. from Holinshed.

35. *The R'inter's Tale* was seen by Forman on May 15, 1611, and as it clearly belongs to the latest group of plays it may well have been produced in that or the preceding year. A document among the revels accounts, also now cleared of the imputation of forgery, gives Nov. j. 1611, as the date of a performance at court. The play is recorded to have been licensed by Sir George Buck, who began to license plays in 1607. The plot is from Robert Greene's *Pandosto, the Triumph of Time, or Dorastus end Fawnia* (1588).

36. The wedding masque in act iv oi *The Tempest* has suggested the possibility that it may have been composed to celebrate the marriage of the princess Elizabeth and Frederick V, the elector palatine, on Feb. 14. 1613. But the document among the revels accounts gives the precise date of Nov. 1, 1611, for a performance at court. Sylvester Jourdan's *A Discovery of the Bermudas*, containing an account of the shipwreck of Sir George Somers in 1609, was published about Oct. 1610. and this or some other contemporary 'narrative of Virginian colonization probably furnished the hint oi the plot.

37. Critical opinion has veered away from the doctrine that *Henry VIII* shows the hand of an author other than Shakespeare. John Fletcher had been named as the collaborator; some scholars had gone so far as to exclude Shakespeare entirely and allot the authorship to Fletcher and Philip Massinger. The inclusion of the play in the First Folio provides strong argument for Shakespeare's having some share in the writing. He was considered to be responsible for no more than act i, sc. 1, 2; act ii, sc. 3, 4; act iii, sc. 2. lines 1–203; and act v, sc. 1. Now that scholarly opinion is turning against the theory of disintegration. it is thought that, in the Fletcherian passages, Shakespeare was writing merely in the Fletcherian style. The play was probably produced in 1613, and originally bore the alternative title of *All Is True*. It was being performed in the Globe on June 29. 1613. when the thatch caught fire and the theatre was burned. The principal source was Holinshed, but Hall's *Union of Lancaster and York*, Foxe's *Acts and Monuments of the Church* and perhaps Samuel Rowley's play of *When You See Me, You Know Me* (1605) appear also to have contributed.

38. The tale of the First Folio dramas is now complete, but an analysis of *The Two Noble Kinsmen* leaves no reason to doubt the accuracy of its ascription on the title page of the First Quarto of 1634 to Shakespeare and John Fletcher. This appears to have been a case of ordinary collaboration. There is sufficient resemblance between the styles of the two writers to render the division of the play between them a matter of some difficulty; but the parts that may probably be assigned to Shakespeare are act i. sc. 1–4; act ii. sc. 1: act iii, sc. 1, 2: act v. sc. 1. 3. 4. Fletcher's morris dance in act iii. sc. 5 is borrowed from that in Beaumont's *Mask of the Inner Temple and Gray's Inn,* given on Feb. 20, 1613. and the play may perhaps be dated in 1613. It is based on Chaucer's *Knight's Tale.*

THE POEMS

Shakespeare's writings outside the field of drama are not numerous. The narrative poem of *Venus and Adonis* was entered in the Stationers' *Register* on April 18. 1593. and at least 17 editions. dating from 1593 to 1675, are known. The *Rape of Lucrece* was entered on May 9, 1594, and the nine extant editions range from 1594 to 1655. Each poem is prefaced by a dedicatory epistle from the author to Henry Wriothesley, earl of Southampton. The subjects. taken respectively from the *Metamorphoses* and the *Fasti* of Ovid. were frequent in Renaissance literature. It was once supposed that Shakespeare came from Stratford with *Venus and Adonis* in his pocket; but it is more likely that both poems owe their origin to the comparative leisure afforded to playwrights and actors by the plague period of 1592–94. In 1599 the stationer William Jaggard published a volume of miscellaneous verse which he called *The Passionate Pilgrint,* and placed Shakespeare's name on the title page. Only two of the pieces included herein are certainly Shakespeare's. and although others may quite possibly be his. the authority of the volume is destroyed by the fact that some of its contents are without doubt the work of Marlowe, Sir Walter Raleigh. Richard Barnfield and Bartholomew Griffin. In 1601 Shakespeare contributed *The Phoenix and the Turtle,* an elegy on an unknown pair of wedded lovers, to a volume called *Love's Martyr, or Rosalin's Complaint,* collected. and mainly written by Robert Chester.

The Sonnets. — The interest of all these poems sinks into insignificance beside that of one remaining volume. The sonnets were entered in the *Register* on May 20, 1609, by the stationer Thomas Thorpe. and published by him under the title *Shakespeares Sonnets, Never Before Imprinted* in the same year. In addition to 154 sonnets the volume, contains the elegiac poem *A Lover's Complaint.* If this is Shakespeare's. which is very doubtful. it probably dates from the *Venus and Adonis* period. In 1640 the sonnets. together with other poems from *The Passionate Pilgrim* and elsewhere. many of them not Shakespeare's. were republished by John Benson in *Poems Written* by *Wil. Shakespeare, Gent.* Here the sonnets are arranged in an altogether different order from that of 1609 and are declared by the publisher to "appeare of the same purity, the Xuthour himselfe then living avouched." No other Shakespearean controversy has received so much attention as that concerning itself with the date. character and literary history of the sonnets. This is intelligible enough. since upon the issues raised depends the question whether these poems do or do not give a glimpse into the intimate depths of a personality which otherwise is at most only imperfectly revealed through the plays. On the whole, the balance of authority is in favour of regarding them as in a very considerable measure autobiographical. This view has undergone the fires of much destructive argument. The authenticity of the order in which the sonnets were printed in 1609 and even Shakespeare's authorship of some of them have been doubted; and their subject matter has been variously explained as being of the nature of a philosophical allegory, of an effort of the dramatic imagination or of a heartless exercise in the forms of the Petrarchan convention. This last theory rests upon the false psychological assumption. which is disproved by the whole history of poetry and in particular of Petrarchan poetry, that the use of conventions is inconsistent with the expression of unfeigned emotions; and it is hardly to be set against the direct conviction which the sonnets carry of the strength and sincerity of the spiritual experience out of which they were wrought. This conviction makes due allowance for the inevitable heightening of emotion itself in the act of poetic composition; and it certainly does not carry with it a belief that all the external events which underlie the emotional development are capable at this distance of time of inferential reconstruction. But it does accept the sonnets as reflecting a part of Shakespeare's life during the years in which they were written. and as revealing at least the outlines of a drama which played itself out. for once, not in his imagination but in his actual conduct in the world of men and women.

There is no advantage to be gained by rearranging the order of the 1609 volume. even if there were any basis other than that of individual whim on which to do so. Many of the sonnets are obviously linked to those which follow or precede them; and although a few may conceivably be misplaced, the order as a whole does not jar against the sense of emotional continuity, which is the only possible test that can be applied. The last two sonnets. however, are merely alternative versions of a Greek epigram, and it is a hazardous assumption that all of the rest have a common subject matter. On this assumption. however, they have generally been interpreted somewhat as follows. There are two series. which are more probably parallel than successive. The shorter of these (cxxvii–clii) appears to be the record of the poet's relations with a mistress. a dark woman with raven brows and mourning eyes. In the earlier sonnets he undertakes the half-playful defense of black beauty against the blond Elizabethan ideal; but the greater number are in a more serious vein, and are filled with a deep consciousness of the bitterness of lustful passion and of the slavery of the soul to the body. The woman is a wanton. She has broken her bed vow for Shakespeare, who on his side is forsworn in loving her; and she is doubly forsworn in proving faithless to him with other men. His reason condemns her, but his heart has not the power to throw off her tyranny. Her particular offense is that she. "a woman coloured ill." has cast her snares not only upon him. but upon his friend, "a man right fair." who is his "better angel." and that thus his loss is double. in love and friendship. The longer series (i–cxxvi) is written to a man. appears to extend over a considerable period of time and covers a wide range of sentiment. The person addressed is younger than Shakespeare, and of higher rank. He is lovely, and the son of a lovely mother. and has hair like the auburn buds of marjoram. The series falls into a number of groups, which are rarely separated by any sharp lines of demarcation. Perhaps the first group (i–xvii) is the most distinct. These sonnets are a prolonged exhortation by Shakespeare to his friend to marry and beget children. The friend is now at the peak of his youth. and should make haste, before the rose of beauty dies. to secure himself in his descendants against devouring time. In the next group (xviii–xxv) a much more personal note is struck. and the writer assumes the attitudes. at once of the poet whose genius is to be devoted to making the beauty and the honour of his patron eternal, and of the friend whose absorbing affection is always on the point of assuming an emotional colour indistinguishable from that of love. The consciousness of advancing years and that of a fortune which bars the triumph of public honour alike find their consolation in this affection. A period of absence (xxvi–xxxii) follows. in which the thought of friendship comes to remedy the daily labour of travel and the sorrow of a life that is "in disgrace with fortune and men's eyes" and filled with melancholy broodings over the past. Then (xxxiii–xlii) comes an estrangement. The friend has committed a sensual fault, which is at the same time a sin against friendship. He has been wooed by a woman loved by the poet, who deeply resents the treachery but in the end forgives it and bids the friend take all his loves, since all are included in the love that has been freely given him. It is difficult to escape the suggestion that this episode of the conflict between love and friendship is the same as that which inspired some of the "dark woman" sonnets. Another journey (xliii–lii) is again filled with thoughts of the friend, and its record is followed by a group of sonnets (liii–lv) in which the friend's beauty and the immortality which this will find in the poet's verse are especially dwelt upon. Once more there is a parting (lvi–lxi) and the poet awaits as patiently as may be his friend's return to him. Again (lxii–lxv) he looks to his verse to give the friend immortality. He is tired of the world, but his friend redeems it (lxvi–lxviii). Then rumours of some scandal against his friend (lxix–lxx) reach him, and he falls (lxxi–lxxiv) into gloomy thoughts of coming death. The friend, however, is still (lxxv–lxxvii) his argument; and he is perturbed (lxxviii–lxxxvi) by the appearance of a rival poet, who claims to be taught by spirits to write "above a mortal pitch," and with "the proud full sail of his great verse" has already found favour with Shakespeare's patron. There is another estrangement (lxxxvii–xc), and the poet, already crossed with the spite of fortune, is ready not only to acquiesce in the loss of friendship. but to find the fault in himself. The friend returns to him. but the relation is still clouded by doubts of his fidelity (xci–xciii) and by public rumours of his wantonness (xciv–xcvij. For a third time the poet is absent (xcvii–xcix) in summer and spring. Then comes an apparent interval: after which a love already three years old is renewed jc–civ) with even richer praises (cv–cviii). It is now the poet's turn to offer apologies (cix–cxii) for offenses against friendship and for some brand upon his name apparently due to the conditions of his profession. He is again absent (cxiii) and again renews his protestations of the imperishability of love (cxiv–cxvi) and of his own unworthiness (cxvii–cxxi). for which his only excuse is in the fact that. the friend was once unkind. If the friend has suffered as Shakespeare suffered. he has "passed a hell of time." The series closes with a group (cxxii–cxxv) in which love is pitted against time: and an *envoi* warns the "lovely boy" that in the end nature must render up her treasure.

Mystery of "Mr. W. H."—Such an analysis can give no adequate idea of the qualities in these sonnets. whereby the appeal of universal poetry is built up on a basis of intimate self-revelation. The human document is so legible. and at the same time so incomplete. that it is easy to understand the strenuous efforts which have been made to throw further light upon it by tracing the identities of those other personalities, the man and the woman, through his relations to whom the poet was brought to so fiery an ordeal of soul, and even to the borders of self-abasement. It must be added that the search has, as a rule, been conducted with more ingenuity than judgment. It has generally started from the terms of a somewhat mysterious dedication prefixed by the publisher Thomas Thorpe to the volume of 1609. This runs as follows: "To the onlie begetter of these insuing sonnets Mr. W. H. all happinesse and that eternitie promised by our ever-living poet wisheth the well-wishing adventurer in setting forth T. T." The natural interpretation of this is that the inspirer or "begetter" of the sonnets bore the initials W. H.; and contemporary history has accordingly been ransacked to find a W. H. whose age and circumstances might conceivably fit the ccnditions of the problem which the sonnets present. It is perhaps a want of historical perspective which has led to the centring of controversy around two names belonging to the highest ranks of the Elizabethan nobility, those of Henry Wriothesley, earl of Southampton. and William Herbert, earl of Pembroke. There is some evidence to connect Shakespeare with both of these. To Southampton he dedicated *Venus and Adonis* in 1593 and *The Rape of Lucrece* in 1594, and the story that he received a gift of no less than £1,000 from the earl is recorded by Rowe. His acquaintance with Pembroke can only be inferred from the statement of Heming and Condell, in their preface to the First. Folio of the plays. that Pembroke and his brother Montgomery had "prosequuted both them and their Xuthour living, with so much favour." The personal beauty of the rival claimants and of their mothers, their amours and the attempts of their families to persuade them to marry, their relations to poets and actors and all other points in their biographies which do or do not fit in with the indications of the sonnets have been canvassed with great spirit and some erudition: but with no very conclusive result. It is in Pembroke's favour that his initials were in fact W. H., whereas Southampton's can be turned into W. H. only by a process of metathesis; and his champions have certainly been more successful than Southampton's in producing a woman, a certain Mary Fitton, who was a mistress of Pembroke's and was in consequence dismissed in disgrace from her post of maid of honour to Elizabeth. Unfortunately, the balance of evidence is in favour of her having been blond and not "black." Moreover, a careful investigation of the sonnets, as regards their style and their relation to the plays, renders it almost impossible on chronological grounds that Pembroke can have been their subject. He was born on April 9, 1580, and was therefore much younger than Southampton, who was born on Oct. 6, 1573. The earliest sonnets postulate a marriageable youth. certainly not younger than 18. an age which Southampton reached in the autumn of 1591 and Pembroke in the spring of 1598. The writing of the sonnets may have extended over many years. but it is impossible to doubt that as a whole it is to the years 1593–98 rather than to the years 1598–1603 that they belong. There is not. indeed, much external evidence available. Francis Meres in his *Palladis Tamia* of 1598 mentions Shakespeare's "sugred sonnets among his private friends," but this allusion might come as well near the beginning as at the end of the series; and the fact that two, not of the latest, sonnets are in *The Passionate Pilgrim* of 1599 is equally inconclusive.

The only reference to an external event in the sonnets themselves which might at first sight seem useful is in the following lines (cvii):

> The mortal moon hath her eclipse endured,
> And the sad augurs mock their own presage;
> Incertainties now crown themselves assured,
> And peace proclaims olives of endless age.

This has been variously interpreted as referring to the death of Elizabeth and accession of James in 1603. to the relief caused by the death of Philip II of Spain in 1598 and to the illness of Elizabeth and the threatened Spanish invasion in 1596. The "mortal moon" is generally considered to be Queen Elizabeth, but though "eclipse" may well mean "death." it is not clear whether to "endure eclipse" is to die or to escape death. Recent arguments that the "mortal moon" was the hostile battle array of the Spanish Armada in 1588, and that all the sonnets are to be dated before 1590, have found slight acceptance among critics.

Allusions to the rival poet do not help much. "The proud full sail of his great verse" would fit, on critical grounds, with Spenser, Marlowe, Chapman and possibly Peele, Daniel or Drayton; and the "affable familiar ghost." from whom the rival is said to obtain assistance by night, might conceivably be an echo of a passage in one of Chapman's dedications. Daniel inscribed a poem to Southampton in 1603, but with this exception none of the poets named is known to have written either for Southampton or for Pembroke. or for any other W. H. or H. W., during any year which can possibly be covered by the sonnets. Two very minor poets. Barnabe Barnes and Gervase Markham, addressed sonnets to Southampton in 1593 and 1595 respectively. and Thomas Nashe composed improper verses for his delectation.

But even if external guidance fails, the internal evidence for 1593–98 as approximately the .sonnet period in Shakespeare's life is very strong indeed. It has been worked out in detail by two German scholars. Hermann Isaac (Conrad) in the *Shakespeare-Jahrbuch* for 1884, and Gregor Sarrazin in *William Shakespeares Lehrjakre* (1897) and *Aus Shakespeares Meisterwerkstatt* (1906). Conrad's work, in particular, has hardly received enough attention from English scholars, probably because he makes the mistakes of taking the sonnets in Bodenstedt's order instead of Shakespeare's, and of beginning his whole chronology several years too early in order to gratify a fantastic identification of W. H. with the earl of Essex. This, however, does not affect the main force of 'an argument by which the affinities of the great bulk of the sonnets are shown, on the ground of stylistic similarities, parallelisms of expression and parallelisms of theme, to be far closer to the poems and the range of plays from *Love's Labour's Lost* to *Henry IV* than to any earlier or later section of Shakespeare's work. This dating has the further advantage of putting Shakespeare's sonnets in the full tide of Elizabethan sonnet production, which began with the publication of Sidney's *Astrophel and Stella* in 1591 and Daniel's *Delia* and Constable's *Diana* in 1592, rather than during years for which this particular kind of poetry had already ceased to be modish. It is to the three volumes named that the influence upon Shakespeare of his predecessors can most clearly be traced; while he seems in 'his turn to have served as a model for Drayton, whose sonnets to Idea were published in a series of volumes in 1594, 1599, 1602, 160j and 1619. It does not of course follow that because the sonnets belong to 1593–98 W. H. is to be identified with Southampton. It is, in fact, extremely unlikely that the publisher of the sonnets would be so careless as to address a great earl as a mere "master!'; and W. H., even if above Shakespeare's own rank, is likely to have been a young man not to be numbered among the noblest families.

There is a possibility that there is an allusion to Shakespeare's romance in a poem called "Willobie His Avisa," published in 1594 as from the pen of one Henry Willoughby, apparently of West Knoyle in Wiltshire. In this Willoughby, enamoured of an innkeeper's wife, apparently at Sherborne, takes counsel with "his familiar friend W. S. who not long before had tryed the curtesy of the like passion, and was now newly recovered of the like infection,." But there is nothing outside the poem to connect Shakespeare with a family of Willoughbys or with the neighbourhood of West Knoyle or Sherborne. Various other identifications of W. H. have been suggested, which rarely rest upon anything except a similarity of initials. There is every reason for the rejection of the theory. broached by Sir Sidney Lee. that W. H. was not the friend of the sonnets at all, but a certain William Hall, who was himself a printer, and might, it is conjectured, have obtained the "copy" of the sonnets for Thorpe. Somewhat more plausible is Sir William Harvey, the third husband of Southampton's mother. But, although it is just possible that "begetter" might mean not "inspirer" but "procurer for the press," the interpretation is shipwrecked on the obvious identity of the person to whom Thorpe "wishes" eternity with the person to whom the poet "promised" that eternity. The external history of the sonnets must still be regarded as an unsolved problem; the most that can be said is that their subject may just possibly be Southampton, cannot possibly be Pembroke and will probably never be convincingly identified. (E. K. C.; J. Cw.)

SHAKESPEAREAN STUDIES

Literary Criticism.—Attempts to interpret Shakespeare's work have, in important ways. controlled and modified English literary criticism in general. The plays have continued to be enjoyed whether whole: cut or adapted, and the peculiar response of each age has governed its major criticism.

Ben Jonson first had to account for his own and his generation's appreciation of Shakespeare, and for his critical impatience. Both he and, later, Dryden spoke with two voices, and for much the same reason, so that their neoclassicism was checked and scrutinized. Jonson saw bombast and lack of art in the dramatist and qualified the honour he did (in *Discoveries)* to the memory of Shakespeare "on this side idolatry"; whereas he could (in his verses for the First Folio) idolatrously put him above the Greeks and Romans, not only, in Milton's words, as a warbler of "native woodnotes wild," but as an artist.

This half line from Milton's "L'Allegro," with its implication that nature had guided the unscholarly pen of the poet. dogged criticism for two centuries. So the anonymous author of the prologue to *Julius Caesar* in *Covent Garden Drolery* (1672) wrote:

> His Excellencies came and were not sought,
> His words like casual Atoms made a thought:
> Drew up themselves in Rank and File, and writ,
> He wondring how the Devil it were such wit.

This may or may not be Dryden's verse, but it does express one of his opinions:

> All the Images of Nature were still present to him, and he drew them not laboriously, but luckily . . . Those who accuse him to have wanted learning, give him the greater commendation: he was naturally learn'd; he needed not the spectacles of Books to read Nature; he looked inwards, and found her there.
> (Dryden, Of *Dramatick Poesie, An Essay,* 1668.)

Like Jonson, and annoyed by the same elements in Shakespeare, Dryden recognized the "largest and most comprehensive soul" among "all Modern, and perhaps Ancient Poets," and Pope's preface to his edition of the plays in 1725 follows him. The easily accepted Platonic notion of a poet possessed by the muse continued to militate against a recognition of Shakespeare's conscious artistry, and a succession of works on his education, beginning with Richard Farmer's *Essay on the Learning of Shakespeare* (1767) and extending to T. W. Baldwin's *William Shakespere's "Small Latine and Lesse Greeke"* (1944), speak for the liveliness of this interest. So, inferentially, do the Baconian and other theories.

Meanwhile, 18th-century editors and critics accumulated information on the writers of Shakespeare's time and his sources, stimulated by Farmer's essay, which had used these for its own purposes. They wrote about the unities, decorum. quibbles, indecencies and anachronisms; blemishes were indicated and beauties marked. Samuel Johnson's *Preface* to his 1765 edition, a commanding work surveying the plays and summing up and transcending the issues of the age while "placing" Shakespeare securely, decided the controversy about the unities. said wise things about the relation of the tragic to the comic. but still balked at the Shakespearean quibble. "A quibble was to him the fatal Cleopatra for which he lost the world, and was content to lose it." The "world" that is lost is fidelity to nature. and the approbation of an age which recognized in Shakespeare this fidelity above all else. The tone of the *Preface* is still judicial.

Walter Whiter defended the quibble in a clever book, *A Specimen Shakspeare . . .* (1794), which was unappreciated in its day but recognized as important in the 1930s, when his points had been unwittingly made all over again. Stressing the unconscious and associative origin of many puns, he touched on Shakespeare's creative processes, isolated image clusters and hinted at an awareness of what Caroline Spurgeon came to call iterative imagery. Shakespeare is, however, no more an artist for being exhibited as a slave of the associative process, and Whiter's apologetic tone is true to his period which, important as it is for its scholarly work, is more concerned with adjudication than interpretation. In surveying it as a whole one sees chiefly promise and prophecy; a clearing of the way.

One work must, however, be excepted: Maurice Morgann's *An Essay on the Dramatic Character of Sir John Falstaff* (1777). This book, certainly important and influential historically, is as wise and broad in its argument as it is vital in expression. There had been essays in the periodicals of the 1750s on the Shakespearean characters; Johnson had made pertinent comments on them in the notes to his edition; and William Richardson's *A Philosophical Analysis and Illustration of Some of Shakespeare's Renrarkable Characters,* more intent on indicating casebooks of experience for the benefit of the reader than on psychological analysis, had appeared in 1774; but Morgann's essay transcends these (and also its immediate issue: the courage or cowardice of Falstaff) in its large, liberal and refreshing response to the plays. Shakespeare, he says: "boldly makes a character act and speak from those parts of the composition. which are *inferred* only, and not distinctly shewn. This . . . seems to carry us beyond the poet to nature itself. . . ." This capacity in Shakespeare for seeing his characters as *"whole,* and as it were original," not imitated, "rather as Historic than Dramatic beings," was central to his purpose, and it remains true despite the critical perversions which have stemmed from it. With Thomas Whately's detailed comparison of *Richard III* and *Macbeth* (1785) it became clear, in Whately's words, that critics thought "the distinction and preservation of *character"* of first importance, and this insistence was to prevail throughout the 19th century and into the 20th. It informs the works of Hazlitt, Coleridge, Frederick Furnivall, Edward Dowden, A. C. Bradley, Harley Granville-Barker and John Dover Wilson.

William Hazlitt, admiring Whately's analysis, published his *Characters of Shakespear's Plays* in 1817. It is an excellent handbook: it has an air oi novelty and adventure, its author being (like all the romantics) more conscious of differences from his predecessors than of a tradition. Enthusiastic, reverential, intuitively perceptive, he has a flair for apt quotation and, coming as he did to Shakespeare as a dramatic critic, he is saved from some of the pitfalls of a purely literary study of character.

Coleridge's lectures on Shakespeare had been delivered before Hazlitt's book appeared. but though they share a primary interest in character, the poet's critical range is far beyond that of his contemporaries and releases us from the 18th-century modes of thought. He was concerned to recognize Shakespeare's powers of judgment and to see him as a conscious artist. He claimed to have argued in a lecture course in 1802 that "Shakespeare's judgment was . . . still more wonderful than his genius, or rather. that the contradistinction itself between judgment and genius rested on an utterly false theory" *(The Canterbury Magazine,* Sept. 1834). This recognition, and the further one that every work of art must be judged by its own organic laws, put an end to the balancing of faults against beauties. Coleridge directed attention to the poems, used before (when read at all) only as quarries for parallel passages, and he analyzed *Venus and Adonis* in chapter 1j of his *Biographia Literaria* (1817). Examples from Shakespeare illuminated his distinction between the imagination and fancy, and both he and Keats, as great poets, revealed much about Shakespeare's creative processes.

The 20th century has seen, indeed. deep affinities in the creative minds of Keats and Shakespeare. Keats's letters are permeated with an awareness of the dramatist. and his attribution to Shakespeare of that envied "negative capability"—"when a man is capable of being in uncertainties, mysteries, doubts, without any irritable reaching after fact and reason" *(Letter to* G. *and T. Keats,* Dec. 21. 1817)—has proved a fruitful issue.

Less fruitful have been the disputes about precedence and originality in the romantic movement. and it is more relevant to recognize that a philosophic temper stimulated. in Germany and England, certain approaches and presumptions. G. E. Lessing had recognized Shakespeare's closer affinity with the Germanic spirit and literature than with the French rules; C. M. Wieland's prose translations (1762–66) and A. W. Schlegel's in verse (1797–1801) had been enthusiastically seized on, and the latter's *Lectures on Dramatic Art and Literature* (1809–11) explored what was. or became, the Coleridgean world. The philosophical significance of character became central, Shakespeare's profundity as a formal artist was acclaimed and a leading idea was seen to inform his work as a whole. When this root idea was analyzed in particular plays (for example, H. Ulrici's analyses) the interpretation was often profitable, but there was in German criticism in this period the kind of insensitivity to language that made Schlegel accept *A Yorkshire Tragedy* as Shakespeare's without qualms. and a lack of knowledge—more serious. even, than that among English writers—about the circumstances in which the plays were written and about their stage origins. Schlegel has, however, fine things to say on particular plays.

In the Victorian period no major critic wrote on Shakespeare. Victor Hugo and Swinburne enthused eloquently, but the first original interpretative work was Walter Pater's *Appreciations* (1889). Scholarship, industry and scientific method were to the fore. Shakespeare societies were begun in England and Germany and their proceedings embody the virtues and faults of the time. Edmund Malone's work on the order of the plays was supplemented and interest in the development of Shakespeare in periods was stimulated: the reach of the whole was surveyed. The dominant work here is Dowden's *Shakspere: a Critical Study of His Mind and Art* (1875). Investigation of spiritual biography as revealed in the plays persisted into the 20th century, but the great book then was A. C. Bradley's *Shakespearean Tragedy* (1904). Here is the culmination of all character analysis. Bradley's very greatness and the finality with which some of his statements were received have irked later critics, and they have overinsisted on his obsession with character, neglect of the poetry and unawareness oi stage conventions. He irritated most when he pursued characters far beyond the circumstances of the play, or subordinated plot and action to psychological study, or, preoccupied with the moral order at the root of tragedy, sentimentalized some of the issues. But his chapters remain as a necessary counterbalance to the works of the undeniably fine interpreters who reacted against him.

This reaction typifies 20th-century criticism. (Some trends may be picked out, but its bulk defies summary.) Sir E. K. Chambers, whose *William Shakespeare* (1930) remains a standard work. brought to the study of Shakespeare's life and plays an unrivaled knowledge of the medieval and Elizabethan stage, and a study of the dramatic conventions of that stage inspired a new school of critics. L. L. Schiicking's *Character Problems in Shakespeare's Plays* (1919; trans. 1922) and E. E. Stall's *Art and Artifice in Shakespeare* (1933) are representative works. Dramatic realism, they argued rightly, was not that of actual life; and inconsistencies of character were best explained in terms of Elizabethan practice and convention. Much of this was salutary for a generation later accused of misunderstanding Ibsen (and, perhaps. Shaw) and putting its faith in dramatic realism. It is even necessary as a corrective to the criticism of Granville-Barker *(Prefaces to Shakespeare,* 1927–48), which was healthy in that it came from a dramatist-actor-producer who had illuminated Shakespeare's art in stage presentation, but limited in its reliance on Bradley and an underlying predilection for the naturalistic theatre.

A further aspect of historical research was the investigation of Elizabethan physiological psychology. Ruth L. Anderson's *Elizabethan Psychology and Shakespeare's Plays* (1928), Lily B. Campbell's *Shakespeare's Tragic Heroes: Slaves of Passion* (1930) and L. Babb's *The Elizabethan Malady* (1951) demonstrate the range of studies in this kind; studies that are either stimulating and corrective or stultifying and peripheral according tc the author's application of his thesis.

One may recognize as a counterblast to historical criticism the contribution of the psychoanalysts. Far from wishing to explain away inconsistencies of characterization. these critics positively welcomed them. J. I. M. Stewart's *Character and Motive in Shakespeare* (1949) discussed the general critical issues arising, and the same year brought Ernest Jones's *Hamlet and Oedipus* (a revision of ch. 1 of *Essays in Applied Psycho-Analysis,* 1921), a development of'ideas prompted by Freud in 1900. Specifically Freudian inspirations apart, there is no doubt that the popularization of notions of the unconscious and the mysteries involved in motivation brought a sense of freedom to interpretation. A wider freedom mas claimed by Lascelles Xbercrombie in his British Academy lecture of 1930. There, in A *Plea for the Liberty of Interpreting Shakespeare,* he says that "anything which may be found" in Shakespeare's art, "even if it is only the modern reader who can find it there, may legitimately be taken as its meaning" (Lascelles Abercrombie, A *Plea for the Liberty of Interpreting Shakespeare,* British Academy lecture, British Academy. London, 1930). His lecture answered the disintegrators who. led by J. M. Robertson, apportioned out plays or parts of plays. deemed to fall below some elusive. subjective standard. to other dramatists. Those elements which Shakespeare adopted and absorbed. Abercrombie argued. became his and were open to interpretation with the rest.

Before 1930, however, the freedom eloquently demanded by Abercrombie had already been exercised. L. C. Knights's article "How Many Children Had Lady Macbeth?" (1933; reprinted in *Explorations,* 1946) reacted against Bradley. and focused a movement which had begun with the early works of J. Middleton Murry and G. Wilson Knight and in the researches of Caroline Spurgeon. These writers, conscious that character analysis was not enough, in their various ways redirected attention to the poetry and symbolism. L. C. Knights argued that "we start with so many lines of verse on a printed page" and that we have to "allow full weight to each word, exploring its 'tentacular roots'" (L. C. Knights, "How Many Children Had Lady Macbeth?" in *Explorations,* Chatto and Windus Ltd., London. 1946). (This direction should be seen against the critical and poetical background of the 1920s and 1930s, with its emphasis on the image and on ambiguity. its reinterpretation of the metaphysical poets and its response to the verse of T. S. Eliot. A critical discipline can be seen evolving, sympathetic to Knights's aims and molded by the thought of I. A. Richards, T. S. Eliot. William Empson's *Seven Types of Ambiguity* [1930] arid F. R. Leavis.) Beginning indeed with the "printed page." Caroline Spurgeon card indexed Shakespeare's images and used them interpretatively. The most brilliant and influential discovery in her work was that of the iterative image, and in *Shakespeare's Imagery and What It Tells Us* (1935) she pointed to prevalent groups of images which characterize the individual plays and unconsciously fashion our response to them. Like Whiter she indicated clusters of images peculiar to Shakespeare, and these were used to throw light on his creative processes and to guide the attribution of scenes and plays to him. W. H. Clemen in The *Development* of *Shakespeare's Imagery* (1936: trans. 1951) studied with insight Shakespeare's dramatic use of metaphor.

The impressive and original body of work produced by G. Wilson Knight is historically linked with this school, but it is more free ranging. Actor. producer and (later) dramatist. he regards each play "as a visionary unit hound to obey none but its on-n self-imposed laws." and his examination relates each "given incident or speech" either to "the time sequence of story or the peculiar atmosphere, intellectual or imaginative. which binds the play" (G. Wilson Knight. The *Wheel* of Fire, Methuen and Co. Ltd.. London. 1930). The "symbolic overtones" are revealed. His method. in a series of books beginning with *The Wheel* of Fire (1930), has radically redirected the attention of the student and freshly interpreted in particular, perhaps. *Measure* for *Measure*, the Roman plays. *Timon* of *Athens* and the final romances. Emphasis on the image has made the business of interpretation more laborious. A book on each play has become common and among the best of these have been two by Roy Walker on *Hamlet* and *Macbeth (The Time* Is *Out* of Joint, 1948; The Time *Is* Free, 1949) and Robert Heilman's on *King* Lcar (*This* Great *Stage*, 1948).

The so-called new criticism. characterized by close, linguistic analysis, has had its brilliant successes. Its excesses. too. have been flagrant, and opposition has taken the form of a move nearer to Bradley, or another kind of historical criticism. Rosemund Tuve (Elizabethan and *Metaphysical Imagery*, 1947) attacked the Caroline Spurgeon approach, and Sister Miriam Joseph (Shakespeare's *Use* of the *Arts of Language*, 1947) pointed to the studied use of the figures of rhetoric in Shakespeare. A wider knowledge of the thought and beliefs in his day. demonstrated in such works as Hardin Craig's *The* Enchanted Glass (1936) and E. M. W. Tillyard's *The Elizabethan World Picture* (1943), has valuably checked and controlled. for instance, any tendency to think peculiar in Shakespeare what was common to his age. Scholarly work on the sources of the plays has also intensified. again with the implication that the ardent critic may overstress the liberty of interpreting. Scholarship and interpretation have, however, happily come more nearly into alliance than at any time since Johnson's day. The New Cambridge and new Arden editions of the plays are in the hands of enlightened critics. An interpretative work, however. roving over all the relevant fields of knowledge and research and surveying (as Johnson could) Shakespeare's achievement, is unlikely to appear. One is thrown back on Heming and Condell's First Folio preface: ". . . his wit can no more lie hid, then it could be lost. Read him, therefore; and againe, and againe. . . ." (G. A. O.)

Textual Criticism. — The textual critic of Shakespeare needs to know about four things: the status of texts and their value as evidence; the language of Shakespeare's time; the author's idiosyncrasies; and the barriers which the Elizabethan or Jacobean printer was likely to erect betueen his "copy" and the printed text.

Texts of Shakespeare. — Eighteen of Shakespeare's plays first appeared in quarto form before 1623. Important editions of the collected plays were published as follows:

First Folio ("F1") (1623)
Second Folio ("F2") (1632)
Third Folio ("F3") (1663)
F3, second issue (1664)
Fourth Folio ("F4") (1685)
Nicholas Rowe (1709, 1714)
Alexander Pope (1725, 1728)
Lewis Theobald (1733, 1740)
Thomas Hanmer (1744, 1745)
William Warburton (1747)
Samuel Johnson (1765)
Edward Capell (1768)
Johnson and George Steevens (1773, 1778)
Edmund Malone (1790)
Steevens (1793)
First Variorum, ed. I. Reed (1803)
Second I'ariorum, ed. by Reed and Malone (1813)
Third Variorum, ed. by James Boswell (1821)
John Payne Collier (1842–44, 1858, 1878)
Alexander Dyce (1857)
Cambridge, ed. by W. Aldis Wright, W. G. Clark and J. Glover (1863–66, 1891–93)
Globe, ed. by Wright and Clark (1864)
Henry Irving edition (1888–90)
Peter Alexander (1951)
New Cambridge, ed. by J. Dover Wilson *et al.* (1921 *et seq.*)

A few. among many, other dates of importance in connection with the study of Shakespeare's texts are:

1726, Lewis Theobald, *Shakespeare Restored*
1844–45, M. C. Clarke, *Complete Concordance to Shakspere*
1862–64, the L. Booth type facsimile of F1
1871, H. H. Furness. New Variorum edition of *Romeo* and *Juliet*
1874, P. A. Daniel (ed.), *Romeo and Juliet*
1874–75, Alexander Schmidt, *Shakespeare-Lexicon*
1880–89, the Griggs-Praetorius quarto facsimiles
1888–1928, *A New English Dictionary,* ed. by J. A. H. Murray *et al.*
1894, John Bartlett, *Shakespeare Concordance*
1902, the Sidney Lee F1 facsimile
1911, C. T. Onions. *Shakespeare Glossary*
1930, E. K. Chambers, *William Shakespeare*
1933, E. E. Willoughby, *The Printing of the First Folio* of *Shakespeare*
1939, R. B. McKerrow, *Prolegomena for the Oxford Shakespeare*
1942, W. W. Greg. *The Editorial Problem in Shakespeare*
1955, W. W. Greg, *The Shakespeare First Folio: Its Bibliographical and Textual History*

F1 collected 36 plays; F2, reprinting these, appeared at various times during and after the year 1632. retaining the date 1632 on the title page. F3 again printed these same plays, but the second issue added Pericles and six plays (*The* London Prodigall, *The* History *of Thomas* Lord *Cromwell*, Sir *John Oldcastle* Lord *Cobham*, The *Puritan Widow*, *A* Yorkshire Tragedy, The Tragedy of *Locrine*) not now believed to be by Shakespeare at all. F4 reprinted the 43 plays of the second issue of F3. Examination of the texts of the four folios makes it evident that. as Samuel Johnson realized in 1765, only the first has any authority. To F1. later folios added errors. modernizations and conjectural improvements; there can be no suggestion that an authoritative manuscript was consulted in connection with the printing of any of them. The text of *Pericles* printed in the second issue of F3 derives from a late (1635) quarto of the play.

Of the editors who preceded him, W. A. Wright wrote in 1893, almost certainly with some excess of charity. "And it is a study of great interest to follow them as they exercise their varied talents on the noblest field which the literature of their country afforded: Rowe. himself a dramatist of no mean skill; Pope, with his deep poetic insight; Theobald. with his fine tact and marvellous ingenuity; Hanmer. whose guesses. however they may pass the sober limits of criticism, are sometimes brilliant, often instructive, and never foolish; Warburton. audacious and arrogant. but now and then singularly happy; Johnson. with his masculine common sense; Capell, the most useful of them all, whose conscientious diligence is untiring. whose minute accuracy is scarcely ever at fault: Steevens. Malone. . . . Boswell, . . . with all their varied learning; together with their successors of the present generation in England. Germany and America, who have devoted themselves to the illustration of Shakespeare as to a labour of love."

It would be unfair, to suggest that the earlier editors. from Rowe onward, did not interest themselves in the establishment of a correct text of their author; but by modern standards they worked by hit-or-miss systems and substituted their own (often excellent) tastes for critical principles. They tended to assemble as many various readings. from various editions, as possible and to use their own judgment as to which was the best. Their success was striking.

The editors of the Cambridge Shakespeare seem to have been the first who made any sort of reasonable attempt to list the old editions and sort out the relationships between them. Their critical apparatus of variant readings and emendations remains unsuperseded. The publication of the Globe edition, based on the Cambridge, provided a standard text which modern scholars find it annoyingly impossible to dislodge. The almost impeccable Booth type facsimile of F1 (edited. it appears, by C. Wright) placed much necessary information before the public and remains the handiest edition for all but the most finical scholarship. The Griggs-Praetorius facsimiles "in photolithography" should no doubt have been even more reliable, but Aldis Wright demonstrated that they had undergone remarkable tinkering (one "facsimile" of a 1595 edition contains words foisted in from a 1619 edition) and that no confidence could be placed in their punctuation. The critical introductions to some of these quarto facsimiles, however — notably those by P. A. Daniel — are of great value. The Lee F1 facsimile, though notably less portable than the Booth, can be said to replace it on the score of indubitable reliability. A series of trustworthy collotype reproductions of quarto texts was begun, under the editorship of W. W. Greg, in 1939.

The path of the Shakespearean textual critic used to contain the major stumbling block of the problem of the early quartos of certain plays: Romeo and Juliet, Henry *V*, Hamlet, *Merry Wives* of *Windsor*, 2 and 3 Henry *VI* and likewise of Richard *ill* and King Lear. The disparity between the earlier texts and the later ones was remarkable. Of *Romeo and* Juliet and *Hamlet*, texts "newly corrected. augmented and amended" appeared in later quartos; better texts of the others were provided first by F1. The first six exhibit such symptoms of textual corruption that they could hardly be accounted for by the wildest theories of the illiteracy of scribes or the intemperance of compositors. Rival explanatory theories long disputed the field: either that here were early versions later revised by Shakespeare (the Henry *VI* plays being, it was suggested, the work of earlier: cruder dramatists,!, or that the corrupt texts were versions of stage performances obtained in shorthand. These theories seem to have been totally routed by the suggestions made by W. W. Greg, A. W. Pollard, J. Dover Wilson and Peter Alexander, that the corrupt versions, or bad quartos, are the result of reconstruction from memory of texts by actors to add to the repertories of near-derelict traveling theatrical companies, not. as was earlier suggested, that the shorthand writers went to work at the behest of fraudulent. stealthy and injurious publishers. It seems evident that the relationship between quarto and folio texts of Richard *III* and King *Lear* is strictly that the quartos are memorial reconstructions; but their relative quality is so good that no satisfactory explanation of them has been offered. Philip Edwards has convincingly suggested that Pericles should be added to the number of the bad quartos: it differs from the others in that it is the work of two reporters of widely differing skill. and in that no good version was ever found to replace it. The shorthand-writer theory was given its deathblow by G. I. Duthie's Elizabethan Shorthand and the First Quarto *of* King Lear (1950).

General attacks on the editorial problem began in three of the annual Shakespeare lectures of the British Academy: A. W. Pollard. *Foundations* of *Shakespeare's* Text (1923), W. W. Greg, Principles oj Emendation in Shakespeare (1928), and R. B. McKerrow, Treatment *of* Shakespeare's Text by His Earlier Editors: *1709–1768* (1933). McKerrow's Prolegomena for the Oxford Shakespeare is a full-dress discussion of the problems; the author's death prevented the publication of any of the projected edition, though more than one play was prepared for publication by him. Greg's *The* Editorial Problem in Shakespeare carried the discussion further; in this and The Shakespeare First Folio (1955) he laid before the scholar convincing arguments to support a theory of the text for every one of the plays. There is no starkness of simplicity in his findings. For no two plays, it seems, is the history of the text the same.

Two of the less complicated text histories may be given as samples. For Romeo and Juliet, the first edition (1597) is a bad quarto. Q2 (1599) is an authoritative text printed, it is believed, from a Shakespeare autograph. Q3 (1609) is printed from Q2, with no further authority. Q4 (undated, but probably 1619) is printed, with curious but apparently unauthoritative changes, from Q3. F1 is printed from Q3. Later researches have led to a belief that a pen-corrected example of Q1 may have been used as copy for Q2, which complicates a hardly pellucid situation with theories of a good text contaminated by a bad one. For Titus Andronicus, Q1 (1594) seems to have been set from a Shakespeare autograph, Q2 (1600) from Q1, Q3 (1611) from Q2. F1 was printed from Q3, with the addition of act iii, sc. 2, which is absent in all the quartos and must derive from authoritative manuscript. Complications arise from the fact that printer's copy was, for various plays, Shakespeare's fair copy, his rougher "foul papers," fair copies apparently made (by a known scribe) especially for use in the printing house, theatrical prompt copies, earlier editions corrected by pen and ink from manuscripts of various status. etc.

The conviction of most scholars that three pages of Shakespeare's autograph are preserved among the British museum manuscripts in The Booke of Sir Thomas Moore led. in the 1920s and 1930s, to a frenzy of solving all problems of text by appealing to Shakespeare's calligraphic style and methods of spelling. This phase of scholarship failed to survive World War II.

Under the influence of Pollard, Greg and McKerrow, a variety of new editions of single plays has been published. Peter Alexander's is the most satisfactory complete text as yet given to the world. The New Cambridge Shakespeare. begun in 1921 by J. Dover Wilson and A. T. Quiller-Couch with the publication of *The* Tempest and to reach conclusion under Wilson and others, after the death of Quiller-Couch, provided a number of stimulating and controversial (if not always convincing) texts. Some of the Arden (1951 et seq.) editions of single plays were evidently influenced; others were not.

Language oj Shakespeare's Time. — Eighteenth-century editors, particularly Theobald, Johnson, Capell, Steevens and Malone, were aware that much of Shakespeare's language was obsolete to the 18th-century reader, and in connection with their editorial task they made considerable study of earlier authors. Several glossaries and illustrative notes appeared. Knowledge of Elizabethan English was, however. genuinely advanced by the publication in 1822 of Robert Nares's Glossary. The next few decades saw, through the medium of various scholarly societies (the Percy, the Camden, the Shakespeare and others), the reprinting of a considerable corpus of Elizabethan literature; in these pies, the main fingers were those of J. P. Collier and J. O. Halliwell (Halliwell-Phillips). Zeal for scholarship, or some other motive, led Collier to extensive forgeries to support his emendations and theories. and Halliwell to the theft of a number of manuscripts from the library of Trinity college, Cambridge. These lapses do not prevent the modern Shakespearean scholar from acknowledging to them a considerable debt. The New Shakspeare society, under F. J. Furnivall (whose probity seems not to have been seriously questioned). later continued the task of reprinting illustrative works by Shakespeare's contemporaries. The publication of the New English Dictionary (N.E.D.), later the Oxford English Dictionary (O.E.D.), owes much to the labours of the (good or bad) reprinters who disseminated earlier English writings. Based on the slips of the N.E.D. is A Shakespeare Glossary by C. T. Onions, himself one of the editors of the greater work. Alexander Schmidt's Shakespeare-Lexicon is a remarkable compilation which antedates the N.E.D. and yet remains valuable to the scholar. Work on the language of Shakespeare is, naturally, not yet at an end. but the labours of Schmidt. Onions and his N.E.D. fellow workers must remain the foundation.

Shakespeare's Idiosyncrasies. — Knowledge of those matters in which Shakespeare differed from his contemporaries — versification, language, methods of thought, methods of composition and other matters — is necessary for the establishment of his text. Here, however, agreement among modern scholars is not easy and subjective thinking plays a larger part. Scholarly aids of the highest value for the language can be found in the great Shakespeare Concordance of John Bartlett (keyed to the Globe text) and its still useful pioneer predecessor by Mrs. Cowden Clarke. Studies of Shakespeare's education, his methods of writing, his use of images, his use of sources, continue to be made and to be published. It is impossible to sum the findings of the researchers; as yet no clearly recognizable pattern in the Shakespearean carpet emerges. Geoffrey Bullough's Narrative and Dramatic Sources of Shakespeare (1957 et seq.) provides the scholar with the poet's source material in reliable text and with trustworthy and illuminating comment.

Shakespeare and His Printers. — The modern scholar, presented with a text of Shakespeare, desires to know what relationship it bears to the author's manuscript — and hopes to be told how he can reconstruct that manuscript from it. Much of the effort to satisfy these feelings has been described above. Considerable activity, however, continues among those who, like Greg and many of the other later scholars mentioned, are interested in the happenings in the Elizabethan printing house. McKerrow's *Introduction to Bibliography fbr Literary Students* (1927) continues as the starting point for such investigations.

The first serious examinations of the First Folio came from Sidney Lee in the introduction to his facsimile and other writings, and from Pollard and Greg. largely in their attempts to traverse his theories. Appreciable headway began to be made. for later workers. with E. E. Willoughby's *The Printing of the First Folio of Shakespeare* (1933). Using a variety of innovating techniques. Willoughby was able to reconstruct many of the day-to-day events in William Jaggard's printing house while F1 was being printed. The later work of-C. J. K. Hinman and J. Shroeder destroyed the validity of some of Willoughby's work; his achievement is. however, more than can be passed off as merely deserving the epithet "pioneer."

The key question in this section at one time would have seemed to be "What did printers do to texts?" U'illoughby saw and showed that it must be narrowed to the particular printers dealing at a particular time with a particular text. Hinman clearly saw for the first time that a given line of type in F1 was composed by an individual man. possibly a different man from the one who composed a given line on the next page. Hinman. by a variety of techniques (including the use of an ingenious instrument for the mechanical collation of two copies of a single book, and the elaboration of methods for distinguishing between the works of different compositors) reached a stage of knowing far more of what went on in Jaggard's shop in 1623 than Jaggard ever knew. Hinman's mechanical labours were completed in the late 1950s but the results had not yet reached publication in their entirety. Some of his methods had been put to good use by A. Walker. F. Bowers and others; Bowers' *On Editing Shakespeare and the Elizabethan Dramatists* (195j) is a valuable manifesto. A knowledge of compositors' idiosyncrasies provides a new weapon for the textual critic; it seems that it also adds to his difficulties and pushes further and further away the goal of a satisfactory scholarly edition of Shakespeare.

Full publication of Hinman's results and the sharing of his techniques seemed likely to mean general approval of his conclusions. He had available not only the Hinman collating machine but also the 79 First Folios collected in the Folger Shakespeare library in Washington, D.C. Corrections at press were constantly being made throughout the printing of F1 (as of all other books of the time) and no two copies of the entire edition of F1 were. Hinman estimates, identical. With full knowledge of all his findings, it should be possible to publish a facsimile of the entire First Folio, not of a single copy of it. Such a publication need not bring textual criticism of Shakespeare to an end; rather it will enter a new phase. The conservative critic is already distressed to discover that new, and apparently more scientific, methods of work on texts have led some scholars to find justification for a new eclecticism in dealing with the plays of Shakespeare. This may grieve the conservative; it may be for the good. It may be hoped that the new textual studies will be purposefully directed toward the making of the desired new edition; it may be feared that bibliographical studies growing out of Hinman's findings and techniques may, in hands less competent than his, become a sterile scholarly game.

(J. Cw.)

The Anti-Shakespearean Theories. — The notion that Shakespeare's plays and poems were not actually written by William Shakespeare of Stratford-on-Avon has been the subject of scores of books and is regarded by many as at least an interesting possibility. The source of confusion over the authorship of the plays lies in the disparity between the greatness of Shakespeare's literary achievement on the one hand and, on the other, his humble origin, the supposed inadequacy of his education and the obscurity and ordinariness of his whole life. In Shakespeare's writings men have claimed to find a familiarity with languages and literature, with such subjects as law, history, politics and geography. and with the manners and speech of courts, which is inconceivable in a common actor, the son of a small provincial tradesman. This knowledge, it is said, is to be found only in a man of extensive education, familiar with such royal and noble personages as figure largely in Shakespeare's plays. And the dearth of contemporary record has been regarded as incompatible with Shakespeare's eminence and as therefore suggestive of mystery. That his greatness was not widely proclaimed and that none of his manuscripts has survived have been taken as evidence that the latter were destroyed to conceal the identity of the author.

Though one or two earlier writers had expressed skepticism about Shakespeare. the first identification of the author as Francis Bacon, viscount St. Albans. appears to have been made about 1785 by the Rev. James Wilmot, rector of Barton-on-the-Heath, Warwickshire. Wilmot communicated his views to one J. C. Cowell of Ipswich, whose account of the matter is contained in a manuscript now in the library of the University of London *(see* Allardyce Nicoll. "The First Baconian," *Times Literary Supplement,* Feb. a5, 1932). A letter from Sir Toby Matthew to Bacon contains the statement. "The most prodigious wit that ever I knew . . . is of your Lordship's name. though he be known by another," and this has been regarded as proof of Bacon's pseudonymous writings. Their similar treatment of references from the Bible. the law and the classics made Bacon a candidate for the authorship of the plays. The first published statement was W. H. Smith's Was *Lord Bacon the Author of Shakespeare's Plays?* (1856), which set on foot the Bacon-Shakespeare controversy. W. S. Melsome *(The Bacon-Shakespeare Anatomy,* 1945) found references in Shakespeare's plays to works of Bacon that were not published during Shakespeare's lifetime, and which he therefore could not have seen; from this Melsome concluded that, as only Bacon could have known of these unpublished works, he must have written the plays containing references to them. Another method of investigation was used by I. Donnelly who. in *The Great Cryptogram* (1887), found ciphered messages embedded throughout the plays that proved Bacon's authorship. and Sir E. Durning-Lawrence (*Bacon Is Shakespeare,* 1910) discovered in *Love's Labour's Lost* the word "honorificabilitudinitatibus;" which forms the anagram *Hi ludi F. Baconis nati tuiti orbi* ("These plays, the offspring of F. Bacon, are preserved for the world"). Others carried this cryptographic line of investigation further, but W. F. and E. S. Friedman, professional cryptologists, examined all the Baconian ciphers and rejected them all as invalid *(Shakespearean Ciphers Examined,* 19j7). Several societies and periodicals devoted to the Baconian claims were founded at the end of the 19th century, but interest later declined.

For several pears after the appearance of his *Shakespeare Identified in Edward de Vere, the 17th Earl of Oxford* (1920), the views of J. T. Looney attracted enough adherents to lead to the formation of Oxfordian societies in London and New York. Looney argued from the biographical similarity of Bertram in *All's Well That Ends Well* and of Hamlet to Oxford himself. and also from the resemblance of the latter's poems to Shakespeare's early work. Oxford's interest in the drama extended beyond noble patronage, for he himself produced some plays although there are no known extant examples. His 22 acknowledged poems were written in his youth, and as he was born in 1550 Looney argued that they were the prelude to his mature work that began in 1593 with *Venus and Adonis.* This is supported by the coincidence of Oxford's named poems ceasing just before Shakespeare's work began to appear. It is claimed that Oxford would have assumed a pseudonym in order to protect his family from the social stigma attached to the stage, and also because ruinous extravagance had brought him into disrepute at court.

Another candidate is William Stanley, 6th earl of Derby, whose claims were advanced by A. W. Titherley *(Shakespeare's Identity: William Stanley, 6th Earl of Derby,* 1952). He was keenly interested in the drama and became the patron of his own company of actors; his brother, Ferdinando Lord Strange, 5th earl of Derby, was patron of the company to which Shakespeare belonged. In the 1580s several poems were written that exhibit signs of an early and immature Shakespearean style, yet could not have been written by Shakespeare who was still a boy at Stratford. One of these poems is in Derby's handwriting, and three of them ("Of silver pure thy penne is made. dipte in the Muses well"; "What shall I say of Gold, more than tis Gold?"; "My thoughts are winged with hopes, my hopes with love") were signed W. S.; these initials were thought to conceal the identity of Derby, and later to have been expanded into William Shakespeare. Derby's motive for this self-concealment would have been. like Oxford's, to avoid the association of his family name with the lower social order of the stage.

A further theory, put forward by C. Hoffman in *The Murder of the Man Who Was "Shakespeare"* (1955), identified Shakespeare with Marlowe. The influence of Marlowe on Shakespeare's early work has long been recognized, and it has even been suggested that he collaborated with Shakespeare in some of the plays. but Hoffman discovered stylistic and linguistic similarities throughout the entire Shakespeare canon. He also noticed that Shakespeare emerged from obscurity with the publication of *Venus and Adonis* in Sept. 1593. only four months after it is generally accepted that Marlowe was stabbed to death at Deptford. Because Marlowe's avowed atheism and probable homosexuality are known to have incurred religious and political disapproval. Hoffman argued that, when Marlowe was arrested by order of the privy council, his friend and patron Sir Thomas Walsingham (cousin of Sir Francis Walsingham) evolved an elaborate plan for his escape. Two of Walsingham's servants murdered an unknown man and alleged it to be Marlowe, while Marlowe himself fled to France and thence to Italy. He continued to write in exile: his work first being sent to Walsingham, who arranged for it to be transcribed and who paid Shakespeare to "father" it. The original manuscripts were thought to be buried with Sir Thomas Walsingham at Chislehurst. Kent, but when the tomb was opened in 1956 this was not found to be so.

G. G. Greenwood (*The Shakespeare Problem Restated,* 1908) and others, not venturing to identify the "true" author, have vigorously disputed Shakespeare's claim to the title.

The Case for Shakespeare.—It can hardly be maintained that no difficulty exists. In spite of recorded allusions to Shakespeare as the author of many plays in the canon, made by about 50 men during his lifetime. it is arguable that his greatness was not as clearly recognized as we might expect. But the difficulties are not so great as the disbelievers have held. and their proposals have raised larger problems than they have resolved. The difficulty, insofar as it exists. can be viewed profitably only in the light of our extensive knowledge of the conditions, about 1600. under which plays were written, produced and preserved, and of the prevailing attitudes toward authorship in general.

Shakespeare's humble origin raises of course no difficulties, for in his time. as in others, poets and men of highest genius arose from all social levels. Of his education more must be said, Stratford-on-Avon possessed a grammar school of better than average quality, which was free for sons of burgesses, Shakespeare included. That we can point to no documentary evidence of his attendance there would be significant only if his name were missing from existing records of attendance. but no such records are known, and it is doubtful that they ever existed. Though we have no specific knowledge of the curriculum of the Stratford school, we can infer it with some confidence from that of other schools and from the degree of uniformity found among these. The natural assumption is. then. that the young Shakespeare spent the usual number of years in a good school where he would have acquired some competence in Latin, some acquaintance with Ovid. Virgil, Cicero. Horace. Livy. Quintilian and several others and a familiarity with certain parts of the Bible and the Book of Common Prayer, together with a thorough grounding in Christian ethics. As Virgil K. Whitaker has shown (*Shakespeare's Use of Learning,* 1953), the Latin authors whom we should expect a boy from a good grammar school of about 1575 to know are just the ones with whom Shakespeare in fact shows some familiarity in his earliest plays and poems. Neither in these nor in his later work does he reveal any knowledge of a large number of books. Latin or English, or a scholar's knowledge of those relatively few books more or less well known to him. Likewise his knowledge of the law as reflected in his plays has been shown (by P. S. Clarkson and C. T. Warren. *The Law of Property in Shakespeare and the Elizabethan Drama,* 1942) to be neither so broad nor so accurate as that of "about half of Shakespeare's fellows." Similarly his acquaintance with history was not extensive; his knowledge of English history appears to have been limited to what he. found in those portions of Holinshed, Hall and other works which he mined for the purposes of his own history plays. On his ignorance of geography (or carelessness about it) he was twitted by Ben Jonson. As for the accurate reproduction of the speech and manners of courtiers which has been thought to provide evidence of the author's high birth, this would be difficult to demonstrate in the absence of authentic records of conversation and comportment at the courts of Elizabeth I and James I. or, indeed, of King John, Richard II, etc. The fact is that we form our impressions of how such persons talked mainly from the plays of the time. How Shakespeare attained his unparalleled insight into human nature must always remain a mystery, and it will scarcely be maintained that university education or high caste have ever been of much service in this direction. Everyone agrees that the author of Shakespeare's plays was a man of extraordinary genius who was endowed with the most brilliant powers of observation and an unexampled ability to synthesize what he experienced (directly or in books) and to give to it artistic shape.

The often repeated assertion that we know almost nothing about Shakespeare's life must be tested historically. We are entitled to suspect the presence of a mystery in the dearth of our knowledge of Shakespeare's daily life, his personality and his opinions (as compared with those of, say. William Wordsworth or Robert Browning) only if we find that he is singular in this regard among dramatists of his day. This is not what we find. It is true that we know more about Ben Jonson. but this is quite clearly because, besides being a dramatist and actor, Jonson was a scholar, a literary critic, a friend and leader of poets, a writer of court and city masques, a man often involved in troubles which became matters of record; in short, a quarrelsome and colourful man. With the exception of Jonson, we know more about Shakespeare than about any other dramatist of the time. Stage plays were not regarded as serious literature, and their writers were not lionized. Much of our comparative ignorance about the dramatists must be attributed to the fact that it was not an age of biography or casual letter writing, of journalism or advertising. What men thought or said about Shakespeare was not, for the most part, written down.

These facts have bearing upon the disappearance of Shakespeare's manuscripts. Once a play was in print, the manuscript possessed no value unless for the acting company that owned it. Autographs of literary men were not collected. On the other hand, paper being a costly, imported commodity, manuscripts were in demand for many practical uses; all in themselves destructive. and used paper was constantly wanted for wrapping, for cleaning and for starting fires. It is not surprising, therefore, that we have no single manuscript, in the handwriting of Shakespeare or any one of his fellow dramatists, of any successful professional play printed before 1640.

There appears to be no obstacle, therefore, in the way of our accepting William Shakespeare as the author of the plays that bear his name. On the contrary, all the positive evidence supports this orthodox position.

From 1598 onward, Shakespeare is named as author on title pages of many editions of the separate plays and poems and the folio editions of the collected plays. Many of Shakespeare's contemporaries wrote of him unequivocally as the author of the plays. Ben Jonson, who knew Shakespeare well, contributed verses to the First Folio of 1623, where (as elsewhere) he criticizes and praises Shakespeare as the author. John Heming and Henry Condell, for a long time fellow actors and theatre owners with Shakespeare, sign the dedication and a foreword to the First Folio and describe their methods as editors. In his own day, in short, he was fully accepted as the author of the plays. Throughout his lifetime, and for 150 years after, no person is known to have questioned his authorship by so much as a hint. In an age that loved gossip and mystery as much as any, is it conceivable that the honest Ben Jonson and Shakespeare's theatrical associates shared the secret of a gigantic literary hoax without a single leak, or that they could have been imposed upon without suspicion? Unsupported and bald assertions that the author of the plays was a man of great learning and that Shakespeare of Stratford was an illiterate rustic do not carry any weight. and only when a believer in Bacon or Oxford or Marlowe produces sound e idence will scholars pay close attention to it and to him. (G. E. D.)

Conclusion.—When the apposite records had been discovered, inspected and interpreted. when the works had been stared at and assessed. critics of an earlier age turned to the elaboration of their portraits of Shakespeare the man. We have been shown Shakespeare the demigod. Shakespeare the shrewd businessman, the woodnotes-wild warbler (hardly distinguishable from Shakespeare the idiot boy), the preacher. the prophet. the sergeant. the seaman, the schoolmaster. the solicitor's clerk. the syndicate. the psyche-ravaged sibling, the Oedipus *de ses jours,* the play patcher, the self-effacing peer, the cipher expert, the man with the nervous breakdown — there was no end to the possibilities.

Some scholars seem to have left the attempt to limn Shakespeare the man for a study of Shakespeare the craftsman. "What was he like?" became a less fashionable question than "How did he work?" Shakespeare was an Elizabethan, the native of an important country town. the product (apparently) of a grammar school. a playwright who was the contemporary of other playwrights. writing for the same stage as they, of his age as well as for all time.

Much research has concerned itself with the normal background of Elizabethan thought and belief. Such matters as the physiological theories of the humours and the Ptolemaic astronomical system were a commonplace of scholarship in the 19th century. We know. as the result of the investigations of numerous researchers, how the ordinary contemporary of Shakespeare looked upon such matters as the organization of society, theories of the state, ideas of world order, political beliefs, theories of the monarchy and man in his environment. There have been many studies of what the Elizabethans said about such things; and the more difficult task of learning what they assumed to be self-evident (and therefore not needing to be said) continues to receive attention.

There is no cessation of study concerning the other Elizabethan dramatists. of the structure of their playhouse. of the dramatic companies. The business of investigating the text of Shakespeare has become a heavy industry; new and more scientific techniques are elaborated. and the old subjective methods are called scientific by their users and are given acceptance by many. Thought has been profitably expended on the questions of what an Elizabethan play audience n-as like and what it expected of the plays it paid to see—when. for instance. a history play was presented, would the audience bring to it a view of history, or would it merely gaze upon the winning and losing of battles. the shedding of blood and the coming of death?

The realization that some parts of some of Shakespeare's plays are less good than others has led in the past to strange conclusions and hypotheses. It has been held that many of the plays, particularly the earlier ones (being patently inferior to the later ones), are the result of the collaborative efforts of a number of minor playwrights. or that they are the end product of a series of revisions. by Shakespeare or others, of plays written by Shakespeare or others. This disintegratory scholarship had apparently fallen into relative desuetude by the 1950s. Scholars tended more and more to accept that the plays as we have them are moderately near to what Shakespeare wrote and that if some are better than others it is because he grew to be maturer. more experienced and richer in his poetic powers; when rawly beginning his labours he may have written in the style of Peele and of Greene and of Kyd so that he might, in the days of his maturity. write like Shakespeare alone.

Perhaps the most promising studies concern themselves with Shakespeare's source materials and precisely how he used them —what really is meant by a statement that he "used" North's Plutarch or Lodge's *Rosalynde* "as a source." With the publication of the sources in accurate texts, the resultant studies can, if competently handled. be expected to offer conclusions in which the subjective does not play too large a part.

No man expects the forts of folly to fall suddenly. and it is not surprising to discover that many remain unpersuaded that the plays of Shakespeare could have been written by a man who had the upbringing that the man of Stratford had. It is not only in monarchical countries that the desire rages to see the immortal bard sitting. writing away at his desk. with a graduate's hood and a peer's ermine hanging on the back of the study door. Authors will not cease to compose nor publishers cease to publish books which are based on the strangest of fixed ideas — that all the tragedies concern themselves only with the deadly sin of pride. or are powerful pleas for national unity, or are all about the earl of Essex. or are written by a blasphemous homosexual Cambridge graduate. or are thinly veiled Catholic (or Puritan) proselytizing propaganda. Highly subjective readings of the late plays will continue to woo (and win) supporters. Critics of eminence will continue to accuse Shakespeare of failing in his attempts without making much effort to discover what he was attempting. We have not heard the last of tragic flaws or the sense of waste. It will be demonstrated and redemonstrated that all the plays are vegetation myths and all the kings are fishers. and no one need believe that Shakespeare the "golden-bough" lad has yet come to dust.

There can never be. one would imagine, an agreement among all the faithful about what is the right doctrine of Shakespeare. He is a god whom all men'desire to make in their own image. To attempt to sum the findings of the interpreters is like trying to sum Niagara; the spate is too vast, too strong and too wild. And the findings are too contradictory to permit of synthesis. A man must take the facts as he knoivs them and construct a fictional hypothesis which will adequately account for them. The hypotheses of other men can provide shreds worthy the weaving into another man's cloth; they cannot be acceptable ready-made garments. (J. Cw.)

THE PORTRAITS OF SHAKESPEARE

The mystery that surrounds much in the life and work of Shakespeare extends also to his portraiture. There are only two likenesses of the poet that can be regarded as carrying the authority of his fellow workers. friends and relations. yet neither of them is a direct life portrait, and the fact that. they differ in essential points has encouraged the advance and foolish acceptance of numerous portraits of wholly different types. The result has been a series of portraits which may be classed as: (1) genuine portraits of persons, not Shakespeare but like the various conceptions of him: (2) memorial portraits based on one or a mixture of two originals believed at various times to be genuine; (3) portraits of persons known or unknown. which have been faked to resemble Shakespeare; and (4) complete fabrications.

The two portraits which can be accepted as authentic likenesses are the bust (really a half-length statue) with its structural wall monument in Holy Trinity church. Stratford-on-Avon, and the copperplate engraved by Martin Droeshout as frontispiece to the First Folio of Shakespeare's plays.

The Stratford bust and monument must have been erected on the north wall of the chancel or choir between Shakespeare's death in 1516 and the publication of the First Folio. as it is mentioned in the prefatory lines by Leonard Digges. The design in its general aspect was one often adopted by the "tombe-makers" of the period, and according to Sir William Dugdale was executed by Gerard Johnson (Gheerart Janssen), a Fleming who had settled and worked in London since 1j67. The bust is supposed to have been commissioned by the poet's son-in-law, John Hall, and like the Droeshout print must have been seen and could have been approved by the poet's widow, who did not die until Aug. 1623. It has been argued that it was modeled from a life or death mask, and is too individual to be considered a generalization of the kind common in funereal sculpture. As was usual, especially in the work of Flemish sculptors. the bust was coloured. which may account for the summary nature of the modeling and the forms. The eyebrows are only slightly indicated by the chisel, and a solid surface represents the teeth of the open mouth: detail was supplied with the paint brush. Malone had the bust covered in white paint in 1793 and the recolouring may be responsible for its present wooden appearance. which shocks many visitors. The bust is of soft stone. but careful examination reveals no sign of an alleged breakage and repair of the nose to which some writers have attributed the apparently excessive length of the upper lip. This is mostly an optical illusion caused by the smallness of the nose and the thinness of the mustache. Some repairs were made in 1649 and in 1748 but there is no mention in church records of any meddling with the bust itself. The inaccuracy of the print by one of W. Hollar's assistants illustrating Dugdale's *Antiquities* of *Warwickshire* (1656) made some writers think that the bust had not merely been restored but replaced. This is not so.

The Droeshout print derives its importance from having been executed at the order of Heming and Condell to form a frontispiece to the *Plays*, and from its claim to be the portrait of the author to whose memory their work was dedicated, and whose real monument lay in the volume itself. Anne Shakespeare must have seen the print; Ben Jonson extolled it, although his dedicatory verses may be regarded as conventional approval. An authentic portrait, since lost, must have been the basis of the engraving, and Sir George Scharf, judging from the contradictory lights and shadows in the head, deduced that the original must have been a shadowless painting which the youthful engraver attempted to put into chiaroscuro with only partial success. This was supported by the "unique proof" of "first impression" first discovered by J. O. Halliwell-Phillips and of which several copies are now known. In this plate the head is far more human and the bony structure corresponds. There is a thin, wiry mustache, afterward widened in the print as used, and there are divergences in several other details. In this engraving the body is too small for the head and the dress is out of perspective — an additional argument that the unpractised engraver had only a drawing as a model.

The portrait which has made the most popular appeal is that called the Chandos, successively known as the d'Avenant, the Stowe and the Ellesmere, which is in the National Portrait gallery, London. It was implausibly attributed to Richard Burbage, who is alleged to have given it to his fellow actor Joseph Taylor who then bequeathed it to Sir William d'Avenant, Shakespeare's godson. No will of Joseph Taylor has been found, and though there is a strong tradition there is no proof that the picture belonged to d'Avenant. It was certainly bought at the sale of the effects of the 2nd duke of Buckingham and Chandos in 1847 by the earl of Ellesmere, who presented it to the nation. The romantic, Italian-looking head differs in many respects from the Stratford bust and the Droeshout print. Though the history of its provenance is seriously faulty, many people approve of the portrait because it suits their notion of what Shakespeare should have looked like. The newly discovered portraits of Shakespeare which arrive at the National Portrait gallery for consideration at the rate of at least one a year tend to have much in common with the Chandos. That it has not been radically altered by restorers is proved by the copy made by Sir Godfrey Kneller to give to John Dryden, and that it was esteemed within 70 years of the death of Shakespeare is shown by the fact that it was then in the possession of the earl of Fitzwilliam.

After Gerard Johnson's bust no statuary portrait seems to have been made until 1740, when the statue in the Poets' corner of Westminster abbey was set up by public subscription. It was "invented" by William Kent, carried out by Peter Scheemakers, and is based on the Chandos portrait. David Garrick commissioned a statue from L. F. Roubiliac in 1758 which is in the British museum, London. Roubiliac is also responsible for the Davenant bust of blackened terra cotta now at the Garrick club, London. It was found bricked up on the site of the old Duke's theatre in Portugal row, Lincoln's Inn fields, London, built by d'Avenant in 1660.

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SHALE is a fine-grained, earthy sedimentary rock that is a somewhat indurated clay and is characterized by a thinly layered or laminated structure, by which it is differentiated from clay. It is usually harder than clay and has less tendency to slake in water. It is usually gray, yellow, green or red.

Shales are sediments that accumulated in past geologic time in lakes, lagoons, oceans, etc. Their properties and composition depend upon the character of those sediments; the uniformity of the source material from day to day and from year to year; variations within the area of accumulation; and changes that took place during and after its deposition in the area of accumulation (see SEDIMENTARY ROCKS).

Some shales contain components other than clay minerals (*see* CLAY AND CLAY MINERALS), and varietal names are given on this basis; *e.g.*, sandy shale. limy shale, bituminous shale, etc. Shales find extended use in the manufacture of structural clay products, such as brick, tile and portland cement. *See* also SHALE, OIL.

(R. E. GM.)

SHALE, OIL. Oil shale is a sedimentary deposit rich in organic matter, which yields oil when heated in the absence of air. Practically all sediments form oil upon distillation, but a sediment must produce 15 gal. of oil per ton to be classified as oil shale. Commercial grades of oil shale give 25–50 gal, per ton and extremes of 150 gal. have been found.

Oil shale in its characteristic form is a thin-bedded sediment, light or dark brown when broken but white on its weathered surface. It is composed largely of remains of small plants. principally algae, rich in fats and waxes, which have decomposed in their own juices in a reducing environment, usually in fresh water.

In its natural state oil shale contains less than 3% of oily and fatty material extractable by ordinary solvents. When heated to 400° F. most of its organic constituents are converted to a form soluble in organic solvents. When heated from 600° F. to 1,300° F. it yields oil and gases. The quantity and quality of oily and gaseous substances vary with the rate and temperature of heating and with the quantity of organic matter in the shale. For example, typical oil shale from the Green river shale deposits of Colorado and Utah, containing from 10% to 30% organic matter, gives 18–50 gal. per ton. The average composition of this organic matter is 12.4% carbon, 1.7% hydrogen, 1.5% oxygen, 0.4% nitrogen and 0.2% sulfur. Under optimum conditions the organic matter yields 65% oil, 10% gas and 25% residual products. The total heating value of the shale is approximately 5,000,000 B.T.U. per ton, of which 76% is produced by the oil, 6% by the gases and 18% by the residual products. Depending upon the temperature and rate of heating, the specific gravity of crude Green river shale oil ranges mainly between 0.900 and 0.930. The lightest oil is produced by slow heating at a temperature of 1,000" F. The crude oil when distilled itself yields 16%–30% naphtha, 15%–24% light distillate, 28%–36% heavy distiilate and 16%–37% residuum. The naphtha contains 19%–25 % paraffins and naphthenes, 43%–60% olefins and 21%–36% aromatics. The nitrogen and sulfur compounds cause difficulty in refining. Practically any grade of petroleum product can be made by appropriate cracking processes.

Shale oil from other regions is similar. In some commercial operations the use of steam facilitates the release of nitrogen compounds. The sulfur enables production of ammonium sulfate fertilizer as a by-product in quantities of 10 to 100 lb. per ton of shale.

The hydrocarbon gases are 28%–50% methane, 5%–11% ethane, 1%–3% propane and less than 1% butanes. Hydrogen is 21%–42%, ethylene 6%–15%, propylene 1%–7%, butenes 1%–4% and hydrogen sulfide 1%–3%. In addition, the gas contains appreciable quantities of carbon monoxide and dioxide.

Oil shale is widespread. being found in Scotland, England, Estonia, Sweden, France, Spain, Czechoslovakia, Rumania, Austria, Germany, the U.S.S.R., the Union of South Africa. New South Wales, Queensland and Tasmania, Austr., New Zealand, Brazil, New Brunswick, Nova Scotia and Ontario, Can., Kentucky, Indiana, Nevada, Wyoming, Colorado and Utah, U.S. Oil shale has been mined commercially for many years in a fen places. The United States has reserves of more than 500,000,000,000 bbl. of shale oil in the Green river formation of Colorado, Wyoming and Utah. In 1944 the U.S. bureau of mines established an experimental mine and refinery to facilitate development of these deposits.

See U.S. Bureau of Mines, "Synthetic Liquid Fuels," *Annual Report of the Secretary of the Interior for 1950,* part *4* (1951); H. S. Bell, *Oil Shales and Shale Oils* (1948). (P. D. T.)

SHALLOT (*Allium ascalonicum,* family Liliaceae), a hardy, onionlike perennial with small, elongated, somewhat angular bulbs that develop in clusters on a common base. The leaves are short, small, cylindrical and hollow. The flowers of the compact umbel are lilac or reddish in colour. The shallot is probably of Asiatic origin. The common so-called shallot that is marketed extensively as green spring onions is in fact a form of *A,* cepa. (V. R. B.)

SHALMANESER (Ass. SULMĀNU-ASARID, "the god Sulman [Solomon] is chief"), the name of five Assyrian princes.

SHALMANESER I, son of Adadnirari I, succeeded his father as king of Assyria about 1273 B.C. He carried on a series of campaigns against the Aramaeans in northern Mesopotamia, annexed a portion of Cilicia to the Assyrian empire and established Assyrian colonies on the borders of Cappadocia. According to his annals, discovered at Ashur, in his first year he conquered eight countries in the northwest and destroyed the fortress of Arinnu, the dust of which he brought to Ashur. In his second year he defeated Sattuara. king of Malatia, and his Hittite allies, and conquered the uhole country as far south as Carchemish. He built palaces at Ashur and Nineveh, restored "the world temple" at Ashur and founded the city of Calah.

SHALMANESER III succeeded his father Ashur-nasir-apli II, 859 B.C. His long reign was a constant series of campaigns against the eastern tribes, the Babylonians, the nations of Mesopotamia and Syria, as well as Cilicia and Urartu. His armies penetrated to Lake Van and Tarsus, the Hittites of Carchemish were compelled to pay tribute and Hamath (Hamah) and Damascus were subdued.

In 853 B.C. a league formed by Hamath, Arvad, Ammon, "Ahab of Israel" and other neighbouring princes, under the leadership of Damascus, fought an indecisive battle against him at Qarqar (Karkar), and other battles followed in 849 and 846. (See JEWS: The Dynasty of Omri.) In 842 Hazael was compelled to take refuge within the walls of his capital. The territory of Damascus was devastated, and Jehu of Samaria (whose ambassadors are represented on the black obelisk now in the British museum) sent tribute along with the Phoenician cities. Babylonia had already been conquered as far as the marshes of the Chaldeans in the south. and the Babylonian king put to death. In 836 Shalmaneser made an expedition against the Tibareni (Tabal) which was followed by one against Cappadocia, and in 832 came the campaign in Cilicia.

In the following year the old king found it needful to hand over the command of his armies to the Tartan (commander in chief), and six years later Nineveh and other cities revolted against him under his rebel son. Civil war continued for two years; but the rebellion was at last crushed by Samas-Rimmon or Shamshi-Adad, another son of Shalmaneser. Shalmaneser died soon afterward in 824 B.C. He had built a palace at Calah, and the annals of his reign are engraved on an obelisk of black marble which he erected there.

See V. Scheil in *Records of the Past,* new series, iv, 36–79.

SHALMANESER V appears as governor of Zimirra in Phoenicia in the reign of Tiglath-pileser III and is supposed by H. Winckler to have been the son of the latter king. At all events, on the death of Tiglath-pileser, he succeeded to the throne the 25th of Tebet 727 B.C., and changed his original name of Ululai to that of Shalmaneser.

The revolt of Samaria took place during his reign (see JEWS: The Fall of the Israelite Monarchy), and while he was besieging the rebel city he died on the 12th of Tebet 722 B.C. and the crown was seized by Sargon.

For these rulers *see* BABYLONIA AND ASSYRIA: *History.* (A. H. S.)

SHAMANISM is a religious phenomenon characteristic of Siberian and Ural-Altaic peoples. The word shaman itself is of Tungus origin (*saman*) and it has passed, by way of Russian, into European scientific terminology. But shamanism, although its most complete expression is found in the arctic and central Asian regions, must not be considered as limited to those countries. It is encountered, for example, in southeast Asia, Oceania and among many North American aboriginal tribes. A distinction is to be made, however, between the religions dominated by a shamanistic ideology and by shamanistic techniques (as is the case with Siberian and Indonesian religions) and those in which shamanism constitutes rather a secondary phenomenon.

The shaman is medicine man, priest and psychopompos; that is to say, he cures sicknesses. he directs the communal sacrifices and he escorts the souls of the dead to the other world. He is able to do all this by virtue of his techniques of ecstasy; *i.e.,* by his power to leave his body at will. In Siberia and in northeast Asia a person becomes shaman by hereditary transmission of the shamanistic profession or by spontaneous vocation or "election.' More rarely a person can become shaman by his own decision or upon request of the clan, but the self-made shamans are regarded as weaker than those who inherit the profession or who are "elected" by the supernatural beings. In North America, on the other hand, the voluntary "quest" for the powers constitutes the principal method. No matter how the selection takes place, a shaman is recognized as such only after a series of initiatory trials after receiving instruction from qualified masters.

Asia. — In Asia as a rule the trials take place during an indefinite period of time in which the future shaman is sick and stays in his tent or wanders in the wilderness, behaving in such an eccentric way that it could be mistaken for madness. Several authors went so far as to explain arctic and Siberian shamanism as the ritualized expression of a psycho-mental disease, especially of arctic hysteria. But the "chosen" one becomes shaman only if he can interpret his pathological crisis as a religious experience and succeeds in curing himself. The serious crises that sometimes accompany the "election" of the future shaman are to be regarded as initiatory trials (see PASSAGE **RITES**). Every initiation involves the symbolic death and resurrection of the neophyte. In the dreams and hallucinations of the future shaman may be found the classical pattern of the initiation: he is tortured by demons, his body is cut in pieces, he descends to the netherworld or ascends to heaven and is finally resuscitated. That is to say, he acquires a new mode of being. which allows him to have relations with the supernatural worlds. The shaman is now enabled to "see" the spirits, and he himself behaves like a spirit; he is able to leave his body and to travel in ecstasy in all cosmic regions. However, the ecstatic experience alone is not sufficient to make a shaman. The neophyte must be instructed by masters in the religious traditions of the tribe, and he is taught to recognize the various diseases and to cure them.

Among certain Siberian peoples the consecration of the shaman is a public event. Among the Buriats, for example, the neophyte climbs a birch, a symbol of the world tree, and in doing this he is thought to ascend to heaven. The ascension to heaven is one of the specific characteristics of Siberian and central Asian shamanism. At the occasion of the horse sacrifice, the Altaic shaman ascends to heaven in ecstasy in order to offer to the celestial god the soul of the sacrificed horse. He realizes this ascension by climbing the birch trunk, which has nine notches, each symbolizing a specific heaven.

The most important iunction of the shaman is healing. Since sickness is thought of as a loss of the soul, the shaman has to find out first whether the soul of the sick man has strayed off far from the village or has been stolen by demons and is imprisoned in the other world. In the former case the healing is not too difficuit: the shaman captures the soul and reintegrates it in the body of the sick person. In the latter case he has to descend to the nether world, and this is a complicated and dangerous enterprise. Equally stirring is the voyage of the shaman to the other world to escort the soul of the deceased to its new abode; the shaman narrates to those present all the vicissitudes of the voyage as it goes on.

Another type of descent is represented by the journey of the Eskimo shaman (see below) to the bottom of the ocean, to the Mother of the Seals; he undertakes this submarine voyage when the seals become scarce and the population is menaced by a famine.

As a rule the shaman has several auxiliary spirits at his disposal. but he is not possessed by them. The spirits help him to find the soul of the sick person, and sometimes they accompany him in his ecstatic voyages. In certain regions the shaman ends by being really possessed by his auxiliary spirits, and he becomes their mouthpiece; but the possession is a secondary phenomenon found especially in those regions where shamanism is mingled with other magico-religious conceptions and techniques.

Shamanism represents the mystical experience characteristic of the primitive and archaic religions. The "flight" of the shaman to heaven can be regarded as the most ancient expression of mystical experience known to mankind. But the shaman is not only a mystic. He is just as much the guardian (and largely the creator) of the traditional lore of the tribe, he is the sage and even the poet of primitive societies. The narrations of his adventurous descents to the netherworld and of his ascents to heaven constitute the material of popular epic poetry in central Asia and in Polynesia.

Eskimo. — Shamanism predominates in the religious life of the Eskimos. The chief prerogatives of the Eskimo shaman (*angakok*; pl., *angákut*) are healing, the ecstatic underwater journey to the Mother of Animals for the purpose of assuring an abundance of game, and the aid he brings to barren women. Sickness is brought on by the violation of taboos or results from the capture of the soul by a ghost. In the first case, the shaman strives to drive out the impurity by collecrive confessions; in the second case, he undertakes the ecstatic journey to heaven or to the depths of the sea to retrieve the sick person's soul and restore it to his body. The angakok is also a specialist in magic flight. Some shamans are reputed to have visited the moon: others claim to have flown around the earth. The *angákut* also know the future, make prophecies, predict changes in the weather and excel at magic feats.

American Indians. — Among many North American tribes shamanism constitutes the most important aspect of the religious life. The shaman is characterized by the supernatural power he acquires as the result of a direct personal experience. This power is obtained either spontaneously or after a voluntary quest. but in either case the future shaman has to undergo certain initiatory trials. In general, the power is utilized in such a may as to affect the whole society. The shaman's principal function is healing, but he also plays an important role in other magico-religious rites such as, for example, communal hunting and, where they exist, secret societies (*q.v.*) or mystical movements (Ghost Dance [*q.v.*] religion type). North American shamans, like all their fellows, claim to control the weather (bring on or stop the rain, etc.), know future events, expose the perpetrators of thefts, etc. Furthermore, they defend men against sorcerers. But the magico-medical powers held by North American shamans do not exhaust their ecstatic abilities. There is every reason to suppose that modern secret societies and mystical movements among the Indians have appropriated in large part the ecstatic activity that once characterized shamanism.

In the tribes of South America the shaman enjoys considerable prestige and authority. Not only is he the healer par excellence and, in certain regions, the guide of souls of the dead to their new abode; he is also the intermediary between men and the gods or spirits, substituting himself for the priest at times. He guarantees the respect for ritual observances. defends the tribe against evil spirits, points out places for fruitful hunting and fishing, increases the wild life, controls the weather, eases childbirth, reveals future events, etc. Of course, the South American shaman can also fill the role of sorcerer; he can, for example, change himself into an animal and drink the blood of his enemies. Yet it is rather to his ecstatic abilities that the South American shaman owes his magico-religious position and social authority.

It is probable that a certain form of shamanism was diffused on the two American continents with the first waves of immigrants from Asia; later contacts between northern Asia and North America made Asian influence possible well after the penetration of the first immigrants.

Africa. — Shamanism does not play a role of the first order in Africa.

Southeast Asia and Oceania. — Shamanism is prevalent in the Malay peninsula and in Oceania. Among the Negritos of the Malay peninsula, the shaman heals with the help of celestial spirits or by using crystals of quartz. But the influence of Indo-Malayan beliefs is noticeable, too (the shaman changing into a tiger, trance achieved by dancing. etc.). In the Andaman Islands, the shaman gets his power from contact with spirits. The commonest method is to "die" and return to life. the traditional pattern of shamanic initiation. The shamans gain their reputation through their acts of healing and their meteoroiogical magic (they are thought to bring on storms).

The distinctive marks of Malayan shamanism are the calling forth of the tiger's spirit and the achievement of the trance (*lupa*), during which the spirits seize the shaman, possess him and reply to questions asked by the audience. Mediumship is also characteristic of different forms of shamanism in Sumatra, Borneo and Celebes. Among the Ngadju-Dayak of Borneo there even exists a special class of shamans, the *basirs* (literally, "incapable of procreation"), hermaphrodites who dress and act like women. These are considered to be intermediaries between heaven and earth because they unite in their own person the feminine element (earth) and the masculine element (heaven).

Possession by gods or spirits is a peculiarity of Polynesian ecstatic religion. The extreme frequency of possession in that region has made possible a proliferation of healers. Priests, inspired persons, medicine men and sorcerers may all perform magical cures. For this reason it is not possible to speak of shamanism *stricto sensu* in Polynesia.

In Australia, a person becomes a medicine man through a ritual of initiatory death, followed by a resurrection to, a new and superhuman condition. But the initiatory death of the Australian medicine man, like that of the Siberian shaman, has two specific marks not found elsewhere in combination: first, a series of operations performed on the candidate's body (opening of the abdomen, renewal of the organs, washing and drying of the bones, insertion of magical substances); second, an ascent to heaven, sometimes followed by other ecstatic journeys into the other world. The revelation concerning the secret techniques of the medicine men are obtained in a trance, a dream or in the waking state before, during or after the initiatory ritual proper.

See Mircea Eliade, *Le Chamanisme et les techniques archaïques de l'extase (1951)*; *M. A.* Czaplicka, *Aboviginal Siberia* (1914).
(M. EE.)

SHAMASH (ŠAMAS), the common Semitic word for "sun." In pre-Islamic times *Šamsu* was regarded throughout Arabia as a goddess and often called *ilā,* "goddess," wife of the moon-god Wadd, and mother of Athtar, the planet Venus. Her symbol in Arabia was a disk. Among the north Semitic races (Canaanitic and Aramaean) the name is *šemeš, šimšā,* and always masculine. Traces of Canaanitish worship are found in the Old Testament, for which see II Kings 23, 11, where the horses and the chariots of Canaanitish heathendom were removed by Josiah. The sun-god is symbolized by the horse in pre-Islamic Arabia also, and pillars called *hammanim,* bearing the sun disk, were set upon the altars of the Canaanitish Ba'als. In Arabia this deity has the epithet '(mistress of heat" when she is the summer sun, and "mistress of the distant region (south)" when she is the winter sun.

When the Semites first appear in history in Babylonia they identified their sun-god (*šamaš*) with the older Sumerian sun-god, Utu, Babbar, and it is probable that this caused the change in gender throughout the north Semitic peoples. This contact of the Semite with the Sumerians occurred as early as 3200 B.C. He became there one of the great deities of ancient religion, and lost all earlier Semitic traces to be completely transformed into a Sumerian deity; as such his cult appears throughout Babylonian and Assyrian history and survived at various Syrian centres to a late period.

The two chief centres of sun worship in Babylonia were Sippar (Sippara), represented by the mounds at Abu Habba, and Larsa, represented by the modern Senkerah. At both places the chief sanctuary bore the name E-barra (or E-babbara), "the shining house"—a direct allusion to the brilliancy of the sun-god. Of the two temples, that at Sippara was the more famous, but temples to Shamash were erected in all large centres—as Babylon, Ur, Nippur and Nineveh.

The attribute most commonly associated with Shamash is justice. Hammurabi attributes to Shamash the inspiration that led him to gather the existing laws and legal procedures into a code, and in the design accompanying the code the king represents himself in an attitude of adoration before Shamash as the embodiment of the idea of justice. Several centuries before Hammurabi, Ur-Nammu of the Ur dynasty (c. 2600 B.C.) declared that he rendered decisions "according to the just laws of Shamash."

Together with Sin and Ishtar, Shamash forms a second triad by the side of Anu, Bel and Ea. The three deities, Sin, Shamash and Ishtar (*q.v.*), the moon, the sun and Venus, form an astronomical triad corresponding to the same early Arabian triad. At times, instead of Ishtar, we find Adad (*q.v.*), the storm-god, associated with Sin and Shamash. In Sumero-Babylonian religion Shamash was regarded as the son of the moon-god Sin.

The consort of Shamash was known as Aya.

SHAMMAI, a Jewish scribe of the time of King Herod, whom tradition almost invariably couples with Hillel (*q.v.*), with whom he stood in striking contrast, not merely in legal-religious decisions and discussions, but also in character and temperament. The opposition between Shammai and Hillel was perpetuated by their respective schools, till, under Gamaliel II, the strife was decided at Jabneh in favour of the school of Hillel.

SHAMROCK. According to an Irish legend, St. Patrick first chose the shamrock as a symbol of the trinity of the Christian church because of its three leafiets. With a shamrock he is said to have driven the snakes of Ireland into the sea. The term shamrock is applied to several plants, among them wood sorrel, Oxalis acetosella; white clover, Trifolium *repens;* suckling clover, *Trifolium dubium;* and black medic, *Medicago lupulina.* In Great Britain the wood sorrel is shipped from Ireland to London and other places in great quantity for St. Patrick's day. See also CLOVER; WOOD SORREL. For that holiday in the United States the plants most commonly used as shamrock are white clover and species of Oxalis. (J. M. BL.)

SHAMYL (c. 1797–1871), the leader of the tribes of the Caucasus in the war against Russia. He was born about 1797 and, educated by the mullah Djemaleddin, soon took a leading part in preaching a holy war against the Russians. He was both the spiritual and military leader of the tribes, who maintained the struggle for 25 years (1834–59). Shamyl's romantic fight for independence, making him a sort of ally of England and France at the time of the Crimean War (1853–55), earned him a European reputation. However, the capacity of the tribes for resistance was already failing, and when at the close of the Crimean War Russia was able to employ large forces on the Caucasus, the defenders were gradually subdued, Shamyl himself being captured in 1859.

The rest of his life was spent in an easy captivity at Kaluga, St. Petersburg and Kiev. He died at Mecca during a pilgrimage in 1871. One of his sons took service in the Russian, the other in the Turkish army.

SHAN, the Burmese term for speakers of Tai (or Thai) languages other than Siamese. Shan principalities (mong) of varying size exist in Assam, Burma, Thailand, Laos, Vietnam, Cambodia and throughout southwest China. No useful estimate of total population can be made, though in Burma Shans number over 1,000,000.

Despite wide geographical dispersal both language and associated culture are fairly uniform. Although holding mainly high upland territory, the Shans themselves live only in the valleys and in stretches of plain. The hill country round about is occupied by a variety of relatively primitive hill peoples living in economic symbiosis with the Shans, but there is no clear racial distinction between the Shans and their neighbours. With minor exceptions modern Shan communities are Buddhist. Most Shans are cultivators of rice; they have a characteristic species of feudal political structure.

Shan culture probably diffused southward and westward from west-central China from Han times onward. The powerful Nanchao kingdom, centred near modern Tali-fu, was of Shan type. The subordination of Nanchao to the Mongol rulers of China in A.D. 1253 was followed by greatly accelerated Shan political expansion toward the southwest. During the 16th century a loose federation of Shan rulers controlled most of Assam, Burma, Siam and the Indochina peninsula. Thereafter Shan power receded. In the early 19th century the political structure throughout this area was still Shan in type.

In a Shan *mŏng* the power of the prince (raohpa, anglicized tsawbwa) is theoretically absolute but is really exercised by appointed ministers (*amat.*). The prince has semidivine attributes and, unlike the commonality who are monogamous, is expected to maintain an extensive harem. In some areas he should marry a half-sister as chief wife. Emphasis on patrilineal descent is confined to the royal lineages. Rank status is hereditary but there is no rigid caste endogamy. Shans are known locally by a great variety of names; *e.g.*, Ahom, Khamti (Assam): Pai-i (Yunnan); Lu, Hkun, Lao (Thailand, Laos, Vietnam, Cambodia).

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SHANGALLA, a name loosely applied by Abyssinians to the non-Arab and non-Abyssinian tribes living in the fertile belt which bounds Abyssinia on the west. The principal tribes are the Legas, Bertat, Gumus, Kadalos and Sienetjo. In some, Galla blood predominates: others are Negroids.

SHANGHAI (SHANG-HAI), a commercial metropolis of China, and one of the world's largest seaports occupying an extraordinary favourable geographical situation for both internal and external trade. Geographic conditions have concentrated China's foreign trade into a single gateway to a degree unparalleled in any other great country. One of the original treaty ports (opened by the treaty of Nanking, 1842), it owed its phenomenal growth to occidental commercial enterprise.

The magnificent natural waterways united in the drainage of the Yangtze river, give to the port at its outlet to the Pacific a vast commercial hinterland producing a great range of commodities and a large consumer market of about 200,000,000 inhabitants. In addition, it serves as the master port for the lesser ports of the China coast from Fukien to Shantung province. Externally, it is the nearest port to Japan, and it lies directly on the great shipping lane from San Francisco to Singapore. Locally, Shanghai occupies one apex of the delta land south of the Yangtze containing 20,000 sq.mi. with over 40,000,000 people, of which about 70% are farmers who supply the city with food arid with cotton and silk for its industries.

Climatically, Shanghai has the monsoon characteristics common to most of the east coast region, with its concentration of high rainfall in the spring and summer. The annual average is 45 in. of precipitation. Weather variability is provided by the frequent cyclonic storms moving eastward along the Yangtze valley, especially in spring. Shanghai's latitude is almost as far south as that of New Orleans, so that summers are uncomfortably hot and humid. Summer temperatures are kept below 90° F. by rains for part of July and August, and they seldom rise above 98°, but humidity averages 84% for this period. In winter humidity drops to about 30% and absolute minimum temperature to 13°.

The harbour.—Shanghai does not escape the problems besetting delta cities. It lies about 14 mi. above the mouth of the Whangpoo river (Huang-p'u Chiang) a small tributary of the Yangtze near its estuary. Daily, rising tide water from the Pacific shunts Yangtze river water up the Whangpoo. The slow current at this stage leads to rapid deposition of sediments. In early times this also resulted in the silting up of Soochow creek (Wu-sung Chiang) which flows from Soochom into the Whangpoo. The Whangpoo during the mid-19th century scoured out a channel to the Yangtze estuary at least 15 ft. deep and was able to accommodate the sailing vessels of the time. This led the British to select Shanghai as one of the five treaty ports opened to trade as a result of their success in the war with China (1839–1842). The Whangpoo's initial advantages were rapidly reduced by further silting. however, and by 1905 the channel depth was only 10 ft. leading to gloomy forecasts of Shanghai's future as a port. The problem, however, was largely solved by the work of the Whangpoo Conservancy board. Its vigorous harbour policy resulted in the development of a good shipway with a minimum depth of 24–26 ft. at the lowest tides and a high water depth of 30–42 ft. Requiring much greater efforts were the main bars of the Yangtze itself at the so-called Fairy flats (Shen T'an). Large ships could enter the river only at high tide and through the south channel, while tides and currents made the approach to Shanghai somewhat difficult. Neglect during World War II and after the Communists took over resulted in a less commodious and useful harbour in the 1950s than during the 1930s.

Port communications.—Numerous canals, some navigable to 80-ton barges and steamboats, lead from the Whangpoo to the surrounding countryside. These include a 36 mi. long canal for navigation and flood control from T'ai Hu, a large lake in the west, to the Whangpoo and constructed in 1958. Shanghai's two chief railroad connections are with Nanking in the northwest and Hangchow in the south, 193 mi. and 118 mi. distant respectively. Through these cities Shanghai has rail connections with the north and south China networks. The role of railroads in Shanghai's growth has been minor, and in the 1930s her two main rail lines carried only the moderate amount of 1,000,000 tons annually per mile. The withdrawal of most of China's shipping by the Nationalist government of China to Formosa in 1949 left water transport at Shanghai at a low ebb. From June 1949 to May 1950 the Nationalist blockade brought the relative shares in total freight of railways and watercraft of all kinds to an approximate ratio of 3.2 to 1. The heavy reliance that was put on carriage by rail contributed in part to the piling up of large quantities of cargo here as in other parts of the country in the late 1950s when there were transport bottlenecks. Although several hard-surfaced roads usable to motor transport lead from Shanghai to the hinterland, the high cost of motor transport resulted in a low volume of trucking from the port.

Port development.—When the British first realized the port potentials of Shanghai during naval operations in the Anglo-Chinese war, Shanghai was a small unimportant walled city on the Whangpoo about a mile above its junction with the Soochow creek. In 1843 the British settlement was established between the Soochow creek and the Yang-ching canal a short distance north of the walled city. Later this strip between the canal and the walls became the site of the French concession, while the American settlement (Hong Kew) grew up on the northern side of the Soochow creek. The American and British sectors were joined in 1863 to form the International settlement. The foreign zones were administered separately until World War II. The settlement area once was marshy paddy land often flooded but through careful drainage and filling, the area was converted to sites suitable for buildings. However, construction faced the difficulty of finding stable foundations, since the unconsolidated sand and silt was about 1,000 ft. deep. Uneven settling of large buildings made it dangerous to construct skyscrapers until the problem was solved for buildings up to about 20 stories by floating them on concrete rafts. Many of the canals and open sewers were culverted over, although some were used for small boat and barge navigation. Pontoon jetties anchored along the bank provided landing facilities. From the wailed city down river on the left bank, and for a longer distance up and down the river on the right bank (an area known as Pootung or P'u-tung) there mere in the 1930s less than 10 mi. of riverside shipping frontages with a minimum depth of 12 ft. The congestion at Shanghai was great. Subsequent work by the Chinese municipality which was continued after 1937 by the Japanese, resulted in additional wharfage just below the Pootung sector of the water front. Postwar construction by the Communist regime include the K'ai-p'ing wharf at Jih-hui Chiang which for the first time provided railroad connection directly to a wharf, and the new wharf at Pei-p'iao begun in June 1956.

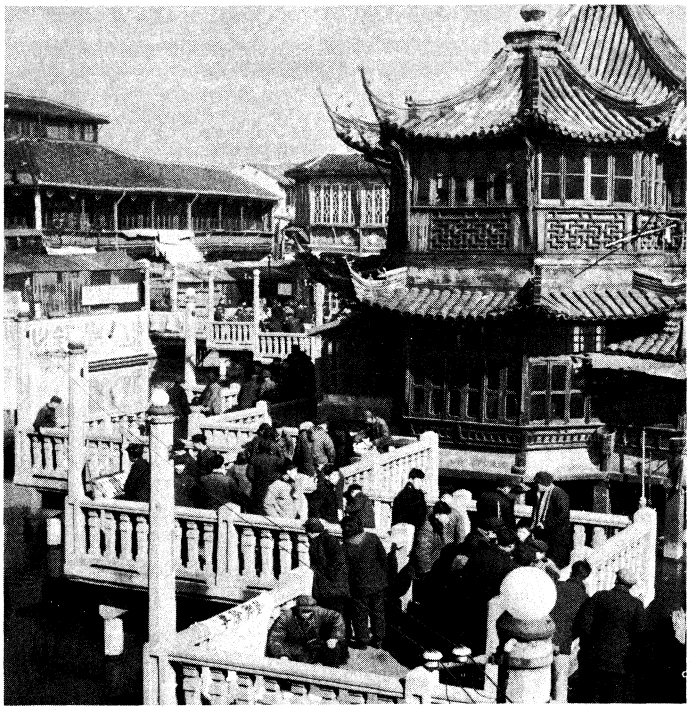
Trade—Shortly after being opened to foreign commerce in the 18th century the port of Shanghai began to dominate China's trade and by the 1870s it was handling about 62% of the total. By 1920 this had dropped to 45% as northern ports developed. In the post-World War II period before the Nationslists took refuge on Formosa, Shanghai accounted for 75% of the imports and 60% of the exports of China. Its importance declined abruptly after 1949 owing to the Nationalist blockade and by the mid-1950s Shanghai was in second place after Tientsin which had become the leading port for Communist China. By the early 1960s, Shanghai's trade had rapidly and progressively increased.

The export of tea and silk. and the import of opium and cotton textiles dominated the greater part of the trade period from 1850 to 1937. During the 20th century, however, especially during the 1920s and 1930s, imports of machinery, metals and raw materials rose to account for more than 65% of the import trade. In exports, the position of raw silk and tea. although not the quantity, diminished sharply, while bulk commodities such as ran' materials, vegetable oils, hides and skins and some manufactured products became increasingly important. T'ung oil and pig bristles were two important raw materials marketed predominantly through Shanghai. In 1939 the value of exports from Shanghai was about the equivalent of U.S. $126,000,000, while imports reached about $94,000,000. These figures, somewhat incomplete because of the abnormal war situation, gives some idea of the trade volume. Wartime trade from 1941 to 1945 was greatly reduced and toward the end amounted to little. The 1946 figures for China's exports as a whole (and Shanghai handled about 60% of this) were very small absolutely and relatively to their prewar ratio to imports. Large quantities of imports were UNRRA and American aid materials. After 1949, mainland China's trade mas predominantly nith the Soviet Union and Communist-dominated countries. There was a marked decline in the importance of consumer goods and a corresponding increase in the import of capital goods. Machinery, metals, chemical raw materials, scientific instruments, drugs and fibres, especially cotton, were leading imports. Food and raw materials continued to furnish the bulk of the exports, but manufactured goods and machinery were also of some importance.

The number of foreign ships visiting the port, not unexpectedly, has declined since the 1930s. While the People's Republic of China claimed in the late 1950s that Shanghai had regained its importance as a leading seaport, this was not borne out by observations of foreign travelers nor by official shipping statistics. It was reported in 1958 that Shanghai harbour handled a record volume of 2,220,000 tons of cargo, the highest in the history of the harbour. Hence, it is assumed that much of this pertained to domestic freight movements.

Industry. — Shanghai not only was China's leading port, but also her leading manufacturing city. Before 1937 it accounted for at least half of the country's large-scale Western-type industrial production. Of this industry, 407,–507, of the value of output and 50%–60% of the labour of the city was in textile manufacturing. This was led by cotton-spinning followed in order by silk-reeling, cotton weaving? wool spinning and wool weaving. Food industries came second with 30%–35% of the value of production. Among these, flour milling and cigarette manufacturing were most important. Other industries in order of importance were leather goods, rubber goods, paper and publishing, chemicals, and machine manufacturing. While cotton and silk industries found their raw materials in Shanghai's immediate hinterland in the Yangtze delta, flour mills depended upon wheat shipped from abroad, while tobacco came from the north China plain. The metals and rubber using industries were farthest removed from their sources of supply. Shanghai's coal was imported from north China, Japan and northern Vietnam prior to 1939. The Shanghai power company, using coal as fuel, produced 70% of the city's power and as coal could be brought in by cheap ocean transportation the city's power rates were among the cheapest in the world. Industries developed along both banks of the Whangpoo except along the Bund (a waterfront thoroughfare), but the east bank was less important because of location factors.

Shanghai emerged from World War II in a precariously depressed condition. Most of the textile plants and spindles as well as other factories were destroyed or inoperative. Rehabilitation began gradually. In 1949 Shanghai metal industries turned out 5,000 tons of steel and about 13,000 tons of steel products. Following the initial take-over, the Communist industrial policy was to keep privately owned plants in operation with the government absorbing the output but at fixed prices. The second step was the formation of joint government-private companies nhich by the beginning of 1956 took in all industrial ventures. This smoothed the transition to full government ownership and operation, since the old managerial staffs were largely retained on a salary basis. Following the Nationalist air bombardment of Feb. 1950, there was a temporary industrial exodus and a move to decentralize Shanghai's industries by removing them to the interior. In 1953 the city had only 20% the total value of mainland China's industrial output, but this was officially claimed to be 368% higher than that of 1950.



EASTFOTO

THE OLD CITY TEMPLE IN SHANGHAI IS FLANKED BY A MANY-ANGLED BRIDGE
According to Chinese legend, a devil must walk a straight line; his progress is thwarted by such bridges

In the late 1950s Shanghai had about one third of China's cotton spindles and produced about 2,000,000 bales of cotton yarn. China's first rayon plant went into production in 1958. In 1950 the city's flour mills had 20% of China's flour making capacity of approximately 140,000,000 bags per year. This was above the consumption requirements of Shanghai, so it was decided to move some of the plant equipment to wheat growing areas in the interior. Rice milling production, however, was insufficient and was increased by the construction of new mills.

Next to Tientsin, Shanghai in the early 1960s was a chief centre of chemical industry in China. The largest chemical factory was the Yung-li plant which produces ammonium sulfate and pure soda. One of China's chief cement plants is at Chiang-nan. A new policy to build up Shanghai as **a** heavy industry and machine manufacturing centre was well underway in the 1960s. In 1958, the year of the "great leap," Shanghai claimed to have achieved its goal of 1,222,000-tons of steel, 1.4 times the production of 1957. Output was scheduled to be further increased in subsequent years. The heavy industry was also pledged to make steel manufacturing equipment for other parts of China, electric power generators and tractors. Among the major plants built or enlarged during the first five-year plan (1953–58) were shipyards at Chiang-nan and Hu-tung, a steam turbine works, a boiler norks, and a lathe plant. Eight steel rolling mills for making seamless tubes, welded pipes, alloy steel and sheet iron were also included in the plan. Total industrial output of Shanghai in 1958 reached a value of 17,100,000,000 yuan. Heavy industrial development increased considerably in the 1950s but on the other hand there was a marked decline in light industry.

Population. — According to the Nationalist census bureau Shanghai's population was 4,630,385 in 1948. The distress in the rural areas following the Communist co-operative farm program grain collections together with natural calamities, brought a rapid urban influx of peasants which by 1953 had boosted Shanghai's population to 6,204,417. Efforts were made to reduce this, by forcible evacuation to the country, but many of these deportees probably managed to drift back. Shanghai's natural population increase since 1949 was estimated at an average rate of 200,000 per year. The city's industrial labour force in the early 1960s was more than 1,000,000. The male to female sex ratio of the population in the 1953 census was 123 to 100.

Social Change and Culture. — Shanghai's social character has greatly changed. In the 1930s there were between 30,000 and 60,000 foreign residents, now few foreigners are to be seen. Known once as a centre of gangsterism and a city of beggars and prostitutes, it is claimed that now not a single night club exists. About 10,000 prostitutes were put into reformatories for labour reform and rehabilitation to Communist society. Gambling was banned along with prostitution, and the famous racecourse and dog race stadium were converted into a recreation park and museum. Numerous regulations were applied to urban inhabitants of Shanghai after 1950 and individual movement about the city was greatly restricted. Under the so-called Democratic Reform movement, begun in Dec. 1952, former independent labour leaders were liquidated, and labour organizations were disbanded. Wholesale arrests of suspected Nationalist sympathizers were made. That the regime's problems were not all solved was indicated by the drive in 1958 to eradicate theft, gambling, vagrancy, census evasions, delinquencies, political sabotage and illegal capitalistic enterprises. Shanghai was charged in 1957 with having over 9,000 clandestine factories with more than 30,000 workers.

In conformity with the national policy of making office workers and officials do manual labour, thousands of cadres were reported to have been organized and sent to rural areas for work. The city is being used as a training centre for clerks, skilled labour, and technicians for the new plants being established in the interior regions. In spite of censorship and reorganization, Shanghai is a major publishing centre, and also maintains its position as a leading educational and cultural centre. It is the seat of Fu Tan and Tungchi universities and there are several medical colleges, museums and libraries. Institutes of Foreign Languages, Technology, Drama, Law, Finance and Economics, and Marine Products and the Shanghai Conservatory of Music are located there.

Municipal administration. — Shanghai is located in, but politically independent of, Kiangsu province. The Communist municipal government has a mayor, 11 elected deputy mayors, 44 members of a peoples' council, and a peoples' congress consisting of 737 delegates, The latter is a number equal to that of any provincial congress. The area of Shanghai at first was divided into 30 wards, but in 1959 only 12 municipal wards *(ch'u)*, three communications wards, and three districts (hsien) were listed. The districts include Shanghai, Chia-ting and Pao-shan. There are southern, western and northern communications wards. The area of Shanghai in 1958 was 270 sq.mi. When the communists first took over in 1949, they went into such detail of organization that in each of Shanghai's 11,185 streets a street committee was set up whose work was divided into six departments: health, education and culture, defense and security, social welfare, conciliation and relief. This was furthered by the establishment in 1951 of the Shanghai Peoples' Control commission. The control function was most likely performed by the Discipline Inspection committee already established in all the administrative units of Shanghai's Municipal Government. Moreover, the municipal peoples' court of Shanghai set up in 1949 was placed under the control of the local Military Control committee, thus reducing the court to a combination of military and administrative tribunal. The close tie with the party organization is shown in the position of Jao Shu-shih, the first secretary of the East China Party bureau and of the Shanghai Municipal Party committee, who in 1950 was also political commissioner to the 3rd Field army under Ch'en I.

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(H. T. Ws.)

SHANGHAI, to drug and ship aboard a vessel needing hands.

SHANHAIKWAN ("the gate between mountain and sea"), an important Chinese garrison town (pop. about 30,000) in the extreme northeast corner of the province of Hopeh in 40° N. and 119° 47' E. It occupies a notably strategic position, commanding the narrow coastal sill between the sea (Gulf of Liaotung) and the outlying mountain ranges of Jehol, followed by the Great Wall, which was formerly continued to the actual coast.

Its historic function has thus been that of a military post, guarding the crucial corridor communicating between the plain of north China and that of south Manchuria, and so it has come into prominence at different periods — as at the time of the establishment of the Manchu dynasty in China, during the Boxer rebellion and the Chinese-Japanese wars.

SHANKARA (780–820), the leading exponent of Advaita Vedanta, nondualism, and author of commentaries on the Upanishads, the Bhagavad-Gita and the Brahma Sutra which are known for their profundity of spirit and subtlety of thought. Shankara attempts to build a spiritual view of life on rational foundations: by reasoning we find that the world is not self-maintaining and must have a cause which is transcendent to it. In spiritual experience we apprehend the reality of this Absolute Spirit, which is called Brahman. The differences of knower, known and knowledge disappear when the Supreme Reality is known.

The world does not exist of itself but is derived from and dependent on Brahman and so is less real than Brahman. It is not, however, an illusion. The individual self which feels, suffers and is affected by the experiences of the world is a phenomenon while the truth is Brahman. To recognize the highest truth as Brahman is to attain release. Meditarion, worship, ritual are intended for a lower class of aspirants, and jnana (wisdom, knowledge of God) is the path to be pursued by the higher class of aspirants who have no desire for earthly prosperity or heavenly joy. There are two kinds of release: *sadyo-mukti* or instantaneous liberation and *krama-mukti* or gradual liberation. The former is the result of jnana, the latter of *upasana* or worship and prayer. Shankara makes out that the identity with the Highest Self is not destruction of soul. It is the perfection of the soul which has no more specific cognition or objective knowledge. See also INDIAN PHILOSOPHY: *Vedanta*. (S. RA.)

SHANKLIN: see SANDOWN-SHANKLIN.

SHAN LANGUAGE. Shan is a language of the Tai linguistic group spoken in the Shan and Kayah states of northern Burma. It is a noninflecting, basically monosyllabic, tonal language. It bears considerable phonological and grammatical resemblance to other Tai languages such as Lao and Siamese (Thai). Compared with these, Shan exhibits a simpler syllabic structure, but greater differences exist in lexicon. Long contact with the Burmese language has influenced Shan, which contains many Burmese loan words.

The Shan script was developed from the Burmese. The traditional writing system is inefficient and causes grave reading difficulties even to Shans. In particular, it lacks sufficient vowel symbols and does not mark tone. These deficiencies were remedied in a series of reforms culminating in that of 1955. and the modern Shan script is an excellent phonetically based writing system.

Dialectal differences exist within Shan, but these are relatively minor. Dialects to be grouped with Shan are spoken by some Tai peoples in southwest China, *e.g.,* the Tai Mao people, and on the borders of Assam, *e.g.,* the Khamti people. These groups employ scripts which, though generally similar to that of Shan, exhibit marked stylistic variations.

Within the Shan state some peoples, notably the Khu'n of the formerly autonomous Kengtung state, speak Tai dialects which must be grouped with those of north Thailand rather than with Shan. *See* SHAN; SHAN STATE: *Race and Language.*

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SHANNON, CHARLES HASLEWOOD (1863–1937), English artist who was notable for his lithographs. He was born at Quarrington, Lincolnshire, April 26, 1863, the son of a clergyman. He was apprenticed to a trade wood engraver, in whose workshop he presently met Charles Ricketts, with whom he lived and worked until Ricketts' death in 1931, although their last direct collaboration was the periodical *The Dial* (1889–97).

Shannon's earliest designs were for Harry Quilter's *Universal Review;* but in 1893 he and Ricketts produced *Daphnis* and Chloe, a book in which text, illustrations and paper of choice quality formed a unique harmony. The first designs savour of early Renaissance book illustration, but the lithographs undertaken by Shannon from 1889 to 1898 are more personal. austere, delicate and full of a silvery chiaroscuro. Often their subject matter is of a recondite mythological character. but among them are valuable portraits such as those of Alphonse Legros. George Moore and Lucien Pissarro. Shannon as a painter was influenced by Titian, Tintoretto and. in allegorical subjects such as the "Vanity and Sanctity" (Diploma gallery, Royal Academy. London), by G. F. Watts; but here again he produced notable portraits such as the "Miss Bruce, Sculptress" in the Luxembourg. Paris. He was elected associate of the Royal Academy in 1911, full member in 1921. Between 1904 and 1919 appeared 46 more lithographs. fuller in form and richer in chiaroscuro than before. Shannon died at Kew, Surrey, on March 18. 1937, after eight years' disablement following a fall. The Ricketts and Shannon collection of prints, famous for its careful and original selection, is now in the British museum, London.

See E. B. George, *C.* H. *Shannon* (1924). (D. C. T. T.)

SHANNON, the principal river of Ireland. It flows with a bow-shaped course from north to south and southwest, from the northwest part of the island to its mouth in the Atlantic on the southwest coast, with a length of about 161 mi. and a drainage area of 4.j54 sq.mi. Rising in County Cavan in some small pools at the foot of Cuilcagh mountain, the Shannon crosses to County Leitrim, traversing Lough Allen (8 mi. in length). the first of a series of large lakes. It then separates County Roscommon on the right (west) bank from the counties of Leitrim. Longford. Westmeath and Offaly on the left. In this part of its course it forms Loughs Boderg (8 mi. long), Forbes (2 mi.) and Ree (18 mi.) and receives from the west the Boyle river and from the east the Inny, while in County Longford it is joined by the Royal canal. It now separates County Galway on the right from Offaly county and County Tipperary, received the Suck from the west and the Brosna from the east. and forming Lough Derg (24 mi.). Dividing County Clare from Counties Tipperary and Limerick. the Shannon reaches the city of Limerick and debouches upon an estuary 60 mi. in length with a direction nearly east and west. This divides County Clare on the right from Counties Limerick and Kerry on the ieft. A wide branch estuary. that of the Fergus. joins from the north. and the Mulkear. Maigue and Deel rivers enter from the south. With the assistance of short canals the river is navigable for light vessels to Lough Allen, and for small steamers to Athlone, while Limerick is accessible for vessels of up to 24-ft. draft. The salmon fishing is famous; trout are also taken in the loughs arid tributary streams. Carrick-on-Shannon. Athlone, Killaloe and Castleconnell are favourite stations for sportsmen. The islands of the loughs are in several cases sites of early religious settlements, while of those on the riverbanks the most noteworthy is that of the Seven Churches of Clonmacnoise (*q.v.*).

Like other rivers of the Irish lowland the Shannon pursues, as far as Lough Derg, a sluggish way through wide areas of lake, bog and marsh. In roo mi. its fall in level is only 44 ft. From its exit from Lough Derg at Killaloe to tidewater at Limerick the gradient increases to just over 100 ft. in 16 mi. No wholly satisfactory explanation of this change in character, from a mature, if not aged, upper course to a youthful lower course. has yet been given. It is this break, however, which has made possible the Shannon power scheme. The Erne system shows the same abrupt change of gradient, similarly used by the Ballyshannon power station, thus suggesting a common origin probably related to changing sea levels along the Atlantic coast.

It is now generally believed that the whole drainage system of central and southern Ireland was originally developed on a Cretaceous cover with a southward slope, although every trace of rocks of that age disappeared long ago. The upper Shannon and the Suck are probably relics of that early system. The existing streams flow generally over a surface of drift deposits left from the Ice Age and their distribution has certainly caused at least minor changes in the drainage pattern. Lough Derg. for example, lies in an ice-eroded basin. The drift cover over a surface of Carboniferous limestone is very thin in many places and there is therefore a considerable loss of water underground from the rivers. Solution of the limestone by this acidified water has caused the surface depressions in which most of the lakes and bogs lie. The water table varies in height with any marked change in rainfall. Since the levels of the lakes correspond to the water-table height, their areas expand rapidly and wide areas of low pasture are flooded when heavy rains or considerable snow melt occur. Dry periods similarly cause falls in level. These unpredictable changes in level create difficulties in power production at Ardnacrusha.

The wide. shalloa, bog-fringed Shannon has always been much more significant as a barrier than as a waterway. Almost throughout its entire length it is a boundary between counties and for over 800 years has limited Roman Catholic diocesan districts. Bridge construction has been hampered by the rare occurrence of firm ground on opposing banks of the river (intervals of 10 to 15 mi. between bridges is common). This has given added importance to such crossing places as Athlone and Killaloe on the Shannon and Ballinasloe on the Suck. The river is also a frontier between the region of small farms to the west and the larger farms of the east. Since the movement of Irish produce has always been eastward toward Dublin and England. the mere direction of the river has seriously limited its value as a waterway. Early in the 19th century it was hoped that its use could be developed by constructing canal links to Dublin. The Royal canal (1817) from Longford through Mullingar has never been of much use, but the Grand canal from Ballinasloe through Tullamore still carries a fair amount of traffic.

The Power Scheme.—One of the first concerns of the Irish Republican government was the provision of cheap electric power to encourage the development of industry in rural areas without increasing the costly import and transportation of coal from Great Britain. It was hoped that by thus creating opportunities for employment and improving living standards, the flow of emigration would be checked. The first step in this program was the establishment of a hydroelectric station on the Shannon at Ardnacrusha. below Lough Derg. The plant so increased the demand for electricity that other hydroelectric stations were established on the Erne at Cathaleen's fall. Ballyshannon. and at Pollaphuca on the Liffey, and the coal-fed stations on Dublin bay and at Cork were extended. The distribution of power is controlled by a semipublic corporation, the Electricity Supply board, with headquarters in Dublin.

In the 20 mi. between its emergence from Lough Derg and tidewater at Limerick the Shannon has a fall of a little over 100 ft. and it is on this difference of level that the power station at Ardnacrusha depends. It was intended that at first Lough Derg and later the whole course of the Shannon would be used for water storage. The lough alone is about 24 mi. long, from ½ to 8 mi. wide and has a maximum depth of 119 ft. A weir at Partreen, 4 mi. below Killaloe, raises the river level to a little over 100 ft. above sea level. The headrace carries nearly all the water of the Shannon by an excavated canal 40 ft. deep, 300 ft. wide and 7½ mi. long to a point 100 ft. above the power station whence it is returned through the tailrace to the river a half-mile above Limerick. Fish ladders permit the passage of salmon to the upper river and two 50-ft. locks carry barges past the power station. The old Shannon Navigation canal is now abandoned.

The scheme was an ambitious experiment in electricity supply to an almost purely agricultural community. It generated, however, only about half the power anticipated. The river, as has been shown, is subject to large and unexpected variations in the volume of water supplied and periods of low rainfall have frequently led to reduced power output. Shortage of rain appears to affect the underground supplies on which the level of Lough Derg largely depends. At such times the coal-fed stations are called upon to supply the deficiency in the national network. To protect the low-lying meadows from flooding in times of excessive rainfall, large embankment schemes have had to be carried out.

Two-fifths of the supply from the Shannon scheme is reserved for industrial power uses. The power is used for the milling of home and imported grains, the extraction of beet sugar, the manufacture of farm equipment and fertilizers, and the manufacture of clothing and boots.

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(T. HER.)

SHANSI (SHAN-HSI SHENG), a province of north China, pop. (1953) 14,314,485, occupies part of the loess plateau and is bounded by the Yellow river in the west and south, the Great Wall in the north and Wu-t'ai and T'ai-hang mountains in the east where they drop off toward the north China plain. Area 60,393 sq.mi. A northeast-southwest series of river basins and valleys roughly divides the eastern plateau from the western plateau into nearly equal halves. The Wu-t'ai and T'ai-hang ranges rise above the general 5,000–6,500 ft. levels and reach 9,974 ft. in a Wu-t'ai peak. In the west the Lu-liang is the chief range of the dissected plateau and reaches a peak elevation of 9,186 ft. Most of the valley land ranges between 2,300–2,600 ft., but southwest of An-i drops to below 1,300 ft. In the north, tributaries of the Yung-ting and Hai Ho have created the Ta-t'ung and Hsin Hsien basins, the latter dividing the Wu-t'ai from the T'ai-hang range. Southward lies the T'ai-yuan basin and provincial seat on the upper Fen river, which runs thence southward and again widens into the lower Fen plain ending at the great lower bend of the Yellow river. The dry climate exhibits a decrease in precipitation from southeast to northwest and from 500 mm. to under 250 mm. yearly. much of the unreliable fall occurring in July and August.

A severe drought in 1957, resulting in a drop in production of 883,000 short tons of grain, was typical of the farming hazards. The growing season ranges from 150 days in the north to 250 days in the south. The rivers, which provide intermittent navigation in summer to flat-bottomed junks, are frozen as well as much constricted in winter. Millets, spring wheat in the north, and winter wheat in the south, kaoliang and corn are the chief crops. Some potatoes and oats are grown. Industrial crops include cotton, tobacco, hemp and peanuts, and there are fruits such as the pear, apricot, persimmon and grape, as well as walnut and the jujube date.

Animal husbandry is an important sideline, especially for the hill farmers who raise chickens, sheep, pigs, horses and donkeys and produce large quantities of eggs, wool, sheepskins and pig bristles. The fertile but easily eroded loess soil blankets most of the hill slopes and permits extensive dry-terrace cultivation. The agricultural heart of the province lies in the Fen valley which is part of the cotton belt that extends southwest into the Wei valley of adjoining Shensi province, and in 1954 the 200,000 ha. of cotton under cultivation produced some 92,000 tons of cotton lint. The landscape generally is barren of trees except in the higher mountains, where over scattered areas forest covers an estimated 10,000,000 mu (1,600,000 ac.). Another 60,000,000 mu were reported suitable for afforestation.

Shansi has numerous scattered iron ore deposits, copper ores in the An-i region in the southwest. where one of China's salt sources also is found in Chieh-chih lake (600,000-ton annual yield), and zinc and silver deposits in the north near Ta-t'ung. However, the province is most noted for being China's richest coal region, with about 47% of China's total coal or an estimated 400,000,000,000 tons, including coking and anthracite coals. The Ta-t'ung deposits lead among the six major fields in the province. Production is not as proportionately large, the planned target in 1957 being only 6,450,000 tons. The more important iron mines are near Ch'ang-chih in the southeast, and at Yang-ch'uan, about 100 km. E. of T'ai-yuan. Railroad communications connect T'ai-yuan with Ta-t'ung and Kalgan in the north, Shih-men in Hopeh province in the east, and the Yellow river bend in the south. Ta-t'ung has rail connections with the industrial centre at Pao-t'ou in Inner Mongolia, and itself is the second most important industrial centre in Shansi, producing cement, Iocomotives and mining machinery, as well as coal. T'ai-yuan is the leading industrial centre (pop. [1953] 720.700) and has one of the largest steel plants in China, as well as numerous chemical, machine and iron smelting plants. Of the new steel plants being built in the latter 1950s, the largest was the Hsiang-feng plant, which was to equal the T'ai-yuan plant in capacity. A phosphorus fertilizer plant with an annual capacity of 100,000 tons was completed in 1957. A high-voltage power line carries power to Yang-ch'uan along the railway eastward, while another line strung in 1957 carries high-voltage power to Fen-hsi in the Fen valley to the south. Highway connections are poor and limited, but a major highway leads from T'ai-yuan to Ta-t'ung in the north, and other roads connect the Fen valley with Ch'ang-chih in the east and the Yellow river in the west.

The provincial area has been part of the earliest heartland of Chinese civilization and was part of the state of Chin under the Chou dynasty. Its name originated during the Yuan period. From 1911 to 1949 it was governed for the most part by Yen Hsi-shan. Between 1937 and 1945 the Japanese occupied parts of the province, while Communist guerrillas harassed the Japanese from the T'ai-hang hills. (H. J. Ws.)

SHAN STATE. The Shan states are a collection of formerly semi-independent states on the eastern frontier of Burma inhabited by the Shan or Thai and other races. With an area of 57,816 sq.mi., they had in 1941 a population of 1,699,000. Before Burma's attainment of independence, the states were governed by their hereditary chiefs, called *sawbwas* by the Burmese, under the control of the governor of Burma, but in 1922 they were federated fer certain common purposes. Under the constitution of independent Burma, introduced on Jan. 4, 1948, the states, together with the Wa states, were constituted a single Shan state, with a minister of the Burmese government at its head, aided by a state council comprising all the members of the Burmese parliament representing the area; these members are elected by universal adult suffrage in the case of the lower house of parliament and by the *sawbwas* in the case of the upper house. The state was given governmental authority in matters of agriculture, fisheries, public works, communications, police, administration of justice, education, public health and local government, thus enjoying powers similar to those of a county council in the United Kingdom. The *sawbwas* retained their former administrative and judicial powers, subject to the minister and state council, until in Oct. 1952 they were induced by the government to surrender their authority, retaining only their right to elect to the upper house of parliament.

The state is divided into three administrative areas, Southern, Northern and Eastern, each under the charge of a resident, but the original states survive as minor administrative units.

Physical Features.—The Shan state borders Burma on the west. China on the north and east, the kingdom of Laos on the southeast and Thailand on the south. The shape of the state is roughly that of a triangle. with its base near the plains of Burma and its apex on the Mekong river. The Shan plateau is properly only the country between the Salween and Irrawaddy rivers. On the west it is marked by the line of hills running from Bhamo to the plains of Lower Burma. On the east it is defined by the rift of the Salween.

The average height of the plateau is between 2,500 and 4,000 ft., but it is seamed and ribbed by mountain ranges, which split up and run into one another. On the north the Shan state is barred by ranges following the line of the Nam Tu. The huge mass of Loi

Leng. 8,768 ft.. projects south from this, and from each side of it and to the south is the wide plain extending to Mong Nai. The highest peaks are in the north and the south. Loi Leng is the highest point west of the Salween and in Kokang and other parts of North Hsenwi there are many peaks above 7,000 ft. The majority of the intermediate parallel ranges have an average height of between 4,000 and 5,000 ft. with peaks rising to over 6,000 ft. The country beyond the Salween is a mass of broken hills, ranging in the south toward the Me Narn from 2,000 to 3,000 ft.. while in the north toward the Wa states they average from 5,000 to 7,000 ft. From December to March it is cool everywhere, and 10° of frost is experienced on the open downs. The hot season temperature is 80° to 90°, rising to 100° in the Salween valley. The annual rainfall varies frotn 60 in. in the broader valleys to 100 in. on the higher mountains.

Race **and** Language. — In 1931 there were 697,417 Shans in the Shan states out of 1,037,406 in all Burma. The Thai or Tai. as they call themselves. were first known to the Burmese as Tarôks or Tarets. The original home of the Thai people was China. It is probable that their first settlement in Burma proper was in the Shweli valley, and that from this centre they radiated at a comparatively recent date north, west and southeast. through Upper Burma into Assam and into Thailand and Indochina. It is supposed that the group numbers among its members not only the Shans proper, the Laos and the Siamese, but also the Muongs of French Indochina: the Hakas of south China and the Li, the inhabitants of the interior of the far eastern island of Hainan in the South China sea.

The Thai language may be divided into two subgroups, the north and the south. The south includes Siamese, Lao. Lu and Hkun; the north. the three forms of Shan, namely North-Burmese Shan. South-Burmese Shan and Chinese Shan with Hkamti and Ahom. The vernacular of the people who are known in Burma as Shan is South-Burmese Shan. This language is isolating and polytonic. It possesses five tones.

Trade, Mining, Agriculture. — The Shans are a peaceful race, fond of trading. During the 20th century the trade with Burma increased largely, especially after the construction of the Lashio (1903) and Shwenyaung (1928) railways. The huge silver-lead-zinc mines of the Burma Corporation, Ltd.. are at Bawdwin in the northern Shan state, but production declined for a time because of destruction suffered during the Japanese invasion and the frequent disruption of road and rail communications in the civil disturbances which often prevailed in Burma from 1948 on. The cultivation of wheat and potatoes in the southern states for export to Burma proper is normally profitable but similarly suffered from interrupted communications.

The States. — The southern area. containing 25 of the former states. has a toral area of 24,048 sq.mi. and a population (1931) of 644.336.

Mong Nai is the largest state with an area of 3,152 sq.mi. and a population (1931) of 55,791, and the smallest is Kyong with an area of only 24 sq.mi. and a population (1931) of 2,571.

Mong Pan ranks next to Mong Nai in size among the southern Shan states, with an area of 2.988 sq.mi. and a population (1931) of 20,712. The main state lies, except for a few circles, entirely west of the Salween. The only considerable area of flat land is around the capital, which lies in a large and fertile plain, marking roughly the centre of the state. From this plain rise low hills covered with scrub jungle, sloping up to ranges of about 5.000 ft. on nearly every side.

Rice is the only crop. irrigated where possible; elsewhere dry cultivation prevails. The state has valuable teak forests. The capital is small, and has only about zoo houses.

Lawksawk has an area of 2,362 sq.mi. and a population of 30,102, and ranks fourth in size among the states of the southern division. The crops are rice, sesamum, cotton, peanuts and oranges. The state is mountainous. To the north the country falls away to the Narn Tu (Myitnge), where there are teak forests. as well as along the Yam Lang and Narn Et, which with the Zawgyi form the chief rivers. Most of them disappear underground which makes the extraction of timber impossible except for local use. Lawksawk is the capital.

Mong Pai is the most southwesterly of the Shan states. It has an area of 736 sq.mi., and a population (1931) of 21,637. The country is hilly, rising westward from the chief stream. the Narn Pilu or Balu Chaung. This is navigable for native boats throughout the year to the point where it sinks underground in Karenni. The chief crop is rice, with about two acres of dry or hill rice to one of wet bottom rice, The hill fields are leit fallow for ten years after two years' cultivation.

Other states in the southern group with an area of more than 1,000 sq.mi. include: Mawkmai (2,500 sq.mi.), Mong Nawng (1.655 sq.mi.), Mong Kung (1,599 sq.mi.), Lai Hka (1.560 sq.mi.), Yawnghwe (1,389 sq.mi.) and Loilong (1,034 sq.mi.).

Taunggyi is the chief town of the Shan states and the meeting place of the state council. It is situated in 97° 02′ E. and 20° 47′ N., at an altitude of about 5,000 ft.. in a depressed plateau on the crest of the Sin Taung hills. It is in the state of Yawnghwe, 12 mi. by motor road from Shwenyaung, the present terminus of the Southern Shan States railway which joins the main Rangoon-Mandalay line at Tliazi. The five-day bazaar is the trading place of the natives. A special quarter contains the temporary residences of the chiefs when they visit headquarters, and there is a school for their sons.

The northern residency comprises North and South Hsenwi, Hsipaw, Namhsan and Mong Mit, with a total area of 18,035 sq.mi. and a population (1931) of 533,154.

Hsenwi, sometimes known by the burmanized name of Theinni, consists of North Hsenwi (6,422 sq.mi., pop. 243,499) and South Hsenwi (2.351 sq.mi., pop. 82,672). The northern part of Ncrth Hsenwi is a mass of hills. in the valleys between which are numerous tracts under rice cultivation. The southern portion has much more flat land, along the line of the Narn Tu, its tributaries. the Narn Yao and the Narn Nim, and the Nam Yek flowing into the Salween. This was formerly thickly populated, and still remains the most valuable portion of the state. Both north and south of the Nam Tu there are many peaks which rise to 6,000 ft., and several over 7.000 ft. The northern portion (about 4,000 ft.) might be called a plateau. It has large, grassy, open downs. This part of the state has fallen almost entirely into the hands of the Kachins. The Shans are found in the Nam Mao (Shweli or Lung Kiang) valley. and in the Nam Tu and other valleys in the southern part of the state.

South Hsenwi is bisected by the huge mass of Loi Leng, 8,768 ft. above sea level. Apart from this it consists of broken hill country or downs. It is watered by numerous streams, of which the chief is the Nampang Chaung, an affluent of the Salween. Considerable deposits of coal, or rather of lignite, exist in both North and South Theinni, but have not as yet been worked. Gold is washed in many of the streams in a fitful way. Little valuable timber exists. Pine forests cover some of the ranges, hut, as elsewhere in the Shan states, oak and chestnut are the commonest forest trees. The climate as a whole is temperate. The average rainfall is about 60 in. yearly. The state regained much population after the British occupation in 1888, especially after the opening of the Mandalay-Lashio railway and the Burma corporation's mine and smelting works.

Hsenwi, the capital of North Hsenwi, stands near the north bank of the Nam Tu. The ruins of the old capital lie at a short distance and show it to have been a large and well-built town. Mong Yai, capital of South Hsenwi, has a population of about 2,000.

Lashio, the chief town of the northern Shan states, lies in North Hsenwi at an altitude of 3,100 ft., on a low spur overlooking the valley of the Nam Yao. It is the terminus of the Mandalay-Lashio railway. A motor road from Mandalay, 176 mi. distant, passes through Lashio and reaches the Chinese frontier at Kyu-Hkok, a further 113 mi., so forming the Burma sector of the Burma road to China (Kunming).

Hsipaw or Thibaw (4,591 sq.mi., pop. [1941] 148,731) is called by the Shans, and officially, Hsipaw, and also frequently Ông Pawng (the name of an old capital). The chief plain land is in the valley of the Narn Tu (Myitnge), near Thibaw town, and the valley or strath of the Pyawnghkawng, Nawngpeng neighbourhood. The hills on the Mong Tung border reach their highest elevations in the peaks Loi Pan (6,848 ft.) and Loi Htan (6.270 ft.). Northwest of Thibaw town. on the Namhsan border, Loi Lung rises to 7,626 ft. The valley of the Nam Tu rises on the east in Mong Tung to a plain level of about 2,500 ft., and on the west in Mong Long to a mass of hills with an average height of 4,500 ft., broken up by the Narn Yawng and Narn Kaw valleys, which are about 3,000 ft. above sea level. The chief river is the Nam Tu or Myitnge Coal of poor quality is found at various places. The average maximum temperature at the beginning of April is about 96°, and the minimum about the same period, 6j°. The rainfall averages about 70 in. The chief crops are rice, cotton, sesamum, tea (in the hills), and *thanat*, the leaf of a tree used for the wrapper of the Burma, or "green," cheroot. Cotton cloth was formerly much more generally manufactured than it now is, and a coarse country paper is made. The government cart road to Lashio passes through the centre of the state, and the Mandalay-Lashio railway also passes through the capital. Teak forests exist along the banks of the Narn Tu and in the Manglun states.

The eastern residency, comprising the territory along the Yunnan China border, consists of Keng Tung. Manglun. Kokang and the Wa country, with a total area of about 15,000 sq.mi. and a population (1931) of about 380,000.

KENG TUNG (12,400 sq.mi.; pop., 1931, 225,894) is the most extensive of the Shan states. About 63% of the area lies in the basin of the Mekong river and 37% in the Salween drainage area. Some peaks rise to over 7.000 ft.; the elevation is nowhere much below 5.000 ft. Successive parallel hill ranges run north and south. Mountainous country predominates. The chief rivers, tributaries of the Salween, are the Narn Hka, the Nam Long, Narn Pu and the Nam Hsim. Much timber goes down the Narn Hsim but rocks and rapids make it unnavigable. Teak forests exist in Mong Pu and Mong Hsat, and also in the Mekong drainage area in the south of the state, but there is only a local market for the timber. Rice, as elsewhere in the Shan states is the chief crop. Next to it is sugar cane. Peanuts and tobacco are the only other field crops in the valleys. On the hills, besides rice. cotton, poppy and tea are the chief crops. The tea is carelessly grown, badly prepared, and only consumed locally. Much garden produce is raised in the valleys. The state is rich in cattle and exports them to the country west of the Salween. As in all parts of the Shan states, there are huge areas which may be capable of some development. Communications are poor: a road, motorable with difficulty in the rainy season, runs 283 mi. from Taunggyi to Keng Tung town. and a dry-weather motor road goes from the town for 110 mi. to the Siamese border near Tachilek.

Keng Tung, the capital (pop. 5,500), is surrounded by a ruined brick wall and moat about 5 mi. around.

MANGLUN (pop. [1931] 38,295) extends for 100 mi. along the Salween river. Its width varies from a mile or even less on either side of the river to perhaps 40 mi. at its broadest point near Ta-Kut, the capital. It is divided into East and West Manglun, the boundary being the Salween. The only flat land is along the banks of streams in the valleys. There are prosperous settlements and bazaars at Nawng Hkam and Mong Kao in West Manglun. Ta-Kut is on a hilltop 6,000 ft. above sea level. The *sawbwa* has control over two substates, Motai to the north and Maw Hpa to the south.

KOKANG, formerly a substate of North Hsenwi, lying between the Saiween and Yunnan, is inhabited almost exclusively by Chinese and was governed by a Chinese chief until Oct. 1952; the people, numbering about 45,000, breed mules and sheep.

The WA area. whose population was recorded in 1941 as 82.614, is an extremely hilly area on the Yunnan. China, border, which is still only loosely administered. The frontier in this region was finally agreed upon by the British and Chinese only in 1941 and was in 1953 still undemarcated on the ground. The Wa are the most primitive of all the peoples of the Shan states and regard head-hunting as essential to their fertility rites at plowing time; rows of skulls are placed in avenues near the villages, the largest being avenues of zoo or more skulls each at Ramoang and Hsan Htung villages. This practice has of late been checked by the authorities.

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SHANTUNG (SHAN-TUNG SHENG), a densely populated coastal province of China between the Yellow sea and the Gulf of Chihli, is bounded by Hopeh in the north, Honan in the west and Kiangsu in the south. Area est. 54,000 sq.mi.; pop. (1953) 48,-876,548.

In early geological times its inland arid peninsular hill masses comprised at least two large islands. while an inland sea or strait stood between them and the T'ai-hang hills of Shansi. Heavy sedimentation from the Yellow and Huai rivers filled this in to form the low-lying Yellow plain around the central hill mass. The province thusforms three physiographic regions: (1) the central hills, a triangular mass culminating in T'ai Shan (Mt. T'ai). elevation 5,069 ft., about 12 mi. northeast of the junction of parallel 36° N. with meridian 117° E. most of the hill lands rise to only around 1,300 ft., but several peaks reach over 3,200 ft. (2) The peninsular hills, with most elevations around 600 ft., but rising to 3,707 ft. in the Lao Shan northeast of Chiao-chou bay and Tsingtao city. A submarine ridge connecting Shantung with Liaotung protrudes above the sea as the Ch'ang-shan archipelago. The islands and the indented peninsula favoured the development of sheltered harbours for fishing and commerce. (3) The plain which from the west slopes eastward to a northwest-southeast oriented trough at the western base of the central hills, and which in the north and south continues to the sea in the alluvial deposits of the Yellow river. The trough is occupied by several elongated lakes utilized in part by the Grand canal cutting through western Shantung. The Yellow river in its present course flows past the northern foothills. Between the central hills and the peninsular hills is the corridor plain formed by sediments of the Pei-chiao and Wei rivers, over 62 mi. long and from 18 to 30 mi. wide.

History.—Western Shantung formed the easternmost parts of the earliest known organized state of China, the Shang (1520–1030 B.C.). Even earlier, an indigenous culture had developed there, as shown by a unique type of polished black pottery excavated at Ch'eng-tzu-yai. Southern Shantung as the state of Lu gave birth to Confucius and Mencius, honoured by a temple on T'ai Shan. The Lu kingdom, together with the Ch'i kingdom in northern Shantung, formed parts of the feudal domains of the Chou dynasty which lasted until the 3rd century B.C. Thus Shantung has from the beginning been part of the core area of the Chinese state. In more recent history Shantung symbolized China's humiliation by Japan and by European powers. It was occupied by Japanese forces during the Chinese-Japanese war of 1894–95. In 1898 Germany forced a lease of Tsingtao from which to exploit the province, while Great Britain similarly obtained a lease of Wei-hai for a naval base. The Boxer rebellion developed out of Chinese resentment against foreigners in Shantung in 1899 and spread to other provinces in 1900. After World War I Japan tried to take over the German sphere of interest in Shantung and garrisoned troops there off and on between 1915 and 1929. When Japan attacked China in 1937, it was at T'ai-erh-chuang in southern Shantung that China won its first major victory over Japanese troops. In the Nationalist campaign against the Communists after World War II, the Communists were able to hold most of the province, and gained their first decisive victory in east China with the capture of the provincial capital of Tsinan in Sept. 1948.

Climate **and** Agriculture.— In climate the peninsula is more moderate than the inland mass which shares the continental dryness and severity of north China winters. The northern part of the province is especially exposed to the northwest winds from Mongolia, but these winds pick up some moisture from the Gulf of Chihli and deposit some snow and rain on Shantung. The harbours freeze over at Chefoo and Lung-k'ou, and the January average for Chefoo is 24° F. while at Tsingtao it is 31.3° F. In summer when the inland plains have 95° temperatures, Tsingtao and Wei-hai only reach about 77°. The precipitation has the usual summer peak, with south-facing slopes of the hill masses receiving over 30 in. and the interior plains only about 20 in. Some 1,200,000 wells (1951 estimate) provided the water for 85% of the land that is irrigated, although river water also is used. Expanded irrigation projects in 1956 provided water for some 17,930,000 mu (about 2,900,000 ac.) of additional irrigated land. The aggregate grain production (largely wheat, kaoliang, millets and corn) in 1956 was about 16,-170,000 short tons, which was about 37% higher than that for 1936 and 86% higher than that for 1949. Other crops include cotton, tobacco and peanuts. Live pigs numbered 5,239,000 in 1956.

The hills are capable of growing forests: but have been denuded during past centuries. Forests were being restored through afforestation in the second half of the 20th century, however, and along the coasts sand drift was being reduced by sand-fixing plants and trees. The convergence of warm and cool currents in the sea off Shantung is conducive to fish production. Tsingtao and Chefoo are the leading fishing centres.

Communications and Industry. — Communication facilities in the latter 1950s included over 9,100 km. of highways connecting all the 104 hsien (districts) of the province. but only about 1,500 km. were all-weather roads in 1957. One major railroad runs from Tsingtao westward to Tsinan, the provincial seat, where it meets the north-south line from Tientsin to P'u-k'ou on the Yang-tzu. A rail line also leads from Tsingtao, the chief port, to Chefoo which is an embarkation port for travelers to Manchuria. Spur lines lead to the coal mining centres of Tzu-pu, Hsin-t'ai and Tsao-chuang in the north-central, central and southern hill areas respectively. The mining development at Tsao-chuang is one of the largest and most mechanized in China. There are numerous gold mines in the peninsular hills, the most important being in Chao-yuan district. The more noted iron ore mines are at Chin-tien-chen and Li-kuo-i, and important aluminum ore mines are at Nan-ting. The coastal salt industry is centred at Chiao Hsien.

Important industries of the province include cotton textiles, cigarette and match making, flour milling and oil pressing, brewing and distilling, machinery and chemicals; 90% of the country's peanut oil was produced there in the latter 1950s. In 1957 almost 293,000 handicraft workers worked in more than 4,400 co-operatives. The industrial production in 1956 reached 1,634,000,-000 Yuan.

Education. — There were seven schools of higher education with 11,600 students in 1957; 416 middle schools with about 270,000 students; and 53,000 primary schools with about 5,016,000 students. (H. J. Ws.)

SHANTUNG. A plain silk fabric of light texture originally produced in the Chinese province of that name from a variety of native silk known as pongee silk obtained from the cocoons of wild silkworms that feed on oak leaves. Hence, pongee is of a strong and rough type of silk with a light tan natural colour and a coarser filament structure than that produced by cultivated silkworms that are fed on mulberry leaves.

Japanese pongee is also a type of wild silk of a similar character to Shantung silk, but of a smoother and more even filament structure than that of Chinese pongee. The word pongee is said to correspond with homespun, hand-spun and hand-woven, as it is chiefly conducted on a very large scale as a home or domestic industry both in China and Japan, although pongee silk or Shantung is now woven on power looms.

Tussah silk is the name applied to a type of low-grade fabric produced from silk spun by a species of wild native silkworms of India. and possessing characteristics similar to those of Chinese pongee silk. Fabrics produced from pongee or other types of wild silk partake of the physical characteristics of such silk and feel somewhat harsh and rough, although the better qualities of these wild silks are said to be of a more durable character and to wear better than silk fabrics produced from the products of cultivated silkworms.

Shantung silk fabrics are also sometimes sold under the trade-name of "Ninghai." (H. N.)

SHANTY or **Chanty,** a song of the class of labour songs which sailors on merchant ships sang as they pulled ropes to hoist yards and sail, raise anchors or work pumps. The word shanty, however it is spelled, is usually thought to be the British sailor's corruption of the French word *chanter* and to come from the French Canadian lumbermen, who sang as they hauied their logs; Sir Richard Terry derives it from the West Indian Xegroes, who move their huts or shanties with ropes and sing as they work, with a shantyman as soloist and leader.

On board ship two varieties of shanties evolved — one for pulling ropes, the other for winding the capstan. The former provides points in the tune for collective pulls (or a simple final pull on the last note), the latter for continuous rhythmical movement. Two kinds of pulling shanties may also be distinguished — the short drag. sung when a few strong hauls will do the work, as in reefing a topsail, and the halyard shanty, accompanying the longer and heavier pulls, such as hoisting a sail. The capstan shanty, as the name implies, was used for a steady winding operation, such as hoisting an anchor or warping a ship into its slip. A fourth variety, the forecastle shanty, which is not a labour song, is generally in the form of a ballad, sung by the sailors in their leisure hours.

The best known of the short drag shanties is "Haul Away, Joe." A famous halyard shanty is "Blow the Man Down." Of the capstan shanties, "Rio Grande," "Yo Heave Ho," and "Shenandoah" (or "Shanandar") are most familiar. "The Boston Come All Ye" and "The Golden Vanity" are typical forecastle shanties.

See Cecil Sharp, *English Folk-Chanteys;* R. R. Terry, *Shanty Book,* 2 vol.; Grove's *Dictionary of* Music. (D. T.)

SHAPING MACHINES: *see* Planing Machines.

SHAPLEY, HARLOW (1885–), U.S. astronomer, pioneer in studies of the structure of the Milky Way and of the universe beyond it, was born in Nashville, Mo.. on Nov. 2, 1885. Having studied at the University of Missouri and at Princeton, he joined the staff of the Mount Wilson observatory in 1914, and later became professor of astronomy at Harvard university. From 1921–52 he was director of the Harvard College observatory.

Shapley's most important early work concerned eclipsing binary stars. With H. N. Russell, in 1913, he devised practical methods for deducing the dimensions of the component stars of these systems from measurement of the light variation during eclipse. These methods, in essentials, remained the standard procedure for more than 30 years. Shapley showed that Cepheid variables cannot be eclipsing binaries, and was the first to advocate the theoretically important view that they are pulsating stars.

He studied the colours and magnitudes of stars in clusters, especially of those in the globular clusters, and was a pioneer in the use of variable stars (Cepheids and RR Lyrae stars) as distance indicators. He made the bold hypothesis, then revolutionary. but later well established, that the globular clusters form a fairly symmetrical swarm about the centre of the Milky Way, and that our sun must therefore be located in the outer parts of the Milky Way system, some tens of thousands of light years from the centre.

With the aid of large numbers of photographs of the sky. made both at Harvard and at the Harvard southern station in South Africa, Shapley studied the structure of the Milky Way and of nearby galaxies, especially the Magellanic Clouds, and the distribution of galaxies in space. He was one of the first to demonstrate that galaxies tend to occur in clusters and that the Milky Way is a member of a local cluster.

Shapley's work, characterized by bold imagination and drive. was mainly of the nature of first surveys. As he himself pointed out in the late 1950s, much further detailed investigation was required.

Shapley's works included *A Source Book in Astronomy,* with H. E. Howarth (1929), *Star Clusters* (1930), *Flights from Chaos* (1930), *Galaxies* (1943), *Inner Metagalaxy* (1957), *Of Stars and Men...* (1957). He edited *Climatic Change* (1954); *A Treasury of Science,* 3rd rev. ed., with S. Rapport and H. Wright (1954). He also wrote many technical papers, especially in the *Astrophysical Journal* and in the *Proceedings of the National Academy of Sciences.* (R. O. R.)

SHAPUR (Pahlavi *Shahpuhr,* "son of the king"; Greek *Sapores;* commonly *Sapor*), the name of three Sassanian kings.

1. SHAPUR I (A.D. 241–272), son of Ardashir I and second in line of the Sassanian kings. The Persian legend that makes him the son of an Arsacid princess is not historical. Ardashir had. toward the end of his reign? renewed the wars against Rome inherited from the Arsacids. On his death Shapur continued the war, conquering Nisibis and Carrhae and advancing deep into Syria. Defeated at Resaena in 243, he was yet able to conclude an advantageous peace in 244 because of the murder of the emperor Gordian III. In 258 he took advantage of the internal chaos within the Roman empire to renew his attacks. Invading Syria, Asia Minor and Armenia. he sacked Antioch but was repulsed by the emperor Valerian. However, in 260 Shapur not only defeated Valerian at Edessa, but captured him and kept him a prisoner for the rest of his life. The capture of Valerian is a favourite subject of Sassanian rock carvings. In attacking the eastern Roman provinces. Shapur does not seem to have aimed at a permanent occupation. He merely carried off enormous booty both in treasure and men. The captives from Antioch were set to work to build the city of Gunde-Shapur (called in an inscription *Vahy-Andiok-Shapuhr,* "better than Antioch [has] Shapur [built]"), later to become famous as a centre of learning. Using the same captives, who excelled the Persians in technical skill, he built the dam at Shushtar (Shustar) known as the *Band-i-Qaisar,* "the dam of Caesar," to' this day.

Shapur was no longer content to describe himself as "king of kings of Iran" as his father had done: he styled himself "king of kings of Iran and Aniran (Aneran)," that is to say, of non-Iranian territories as well. Possibly in connection with these secular imperialist ambitions Shapur appears to have tried to find a religion that would be suitable to all his subjects, whether of Iranian stock or not. He showed marked favour to Mani, the founder of Manichaeism, and at least one of his brothers adopted the Manichaean faith. He himself does not seem to have taken this final step, for the inscriptions show that he founded fire temples both on his own behalf and on that of his wife and sons. He sought, however, to broaden the basis of the newly revived Zoroastrian religion by the addition of material derived from both Greek and Indian sources; there is evidence that he favoured the heretical "Zervanite" wing of Zoroastrianism which derived both Ohrmazd and Ahriman, God and the devil, from the principle of Infinite Time.

If the credit of the founding of the Sassanian empire belongs to Ardashir I, it was nevertheless Shapur who consolidated and expanded it. He thought of the new empire as a multinational state in which Manichaeism, drawing on Christian and Buddhist as well as on Zoroastrian sources, might serve as a unifying factor.

2. SHAPUR II (310–379, usually called "the Great"), ninth of the Sassanian kings. At the death of Hormizd II, the Persian nobles killed his eldest son, blinded the second and imprisoned the third. The throne was reserved for the unborn child of one of the wives of Hormizd. This was Shapur, who was thus born king.

With the adoption of Christianity by Constantine and the subsequent christianization of the Roman empire, Persia found itself saddled with what it considered to be a powerful Christian "fifth column." Thus Shapur resumed the policy of fierce intolerance toward non-Zoroastrians which had been initiated by the high priest Kartir in the reign of Bahram I, and singled out the Christians for fierce persecution. He summoned a conference of all creeds, and decided in favour of one Adhurbadh, son of Mahraspand, a dualist Zoroastrian of strictly orthodox views. Thus Shapur II sought to unite his empire by enforcing Zoroastrian orthodoxy on frequently unwilling subjects.

His external policy was one of war and expansion; during his reign the insane and semipermanent struggle between the rival empires of Rome and Persia swayed in favour of the latter. In 337 he broke the peace which had been concluded 40 years before between Narses and Diocletian, and embarked on a 26-year war. Shapur attempted with varying success to reduce the great Mesopotamian fortresses of Singara, Nisibis and Amida. Though Constantius was invariably defeated on the field, Shapur made little real progress. He was not strong enough permanently to occupy the conquered provinces because his eastern frontier was continually raided by central Asian tribes, prominent among which were the Chionites. After a prolonged struggle Shapur finally forced their King Grumbates to conclude a peace, whereupon the latter allied himself to Shapur in a renewed onslaught on the Roman power. With Grumbates' aid Shapur at last reduced both Amida and Singara (359–360). In 363 the emperor Julian advanced against him in force. but was killed in battle. His successor. Jovian. was defeated and made to sign an ignominious peace by which he ceded the frontier marches on the Tigris and Nisibis and gave the Persians a free hand in Armenia. This victory is celebrated in the rock carvings near Shapur. not far from the modern Shiraz.

Shapur now turned his attention to the subjugation of Armenia. He captured the pro-Roman Arsaces III and imprisoned him in Susiana, where he committed suicide. His attempt to force Zoroastrianism on an Armenia which had only just accepted the Christian faith met with fierce and successful resistance. Arsaces' son Pap was smuggled out into Pontus and the Armenian resistance remained unbroken. The emperor Valens succeeded in restoring Pap in violation of the treaty concluded between Jovian and Shapur, but Pap repaid him by poisoning the patriarch, Nerses, the very symbol of national resistance, and executed Cylax and Artaban, the leaders of the anti-Persian party. In so doing he may have been trying to preserve a precarious balance between Persia and Rome in Armenia. Be this as it may, he was treacherously murdered by the Romans in 374. For five years Armenia was progressively weakened by an internecine struggle among its nobles. Shapur's last act was to win over Armenia by a discreet distribution of gifts. The country's autonomy under Persian suzerainty was recognized and the Christian religion respected. Thus Shapur II left Persia with its territory considerably augmented: he had pacified the eastern frontier and gained the suzerainty over Armenia. The Persian empire had never been stronger; but war with Rome became a natural state of affairs. and its continuance did more than anything to undermine the strength of the Sassanian empire.

3. SHAPUR III (383–388), son of Shapur II, elevated to the throne by the nobles against his uncle Ardashir II, and killed by them after a reign of five years. He concluded a treaty with Theodosius the Great. (R. C. Z.)

SHARE. In the language of finance a share is defined as one of the portions into which the capital stock of a corporation is divided. In Great Britain the plural "shares" signifies all of the concern's capital invested by owners of the individual shares. The equivalent U.S. term is "stock," though the expression "share of stock" is also common. In Great Britain a share always has a definite nominal or face value, as £1 10s. or even 1*s*.

See STOCK.

SHARI, a river of north-central Africa. carrying the drainage of a large area into Lake Chad. Its headstreams rise on the watersheds between the Chad basin and those of the Nile and Congo. The principal headstream, known generally as the Wam, rises. in about 6° 30' N., 15° E. in mountainous country forming the divide between the Chad system and the basin of the Sanga affluent of the Congo. From the source of the Wam to the mouth is a distance, following the windings of the stream. of fully 1,400 mi.

The Wam flows east and then north and in about 7° 20' N., 18° 20' E. is joined by the Fafa, a considerable stream rising east of the Wam. The upper course of the Wam is much obstructed by rapids. but from a little above the Fafa confluence it becomes navigable. Below the confluence the river, now known as the Bahr Sara. receives three tributaries from the west. In about 9° 20' N., 18° E. it is joined by the Bamingi, which is formed by the junction of the eastern headstreams of the Shari. One of its branches, the Kukuru. rises in about 7° N., 21° 15' E. About 90 mi. from its source the Bamingi becomes navigable, being 12 ft. deep and flowing with a gentle current. In 8° 42' N. it receives on the west bank the Gribingi. a river rising in about 6° 20' N. It is narrow and tortuous with rocky banks and often broken by rapids. It flows in great part through a forest-clad country. A few miles above its confluence with the Bahr Sara the Bamingi receives on the right hand another large river, the Bangoran, which rises in about 7°

45′ N. and 22° E.. in a range of hills which separates the countries of Dar Runga and Dar Banda and. like the Bamingi, flows through open or bush-covered plains with isolated granite ridges.

Below the junction of the Bahr Sara and the Bamingi the Shari, as it is now called, becomes a large river, reaching, in places, a width of over 4 mi. in the rains; while its valley, bordered by elevated tree-clad banks, contains many temporary lakes and backwaters. In 9° 46' N. it receives the Bakare or Awauk (Aouk) from the east, known in its upper course as the Aukadebbe. This, like the Bahr es Salamat, which enters the Shari in 10° 2′ N., traverses a wide extent of arid country in southern Wadai, and brings no large amount of water to the Shari. In 10° 12' a divergent branch, the Ergig, leaves the main stream, only to rejoin it in 11° 30'.

In 12° 15′ N. and 15° E. the Shari receives on the west bank its largest tributary. the Logone, the upper branches of which rise far to the south between 6° and 7° N. The principal headstreams are the Pende and the Mambere. Its system is connected with that of the Benue (see NIGER) by the Tuburi swamp, which sends northward a channel joining the Logone in about 10° 30' N. Below the Logone confluence the Shari, there a noble stream, soon splits up into various arms. forming an alluvial delta, flooded at high water, before entering Lake Chad.

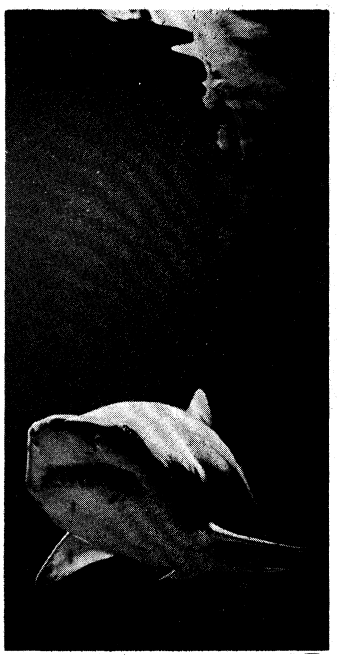
The existence of the Shari was made known by Oudney, Denham and Clapperton, the first Europeans to reach Lake Chad (1823). In 1852 Heinrich Barth spent some time in the region of the lower Shari and Logone, and in 1872–73 Gustav Nachtigal studied their hydrographical system and explored the Gribingi, which he called the Bahr el Ardhe. But the most prominent explorers have been Frenchmen. In 1896 Émile Gentil reached the Bamingi and in a small steamer passed down the river to its mouth. In 1907 an expedition under Capt. E Lenfant followed the M'am-Bahr Sara from its source to the confluence with the Bamingi and showed it to be the true upper course of the Shari. The same expedition also discovered the Pende tributary of the Logone. From the mouth of the Shari in Lake Chad there is a current toward the Bahr-el-Ghazal channel at the southeastern end of that lake (*see* CHAD, LAKE). This channel has been supposed to be a dried-up affluent of the lake. Investigations by the French scientists E. F. Gautier and R. Chudeau led Chudeau to the conclusion that the Shari did not end in Lake Chad, but. by way of the Bahr-el-Ghazal, passed between Tibesti and Ennedi and ended in some *shat* in the Libyan desert. The major part of the Shari basin is in former French Equatorial Africa; some of the western affluents are in Cameroon.

See the works of Barth, Nachtigal and other travelers, especially Lenfant, La *Découverte* des grandes sources du centre de *l'Afrique* (1909).

SHARK, any of the cartilaginous fishes with a pointed snout extending forward and over a crescentric mouth set with sharp triangular teeth, and with paired, largely lateral, gill slits. well defined eyes, pointed fins and a muscular, upturned tail (see CHONDRICHTHYES). Larger kinds are suspected as being dangerous to man; smaller ones, called topes, hounds and dogfishes, are fished commercially.

Description and Habits.—Shark species are often similar in appearance and nondescript in colour, varying from gray to bluish or brownish, often patterned with spots, bands, marblings or protuberances. The whale sharks (Rhineodon) and basking sharks (*Cetorhinus*), which may reach 50 ft. and weigh several tons, are harmless giants that subsist on plankton strained from the sea through modified gill rakers. All other sharks are carnivorous, the largest among them being the voracious 40-ft. white shark (*Carcharadon*), which attacks seals, sea turtles, large fish and, on more than one occasion, man (see Hazards to *Man,* below). The sluggish Greenland shark (Somniosus) of cold deep waters has been known to feed on seals. reindeer, large fish and whales. Normally sharks feed on fish, often attacking in schools; open-ocean species such as the mackerel. mako and thresher sharks frequently feed near the surface, and are much sought after by rod and reel sportsmen as prime game fish. Beautifully streamlined and powerful swimmers, these open-ocean sharks are adept at feeding on fast tuna, marlin, etc. Bottom-feeding sharks are stout, blunt-headed forms. tending to flattened bodies with well developed spiracles and larger eyes; the shellfish eaters have coarse, pavementlike crushing teeth. So characteristic are shark teeth that it is possible to identify fossil and modern species from one or two teeth.

The origin of sharks is obscure, but their geological record goes back to pre-Devonian times (more than 320.000.000 years ago). Their present diversity of forms and numbers, estimated at some 300 species, equals their past abundance; many recently found species have long been known from the fossil record.



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SAND SHARK (CARCHARIAS TAURUS)

The living sharks (order Pleurotremi) fall into three suborders. The first is the Notidanoidea, a small group of primitive sharks distinguished by six or seven gill clefts and one dorsal fin; examples are the frilled (*Chlamydoselachus*) and six-gilled (Hexanchus) sharks. These are deepwater fishes; the former are eel shaped and may reach over 6 ft.; the latter attain a length of over 20 ft. The suborder Squaloidea is characterized by five, rarely six, gill clefts and two dorsal fins preceded by spines. This group includes the bullheaded, or horn, shark (Heterodontus); the spiny dogfish (*Squalus*), a small shark of temperate seas, which travels in schools and is a pest to commercial fisheries; the bramble shark (*Echinorhinus*), a bulky shark with spiny tubercles on the skin; and the Greenland shark (*Somniosus*), which grows to 25 ft. The specialized saw sharks (Pristiophorus) and the bottom-dwelling angel sharks (*Squatinidae*) with elongated bodies and muscular tails are also of this suborder. The third suborder, the Galeoidea, are typified by five gill clefts, two spineless dorsal and one anal fin The bulk of the sharks. and many aggressive representatives of the requiem sharks (Carcharinidae), feared because of their attacks on man, are associated with the galeoids. This suborder also includes the families Odontaspidae (the sand and elfin sharks), Lamnidae (man-eater, porbeagle, basking, mackerel and thresher sharks), Carchariidae (topes, hounds, blue and hammerhead sharks), Scyliorhinidae (dogfishes) and Orectolobidae (carpet, tiger, nurse and whale sharks).

Although chiefly marine. sharks often enter fresh water; requiem sharks of the genus *Carcharhinus* occur commonly in the Zambezi, Tigris and Ganges as well as other rivers in subtropical and tropical areas. The Lake Nicaragua shark is a landlocked form found in Central American lakes. Carcharhinus species are small to medium sized. but they are aggressive, persistent and generally feared wherever they occur.

Hazards to Man.—In Australia, South Africa and elsewhere along coasts exposed to the shark nuisance, public beaches are often provided with lookout towers, bells and sirens or nets—proof of public concern toward the shark hazard. The most feared species is the great white shark (Carcharadon), whose erratic presence in United States coastal waters has given rise to particularly distressing attacks in Buzzards bay, Massachusetts, off the New Jersey shore and, with most frequency, along the California coast. Other sharks involved in attacks on humans are the whale (Galeolamna), tiger (Galeocerdo). blue (Prionace), gray nurse (Carcharias) and hammerhead (*Sphyrna*).

Of course, the larger the shark. the more formidable the attack, but several small specimens can be equally hazardous, a fact well attested to by wartime sea survivors. The zone of greatest hazard lies approximately between latitudes 40° N. and 40° S. and coincides with the warmer months, when average surface sea temperatures vary between 60° and 70" F. Fatalities are greatest in late afternoon; men have been attacked more frequently than women. The majority of attacks are on bathers in shallow water (between 2 and 3 ft.); however. participants in underwater activities also risk injury from sharks in warm seas. Injury is greatest on the lower limbs and buttocks and, secondarily, on the forearms and hands. The above information, however, may reflect the habits of bathers as well as the habits of sharks. Mortality is as high as 70%; this is largely due to hemorrhage and shock, controllable through first-aid measures. Increasing public interest in seashores for recreation and sport emphasizes the need for uniform safety measures to prevent loss of life. The incidence of attack by sharks is no greater than that for land carnivores. but the probability of a rise in shark attacks is greater since increasingly greater numbers of people, with little realization of marine hazards, are entering the sea during the season when sharks are closest to the shore. Shark repellents are constantly being sought; several, like "Shark Chaser," consisting of copper acetate and a black marker dye, nigrosine, in a water-soluble wax, appear to be some help in repelling some species.

Economic Importance. — Shark fishing is a relatively minor industry of local importance in a few regions. Shark-liver oil, high in vitamin A, has been used for pharmaceutical and proprietary medicines when supplies of cod-liver oil, formerly a chief source of the vitamin, have been reduced. Lower-grade shark oils have industrial application in tanning and other industries. Shark skin is the source of shagreen, a very durable leather for which there is only a very limited demand. Spiny (*Squalus*) and smooth (*Mustelus*) dogfishes serve as objects of anatomical dissection in many school laboratories of zoology. Past attempts in the United States to popularize spiny dogfish *(Squalus acanthias)* flesh as edible "gray fish" proved unsuccessful. However, the use of shark flesh elsewhere is more widespread; large quantities are sold in Europe, South America and South Africa. In Latin-American countries sun-dried or salted shark flesh is shipped into inland areas.

The school shark *(Galeorhinus australia)*, originally fished for vitamin A in Australia, is now processed into fresh shark fillets. Several million pounds annually are sold as "flake," the principal source of fish in "fish and chips"; the Australian government has been concerned with the dwindling number of this commercially valuable species in its territorial waters. (Strangely enough, regardless of where shark flesh is sold, it rarely is described as a shark product.) Sharks are also used as bait for lobsters and crabs. and considerable amounts of shark meat are processed for fertilizer and for livestock feed.

Bibliography.—V. M. Coppleson, *Shark Attack* (1958) ; G. A. Llano, *Airmen Aqainst the Sea,* Air University USAF (1955) ; "Sharks *v.* Men," *Scientific American* 196(6):54–61 (1957); J. R. Thompson and S. Springer, "Sharks, Skates, Rays and Chimaeras," U.S. Fish and Wildlife Service *Circular* 119 (1961). (G. A. Ll.)

SHARON, an industrial city of Mercer county, Pa.. U.S., is situated on the Shenango river at the Ohio-Pennsylvania border. It has plants manufacturing chemical. food, lumber, steel, electrical and textile products. The area contains significant deposits of natural gas, crude oil, bituminous coal and sand. Settled in 1795 and laid out by William Budd in 1815, Sharon was incorporated as a borough in 1841 and as a city in 1918. It has rail and road transportation, and air facilities through Youngstown, O. About equidistant from Erie and Pittsburgh, Pa., and Cleveland. O., the city is well located commercially. For comparative population figures *see* table in Pennsylvania: *Population.* (C. C. G)

SHARP, CECIL JAMES (1859–1924), British musician and writer, was born in London, Nov. 22, 1859. He was educated at Uppingham and at Clare college, Cambridge. and in 1853 went to South Australia where he founded a school of music at Adelaide. He was principal at the Hampstead Conservatoire, London, 1896–1905, and director of the English Folk-Dance society which he founded in 1911. His work in collecting and arranging English folk songs and dances and lecturing revived interest in English national music. During a visit to America he discovered in the Appalachian mountains survivals of old national melodies. He died in London, June 23, 1924.

Sharp's works include: *A Book of British Song* (1902): with C. L. Marson, *Folk Songs From Somerset,* series 1–5 (1904–19); *Folk Songs for Use in Schools,* sets 1–10; *English Folk Songs From the Southern Appalachians* (1917); *American English Folk Songs,* etc.; *English Folk Songs,* 2 vol. (1921) ; with A. P. Oppé, *The Dance, an Historical Survey of Dancing in Europe* (1924).

See W. A. S. Shaw, *Cecil Sharp, an Appreciation* (1925).

SHARP, GRANVILLE (1735–1813), English philanthropist, was born at Durham, the son of Thomas Sharp (1693–1758), a theological writer and the biographer of John Sharp, archbishop" of York.

Granville was apprenticed to a London draper, but in 1758 he entered the government ordnance department. A diligent student of Greek and Hebrew, he published several treatises on biblical criticism, one of which, *Remarks on the Uses of the Definitive Article in the Greek Text of the New Testantent,* gave rise to a controversy on account of the proposition, known as "Granville Sharp's canon," which it contained. His fame rests, however, on his untiring efforts for the abolition of slavery. In 1767 he became involved in a lawsuit with a slave owner in which it was finally laid down that a slave becomes free the moment he sets foot on English territory.

Sharp advocated the cause of the American colonies, supported parliamentary reform at home and the legislative independence of Ireland, and agitated against press gangs. In 1787 he founded a society for the abolition of slavery, and he was a joint founder of the British and Foreign Bible society and of the Society for the Conversion of Jews.

Sharp died on July 6, 1813, and a memorial to him was erected in Westminster abbey.

Bibliography.—Prince Hoare, *Memoirs of Granville Sharp* (1820), which contains observations by Bishop Burgess on Sharp's biblical criticisms; Sir James Stephen, *Essays in Ecclesiastical Biography* (1860) ; Thomas Clarkson, *History of the Rise, Progress and Accomplishment of the Abolition of the African Slave Trade by the British Parliament* (1839).

SHARP, JAMES (1613–1679), Scottish archbishop, the son of William Sharp, sheriff clerk of Banffshire, was born in Banff castle on May 4, 1613. In 1633 he went to King's college, Aberdeen, where he graduated in 1637. On the outbreak of the Covenanting War he visited Oxford, and perhaps Cambridge, becoming acquainted with the principal English divines. On his return he was chosen (1643) one of the "regents" of philosophy in St. Leonard's college, St. Andrews, and in 1648 was appointed minister of Crail in Fifeshire. In the great schism of Resolutioners and Protestors he took active part with the Resolutioners, and in March 1651 was taken prisoner by Cromwell, but subsequently liberated on parole. In 1657 he went to London to counteract the influence with the Protector of Archibald Johnston, Lord Warriston. He was again sent to London in Feb. 1660 to watch over the interests of the Resolutioners at the time of Monk's march to London. He was favourably received by Monk, who sent him to the king at Breda. He certainly regarded himself equally as the emissary of the Scottish kirk; he was also the bearer of a secret letter from Lauderdale to the king. There can be little doubt that he was finally corrupted by Charles and Clarendon, and decided that the interests of the kirk should not imperil his own chances. He returned to Scotland in May 1660 and. while successfully stopping all petitions from Scottish ministers to the king, parliament or council, was at pains to allay the suspicions of his loyalty to the kirk which had been aroused by his attitude in London. A letter of his to Middleton the high commissioner shows that he was in communication with Clarendon and the English bishops; that he was co-operating in the restoration of episcopacy in Scotland; that he was aware that Middleton, with whom he had held conferences, had all along intended it; and that he drew up the quibbling proclamation whose sole purpose was "the disposing of minds to acquiesce in the king's pleasure." The mask at length dropped in August when episcopacy was restored and Sharp was rewarded with the archbishopric of St. Andrews. On April 20, 1661, Sharp preached his first sermon at St. Andrews.

Sharp had kept on good terms with Lauderdale and avoided acting against him on the occasion of the billeting plot concocted in Sept. 1662 by Middleton. When Lauderdale's supremacy was established he co-operated in passing the National Synod act in 1663, the first step in the intended subjection of the church to the crown. In 1664 he obtained the grant of a new church commission. Sharp now placed himself in opposition to the influence of Lauderdale, in alliance with Rothes, Hamilton, Dalyell and others, but in 1665 he suffered a complete humiliation at the hands of Lauderdale. The result of their system of violence and extortion was the rising of the Covenanters, during which Sharp showed, according to Bellenden, the utmost fear, only equaled by his cruelty to the prisoners after the rout of Pentland. When the convention of estates met in Jan. 1667 Hamilton was substituted for him as president, and he now wrote groveling letters to Lauderdale, who extended him a careless reconciliation.

For a time he helped to restrain his brethren from complaining to London of Lauderdale's conciliation policy. In the debates on the Supremacy act, by which Lauderdale destroyed the autonomy of the church, Sharp's reluctance gave way upon the first pressure, but he actively opposed Leighton's endeavour, as archbishop of Glasgow, to carry out a comprehensive scheme. From this time he was completely subservient to Lauderdale, who had now finally determined upon a career of oppression, and in 1674 he was again in London to support this policy. In this year James Mitchell, who had shot at him six years before, was arrested, and Sharp obtained from him privately a full confession by a promise of pardon which he afterward repudiated. It was, however, confirmed by the entry of the act in the records of the court. Mitchell was finally condemned and Sharp refused to support the appeal for a reprieve. On May 3, 1679, while driving with his daughter Isabel to St. Andrews, he was set upon by nine men and murdered in revenge. The place of the murder, on Magus Muir, is marked by a monument.

SHARP, WILLIAM (1749–1824), English line engraver, was born at London on Jan. 29, 1749. He was originally apprenticed to what is called a bright engraver and practised as a writing engraver, but gradually became inspired by the higher branches of the engraver's art.

In his youth, owing to his hotly expressed adherence to the politics of Paine and Horne Tooke, he was examined by the privy council on a charge of treason. Mesmer and Brothers found in Sharp a staunch believer, and for long he maintained Joanna Southcott at his own expense.

As an engraver Sharp achieved a reputation throughout Europe and enjoyed many foreign honours as well. Among his earlier plates are some illustrations, after Stothard, for the *Novelists' Magazine.*

He also engraved the "Doctors Disputing on the Immaculateness of the Virgin" and the "Ecce Homo" of Guido Reni, the "St. Cecilia" of Domenichino, the "Virgin and Child" of Dolci and the portrait of John Hunter of Sir Joshua Reynolds.

Sharp died at Chiswick on July 25, 1824.

SHARP, WILLIAM (1856–1905), Scottish poet and man of letters, was born at Paisley on Sept. 12, 1856. During his lifetime he was known solely for poetical and critical works of great but not outstanding merit, while from 1894 onward he published, with elaborate precautions of secrecy, under the name of "Fiona Macleod," stories and sketches in poetical prose which made him perhaps the most conspicuous Scottish writer of the modern Gaelic renaissance. His early life was spent chiefly in the west Highlands of Scotland, and after leaving Glasgow university he went to Australia in 1877 in search of health. After a cruise in the Pacific he settled for some time in London as clerk to a bank, became an intimate of the Rossettis and began to contribute to the *Pall Mall Gazette* and other journals. He spent much time abroad, in France and Italy, and traveled extensively in America and Africa. In 1885 he married his cousin, Elizabeth Amelia Sharp, who collaborated with him in compiling the *Lyra Celtica* (1896). His volumes of verse were *The Human Inheritance* (1882), *Earth's Voices* (1884), *Romantic Ballads and Poems of Fantasy* (1886), *Sospiri di Roma* (1891), *Flower o' the Vine* (1894), *Sospiri d' Italia* (1906). William Sharp was the general editor of the "Canterbury Poets" series. He was a discriminating anthologist, and his *Sonnets of the Century* (1886), to which he prefixed a useful treatise on the sonnet, ran through many editions. This was followed by *American Sonnets* (1889).

Sharp wrote biographies of Dante Gabriel Rossetti (1882), Shelley (1887), Heinrich Heine (1888) and Robert Browning (1890) and edited the memoirs of Joseph Severn (1892). During the later years of his life he was obliged for reasons of health to spend all his winters abroad. The secret of his authorship of the "Fiona Macleod" books was faithfully kept until his death, which took place at the Castello di Manlace, Sicily, on Dec. 12, 1905. Publication of the tales and sketches of the primitive Celtic world began in 1894 with *Pharais: a Romance of the Isles.* They found only a limited public, though an enthusiastic one.

See a memoir by his wife (1910).

SHARP (IN MUSIC): *see* ACCIDENTALS.

SHARPEY-SCHÄFER, SIR EDWARD ALBERT (1850–1935), British physiologist and inventor of the prone-pressure method of artificial respiration (*q.v.*), was born at Hornsey, Middlesex, on June 2, 1850. He was educated at University college, London, where he met William Sharpey, the professor of general anatomy and physiology, and in 1918 he prefixed Sharpey's name to his own in order to perpetuate the name of his teacher. He became Jodrell professor at University college (1883), Fullerian professor at the Royal institution (1878–81) and professor of physiology at Edinburgh university (1899–1933). Sharpey-Schäfer made important contributions to the knowledge of cerebral localization, of the heart sounds and of muscular contraction. In 1894 (with George Oliver) he demonstrated the existence in the adrenal glands of a substance (adrenaline) which raised the blood pressure, and this stimulated research on the internal secretions (hormones) of the ductless glands. Sharpey-Schafer's method of artificial respiration was adopted by the Royal Life Saving society, and he received many honours, including the presidency of the British association (1912) and a knighthood (1913). He died at North Berwick, East Lothian, on March 29, 1935.

(W. J. BP.)

SHASI (SHA-SHIH), a commercial city and water transportation centre on the Yangtze in central Hupeh province, China. Pop. (1953) 85,800. Called "Little Hankow" after the most important commercial port of central China about 120 mi. eastward, Shasi is the centre for numerous canal connections, one of which shortens to a third the circuitous Yangtze river distance to the Wu-Han metropolitan area. Across the Yangtze and southward, the T'ai-p'ing and Ou-ch'ih canals lead to Tung-t'ing lake in Hunan. Between these two canals a flood-detention basin covering 350 sq.mi. was constructed in 1952–53. Because of its situation in the cotton-growing region of Hupeh, cotton and cotton seed, as well as other produce such as rape seed are exported through Shasi. The city also is a distribution point for upriver Szechwan salt. Cotton textile and flour mills west of the city form two of its most important industries. Shasi has no rail connections but a motor highway runs south from across the Yangtze around Tung-t'ing lake to Ch'ang-sha, and another highway runs north to Hsiang-yang on the Han river, crossing an east-west highway between Wu-Han and I-ch'ang.

Shasi was flourishing as early as the T'ang dynasty, and superseded in the 1870s contiguous Chiang-ling (formerly Ching-chou, which dates far earlier) as the local commercial centre. Shasi was one of the treaty ports opened in 1896, but the foreign trade only became significant after World War I. (H. J. Ws.)

SHASTA, an Indian group, of Hokan speech stock, lived on and south of Klamath river, east of Mt. Shasta. Culturally they stood intermediate between the northwestern tribes, such as the Yurok and Hupa (*qq.v.*) and the Maidu (*q.v.*) and other central Californians. Originally numbering an estimated 2,000 in 1770, they dwindled to a few dozen scattered households in the second half of the 20th century.

See John R. Swanton, *The Indian Tribes of North America,* Smithsonian Institution Bureau of American Ethnology Bulletin 145 (1953).

PHOTOGRAPHS BY HERMAN HARRIS LAMB

SHAVING MUGS IN OLD BARBER SHOP RACK

Top row, left to right: Two glass-covered label mugs, name mug, signature mug, floral mug, bird mug, scenic mug
Second row: Numeral mugs
Third row: Occupational or trades emblem mugs
Fourth row: Sports occupational mugs
Bottom row: Society emblem mugs (first four from left), occupational mugs illustrated with photographs

PHOTOGRAPHS BY HERMAN HARRIS LAMB

OLD ENGLISH AND AMERICAN SHAVING MUGS

1. Reading clockwise from the 12 o'clock position: three early American pottery mugs; English copper lustre mug; "The Utility Shaving Mug," containing spaces for razor, brush, hot water and shaving soap; silver dome covered mug; patented shaving mug (July 16, 1867), the first mug with a real soap compartment; patented shaving mug (Sept. 20, 1870) of the coal-scuttle type, in which the soap compartment was first given drain holes: head coal-scuttle mug; "The Requisite"; "The Champion"; "The Toilet." Centre, 18th century bishop's barber bowl

2. A different view of the same mugs shown in Fig. 1, except that the silver dome covered mug is omitted

SHAVER, ELECTRIC: *see* RAZOR.

SHAVING MUG. The shaving mug played an important part in man's effort to keep himself clean shaven during the period from 1830 to 1930. The parent of the shaving mug was the barber's shaving basin and shaving bowl, made of brass, silver, earthenmare or china, in use from the 15th to early 19th centuries. Each basin or bowl contained a half-moon indentation on the edge shaped to fit a customer's neck as he reclined in the barber's chair and held the bowl on his chest. The shaving mug, after sporadic appearances around 1800, came into its own in the United States in 1830 with early types in pottery ware, in Pennsylvania and New England. Originality was displayed in the fashioning of these pottery shaving mugs since a good number of them were furnished with soap compartments at front, side, or on the inside of. the mug near the handle, 30 years before the appearance of mugs with patented soap compartments.

The United States became the cradle of the shaving mug trade, (1) by reason of the many patented shaving mugs beginning with the year 1860; and (2) because of the trend toward individually decorated shaving mugs for barber shop use. The first patent for a shaving mug was granted on May 1, 1860, to Thomas E. Hughes of Birmingham, Pa., and during the 80-year period ending in 1940 —a good ten years beyond the popular taste for shaving mugs—a total of 94 United States patents mas granted for shaving mugs.

The vogue for the barber shop shaving mugs, decorated and named to suit each customer! was peculiar to the Gnited States. The following classifications cover the field of the individual shaving mug, decorated expressly for barber shop use, and placed in barber racks or pigeonholes for the daily customers:

1. *Glass covered label mug,* a white shaving mug to which was glued a thick lithographed label covered by a thin coating of glass for protection from moisture. Gold bands were added to top and bottom.
2. *Shaving mug with owner's name* in gilded lettering of Old English style, but occasionally in plain letrering and coloured blue or black.
3. *Shaving mug with floral, bird, or scenic design,* and with owner's name above or below design.
4. *The trades emblem* or occupational shaving mug, illustrating owner's trade, occupation, favourite sport, or secret society, together with his name or initials.
5. *Numeral shaving mug:* a shaving mug with nothing but a large gilded numeral for use in barber shops where the customer turnover was great.
6. *Photograph shaving mug:* a branch of trades emblem mug. Instead of a hand-painted scene of the owner's trade: the photograph mug carried a real photographic scene, developed on the surface of the mug and fired into glaze.

The quality of each shaving mug depended upon three things: the composition of mug (grade of china), the skill and care with which the artist decorated the mug, and the quality of gold used.

The individual barber shop shaving mug began to disappear during World War I when many soldiers learned to shave themselves. In addition, the Sunday curfew imposed on barber shop openings during and after 1905, coupled with the advent of the safety razor, made real inroads on the kept shaving mug. Brushless shaving creams appeared along with electric razors. The price of a shave rose high above the old 10 and 15 cent charge of 1900. In short, it became impractical to be shaved daily by the same barber. Finally, in the year 1930, the curtain fell and and the individual shaving mug became a custom of the past.

(W. P. W.; X.)

SHAW, ANNA HOWARD (1847–1919), English-born U.S. reformer, was born at Newcastle upon Tyne on Feb. 14, 1847. When she was a small child, her parents moved to the United States. From 1872 to 1875 she studied at Albion college, Albion, Mich., and in 1878 graduated from the theological school of Boston university. The district conference of the Methodist Episcopal Church granted her a local preacher's licence, but the New England conference of the M.E. Church refused to ordain her because of her sex, and the refusal was upheld by the general conference at Cincinnati in 1880. The same year she was ordained in the Methodist Protestant Church. While preaching she had studied medicine and received the degree of M.D. from Boston university in 1885.

She was associated after 1886 with the National American Woman Suffrage association in various capacities, from 1904–15 as president. In 1917 she was chairman of the woman's committee of the Council of National Defense. She died at Moylan, Pa.. on July 2, 1919.

SHAW, GEORGE BERNARD (1856–1950), Irish critic, pamphleteer and playwright, was born in Dublin, July 26, 1856. He claims descent from Macduff, Thane of Fife, and from Oliver Cromwell. His father, George Carr Shaw, son of Bernard Shaw, sometime sheriff of Kilkenny county, mas married to Lucinda Elizabeth Gurley, daughter of Walter Bagenal Gurley, landed proprietor of County Carlow. The Shaws were of the Irish gentry, "revolving impecuniously in a sort of vague second cousinship round a baronetcy."

Bernard grew up wild, his father being preoccupied with a declining business, his mother devoted to musical interests. After his civil service post in the Dublin courts of justice was abolished in 1850, Shaw's father received a small pension uhich he sold to become a member of the Dublin Corn exchange as a wholesale merchant. Tutored in the classics by his uncle, the Rev. William George Carroll, vicar of St. Bride's, Dublin, at the age of ten Shaw entered the Wesleyan Connexional school, and after a brief meteoric flight to the top, quickly declined and remained "generally at or near the bottom of his classes." In three other schools which he subsequently attended, he found he could learn nothing in which he was not interested, and consequently "took refuge in idleness." Algebra obfuscated him, the classics left him cold, but he excelled in English composition, for ahich no prizes were given; and he often regaled his classmates with stories from the *Iliad* and *Odyssey,* narrated with a Shavian slant. The vital interests of this pert, voluble and athletically tireless boy were literature, music and the graphic arts.

A distinguished teacher of music, George John Vandaleur Lee, made his home with the Shaws; and Mrs Shaw, who had a pure mezzo-soprano voice, aided him in all his numerous musical activities. Bernard received from his mother lessons in voice culture, nhich later on stood in good stead the spellbinder of countless platforms. As a lad he sang incessantly to himself, and affirmed that before he was 15 "he knew at least one important work by Handel, Mozart, Beethoven, Mendelssohn, Rossini, Bellini, Donizetti, Verdi and Gounod from cover to cover." He scribbled incessantly with coloured crayons and even went through the prescribed subjects of the School of Design, only to discover that he had no talent for art. In solitary state he haunted the halls of the National Gallery of Ireland. and devoured the Bohn translations of Vasari and Duchesne's outlines of the old masters. He was an unusually matured, self-educated lad at 15, thanks to the all-pervasive influence of music, communism in art, and the free sky-gallery of Dalkey Hill, where the Shaws had a summer home

In 1871 an uncle secured for him the post of office boy to a Dublin estate agent. Charles Uniacke Townshend, at a monthly salary of $4.50; and sometime later he was temporarily tried out as cashier. He made good against his will, and held this position for four years, finally receiving $450 annually. During this period Shaw submitted to magazines and newspapers numerous literary contributions which were invariably rejected; and he and Edward McNulty, who later achieved some note as a novelist, carried on an extended correspondence full of imaginative outpourings. One only of Shaw's early compositions, a caustic comment on the vastly popular Moody and Sankey revival meetings, appeared in print (Public Opinion, April 3, 1875) to the scandal of all his relatives.

In 1872 Lee went to London to become a fashionable teacher of music: and soon thereafter Mrs. Shaw, accompanied by her two daughters, Lucinda Frances who became a professional singer, and Elinor Agnes aho died in 1876, went to London to become a professional teacher of music. In 1876 Bernard suddenly resigned his cashier's position to throw in his lot with his mother and sister. irresistibly impelled by two desires: to find his *métier* and, in violation of traditional filial duty, never again to do another "honest day's work." His subsequent history validated his decision to disregard "all the quack duties which lead the peasant lad of fiction to the White House."

During the next nine years, except for a brief interlude of employment by the Edison Telephone company in London, Shaw remained an incorrigible unemployable, being supported by his parents. The possession of a suit of evening clothes and facility in pianoforte accompaniment gave him the *entrée* to certain artistic and musical circles of London society. Over a period of nine years (1876–85) he earned by his pen over his own signature an average of only a cent a day; aside from ghost-writing music criticism for Lee on *The Hornet*, he sold an article, "Christian Names," to *One and All*, edited by George R. Sims, for 15*s*., a verse for a school prize book for 5*s*., and a patent medicine advertisement for £j. Only confidence in his own powers and belief that he belonged in the company of the immortals enabled him to rise above one of the most devastating initial failures in literary history.

From 1879 to 1883 he doggedly persisted in the attempt to write fiction, at the daily rate of five foolscap pages. Of his five novels, the first, fitly entitled *Immaturity*, remained unpublished; the other four, although refused by all the publishers of London, eventually padded out propagandist magazines edited by Shaw's radical friends and associates. *An Unsocial Socialist*, an instalment of a huge projected work to cover the entire social movement, appeared in a Socialist magazine, *To-Day* (1884) edited by Henry Hyde Champion, as did also a glorified juvenile with a pugilist hero, *Cashel Byron's Profession* (1885–86), which delighted William Archer and William E. Henley, and which convulsed Robert Louis Stevenson with its hilarious nonsense. It was published in a dramatized form. *The Admirable Bashville; or Constancy Unrewarded* in 1901. *The Irrational Knot*, which for its modernist treatment of marriage, Shaw pronounced a fictive forerunner of Ibsen's *A Doll's House*, appeared in *Our Corner* (1885–87), edited by Annie Besant, orator and radical leader; and it was followed in the same magazine (1887–88) by *Love Among the Artists*, based in part upon the life of Beethoven. The novels failed because of their immature criticism of Victorian respectability and morality. These novels are packed with dramatic situations; and in working off the "greensickness" of fiction, Shaw was unwittingly serving his apprenticeship to the profession of playwriting.

On joining in 1879 the Zetetical society, a discussion club, where he formed an historic and fruitful association with Sydney Webb, Shaw was launched upon one of the most extraordinary of careers as expository orator and spellbinder. By grim persistency he succeeded in transforming himself from a timid novice into a master of the platform. Over a period of 12 years (1883–95) he spoke, without compensation, three times weekly in harangues ranging from brief street corner talks to loitering listeners and watchful policemen and public debates in crowded halls to formal papers before the British association and four-hour addresses to great throngs in the open air.

On Sept. 2, 1882, at the Memorial Hall in Farringdon street, London, occurred Shaw's historic conversion to Socialism by Henry George, whose *Progress and Poverty* was then having an immense vogue in England. After hearing Henry George, Shaw confessed: "The importance of the economic basis of society dawned upon me." He studied Karl Marx's *Das Kapital*, attended a Marxist reading circle, and on Sept. 5, 1884, eight months after its founding, joined the Fabian society, a revolting sect from the Fellowship of the New Life, founded by the Utopian philosopher, Thomas Davidson.

From the outset of his career as a Fabian, Shaw became closely associated with many social reformers, notably Sydney Webb, Beatrice Potter, Hubert Bland, Graham Wallas, James Leigh Joynes, Sydney (later Lord) Olivier, Rev. Stewart D. Headlam, Henry S. Salt, William Morris, Annie Besant, Edward Carpenter, Walter Crane, Henry H. Sparling, Henry M. Hyndman, J. Ramsay MacDonald and Eleanor Marx. In the Fabian society, a sort of people's university, Shaw performed herculean labours in committee work, drafting tracts, editing books, and delivering notable addresses habitually boycotted by the press. The appearance of *Fabian Essays* (1887), edited by Shaw, was an event of the first importance in the history of contemporary Socialism: and the studies of the economic bases of society embodied in many of the society's publications exercised marked influence upon modern social and political movements. After serving 27 years, along with Webb, Bland, Wallas and Olivier, on the executive committee, Shaw resigned in 1911. After joining the Fabian society, he carried on with rare dialectical skill innumerable discussions in the press on many of the leading issues of the day along all lines. He achieved international notoriety as a pamphleteer with his *Common Sense about the War* (*The New Statesman*, supplement, Nov. 14, 1914), a drastic criticism of the British government, which sold 75,000 copies, cost him some friendships, and provoked an abortive attempt at ostracism. In the U.S.S.R., which he visited in 1931, he discerned the triumph of Fabian, rather than of Marxian, policy and the realization in practical operation of Webb's doctrine of "the inevitability of gradualness." Shaw's *The Intelligent Woman's Guide to Capitalism and Socialism* (1928), in which he expounds Edward Bellamy's doctrine of equality of income, was the most lucid *vade mecum* to socialist theory and practice so far penned. In 1897, Shaw became a member of the vestry of the Parish of St. Pancras, and three years later a member of the borough council, serving until Oct. 31, 1903. During this period he laboured unremittingly on vestry and borough council and also through communications to the press for the betterment of the poorer classes and tlia municipalization of industry. As a Progressive candidate for a seat on the London County council in 1903, Shaw was overwhelmingly defeated because of his irrepressible outspokenness. His small work, *The Common Sense of Municipal Trading* (1904) is an effective Socialist plea in behalf of the municipalization of enterprise. Ironically enough, one of the duties of this inveterate vegetarian, in serving on the Health committee, was the holding of inquests on tuberculous cattle, to guarantee the condition of meat in his parish.

Over a period of 13 years (1885–98), Shaw wrote for many newspapers and magazines as critic of art, literature, music and drama. After serving on *The World*, the *Scots Observer*, the *Daily Chronicle* and the *Pall Mall Gazette* he became in 1888 music critic on *The Star*, with the pseudonym, "Corno di Bassetto," a musical instrument which went out of use in Mozart's time. He wrote music criticism for *The World* (1890–94), winning wide appreciation for relating music to the life of the average man and woman. In 1895 he entered upon his most exciting era of critical propaganda, on *The Saturday Review*, edited by Frank Harris; and published his valedictory on May 21, 1898. He conducted a one-man crusade on behalf of Ibsen and the new drama, shocked all England by his extravagant depreciation of Shakespeare, and refused to accept Pinero as an English Ibsen. In a memorable correspondence with Ellen Terry, published in 1931, he sought unsuccessfully, as knight errant of modernism, to rescue the imprisoned damsel, Ellen Terry, from the dungeon of the demoded Lyceum, guarded by her jailer, Henry Irving. By his clever and propagandist drama criticisms (*Dramatic Opinions and Essays*, N.Y., 1907), Shaw won incontestable eminence as the most effective British *feuilletonist* of his day. Basic precipitations from these critical researches are *The Quintessence of Ibsenism* (1891, 1913), *The Sanity of Art* (1895, 1908), and *The Perfect Wagnerite* (1898). In 1898, after recovering from a nervous breakdown, Shaw was married to Charlotte Payne-Townshend, an Irish heiress. She died in 1943.

Shaw's career as a dramatist covers a period (1885–1939) of more than Shakespeare's entire life span. In 1885, William Archer suggested collaboration with Shaw on a play, as he was conversant with construction and Shaw was adept at dialogue. Archer outlined the plot, and Shaw soon reported that he had used up all the plot in one act and needed more to go on with. The project fell through; but seven years later, at the request of J. T. Grein, director of the Independent theatre, Shaw transformed Archer's "twaddling cup-and-saucer comedy" into a dramatic tract on slum landlordism. The play, *Widowers' Houses,* achieved a *succès de scandale* at the Royalty theatre, London, Dec. 9, 1892, with hostile repercussions in the press. *The Philanderer* (1893), a play on Ibsenism and the "new woman." proved unsuited to the resources of the Independent theatre; and *Mrs. Warren's Profession* (1893), a daring *exposé* of the "economic basis of modern commercial prostitution," was automatically barred from production by the existence of the British censorship. These Shaw-called "unpleasant" plays were succeeded by "pleasant" plays *(Plays, Pleasant and Unpleasant,* 2 vols., 1898); and Shaw's most internationally popular success, *Arms and the Man,* a satire on the military profession produced at the Avenue theatre, London, April 21, 1894, marks the true beginning of Shaw's recognition as a popular dramatist. Richard Mansfield's American productions of *Arms and the Man* (1894) and *The Devil's Disciple* (1897) enhanced Shaw's reputation as a popular entertainer and rendered him financially independent. Successful productions in Germany, Austria, Hungary and Russia of *Arms and the Man, The Devil's Disciple, The Man of Destiny* and *Candida,* in which plays Agnes Sorma, Lili Petri and Otto Sommerstorff played leading roles, gave Shaw continental vogue; and as early as 1904 he was, somewhat extravagantly, hailed in the Berlin press as "a king of the German stage." Arnold Daly's production of *Candida,* Princess theatre, New York, Dec. 8, 1903, produced a sensational effect; and Robert Loraine's admirable production of *Man and Superman,* Hudson theatre, New York, Sept. 5, 1905, achieved Shaw's conquest of the American theatre-going public, The (Vedrenne-Barker) productions at the Royal Court theatre, London (1904–07), of the New York Theatre guild, of the Malvern Festival, and of the Birmingham Repertory theatre were among the highest manifestations of contemporary dramatic art. By 1915 Shaw's international fame was firmly established and he was being played in many countries of the world, from Britain to Japan. He was awarded the 1925 Nobel Prize for Literature. He gave the prize, £7,000, to establish the Anglo-Swedish alliance for spreading a knowledge of Swedish literature in English-speaking countries.

During the period of his active dramatic composition (1893–1939) Shaw wrote 47 plays, an average of a play a year. Despite offers, he allowed the filming of only a few of his plays, the most notable being *Pygmalion.* He was the first economist in history to win world fame as a dramatist; and he informed his biographer: "In all my plays my economic studies have played as important a part as a knowledge of anatomy does in the works of Michelangelo." His characters are less individualized human beings than types, intellectual abstractions bearing the *vraisemblance* of reality. Many of the plays are not dramas in the classic sense, but moralities, presenting the clashing ideas and conflicting ideologies of the epoch.

Shaw took Shakespeare to task for having no message for his age. Every Shaw play is a message to the times, a testament of faith: *Candida* on love as pity, *Man and Superman* on eugenics and race betterment, *Major Barbara* on poverty, *Androcles and the Lion* on the nature of religious faith., *The 'Doctor's Dilemma* on the parlous state of the medical profession, *John Bull's Other Island* on the political contrasts of England and Ireland, *Saint Joan* on heroism and saintliness, *Heartbreak House* on World War I, *Caesar and Cleopatra* on genius and greatness. Following a practice common in English literature after Dryden, Shaw's plays carry carefully written prefaces, in excellent journalistic style; and often these prefaces, rather than the plays they precede, convey his immediate message. Shaw was primarily interested, not in events, but in people's reactions thereto; and many of his plays are dramas of conversion. the death of old, the birth of new, faiths. He derided plots as "clockwork mice," and insisted that he wrote plays without prematured design.

Shaw created a novel type of debated drama. He took his cue from the last act of Ibsen's *A Doll's House,* but spread discussion and controversy throughout the entire play, and disarmed the critics by calling his plays conversations, arguments and debates. Some of his plays resemble light operas of Mozartian *timbre,* notably *The Man of Destiny, Arms and the Man, The Devil's Disciple* and *Captain Brassbound's Conversion;* and after one of them, *Arms and the Man,* was drawn a widely popular musical comedy, *The Chocolate Soldier,* with libretto by Oscar Straus. Other Shaw plays, ostensibly period pieces and chronicle plays, are actually historical extravaganzas: *Caesar and Cleopatra, The Apple Cart, The Six of Calais* and *Geneva.*

It was not until he had appreciably exceeded Shakespeare's life span that Shaw began to create plays acclaimed great. *Pygmalion, Candida, Arms and the Man, The Doctor's Dilemma, You Never Can Tell* and *Man and Superman* were sure-fire popular successes, and *Fanny's First Play* ran continuously for more than 400 performances; but *Heartbreak House, Back to Methuselah, Androcles and the Lion* and *Saint Joan,* written between the ages of 57 and 67, deserve to rank as his greatest dramatic works. *Saint Joan,* exhibiting the Maid as the incarnation of the Protestant soul in tragic conflict with the mightiest forces of institutionalism in church and state, is one of the most uplifting dramas in English since Shakespeare. After *Saint Joan,* Barrie called Shaw "our only angel." *In Good King Charles's Golden Days,* published at the age of 83, is a *tour de force.* In persistence of creativity in art to an advanced age, Shaw belongs in the mighty company of Sophocles, Michelangelo, Voltaire, Goethe and Victor Hugo.

Shaw first appeared as a philosopher in *Man and Superman* (1901), a Shavian distillation of Bergson's *Creative Evolution;* but it was not until two decades later that his basic philosophy was fully expounded in *Back to Methuselah* (1921). Shaw's conversion, which was induced by a study of Samuel Butler, resulted in the discarding of Darwin's theory of Natural Selection in favour of Lamarck's doctrine of Functional Adaptation. Shaw identified God with what he called the Life Force *(élan vital)*; he saw the universe as God in the act of evolving Himself. Life will evolve, he believed, through all the stages from amoeba, through man, to God. In *Back to Methuselah,* Shaw opened up the prospect of man's ultimate redemption from the bondage of the flesh. Man, as expression of God, must will his own destiny. The philosophic man Shaw defined as "he who seeks in contemplation to discover the inner will of the world, in invention to discover the means of fulfilling that will, and in action to do that will by the so-discovered means " Shaw died at Ayot St. Lawrence, Eng , on Nov. 2, 1950.

See also Index references under "Shaw" in the Index volume.

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(A. HE.; X.)

SHAW, HENRY WHEELER: *see* BILLINGS, JOSH.

SHAW, LEMUEL (1781–1861), chief justice of the supreme judicial court of Massachusetts, from 1830 to 1860, who left an indelible mark on the law of the commonwealth and significantly contributed to the structure of American law. Born on Jan. 9, 1781 at Barnstable, Mass., he was educated at Harvard, studied law with David Everett, and was admitted to the bar in 1804. While a practitioner and Federalist officeholder in Boston he had extensive experience with public affairs, and was counselor to many ascendant industrial interests.

Respectful of the legislative will when statutes made it clear, Shaw did not hesitate to mold the common law to meet the needs of a changing society. He made the fellow-servant rule a principle of American law (*Farwell* v. *Railroad,* 4 Metcalf), he freed unions from the abusive application of the law of conspiracy *(Commonwealth* v. *Hunt,* 4 Metcalf) and he denied that racial segregation in public schools created unconstitutional inequalities *(Roberts* v. *Boston,* 5, Cushing). He died on March 30, 1861.

See F. H. Chase, *Lemuel Shaw* . . . (1918); L. W. Levy, *The Law of the Commonwealth and Chief Justice Shaw* (1957). (M. DeW. H.)

SHAW, SIR (WILLIAM) NAPIER (1854–1945), English meteorologist, whose scientific contributions bridge the transition from the 19th-century era to the rejuvenated state of meteorology resulting from the ideas of the Norwegian school (1919) and from the direct analysis of the upper air. Born March 4, 1854, at Birmingham, he began his career teaching physics at Cambridge, where he had been a student, a task he performed with distinction for more than 20 years. Elected a fellow of the Royal society in 1891, he was called from Cambridge in 1900 to become secretary of the Meteorological council, which was the governing body of the Meteorological office. His influence led to the reorganization, with noteworthy improvements, of the Meteorological office. In 1905 he became director of the office, serving until his retirement in 1920. He then was named the first professor of meteorology at the Royal College of Science of the Imperial College of Science and Technology, retiring in 1924. Subsequently he devoted his attention to international meteorological affairs and to completing his four-volume *Manual of Meteorology* (1926–31). He died in London, March 23, 1945. (H. R. B.)

SHAW, RICHARD NORMAN (1831–1912), British architect who specialized in domestic buildings, was born in Edinburgh, Scot., on May 7, 1831. After an apprenticeship to William Burn, he attended the architectural schools of the Royal Academy and later entered the office of G. E. Street. In 1863 Shaw began to practise. He broke away from the academic tradition in which he was trained to adopt the characteristic style which entirely changed English domestic archirecture. His style was vulgarized by the imitations of the speculative builder, but the houses he himself designed were admirable in proportion and in their adaptation to their purpose. As his powers developed, his buildings gained in dignity and had an air of serenity and a quiet homely charm which were less conspicuous in his earlier works; the "half timber" was more sparingly used and finally disappeared entirely.

Characteristic examples of Shaw's work are Preen manor. Shropshire; Pierrepont, Wispers, and Merrist wood, in Surrey; Lowther lodge. Kensington; Adcote, in Shropshire, one of his finest country houses; his houses at Kensington, Chelsea and at Hampstead; Flete house, Devonshire; Greenham lodge, Berkshire; Dawpool, in Cheshire; Bryanston, in Dorset; New Scotland Yard. London, considered his outstanding work; several fine works in Liverpool and nearby. He died at Hampstead, Nov. 17, 1912.

SHAWINIGAN, previously called Shawinigan Falls, is an industrial city in St. Maurice county, Quebec, Can., on the right bank of the St. Maurice river, 20 mi. above Three Rivers. Pop. (1956) 28,597. The falls near the city drop 165 ft. and 416.000 h.p. have been developed in two plants, supplying power both locally and to Montreal and Quebec. In 1901 an aluminum smelter and a pulp and paper mill were installed in the village of Shawinigan Falls, forming the basis for its considerable industrial expansion. Other industries produce chemicals, abrasives and textiles. The city is divided into two residential areas by the industrial belt and railway lines of Canadian Pacific and Canadian National railways. In 1951, 94% of the population was French-Canadian and 96% Roman Catholic. Shawinigan South, on the left bank of the St. Maurice river, had 10,947 persons in 1956. Shawinigan was incorporated as a village in 1901, a town in 1920 and a city in 1921. The name is the Algonkin word for "crest," used as a place name because the portage beside the falls of the river led over a crest of rocks. (M. C. Ba.)

SHAWL, a term applied to a square, oblong or triangular article of dress worn as a protective or ornamental covering over the shoulders, neck or head. It is found as clothing in most parts of the world. The word is of oriental origin deriving from the Persian *shal*. Records seem to indicate Bukhara as the birthplace of the shawl-weaving industry. Shawls have been worn since the earliest times but the 19th century is known as the "shawl period" because then the shawl reached such a height of popularity that it became a necessity in the wardrobe of every woman in western Europe and America.

The first of the handsome oriental shawls appeared in Europe after the Egyptian campaign in 1798. The most beautiful import was the Cashmere shawl produced in the valley of Kashmir in India. There the Tibetan goat produced a long fine fleece called pashm, which was softer than any wool known. The wool was woven into shawls by expert weavers trained for generations to a sensitive feeling for design and glowing colour. There are two types of Cashmere shawls, the woven shawl and those embroidered in imitation of weaving. In shape they were both square and oblong. The characteristic design was always the "cone" pattern inspired by the jeweled ornament in the turban of the Mogul emperors.

The Paisley shawl, machine produced in Scotland to meet the demand for the Cashmere, was an adaptation rather than an imitation of the oriental shawl. Scarves) boas, mufflers, stoles and smaller shawls are forms of the shawl popular as articles of dress in the 20th century.

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SHAWM (Shalm), the medieval forerunner of the wooden double-reed wind instrument now called the oboe (*q.v.*).

SHAWN, TED (Edwin M.) (1891–), U.S. dancer, choreographer, and dance educator who significantly increased the stature of the American dance and the respect accorded to it, especially to dancing as a career for men. Born in Kansas City, Mo., Oct. 21, 1891, he was originally destined for the ministry, but turned his attention to the dance after a serious illness interrupted his studies. He was just beginning his career when in 1914 he met and married Ruth St. Denis (*q.v.*), with whom he founded the Denishawn school, where every dance technique was taught, and the Denishawn company which toured extensively in the United States and visited the orient in 1925–26.

From 1933 to 1940, after his separation from St. Denis, Shawn devoted himself to building a group of men dancers that presented such impressively masculine works as *Labor Symphony, Olympiad* and *Kinetic Molpai.* He next developed the Jacob's Pillow Dance festival (Lee, Mass.), which was modestly inaugurated in 1933; under Shawn's leadership it became a dance centre of international importance, with its own school and theatre. Shawn also wrote and lectured extensively.

See Katherine S. Dreier, *Shawn, the Dancer* (1933), and the chapter on Shawn in Walter Terry, *The Dance in America* (1956). (Ln. Me.)

SHAWNEE, an Algonkian-speaking Indian tribe that lived in the central Ohio valley until the 17th century, when they were driven out by the Iroquois and scattered into widely separated areas. Some settled in what is now Illinois and others in the Cumberland valley, while one group moved to the southeast, giving its name to the Savannah river. After 1725 the tribe united again in the region of Ohio, nhere they formed the principal barrier to the advance of American settlers. Following the American victory at the battle of the Fallen Timbers and the failure of Tecumseh's attempt to unite the Indians of the Ohio valley, they moved westward, breaking up into three independent branches, the Absentee, Eastern and Cherokee Shawnee, which eventually settled in different parts of Oklahoma.

Closely related in language and culture to the Sauk, Fox and Kickapoo, the Shawnee were also influenced by their long association with the Delaware and Seneca, and combined eastern woodland and prairie traits. During the summer they lived in bark-covered houses grouped into large villages, where women raised corn while men hunted; in winter, small family groups realigned themselves into hunting camps. Each village had a large council house that was also used for religious ceremonies such as the ritual purification of warriors. Other important ceremonies included the spring Bread dance held when the fields were planted; the Green Corn dance marking the ripening of crops; and the autumn Bread dance. The social organization included patrilineal clans and an "Omaha type" kinship system, based on the lineage principle (*see* Kinship Terminology). Early Shawnee population was estimated at 2,000 to 3.000; in 1960 the three main settlements in Oklahoma numbered about 2,250.

See C. C. Trowbridge, "Shawnese Traditions" ed. by V. Kinietz and E. W. Voegelin, *Occasional Contributions From the Museum of Anthropology of the University of Michigan,* no. 9 (1939). (CH. C.)

SHAWNEE, a prairie city of central Oklahoma. U.S., on the North Canadian river. 38 mi. E.S.E. of Oklahoma City; the county seat of Pottawatomie county. It was named for the Shawnee Indians who came west after the defeat of Tecumseh in 1812, joined the Potawatomi and in 1867 were brought into the Indian Territory. In 1891 their land was opened to white settlement. The city. originally known as Shawnee Town because it was a trading place for Indians, was incorporated in 1894 as Shawnee. Farming, stock raising, oil and diversified industries are the bases of its economy. Educational facilities include St. Gregory's college, a Roman Catholic junior college for men established in 1915 and noted for its museum and library, and Oklahoma Baptist university, a four-year coeducational institution established in 1911. Places of historical interest include the Quaker Mission church, established in 1872, and the Shawnee Indian sanatorium.

For comparative population figures see table in OKLAHOMA: Population. (AN. L.)

SHAPS, DANIEL (1747–1825), U.S. soldier, the leader of Shays's rebellion, 1786–87 (see MASSACHUSETTS : History). Most accounts state that he was born in Hopkinton, Mass., in 1747. In the Revolutionary War he served as second lieutenant in a Massachusetts regiment from May to Dec. 1775, and became captain in the 5th Massachusetts regiment in Jan. 1777. He took part in the battle of Bunker Hill, and in the expedition against Ticonderoga, participated in the storming of Stony Point and fought at Saratoga. In 1780 he resigned from the army. During the depression that followed soon after the end of the war, Shays was a prominent leader of a group of insurgent debtors who in 1786–87 resisted state authorities in what came to be known to history as Shays's rebellion. After defeat of the insurgents, Shays escaped to Vermont and in June 1788 received a pardon. He spent the remaining years of his life in western New York and died at Sparta, N.Y., on Sept. 29, 1825.

SHCHERBATSKY, FEDOR IPPOLITOVICH (1866–1942), Russian philologist, whose works on Buddhist logic and philosophy became known as authoritative and valuable, was born in St. Petersburg on Oct. 1 (new style; Sept. 19. old style), 1866, of a family of old nobility. He was educated at Tsarskoye Selo and studied philology at St. Petersburg, Vienna and Bonn. In 1904 he became professor of Indian literature at St. Petersburg. He spent a few years in Mongolia and India and selected for special study Buddhist logic and metaphysics. He was greatly influenced by Dharmakirti's logical work, cf which he published a translation with a detailed commentary. His chief works are Logic *in* Ancient India (1902); Buddhist *Philosopher* on *Monotheism* (1904); Theory of Knowledge and Logic according to the Later Buddhists (part i, Text Book of Logic by Dharmakirti; part ii, Study *of* Perception and *Deduction* [1909]); *Study* of *the* Categorical *Imperative* Amongst Brahmans (1918); The Conception of Buddhist *Nirvana* (1927); and *Buddhist* Logic, 2 vol. (1930–32). He also published many Sanskrit manuscripts in the *Bibliotheca* Buddhica of the Academy of Sciences. He died on March 18, 1912. (S. RA.)

SHEARING MACHINES: see MACHINE TOOLS.

SHEARWATER, any of 40 or so medium-sized plainly coloured petrels (*q.v.*), chiefly of the genera *Puffinus* and *Pterodroma*. Most species nest in the southern hemisphere; a few, such as the sooty shearwater (*Puffinus* griseus) and the greater shearwater (*Puffinus* gravis), reach the shores of the northern hemisphere on their migrations. The Manx shearwater (P. *puffinus*) nests on the coasts of Europe. Shearwaters spend the greater part of their lives on the ocean. The single white egg is laid in a hole underground. The young are thickly covered with long down and become extremely fat. In this condition they are considered good eating, and enormous numbers are caught in some localities, especially on islands off Australia, where they are known as muttonbirds. (DN. A.)

SHEATHBILL, a bird so called from the horny case which ensheaths the basal part of its bill. There are two species, constituting the family Chionididae of the plovers. They are found only in the antarctic regions.

The sheathbill is about the size of a pigeon, which it in many ways resembles. Its plumage is pure white, its bill somewhat yellow at the base, passing into pale pink toward the tip. Round the eyes the skin is bare and beset with cream-coloured papillae, while the legs are bluish gray. The eastern species, *chionis* minor, is smaller than the western, C. alba, with a dark bill and legs and a differently shaped "sheath." The western species gathers its food, consisting of seaweeds and shellfish, on rocks at low water; but it is also known to eat birds' eggs. Though most abundant as a shore bird, it is frequently met with far out at sea. The eggs of both species are not unlike those of oyster catchers.

SHEBOYGAN, a city of Wisconsin, U.S., on Lake Michigan at the mouth of the Sheboygan river, 57 mi. N. of Milwaukee and 140 mi. N. of Chicago. It is the county seat of Sheboygan county.

Sheboygan was first visited by a white man in 1699 (the missionary Father St. Cosme). A trading post was established at the mouth of the Sheboygan river about 1820 and settlement began about 1834, when a sawmill was built at the first rapids, about 2 mi. above. It became a village in 1846 and a city in 1853. Early settlers, primarily of English ancestry, were from eastern states. After the 1848 revolution in Germany, Sheboygan received a large influx of German immigrants so that a majority of the population is of German stock. Many of them artisans, craftsmen and university graduates, they brought with them a reputation for industry and thrift.

The city ranks eighth in the state in population; in number of manufacturing employees it ranks fifth. It has diversified industries including furniture, plastics, leather, shoes, knit goods, toys, gloves, stainless steel, enamelware, paper products, hydraulic equipment and plumbing. It is an active Great Lakes port for coal, stone, oil; clay and other raw materials.

Sheboygan parks comprise about 300 ac. The city has numerous churches. two modern hospitals, a public-library system and a University of Wisconsin extension centre. A county normal school and Lakeland college are in the county. There is a community players organization and a symphony orchestra and there are several bands and singing groups.

For comparative population figures see table in WISCONSIN: *Population.* (M. W B)

SHECHEM (SICHEM), a city of ancient Palestine, 8 mi. S.E. of Samaria It is now a large mound calied Balatah about 1½ mi. E. of Nablus (Roman Neapolis) in western Jordan, in the valley between Mt. Ebal and Mt. Gerizim. A few hundred yards from Balatah touard the adjacent alluvial plain are the traditional sites of Jacob's well and of the tomb of Joseph. Since the mound, despite its extent, had been almost buried by the earth and stones washed down from the mountains, it was not identified with Shechem until shortly before World War I, when Ernst Sellin recognized its significance and led a German expedition to open it up (1913–14 and 1926–34). The excavations of Sellin, followed after 1928 by G Welter and H. Steckeweh, unearthed a massive pre-Israelite city wall, two monumental city gates, a citadel with a massive Canaanite temple and other important remains. Most of the German work was done before the chronological value of pottery was generally accepted. so the direct historical results were somewhat meagre. In 1956 excavations were resumed by a U.S. expedition headed by G. E. Wright and B. Anderson. By means of modern pottery chronology, the history of the site has been worked out in detail. Combined nith the information from Egyptian and cuneiform inscriptions, as well as with biblical and Greco-Roman data the archaeological finds on the site yield a fairly complete picture from *c.* 2000 B.C. down to the final abandonment of the site in the 1st century A.D.

By the time of the Egyptian middle kingdom (*c.* 2000–1800 B C.) Shechem was one of the most important towns of the Palestinian hill country, as shown by references to it as a focus of actual or feared rebellion. It must already have been a leading centre for trade and communication because of its position at the southeastern edge of the Nablus pass, which led directly across the watershed ridge of western Palestine. When the Hyksos were ruling in Egypt, Shechem became a stronger fortress than any yet excavated in Palestine. Its importance during the entire first half of the 2nd millennium B.C. is illustrated by numerous references to it in connection with the stories of Abraham and Jacob (*e.g.,* Gen. xii, 6; xxxiii, 18). In the 15th–14th centuries B.C. the population was already very mixed, as shown by the personal names in cuneiform tablets from the Shechem area found at Tell el-Amarna in Egypt as well as at Balatah itself. Horites (so read in Gen. xxxiv, 2, with the Greek translation, instead of "Hivite") and Indo-Aryans lived at Shechem together with Hebrews and other Semites. In the early 14th century B.C. a chieftain with the good Hebrew name of Lab'ay ("lion-man") ruled the Shechem district. In the Amarna tablets the Hebrews (Apiru) are said to have been in control of the town. (Note that in Gen. xxxiv the house of Jacob is said to have conquered Shechem.)

Shechem was not destroyed at the time of the Israelite occupation of the rest of the hill country of Palestine, and in the time of Joshua it became (together with Shiloh) the chief meeting place for representatives of the tribal confederacy (Josh. xxiv, 1). In the early 11th century it was briefly the capital of the ephemeral monarchy set up by Abimelech (Judg. ix), and Jeroboam made it the first capital of the northern kingdom (I Kings xii, 25), about 922 B.C. After the exile it became the religious capital of the Samaritan sect, which replaced Jerusalem by Gerizim as its holy mountain. About 130 B.C. it was occupied by the Hasmonaean king John Hyrcanus I, and it never recovered its importance.

See G. E. Wright, articles in *Bulletin of the American Schools of Oriental Research,* no. 144 (1956) and 148 (1957). (W. F. A.)

SHEEP. Sheep belong to the family of hollow-horned ruminants or Bovidae (*q.v.*). They pass almost imperceptibly into the goats. Both sexes often possess horns, but those of the females are small. In the males the horns are generally angulated, and marked by fine transverse wrinkles; their colour is greenish or brownish. They are directed outward. and curve in an open spiral with the tips directed outward. Although there may be a fringe of hair on the throat, the males have no beard on the chin; and' they also lack the strong odour characteristic of goats. Usually the tail is short; and in all the wild species the outer coat takes the form of hair, though beneath lies a short undercoat of fine wool which has been developed into the fleece of domesticated races. Weight varies from less than 100 lb. to several hundred pounds.

Like goats, sheep have narrow upper molar teeth, very different from those of the oxen. and narrow hairy muzzles. Between the two middle toes. in most species. is lodged a deep glandular bag, having the form of a retort with a small external orifice. which secretes an unctuous and odorous substance. This, tainting the herbage or stones over which the animal walks, affords the means by which, through the powerfully developed sense of smell, the neighbourhood of other individuals of the species is recognized. The crumen or suborbital face gland. which is so largely developed and probably performs the same office in some antelopes and deer, is present, although in a comparatively rudimentary form, in most species, but is absent in others. It may be added that the long tails of most tame breeds are, like wool, in all probability the results of domestication.

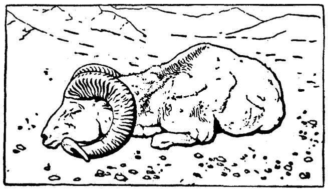
Origin and History. — The bones of sheep are found with other evidences of early human habitation at sites ranging from the middle east to the crannogs of Ireland. Remains at Tell Hassuna in upper Mesopotamia and at Tepe Sialk in central Iran are indicated as very early sites. But archaeological evidence presumably accumulated considerably later than domestication took place. for the Neolithic period appears to have opened with a well-established agriculture and a rather full complement of crops and animals which are still basic to the farmer of the old world. Other evidence. particularly that from religious history! also suggests early domestication — the sheep is the preferred animal for sacrifice in ancient as well as some modern religious ceremonials.

Carl O. Sauer associated domestication of sheep not with hunters or nomads but with sedentary seed farming, with southwest Asia indicated as the most probable hearth of domestication. Leopold Adametz associated an early domestic form with spiral horns with a variety of *Ovis vignei* living from the Salt range of the Punjab to Baluchistan, from where they passed to the near east and beyond. In the Copper Age a new breed *(Ovis aries studeri).* with massive spiral horns, appeared in Europe, and J. U. Duerst showed that it was almost certainly derived in part at least from the wild mouflon *(Ovis musimon).* In Sardinia. as has been known since the time of Pliny, the mouflon interbreeds freely with domesticated sheep. The bulk of modern breeds are obviously much more closely related to the sheep of the Copper Age than to the earlier turbary type; while it thus seems likely that the mouflon played the major part and the urial a minor part in producing farm flocks. it is by no means certain that other species, such as the argali *(Ovis ammon),* were not concerned.

VARIETIES AND DISTRIBUTION

Wild Sheep. — Wild sheep attain their maximum development, both in number and size, in central Asia. They associate either in large flocks or in family parties, the old males generally keeping apart from the rest. Although essentially mountain animals, sheep generally frequent open, undulating districts rather than the precipitous heights to which goats are partial.

The Pamir plateau, on the confines of Turkistan. at an elevation of 16,000 ft. above sea level, is the home of the magnificent *Ovis poli,* named after the celebrated Venetian traveller Marco Polo, who met with it in the 13th century. It is remarkable for the great size of the horns of the old rams and the wide open sweep of their curve, so that the points stand boldly out on each side, far away from the animal's head, instead of curling round nearly in the same plane, as in most of the allied species. A variety inhabiting the Tien-shan range is known as *O. poli karelini,* and other racial forms occur in the mountains and lower ground of Turkistan, and in central Asia.



BY COURTESY OF AMERICAN MUSEUM OF NATURAL HISTORY

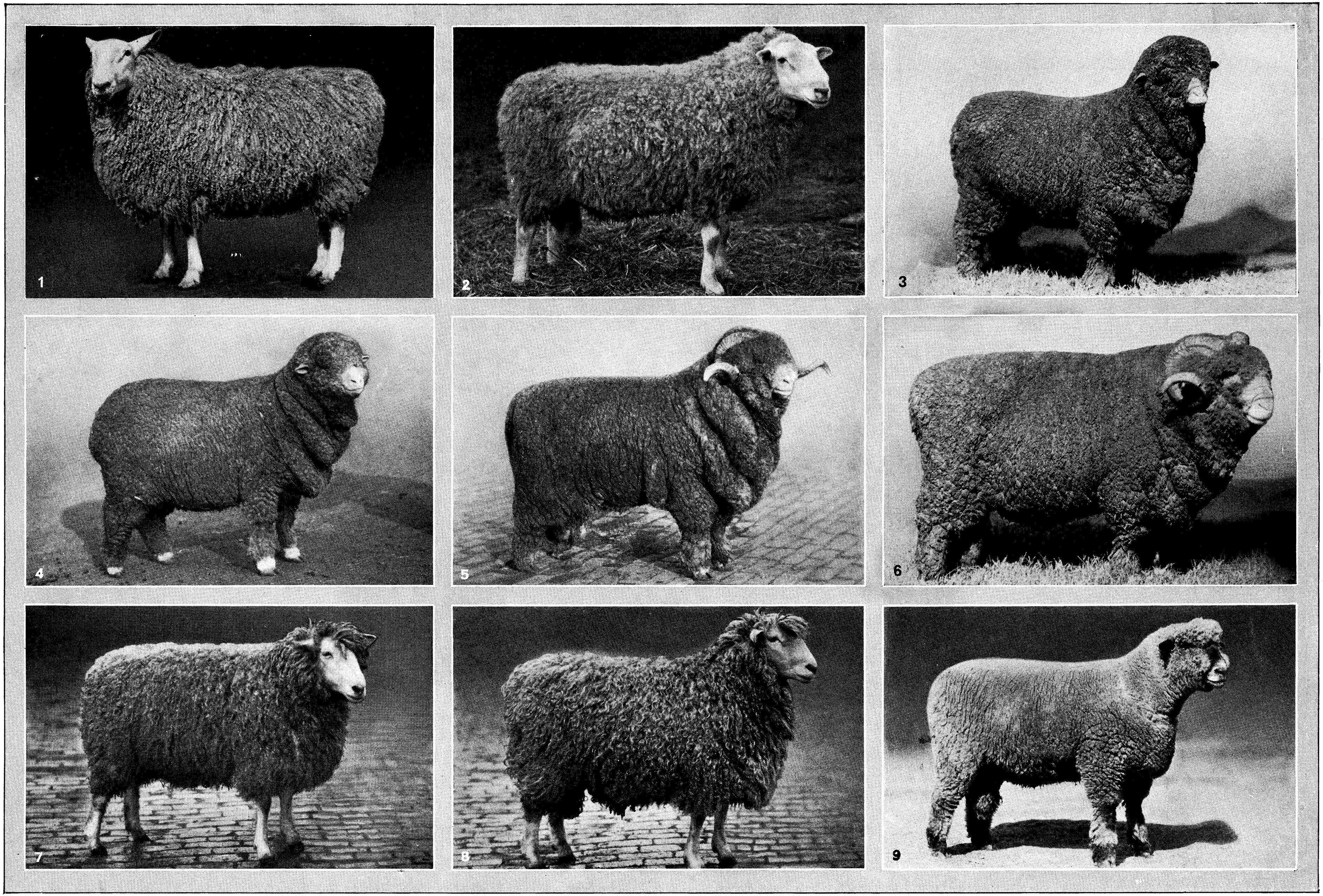
THE *OVIS POLI* OF TURKISTAN, REMARKABLE FOR THE GREAT SIZE OF THE HORNS

An even larger animal is the argali, *O. ammon,* typically from the Altai range but represented by one race in Ladakh and Tibet (*O. ammon hodgsoni*), by a second in eastern Mongolia and by a third in the Gobi desert. Although its horns are less extended laterally than those of *O. poli,* they are grander and more massive. In their short summer coats the old rams of both species are nearly white. *Ovis sairensis* from the Sair mountains and *O. littledalei* from Kulja are closely allied forms.

In the Stanovoi mountains and neighbouring districts of east Siberia and in Kamchatka occur two sheep which have been respectively named *O. borealis* and *O. nivicola.* They are. however. so closely allied to the so-called bighorn sheep of North America that they can scarcely be regarded as more than local races of *O. canadensis* or *O. cervina,* as some naturalists prefer to call the species. These bighorns are characterized by the absence of face glands and the comparatively smooth front surface of the horns of the old rams, which are thus very unlike the strongly wrinkled horns of the argali group.

The typical bighorn is the khaki-coloured and white-rumped Rocky mountain animal; but on the Stikine river there is a nearly black race. with the usual white areas (*O. canadensis stonei*), while this is replaced in Alaska by the nearly pure white *O. c. dalli,* the gray sheep of the Yukon (*O. c. fannini*) being perhaps not a distinct form. Other geographical races of the bighorn. distinguished chiefly by the colour of the coat, include the mountain sheep of Mexico, of Lower California, of upper Missouri and of the Kenai peninsula.

Returning to Asia, we find in Ladakh, Astor, Afghanistan and the Punjab ranges a sheep whose local races are variously known as urin. urial and shapo and whose technical name is *O. vignei.* It is a smaller animal than the members of the argali group. and approximates to the Armenian and the Sardinian wild sheep or mouflon (*Ovis orientalis* and *O. musimon*). (*See* MOUFLON.) In Tibet is the bharal or blue sheep, *Ovis (Pseudois) bharal,* and in north Africa the udad or aoudad, *O. (Ammotragus) lervia,* both of



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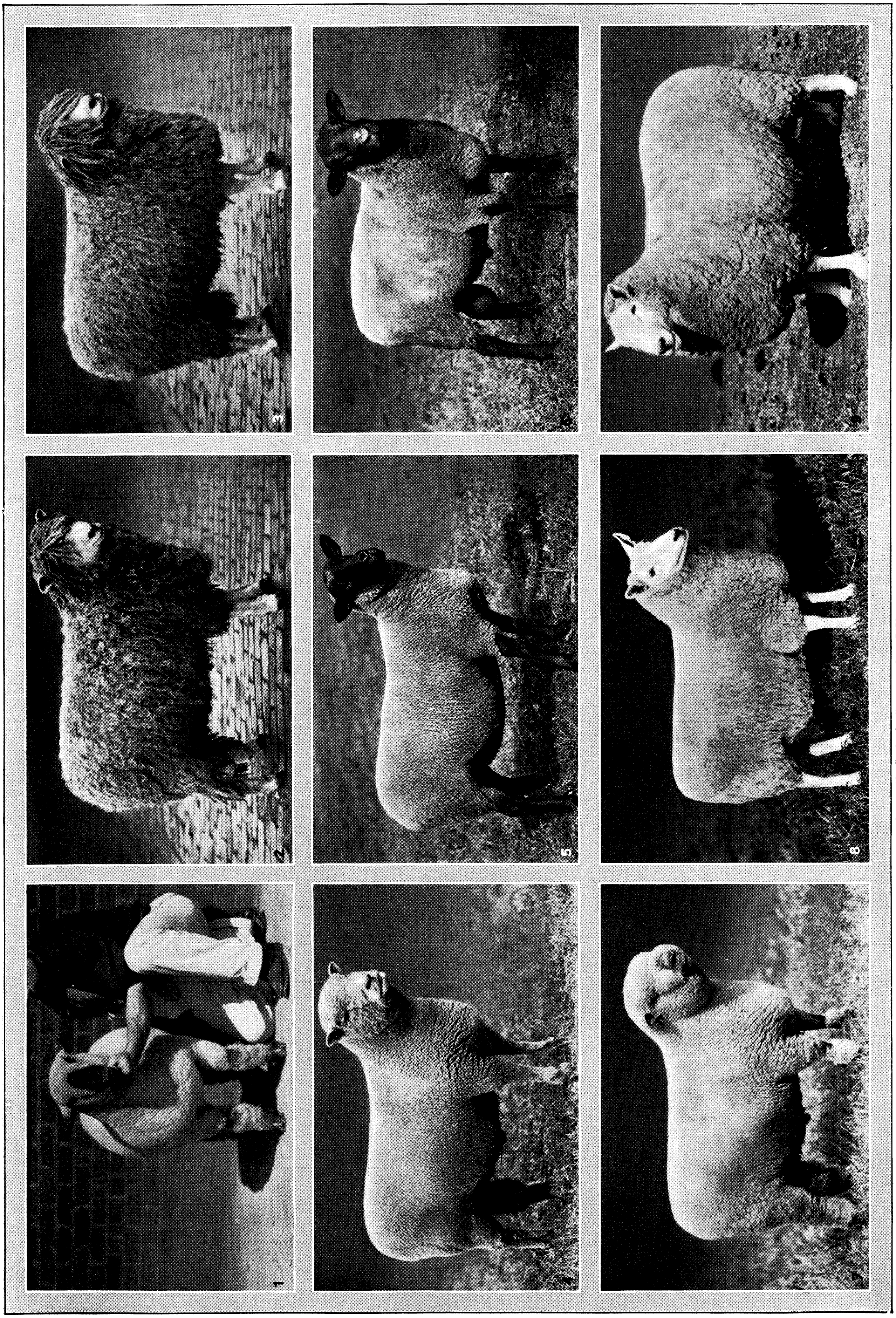
BREEDS OF SHEEP

1. Border Leicester ewe
2. Border Leicester ram
3. Merino ewe
4. Rambouillet ewe
5. Rambouillet ram
6. Merino ram
7. Lincoln ewe
8. Lincoln ram
9. Oxford ram

SHEEP



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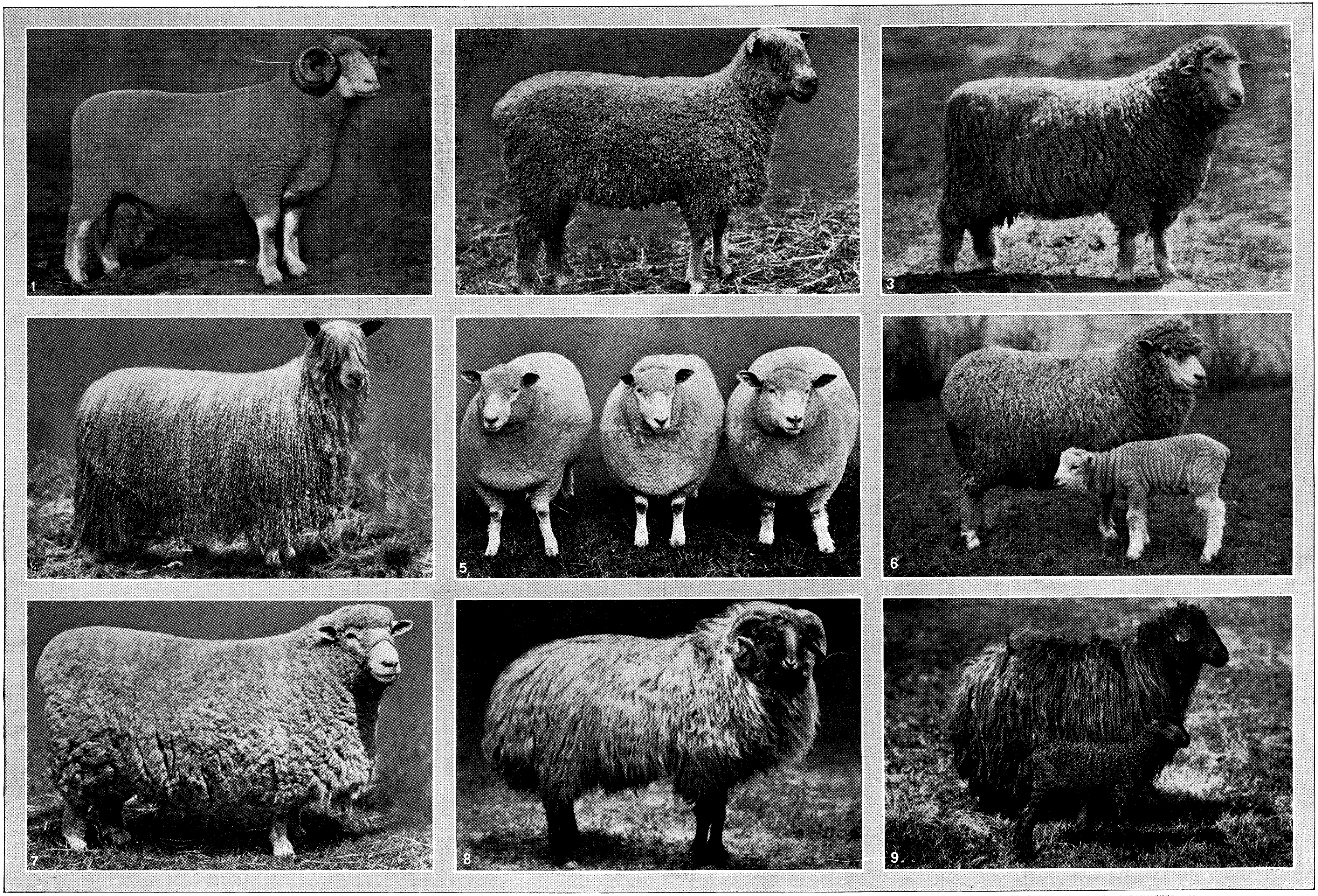
BREEDS OF SHEEP

1. Hampshire ewe
2. Cotswold ewe
4. Southdown ram
5. Suffolk ewe
7. Shropshire ram
8. Cheviot ewe



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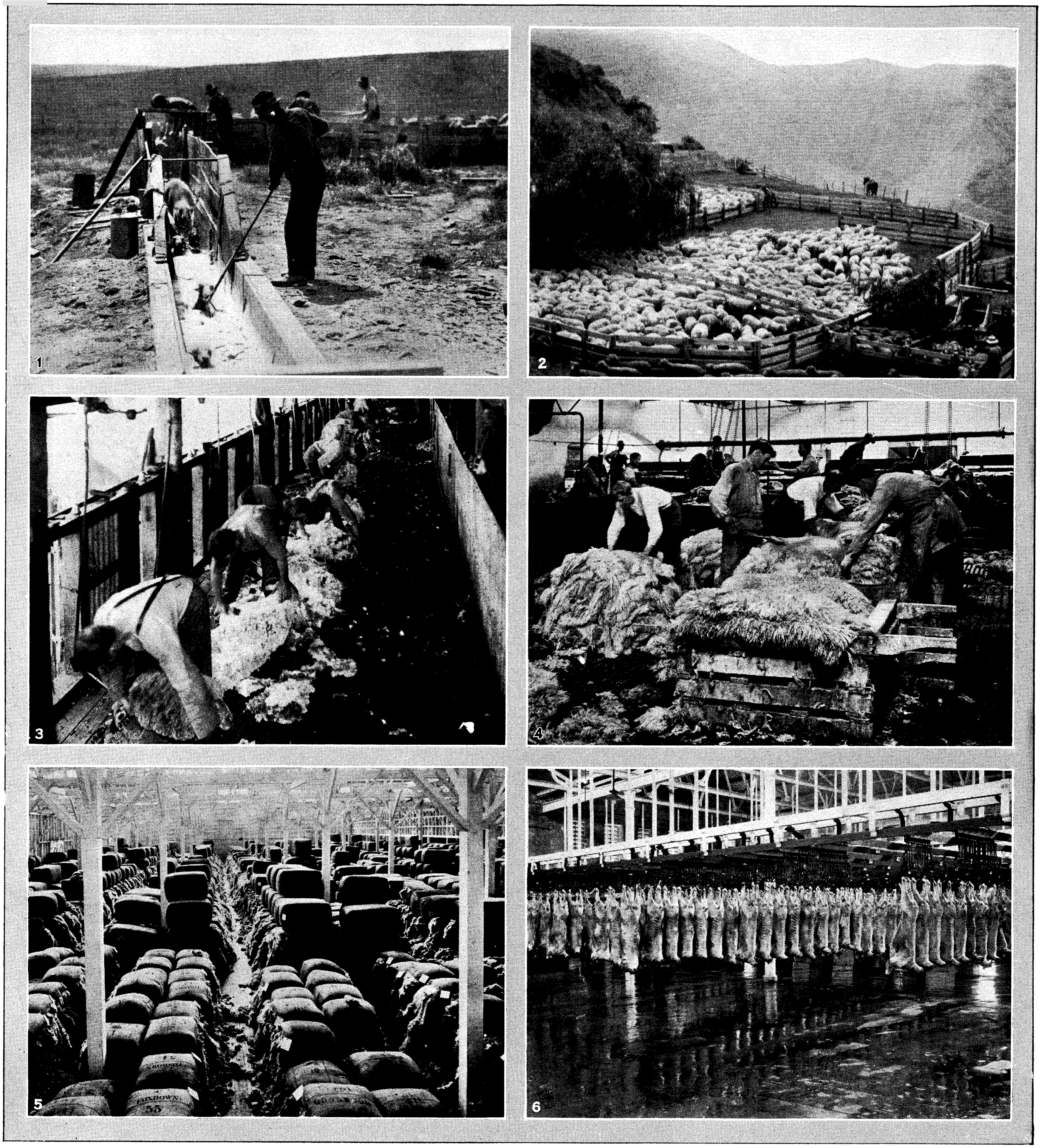
BREEDS OF SHEEP

1. Dorset ram
2. Wensleydale ram
3. Columbia ram
4. Wensleydale yearling ewe
5. Three Ryeland ewes
6. Corriedale ewe and lamb
7. Romney (Kent) ram
8. Karakul ram
9. Karakul ewe and lamb



BY COURTESY OF THE NEW ZEALAND HIGH COMMISSIONER

WOOL AND FROZEN MEAT PRODUCTION IN NEW ZEALAND

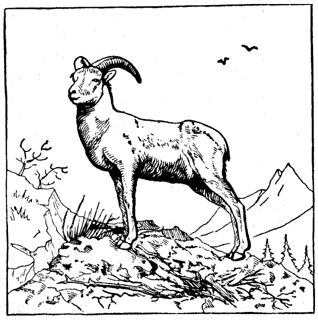
1. Dipping sheep in a small vat on the prairie of New Zealand
2. Great sheep dipping yards on North Island, New Zealand, where immense flocks of sheep are immersed in large vats
3. Crew of expert shearers in shearing shed
4. Fellmongery (separating wool from pelts) in New Zealand
5. Thousands of bales of wool in a wool store in Canterbury
6. Cooling room of a freezing works in New Zealand filled with sheep carcasses that will be frozen thoroughly for export

which have no face glands and in this and their smooth homs approximate to goats. *(See* BHARAL; UDAD.)

On the west coast of Africa two distinct breeds of hairy sheep are indigenous, the one characterized by its large size, long limbs and smooth coat, and the other by its inferior stature, lower build and heavily maned neck and throat. Both breeds, which have short tails and small horns (present only in the rams), were regarded by the German naturalist Leōpōld Fitzinger as specifically distinct from the domesticated *Ovis aries* of Europe; for the first type he proposed the name *O. longipes* and for the second *O. jubata.*

The long-legged hairy sheep, which stands a good deal taller than a Southdown, ranges, with a certain amount of local variation, from lower Guinea to the Cape. In addition to its long limbs, it is characterized by its Roman nose, large (but not drooping) ears and the presence of a dewlap on the throat and chest. The ewes are hornless, but in Africa the rams have very short, thick and somewhat goatlike horns.

In Angola occurs a breed of this long-legged hairy sheep which has probably been crossed with the fat-tailed Malagasy breed; while in Guinea there is a breed with lappets, or wattles. on the throat, which is probably the result of a cross with the lop-eared sheep of the same district. The Guinea lop-eared breed, it may be mentioned, is believed to inherit its drooping ears and throat wattles from an infusion of the blood of the Roman-nosed hornless Theban goat. *(See* GOAT.) Hairy long-legged sheep are also met with in Iran, but these are not purebred. being apparently the result of a cross between the long-legged Guinea breed and the fat-tailed Persian sheep.



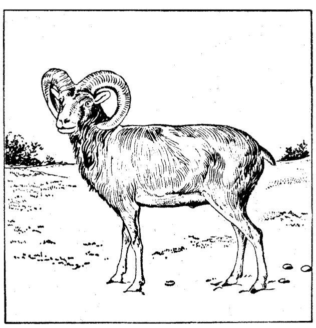
BY COURTESY OF THE CANADIAN NATIONAL RAILWAYS

THE ROCKY MOUNTAIN BIGHORN (OVIS CANADENSIS), A WILD SHEEP

The maned hairy sheep (*Ovis jubata*), which appears to be confined to the west coast of Africa. takes its name from a mane of longish hair on the throat and neck, the hair on the body being also longer than in the ordinary long-legged sheep This breed is frequently black or broun and nhite; but in a small subbreed from the Cameroons the general colour is chestnut or foxy red, with the face, ears. buttocks, lower surface of tail and underparts black.

The most remarkable thing about this Cameroon sheep is, however, its extremely diminutive size a full-grown ram standing only 19 in. at the withers. In point of size this pygmy Cameroon breed comes very close to an exceedingly small sheep of which the limb bones have been found in certain ancient deposits in the south of England: and the question arises whether the two breeds may not have been nearly related

Although there are no means of ascertaining nhether the extinct pygmy British sheep was clothed with hair or with wool it is practically certain that some of the early European sheep retained hair like that of their wild ancestor; and there is accordingly no prima-facie reason nhy the breed in question should not have been hairy On the other hand since the so-called peat sheep of the prehistoric Swiss lake dnellers appears to be represented by the existing Graubünden (Grisons) breed which is woolly and coloured something like a Southdonn. it may be argued that the former was probably also woolly and hence that the survival of a hairy breed in a neighbouring part of Europe would be unlikely. The latter part of the argument is not very convincing and it is legitimate to surmise that the small extinct sheep of the south of England may be a possible relative of the pygmy hairy sheep of nest Africa.



A SARDINIAN MOUFLON SHEEP

Fat-rumped sheep, *Ovis steatopyga*, are common to Africa and Asia. and are piebald with rudimentary horns and a short hairy coat. being bred entirely for their milk and flesh. In fat-tailed sheep, on the other hand, which have much the same distribution, the coat is woolly and generally piebald. Four-horned sheep are common in Iceland and the Hebrides, and in early historic times they occurred frequently in the sheep flocks then present in Lowland Scotland. There is another four-horned breed, distinguished by its black (in place of brown) horns, whose home is probably South Africa.

In the unicorn sheep of Nepal or Tibet the two horns of the rams are completely welded together. In the Himalayan and Indian hunia sheep, the rams of which are specially trained for fighting, and have highly convex foreheads, the tail is short at birth. Most remarkable of all is the so-called Walachian sheep or Zackelschaf (*Ovis strepsiceros*), represented by several more or less distinct breeds in eastern Europe. in which the long upright homs are spirally twisted in a manner similar to those of the markhor wild goat. (R. LY.; J. RI.; J. K. R.)

Domestic Sheep. — Domestic sheep differ from their wild progenitors and even among themselves in conformation, quantity and quality of fleece. colour. size, milk production and other characteristics. Breeds of sheep have been developed to meet environmental conditions influenced by latitudes and altitudes and to satisfy variable desires of the people for clothing and food. The commodities for which sheep have been bred include wool, fur, meat and milk.

Of more than 200 breeds of sheep in existence in the world, the majority are of limited interest, except in the localities where they are raised. About 30 of the breeds which are most extensively raised or have otherwise attained prominence provide the principal basis for this discussion. They may be grouped into the following six types according to the kind and quality of commodities which they produce:

Fine-wool type: Merino and Rambouillet.

Medium-wool type: white-face sheep—Cheviot, Columbia, Corriedale, Dorset, Ile de France, Le Contentin, Oldenburg White Head, Panama, Romeldale, Ryeland, Targhee, Texel and Welsh Mountain; dark-face sheep — Hampshire, Kerry Hill, Oxiord, Shropshire, Southdown and Suffolk. Except for the Kerry Hill, these dark-face sheep are also called Down sheep, as they originated in the Downs of England and may have been the autochthonous sheep of the open-field farmer.

Long-coarse-%lool type: white-face sheep — English Leicester, Border Leicester, Cotswold, Lincoln, Romney and Wensleydale; dark-iace sheep—Scotch Blackface Highland. The progenitors of these breeds, especially the Lincolns and the Romney Marshes, were probably of Flemish origin

Fur type: Karakul and Romanov.

Woolless mutton type: Blackhead Persian.

Milk type: East Fresian, La Razza Sarda, Pelvin, Sevlievo, Stara Zagora and Svishtov.

Brief descriptions of these breeds follow.

The *Merino,* a fine-wool sheep, originated in Spain. It was known as early as the 12th century and may have been a Moorish importation. It was particularly well adapted to semiarid climates and to rranshumance. It is a prominent breed in many countries, notably Australia. the United States, the Union of Soviet Socialist Republics, the Union of South Africa, Argentina, France and Germany. This breed has been designated by various names such as Australian Merino in Australia. American Merino and Delaine Merino in the United States, Merino Trashumante in Spain, Merino Volosh in the Cnion of Soviet Socialist Republics, Merino Argentino in Argentina, Merino Precoce in France and Thuringia Merino-Meat in Germany. Some of these names signify strains of the parent breed that have been modified by selective mating, but all the sheep have rather heavy fleeces of fine wool that is pure white when scoured.

Merinos vary considerably in size, conformation and extent of skin folds. but the prevailing trend in breeding the modern Merino breed is to develop sheep of medium size, fair mutton conformation and freedom from excessive skin folds. The colour of their faces and legs is white. .Although they have a considerable growth of wool on their faces, it is seldom extensive enough to cause wool blindness. The fine wool fibres of Merino fleeces are beautifully crimped and the fleeces hat-e a natural tendency to carry sufficient wool oil to keep the fibres oi the inner part of the fleeces soft and pliable. The wool oil in combination with the dust and soil of natural surroundings forms a dark covering on the outer part of the fleece that protects the beautiful. fine, white wool fibres of the inner portion. Through selective mating and crossing with other breeds, the Merino has served extensively as foundation stock in the creation of many useful breeds and strains of sheep. Of the iour Merino types which became widely known and provided the basis for the expansion in apparel wool production in the 19th century, the heavily wrinkled Negretti became the basis for most of the English Merino development. The small, tighter-skinned Escurial appears to have been basic to the Rambouillet and Saxon developments, whereas the Paular and Infantado appear to have participated only slightly.

The *Rambouillet,* also a fine-wool sheep, originated in France. It was developed from excellent selections in 1786 and again in 1799 of a few hundred oi the best Merino sheep in Spain. The French government made these selections and placed the flock at its national sheepfold. Rambouillet, Fr., where this breed originated. It is the largest of fine-wool sheep. Breeders in Germany made important contributions to the development of the Rambouillet, especially to its fleshing qualities.

Sheep of this breed mere first imported into the United States in 1840. Through selective mating the breed was successfully moulded to meet the needs of a large class of U.S. sheep producers. Rambouillets prevail on the western ranges where two-thirds of the sheep of the United States are produced. The face and legs of this breed are white. The face covering of wool is rather heavy, even to the extent of wool blindness in some specimens, but through selective mating breeders are making progress in developing strains free from such excessive face covering. Fleeces of Rambouillet sheep are relatively heavy. The lambs grow rapidly, attaining under good ieed conditions satisfactory market weights, and finish at from six to nine months of age. The crossbreeding oi Rambouillet emes with medium-wool and long-coarse-wool rams is practised extrnsively ior the production of choice market lambs and of rugged breeding ewes that produce heavy fleeces of attractive medium wool.

The *Cheviot* is a medium-wool breed. It is a hardy, white-face, hornless sheep developed in Scotland and Northumberland, Eng. Cheviots have no wool on their heads and ears or on their legs below the knees and hocks. As a consequence they present an attractive and alert appearance. The wool of their fleeces is relatively straight. of moderate length, close set and free from black fibre. Cheviots are used in crossbreeding, especially with Border Leicesters and Lincolns, for market lambs.

The *Columbia* is a medium-wool. white-face, hornless breed developed in the United States by the U.S. department of agriculture. It was formed by crossbreeding Lincoln rams and Rambouillet ewes and interbreeding the resulting crossbred ewes and rams and their descendants without backcrossing to either parent stock. The initial crossbreeding began at Laramie, Wyo., in 1912, and after 1918 the moulding of the breed was carried out at the United States sheep experiment station, Dubois, Ida. The sheep of this breed are large and rugged, and they excel in the production of both wool and lambs. The breed is popular, especially in the western U.S. range region, where private breeders organized the Columbia Sheep Breeders' association.

The *Corriedale* is also a medium-wool, white-face, hornless breed. It originated in New Zealand as a result of crossbreeding Lincoln rams and Merino emes, beginning about 1880. The breed is valued especially in New Zealand, Australia and the United States. Corriedales are of medium size, and they produce wool and lambs of very good quality. The breed is adapted to both iarms and ranges.

The *Dorset* is a medium-wool, white-face sheep. Both ewes and rams have horns; the breed is sometimes called the Dorset Horn. It originated in England. The ewes are heavy milkers and their lambs grow rapidly. The fleece is pure white, rather short and open. The breed is valued also in the United States and other countries for the production of fancy hothouse lambs, as a portion of the ewes will breed out of season. The?; also cross well with Merinos for the production of crossbred ewes well suited to hothouse lamb production.

The *Ile de France* is a medium-wool, white-face, hornless sheep that is an excellent producer of hoth meat and wool in France. It is especially noted ior its early maturity and the rapid growth of its lambs.

The Le *Contentin* is a medium-wool, white-face, hornless sheep of France maintained primarily as a grazing sheep. The emes are good milkers and raise their lambs well. They have good coniormation and their meat is of first quality. They are also good wool producers.

The *Oldenburg White Head* is a medium-wool, white-face, hornless sheep of Germany, noted as a hardy grazing breed. It is very prolific and an excellent producer of both lambs and wool.

The *Panama* is a medium-wool, white-face, hornless breed of the western United States, originated in Idaho in 1912 by crossbreeding Lincoln ewes and Rambouillet rams. These sheep have good size, are hardy and are well adapted to the range. The ewes are good milkers and raise their lambs well. Their fleeces of white wool are heavy.

The *Romeldale* is a medium-wool, white-face, hornless sheep of the western United States, especially raised in California. It resulted irom the crossbreeding of Romney rams and Rambouillet ewes, beginning about 1915. It is well suited to pasturage of alfalfa and heavy forage, as well as being hardy and well suited to range conditions. The Romeldale produces wool and lambs of high quality.

The *Ryeland* is a medium-wool, white-lace, hornless sheep oi England. The lambs grow quickly; the wool is good quality, of deep staple and thickly set on the skin. Sheep of this breed were raised to some extent in the United States, especially in Kentucky.

The *Targhee* was developed at the U.S. experiment station at Dubois, Ida., after 1926 by vigorous selection and inbreeding of various Rambouillet-Columbia-Corriedale combinations to produce a true-breeding strain intermediate to the smaller fine-wool breeds and the large crossbreeds. Hardy and of medium size, it is well adapted to the range; it is of compact conformation with a moderately low-set, broad, level back, good bones and straight legs. The rump and leg of mutton are well developed. The fleece is heavy, of desirable fineness (60s and 62s) and staple length. Ewes are good mothers and handle easily; necks are without folds and faces are open.

The *Texel* is a medium-wool, white-face, hornless sheep of the Netherlands, well adapted to range conditions and very prolific. The lambs grow rapidly. The fleeces of this breed are of good, heavy, white wool. The Texel is raised also in France, Belgium, Denmark, Spain, Indonesia, South America, South Africa and Mexico.

The *Welsh Mountain* is a medium-wool, white-iace sheep of Wales, and is of importance in other parts of the United Kingdom. The rams have horns and the ewes are hornless. It is noted for its very high-quality mutton. The fleeces are light in weight but of good quality.

The *Hampshire* is a medium-wool, dark-face, hornless sheep that originated in England. It is large and blocky and, as a superior mutton breed, is noted for its early maturity. It is one of the most popular meat breeds in the United States, where it is raised extensively for market-lamb production in farming regions and for crossing with white-iace range ewes in the western range regions for the production of market lambs. The wool of Hampshire fleeces is strong, oi medium fineness and length and desirable for manufacturing purposes except for the occurrence of black fibres in a small percentage of fleeces.

The *Kerry Hill* is a medium-wool, hornless sheep with markings that consist of black speckles on white iaces, ears and legs. It originated in the British Isles and is a hill sheep that combines desirable features of the Hill and Down types. Its fleece resembles that of the Shropshire but is not so good in quality. It produces good mutton and is excellent for crossbreeding.

The *Oxford* is a medium-wool, dark-face, hornless sheep, and it is the heaviest of the Down breeds. It was produced by mating Hampshires and Cotswolds in Oxford county, Eng. The ewes are good mothers and the lambs grow rapidly. Their fleeces are heavy and the wool is of good length for sheep of the medium-wool type. They are popular on farms that have abundant ieed. Considerable numbers are found in England and the Great Lakes region of the United States.

The *Shropshire* is a medium-wool, dark-face, hornless breed that originated in the Downs oi England. It is one of the most popular farm sheep in middle western United States. It produces good wool and mutton and subsists on sparse pasturage better than breeds such as the Hampshire or Suffolk. For crossbreeding it is better adapted to iarms than to range conditions. Its face covering of wool is excessive, which is more easily dealt with on iarms than on ranges.

The *Southdown* is a medium-wool, dark-face, hornless sheep. It is a Down breed that was raised on the Sussex hills of England. The Southdown is the oldest of all British breeds of sheep, and it has an ideal body conformation for meat production. Its fleece is close and the finest oi the British breeds; but although white and of good quality, the wool is short and the fleeces relatively light in weight. The colour of its face and legs is brown to light brown or mouse colour. Southdowns are popular in many parts of the world, especially in British countries and the United States.

The *Suffolk* is a medium-wool, dark-face, hornless sheep. It was developed in England by mating Norfolk horned ewes with Southdown rams during the years 1800 to 1850. Suffolks are prolific, early maturing sheep with excellent mutton carcasses. They are energetic and the whole carriage is alert, showing stamina and quality. Suffolk lambs gain rapidly and the breed is noted for mutton production. This breed is not desirable for wool production. The fleeces are short in staple and light in weight, and they have black fibres. As lamb producers, Suffolks are popular in British countries and in the United States.

The *English Leicester* is a long-coarse-wool breed that originated in England through improvement by the noted breeder, Robert Bakewell, about 1755. This breed has white faces and legs. They are hornless, broad-backed, thick-fleshed and early maturing. Their fleeces are heavy with a tuft on the forehead and wool hanging in compact locks on the body. Some of the choicest wool oi crossbred sheep is produced by offspring of Merino ewes and English Leicester rams.

The *Border Leicester* is a long-coarse-wool, white-face, hornless sheep that was developed in the border counties oi England and Scotland by crossbreeding sheep of the English Leicester and Cheviot breeds. The head is free from wool, bold and carried high. The whole carriage of this choice mutton body presents a square, alert, stylish appearance. The wool is long, soft and in small locks, but fairly compact.

The *Cotswold* is a long-coarse-wool, white-face, hornless sheep that originated in England. The back is broad and flat, but the body is only moderate in depth. The fleeces are heavy and on the surface the wool lies in open curls. This breed is used successiully in crossing with Merinos and Rambouillets to increase size of body and length oi wool fibre.

The *Lincoln* is a long-coarse-wool, white-face, hornless sheep, native of England. It is a large mutton sheep with heavy fleeces of tuited wool, and the poll is covered with wool. Rams of this breed are used extensively in many countries for crossbreeding with fine-wool ewes.

The *Romney* is a long-coarse-wool, white-face, hardy, polled sheep that originated in Kent, Eng. It is sometimes called the Kent or the Romney Marsh. Sheep of this breed are popular in South America, Australia, New Zealand and in some western areas of the United States. Their fleeces are relatively dense and on the average are the finest of the long-coarse-wool fleeces. The rams are used rather extensively in the western U.S. for crossbreeding with Rambouillet ewes.

The *Wensleydale* is a long-coarse-wool, white-face, hornless breed of England. The wool is long, lustrous and in wavy locks. The skin on the face, ears and legs, and sometimes on the body, is of a bluish tinge. In England they are crossed with other long-coarse-wool breeds. Their mutton is of good quality, but they mature rather slowly.

The *Black-lace Highland* is a long-coarse-wool, dark-face, horned, mountain sheep, native of Scotland. It is extremely hardy, matures quickly and produces mutton of excellent quality. The wool of the fleeces of this breed is used extensively in the manufacture of tweeds, and the coarsest of it makes good, strong carpet wool.

The *Karakul* is a fur sheep, native of central Asia. Black is the prevailing colour of newborn lambs, which in most eases have beautiful tight-curled coats that, when skinned at about one to three days old, provide the commercial lambskin fur for which they are raised. A large percentage of the lambskins are classified by the trade as Persian lambskins. The wool of grown sheep is a mixture of coarse and fine fibres, of colours varying from black to various shades of brown and gray. The prevailing colour of the face and legs is black. The ewes are good mothers, and the lambs grow rapidly and produce good meat, but the breed is primarily intended for lambskin-fur production. Horned and hornless sheep occur in both sexes. Karakul sheep are raised in several countries of Asia, Europe, Africa and the Americas.

The *Romanov* is a fur sheep of the Union of Soviet Socialist Republics, and it is found particularly in the Yaroslavl region. It is noted as a fur-producing sheep that excels in prolificacy. Black and white occur on face and legs and in the fibres of the fleeces.

The *Blackhead Persian* is a woolless fat-rumped sheep that has been highly developed for mutton production in South Africa, where it thrives on lands not well suited to woolled sheep. The head and neck are black and the body is white. This breed is indigenous to North Africa, Somaliland and Arabia. The name "Persian" is misleading, for none of these sheep have come from Persia.

The *East Fresian* is a white-face milk sheep, native of Germany. It is considered to be one of the best milk breeds of sheep in Europe. In addition to its heavy milking qualities it is also well fleshed and woolled with heavy fleeces of white medium to coarse wool. The head is bare of wool and polled.

The *La Razza Sarda* is a milk sheep, native of Sardinia, It. The face is white with small black spots about the eyes and muzzle. It is noted as a heavy milk producer and also valued as a producer of long, white wool of coarse but good quality.

The *Pelvin* is a black-face milk sheep of Bulgaria, valued especially for milk production in one of the largest sheep-producing areas. It also produces a good weight of wool that is grayish in colour and medium to coarse in fineness.

The *Sevlievo* is a dark-face milk sheep of the mountain type, from Bulgaria. It is one of the more abundant milk-producing sheep and a fair producer of pigmented wool of medium fineness.

The *Stara Zagora* is a large, white-face, horned milk sheep of Bulgaria, developed for an abundance of milk but also valued for its white medium-wool fleece.

The *Svishtov* is a white-face, horned milk sheep of the region between the Danube river and the Balkan mountains. It is noted for its abundant production of milk and for its good fleece of long, white, coarse wool. (D. A. S.; J. K. R.)

WORLD SHEEP INDUSTRY

Major Producing Areas.— Distribution of sheep is, of course, limited by grazing lands and somewhat by climatic conditions. Some cold areas, even if unfavourably wet, are usable. and warm areas, if dry, are used, but sheep are not numerous in the warmer areas of the tropics.

Honever, northern Australia above the Tropic of Capricorn contained in the mid-1950s between 5% and 10% of the sheep population of Australia—130,000,000. These were about 75% Merinos and grazed successfully, except for some problems of infertility which are not uncommon in hot arid areas with approximately equal hours of daylight and darkness

The distribution pattern of sheep differs from other livestock in the emphasis on the southern hemisphere. Entirely a development that occurred after 1850, it appears to be related, first, to the storability and transportability of wool. well adapted to frontier conditions of subhumid climates.

In such subhumid areas the Merino sheep with its fine apparel wool developed under large-scale ranching conditions. Later the development of refrigerated ocean shipping enabled some of the thinly settled areas to increase the production of lamb for the European market.

By the mid-1950s world sheep numbers increased nearly 22% as compared with pre-World War II figures, with major increases reported for the C.S.S.R. and Australia. There were increases in all continents except North America, where sheep numbers decreased by 35%. The decline in the United States is difficult to understand at first glance. One might think that emphasis on soil conservation. grassland farming, new developments in better-adapted and more productive grasses and the adoption of new ways of curing hay and making and using grass silage should have led to increased sheep production.

TABLE I.—Sheep *Distribution* by *Areas and Major Producing Countries* (in 000s)

Area	1936–40	1946–50	1951–55	1955*	1956*
Asia	156,700	156,000	176,040	182,400	184,600
India	41,000	38,200	39,900	40,000	—
China	30,000	28,000	—	—	—
Turkey	21,656	24,043	25,565	26,800	—
Iran	14,497	12,800	16,724	18,000	—
Oceania	144,000	136,300	159,560	170,000	177,000
Australia	112,571	103,261	122,821	130,849	137,000
New Zealand	31,352	32,973	36,698	39,117	40,000
Europe	121,000	103,600	116,200	121,200	122,500
Cnited Kingdom	26,112	19,032	21,985	22,957	23,600
Spain	—	16,132	16,621	17,000	—
Italy	9,650	9,624	10,015	9,746	9,650
South America	100,900	116,900	125,200	129,400	130,000
Argentina	44,900	50,000	—	—	—
Uruguay	17,931	21,600	25,441	27,000	26,850
Brazil	14,438	14,413	16,142	17,503	18,300
Africa	99,700	98,400	120,080	126,300	128,500
Union of South Africa	39,899	31,542	36,287	38,000	—
French Morocco	9,976	7,939	11,708	14,000	—
U.S.S.R. !Europe and Asia)	66,000	67,700	104,260	124,900	—
North America	59,700	42,800	39,080	39,400	39,000
United States	51,404	34,993	31,491	31,582	31,109
World total:	748,000	721,700	840,420	893,600	909,600

*Preliminary.

Totals are estimated and rounded. Month of estimate and basis and source of data vary from country to country

Source U S Department of Agriculture, Foreign Crops and ***Markets,*** pp. 532–533 (April 23, 1956).

The explanation appears to be more in the realm of comparative economics and cultural trends. Cattle seemingly made more profitable the use of some grazing areas which previously had been devoted to sheep. paying a better return on capital invested. Moreover, labour of the types needed for successful sheep ranching, particularly the excellent Basques, was increasingly difficult to obtain after 1940.

Care and Management.— This differs considerably from area to area, and more particularly between the small flock of 10 to 100 operated as an incidental part of a general farming operation and the large ranch or station band of one to several thousand head. The latter may involve moving with the season from valley to mountain to valley again (transhumance) over long trails distant from the home base.

Such far-flung operations may require spending the major part of the year on public land, returning to the home base only for wintering and the spring lambing season.

Regardless of the size or nature of the operation, skilled care and attention is required at lambing time. not only to assist with difficult deliveries but especially to make certain that the lamb does not become chilled after birth and that the ewe recognizes the lamb and allows it to nurse. By the 1950s heat lamps were used to some extent to warm and dry the newborn. Protection and even rescue and perhaps supplementary feeding of the flock may be required during the worst winter months in some areas, particularly if there is deep snow.

It is seldom profitable to feed grain to breeding sheep or suckling lambs as long as they have an abundance of succulent grazing forage. Though they do best on pastures and ranges which provide choice grass or legume forage which is short and fine, they will consume considerable quantities of high, coarse, brushy material and weeds.

Hay and other roughage can be used, particularly in winter or drought periods. Grain may be used in small amounts for flushing at breeding time and, of course, for fattening. Fattening on grain and concentrates is carried on mostly between the ranch and the consuming market and in general is a more delicate operation than cattle fattening.

Except on alkali ranges, breeding sheep must be provided with about one-half ounce of salt a day and fattening lambs about half as much. Calcium supplements of about one-fourth ounce a day may be needed if legume forage or hay is not included. Phosphorus, if deficient in the range plants, may be supplemented by adding two parts of bone meal to one part of salt. In areas where newborn lambs are afflicted with goitre, iodized salt in moderate amounts may be fed to the pregnant ewes. Vitamin A appears to be the only one likely to be deficient and that when food is limited to cereal straws. low-quality hay or cottonseed hulls.

Sheep need as much as $1\frac{1}{2}$ gal. of water a day, though dew on grass or snow, if available, may suffice for much of the requirement. They should not have to travel more than three to four miles between grazing and water in cool weather. or about two miles in warm weather; animals with young should be even closer. Thus the number of animals which may be supported in semiarid areas is rather strictly limited by the availability and spacing of water holes. Shade during hot weather is desirable as is protection from predatory animals — dogs. wolves. eagles, etc. Sheep should be shorn only when the fleece is dry and settled weather is in prospect, for wet snowstorms or severe cold may cause heavy losses from exposure after shearing unless protection is available. Except in areas of bitter winter, only the simplest, cheapest shelter or none at all is required.

Approximately one mature ram is kept for each 3 j ewes. Range ewes are seldom kept beyond the sixth year though they may be moved to areas with softer food and used as breeding stock for one or more additional years.

There is considerable variation in lamb crop. loss of animals and, of course, in income, from year to year; a summary of various factors for a major U.S. area is given in Table II.

TABLE 11.—*Sheep Production Rates, Per Ranch, Family Operated Sheep Ranches, Southwestern Nonmigratory Area of the U S , 1940–54*

Year	Breeding ewes Jan. 1	Lamb crop*	Death loss†	Wool clip per sheep sheared	Net production per ewe in flock on Jan. 1‡	
					Lamb & mutton	Wool
	no.	%	%	lb.	lb.	lb.
1940	1,251	68	5.7	8.5	39	9.4
1941	1,323	72	6.8	8.5	42	9.1
1942	1,406	71	6.6	8.3	39	8.9
1943	1,288	65	6.0	9.2	34	10.8
1944	1,167	68	6.3	9.2	34	11.7
1945	1,250	70	7.2	8.8	37	9.9
1946	1,169	67	7.0	8.9	38	10.3
1947	1,052	68	6.9	9.0	38	11.0
1948	1,104	65	9.7	9.1	29	10.5
1949	1,062	73	7.3	8.6	39	9.1
1950	1,059	75	7.6	9.4	36	10.4
1951	985	60	6.4	9.6	33	11.8
1952	999	65	7.3	9.4	32	11.1
1953	994	67	8.0	9.3	35	10.9
1954	911	72	6.5	9.2	43	10.6

*Lambs born as a percentage of breeding ewes Jan. 1. †Death loss as a percentage of total number in flock on Jan. 1, excluding lambs that were born and died prior to the fall marketing season. ‡Sales plus inventory gains or losses less purchases.

Source: James R. Gray, "Southwestern Sheep Ranches Organization, Costs and Returns, 1940–54," Agricultural Experiment Station *Research* Report 7, pp. 2–6 (May 1956), New Mexico Agricultural Experiment Station, State College, New Mexico.

Diseases. — Prior to the 20th century, sheep owners commonly accepted heavy losses from disease in their flocks as inevitable. After the early 1900s, however, marked progress was made by the veterinary profession in the prevention and control of many of the diseases that were once ovine scourges.

Bacteria of the genus *Clostridium* probably cause greater death losses than any other single class of microorganisms. These spore-bearing organisms are capable. generally, of producing powerful, lethal toxins. Some of the diseases they produce in sheep, and the organisms which cause them, are as follows:

Enterotoxemia (struck. pulpy kidney disease); lamb dysentery — caused by *Bacillus (Clostridium) welchii.*

Braxy or bradsot; malignant edema — caused by *Bacillus (Clostridium) oedematis—maligni.*

Black quarter or blackleg — caused by *Bacillus (Clostridium) chauvoei.*

Infectious necrotic hepatitis or black disease — caused by *Bacillus (Clostridium) novyi.*

Tetanus — caused by *Bacillus (Clostridium) tetani.*

Struck, braxy and black disease are particularly acute and lethal diseases. As in infection by anthrax (*q.v.*), affected sheep may die in a few hours after they first show symptoms, or they may be found dead without symptoms ever having been observed. These diseases are peculiar in that they commonly affect the most vigorous and thrifty sheep in the flock. Fortunately, through proper management and vaccination, losses from these diseases may be largely controlled, if not eliminated.

Struck or lamb dysentery affects the young, as the latter name implies. Unsanitary conditions and close confinement contribute to the danger from this disease. which attacks in from a few hours to a week after birth. The mortality may be high if precautionary measures are not used. At mid-20th century the anthrax problem was not as serious in the western hemisphere as in the old world, where repeated epizootics of anthrax over the decades and centuries resulted in heavy contamination, particularly in Asia, southern Europe and Africa.

The spore form of *Bacillus anthracis* is very resistant to chemical and environmental influences and can survive for years in contaminated soil and in animal products, including wool. Feedstuffs and fertilizers. moreover, may be contaminated. The main source of infection in agricultural workers is from contact with contaminated carcasses! wool: hair, hides and insufficiently cooked meat. Many different preparations of anthrax spore vaccines are useful for the prevention of the disease, particularly spore suspensions in glycerin-saline solution for intradermic use and spore suspensions in saponin solution for subcutaneous use. The avirulent, noncapitulated strain of *B. anthracis* used in the spore vaccine developed at the Onderstepoort Veterinary Research laboratory, Pretoria, U. of S. Af., was used with considerable success in many countries.

Blackleg, tetanus and malignant edema result from infections of wounds. The freshly ruptured navel! shearing cuts and the wounds resulting from castration, docking and earmarking are the usual avenues for entrance. To prevent these diseases, great care should be taken in operations, using clean instruments and techniques. Lambing should be done in cleaned and disinfected buildings or, when weather permits, outside on uninfected land. Infections with pus-forming bacteria also enter through .wounds, resulting in arthritis and abscesses in the internal organs, including the brain and spinal cord. An effective means of prevention is to dip the stump of the navel cord in tincture of iodine or other effective antiseptic as soon as possible after birth.

Contagious pustular dermatitis or sore mouth is an especially widespread filterable virus disease of sheep and goats. The disease occurs in England and other parts of Europe, North and South America and Australia. Aside from the loss of body weight that results, the disease is usually not serious. The animals usually recover, but secondary infections caused by bacteria, especially *Bacillus (Actinomyces) necrophorus,* may cause death. An effective vaccine was developed as a preventive.

Bluetongue, a little-known virus, infected thousands of sheep in the southwestern United States and is known in other countries.

Foot rot or foul foot is more or less prevalent in most sheep-raising countries of the world. Because of extreme pain in the feet. some animals on sparse pastures may starve to death through inability to travel and procure feed. Cure is tedious and pains-taking. The infection may be largely avoided by preventing healthy sheep from having contact with infected sheep or soil.

Sheep rarely develop tuberculosis. The few cases observed were mostly of the avian type, contracted from tuberculous fowls. A common disease of sheep the world over is pseudotuberculosis or caseous lymphadenitis. It is a chronic, bacterial disease of the lymph nodes, caused by *Corynebacterium ovis* (*Preisz-Nocard bacillus*). It seldom causes death, except in aged animals, but it requires considerable attention from the standpoint of meat inspection.

In some flocks mastitis (inflammation of the udder, blue bag) is a serious problem. Various bacteria are implicated as causative agents. Sanitation and biological products may be applied as preventives.

Louping ill. an encephalitis caused by a filterable virus, mas reported only from Scotland and other parts of the British Isles. The disease is transmitted by the tick *Ixodes ricinus*. An effective vaccine was developed as a preventive.

Pregnant ewes. especially those carrying twins or triplets, may develop pregnancy toxemia or pregnancy disease if they are underfed, closely confined or subjected to sudden changes in feed or environment. Treatment is generally ineffectual for this highly fatal metabolic disease. Prevention consists in keeping ewes in a thrifty gaining condition during pregnancy, especially during the last two months.

Other diseases that affect sheep. but are generally less widespread or less serious than those mentioned, include sheep pox, Johne's disease, hemorrhagic septicemia, paratyphoid, rabies, foot-and-mouth disease (*q.v.*), Q fever and various forms of malnutrition. (M. S. Sn.: J. K. R.)

Parasites of Sheep. — Sheep probably suffer more from parasitism than any other class of livestock. the damage being greatest among lambs and young animals. The losses from the effects of protozoa. worms and arthropods are so extensive at times as to make sheep raising an unprofitable undertaking. Fortunately, control measures for most parasites are available and. if followed. the loss can be substantially reduced.

The most injurious of the protozoan parasites are coccidia. of which there are several species. Coccidia are minute organisms that develop in and destroy the cells lining the intestinal tract. causing bloody diarrhea and frequently death. Coccidiosis is particularly prevalent where lambs are concentrated in feed lots for fattening and finishing for market. It can be controlled to a large extent by sanitation and frequent cleaning of the feed troughs to prevent accumulation in them of manure containing the oocyst or infective stage of the organisms, which may be swallowed with the feed.

The worm parasites include flukes. tapeworms and roundworms. The common liver fluke. *Fasciola hepatica,* occurs in most parts of the world and is one of the deadliest parasites of sheep. The flat. leaflike parasite lives in the liver, causing a condition known as liver rot. The symptoms of fluke infestation are principally unthriftiness, anemia and abdominal dropsy. and differ little from those caused by other worm parasites. An acute. frequently fatal bacterial disease known as black disease is often associated with liver fluke infestation. The life cycle of the fluke is complicated. requiring water snails (*Lymnaea* and related genera) as intermediate hosts. The larval stages develop in the snails and the infective stage. or cercaria. that escapes becomes encysted on aquatic vegetation and is swallowed by sheep while grazing.

Control of liver flukes depends upon destruction of the snails. either by drainage to destroy their breeding places or by the use of chemical poisons. such as copper sulfate, broadcast over the snail-infested areas. Medicinal treatment with small individual doses of carbon tetrachloride or hexachlorethane will destroy the adult flukes in the bile ducts. Young flukes in the liver tissue are not affected by the treatment.

Several species of adult tapeworms parasitize the digestive tract of sheep. but as a general rule they cause little injury. The fringed tapeworm. *Thysanosoma actinioides,* frequently occurs in the bile ducts, rendering the liver unfit for human consumption. So far as known. the larval stage of sheep tapeworms develops in grass mites. The larval stages of several dog tapeworms (*Echinococcus granulosus, Taenia hydatigena* and *T. ovis*) occur in sheep; they render the carcass or the organs affect'ed unfit for food. As a preventive measure. all dogs on farms where sheep are kept should be examined periodically for tapeworms by a veterinarian. and the infested animal should be treated for their removal.

The important roundworms of sheep are the stomach worm (*Haemonchus contortus*), nodular worm (*Oesophagostomum columbianum*), and several species of small threadlike worms belonging to the genera *Cooperia*, *Ostertagia* and *Trichostrongylus*. Infestations are acquired by the animals while grazing. The common symptoms are unthriftiness. anemia and diarrhea. Death loss from stomach worms and the small roundworms is sometimes very extensive. In addition to the usual bad effects of parasitism caused by roundworms. the nodular worm ruins the small intestines for use as sausage casings. surgical suture material and for other purposes. In areas where freezing weather prevails for long periods. the infective larvae of roundworm parasites on pastures are destroyed. Treatment of the breeding flock with appropriate individual doses of phenothiazine in the late fall or early winter and again in the spring will remove the adult worms, the eggs of which contaminate the clean pastures.

Phenothiazine in salt was given to the same flock for ten years without ill effects and without losses from parasitism. After the sheep and lambs are placed on pasture. free access to salt licks containing phenothiazine in the proportion of one part of the drug to nine parts of granular silt will effectively control most roundworms. In warmer climates two or more individual doses of phenothiazine. in addition to the medicated lick, may be necessary for effective roundworm control.

The arthropod parasites include the sheep tick or ked. nose grub, screwworm and several kinds of lice and scab mites. The sheep ked is a wingless fly which sucks blood and causes skin irritation; it also stains the wool and reduces its market value. Keds may be controlled by immersing infested sheep in dips containing rotenone or other insecticidal substances and also in an aqueous suspension of 0.03% lindane. Nose grubs. which are larvae of the fly *Oestrus ovis,* live in the head sinuses. They may be destroyed by spraying into the nostrils. under pressure, a solution of saponified cresol. Screwworms are the larvae of the blowfly. *Cochliomyia americana;* they infest wounds and cause extensive damage. Screwworm infestations are best treated by the application of a smear having diphenylamine as its basic ingredient. Lice suck blqod and irritate the skin: they may be controlled by the use of insecticidal dips or applications containing coal tar creosote. arsenic or nicotine. Scab mites cause skin irritation, falling out of the wool. unthriftiness and even death; control or eradication is accomplished by dipping in lime sulfur and nicotine dips.

A dip prepared from benzene hexachloride (BHC). found to be highly effective against scale mites, requires only one dipping instead of the usual two needed when the older dips are used. The dipping vat should be filled with enough clean. .unheated water to cover the sheep and the required amount of BHC powder added and thoroughly stirred. The head of each sheep should be submerged at least twice for an instant so that the wool about the head and face are thoroughly wet. The dip should he changed when it becomes filthy because BHC will not kill bacteria and open wounds may become infected with dirty dip.

(E. W. Pe.; J. K. R.; M. A. D.)

Products. — For wool and meat production, *see* Wool; Lamb and Mutton. The pelt is also a major by-product of sheep slaughter. The pelts, with the wool removed, known as slats. are tanned for leather which is used for upholstery, bookbinding. gloves, clothing and shoe uppers. With the wool. the pelts are a basic material for the manufacture of durable and warm outer clothing.

Not only the carcass as such but the liver, heart. kidney and some other parts are used for human food. Some of the internal glands have pharmaceutical uses. The small intestines are valuable sausage casings and are significant in international trade. They also are used to make surgical and musical catgut. Wool grease or lanolin has important uses in lubricants. ointments and cosmetics. Sheep tallow has both edible and inedible uses.

Live sheep enter international trade in comparatively small numbers, mostly as select breeding stock.

Improvement of Sheep. — The existence of more than zoo different breeds of sheep. differing in appearance as well as in function. indicates the variety of ideals held by breeders. It also indicates the wide range of genetic material available for experimentation. Unfortunately, most herdsmen in the past made little use of either line breeding or inbreeding to develop their flocks. By mid-20th century those techniques were utilized as well as progeny testing and some selection indexes and performance yardsticks. Most sheep are raised for two principal products. meat and wool. In the case of the Merino. the annual wool clip is more valuable to the grower than the yearly crop of lambs sold for meat.

In most of the Down breeds, which originated in the British Isles, the meat produced chiefly as fat lambs is more valuable than the yield of wool.

In a few parts of the world, such as in the Roquefort cheese-producing region in France and the Balkan countries, sheep are triple-purpose creatures because of their yield of milk. Even in their production of wool, sheep vary greatly. Some breeds yield long, coarse wool used chiefly in rug- and carpetmaking, as the sheep bred by the Navaho tribe of American Indians, which yield a coarse, carpet-type fleece. Merino wool can be woven into a fabric almost as sheer and resilient as silk, yet possessing greater strength and warmth. Karakul sheep, which originated in Bukhara, are valuable chiefly for their lambs, which are sacrificed when less than a week old to yield a tightly curled, beautifully patterned and lustrous soft dark fur. It was found that the curl size of Karakul lambskin fur was shifted favourably toward a smaller curl by selection in the breeding flock over a few generations.

Environment, distance from market and economic competition also influenced sheep types. Some breeds, such as the Rambouillet, have a natural herding instinct. They graze by day and bed down at night in closely gathered flocks, sometimes containing more than 1,000 sheep. Sheep which scatter when grazing because of lack of the herding instinct would soon be lost or fall victim to predatory animals.

Fortunately it was possible, by careful breeding, to make notable progress with the Rambouillet as to staple length of wool, mutton type and freedom from skin folds. Not only are good mutton type and condition of flesh associated with heavier body weights and fewer skin folds, but staple length of wool and the weight of wool, either as clean or grease wool, are positively associated. Freedom from wool blindness is somewhat less closely associated. Progress was far greater from the selection of sires than from the selection of dams.

The semiarid regions of Australia, where an area three-fifths as large as continental United States averages only 15 in. of rainfall a year and offers spare grazing of a weedy, shrubby character, are unsuitable for producing choice fat lambs, but the Merino sheep with its excellent fleece of fine wool thrives there. The long distance of Australia from most of the world's markets is not a serious factor for a product as imperishable and light in weight as wool. Nevertheless, the Merino represented a declining percentage of the Australian sheep number from 1939 to 1947, due mainly to the wartime demand for crossbred sheep and to droughts in the pastoral areas where Merinos predominate. Merinos increased from 70% to 74% between 1947 and 1953. A notable postwar development was the increase in "other" breeds, mainly Corriedales and Polworths. The Merino was found to be uncommonly effective in grading up the common sheep flocks of India and the middle east.

Shifts in the relative profitableness of mutton and wool have been a cause of considerable crossbreeding in sheep production. The Corriedale breed, which originated in New Zealand from crossing the Lincoln and Merino breeds, is about equally valuable for lambs and wool under range conditions. The same is true of the Columbia, developed by the U.S. department of agriculture from a Lincoln-Rambouillet cross. The Corriedale and Columbia possess the herding instinct; their ewes have the mothering qualities so necessary in range sheep and they produce large lamb crops. The experiments which resulted in the Corriedale were begun before 1870, utilizing Lincoln, Romney or Leicester rams on Merino ewes, after which, by inbreeding, a not yet completely standardized dual-purpose animal was developed having a heavy yield of near-Merino quality wool as well as good meat quality whether taken as fat lamb or ewe mutton. It is adaptable to areas as diverse as Kenya and Tierra del Fuego and gives a high lambing ratio. Flocks were established in most sheep regions, particularly those of the southern hemisphere. In western United States, Corriedale rams were used especially on Rambouillet ewes to give an improved quarter-bred.

Scientific crossing has given good results. Crossbred Hampshire, Shropshire and Southdowns gave a much better survival ratio to weaning time, plus more rapid weight gains. Crossing of Columbia with Southdown gives wool production of very good staple length, quality and quantity, as well as producing excellent feeders with a satisfactory market finish at desirable weights. Southdown and Shropshire lambs excel in edible meat production, giving the highest proportion of preferred cuts, including legs, loins and ribs.

In the United States several state and regional experiment stations, particularly the sheep experiment station at Dubois, Ida., and the southwestern range and sheep breeding laboratory, Fort Wingate, N.M., compare different systems of breeding and develop more effective methods of selection. Various traits of lamb and wool production are analyzed for heritability and economic importance. Comparisons are made between inbred lines formed by selection within lines and by recurrent selection of sires from line-cross and top-cross progeny tests. Non-inbred selected groups are developed in each breed for comparison with inbred lines and their crosses. A genetically stabilized group is also established with selection at random to serve as a control for the selected groups.

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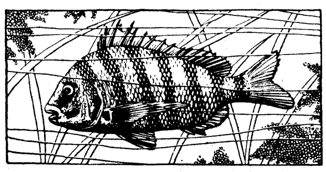
SHEEPSHEAD, one of the large species of the genus *Archosargus.* These fishes possess two kinds of teeth: one, broad and flat, like incisors, in a single series in the front of the jaws; the other, semiglobular and molar-like, in several series on the sides of the jaws. The genus belongs to the acanthopterygian family Sparidae, which includes the sea breams. The common sheepshead occurs in abundance on the Atlantic coasts of the United States, from Cape Cod to Florida and Texas, and is one of the most valued food fishes. It may attain a length of 30 in. and a weight of 15 lb. Its food consists of shellfish which it detaches with its incisors, then crushing them with its powerful molars. It may be distinguished from allied species by its seven or eight dark cross-bands.



BY COURTESY OF THE N.Y. ZOOLOGICAL SOCIETY

SHEEPSHEAD (ARCHOSARGUS PROBATOCEPHALUS), A FOOD FISH FOUND ALONG THE EASTERN COAST OF NORTH AMERICA

The term "sheepshead" is also given in some parts of North America to a fresh-water sciaenoid, *Aplodinotus grunniens.*

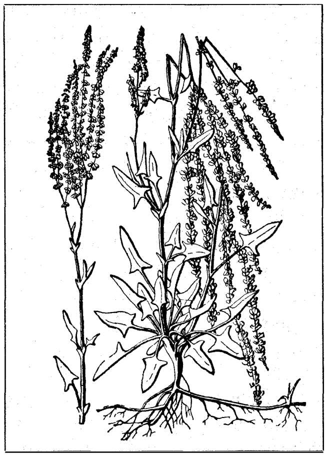
SHEEPSHEARING MACHINES. In countries where individual flocks of sheep are large or where wages are high, mechanical aids to hand clipping are employed in order to lower the cost or to speed up the work. In the pastoral districts of Australia, New Zealand and South America mechanical shearing is almost universal. In Great Britain, although hand clipping is still widely practised, the use of shearing machines is gradually extending. Hand shearing leaves the clipped surface in ridges whose evenness and symmetry are an indication of the skill of the operator while the machine leaves the surface level. It is claimed that the machine clips a heavier fleece than hand shears; but the result depends largely on the comparative skill of the operators.

The essential components of a shearing machine are a comb which is guided by hand over the body of the animal; a cutter with sharp edges which shears the wool by passing backward and forward across corresponding edges on the comb. a reciprocating device for actuating the cutter, a flexible or universally jointed coupling for driving the cutter, and the hand wheel or power unit. The moving parts of the actuating mechanism are protected so as to prevent them becoming entangled in the wool. Hand machines are usually mounted on a metal stand and can be easily carried by one man. They are driven by a chain or belt from a wheel to which the handle is attached, and require two persons to operate them, one to turn the handle and the other to clip the sheep. These machines are suitable only for small flocks. When large numbers of sheep have to be clipped, the machines are invariably power driven. A long shed may be specially adapted for shearing: shafting is then mounted along one side to which several shearing machines are connected: an internal-combustion engine or other motive power is used to drive the shafting. Portable shearing outfits are also common and enable the machine to be taken to the flock. The power unit (usually an internal-combustion engine) is mounted on a suitable transport truck and the shearing units are either connected to a portable shafting or to separate points on the truck itself. Electric drive has been found to be the most satisfactory for shearing machines and it is not unusual to employ an internal-combustion engine to drive a dynamo which in turn is used to operate separate motors for driving the shearing units.

(B. J. O.; H. G. R.)

Horse-clipping machines do not differ materially from sheep-shearing machines but special combs and cutters are used. The latest development for shearing small flocks is the self-contained electric machine having a motor in the handle.

SHEEP SORREL (*Rumex acetosella*), a small perennial plant of the buckwheat family (Polygonaceae), native to Eurasia. It is common in northern Europe and is naturalized in North America. It has two kinds of plants, staminate and pistillate; the latter usually turn red as the seeds mature in the numerous slender flower clusters. The leaves have a sour taste. The plant, though frequently considered as an indicator of acid soil, also thrives on neutral or alkaline soils if these are low in nitrate nitrogen.



SHEEP SORREL, A HARDY SUMMER WEED OF THE TEMPERATE ZONE

SHEERNESS, a seaport, naval establishment and urban district on the Isle of Sheppey (*q.v.*), in the Faversham parliamentary division of Kent, Eng., on the right bank of the Medway estuary at its junction with the Thames, 48 mi. E. of London. Pop. (1961) 14,123. Area 1.5 sq.mi. The town is divided into three sections—naval; residential and business; and recreational. Blue town, the oldest, contains the naval dockyard built on a site surveyed by Samuel Pepys. secretary to the navy, in 1665. The fort at Garrison point was built after the taking of Sheppey by the Dutch in 1667. In 1797 Sheerness was involved in the Nore mutiny by the landing in force of the mutineers and it was there that Lord Nelson's body was brought ashore irom his flagship, the "Victory." Mile town, built after Blue town, comprises shopping and residential streets; while Marine town, lying along the sandy eastern shore, forms an additional residential area, with pleasure gardens and an open-air swimming pool.

SHEETS, IRON AND STEEL. The production of rolled sheet iron dates back before 1620 in Bohemia and mas introduced in Wales in 1720. Most of the rolling was done by hand, and great skill was required. The sheets were usually made of puddled or wrought iron. Upon the development of the Bessemer process and the open-hearth process (*see* CONVERTER STEEL; OPEN-HEARTH STEEL PROCESS), steel was produced more rapidly and cheaply and practically replaced iron. However, steel sheets showed shorter service life under corrosive conditions, and interest in sheet iron reawakened. Metallurgists found methods of manufacturing it in larger quantities and less laboriously. To-day iron sheets are generally available and marketed at prices not greatly different from those of steel sheets.

Production.—In the production of sheets and strip, the first part of the process is much the same as that employed for plates, sections, and other products. The metal is refined, teemed into ingot moulds, heated again in the soaking pits to insure uniform heat before rolling.

Old Rolling Practice.—Under the old hand-operating practice—now largely outmoded by the continuous mill—ingots were reduced to slabs in the blooming mill, further reduced in the bar mill, cut into specified bar lengths, which became the width of the sheets to be rolled from the bars. Bar thickness governed the ultimate gauge of the sheet.

Continuous Mill.—In modern mills the ingot is rolled to a slab in a mill having horizontal rolls and a second mill with vertical rolls, known as an edger, arranged in tandem with a turning mechanism between and spaced approximately thirty feet apart. With this mill arrangement it is possible to roll a slab having any desired width (within the capacity of the mill) without regard to the ingot width. The width of the finished strip is not limited to the width of the ingot from which it is rolled. The usual practice is to roll the slab from 4″ to 6" thick and equal to the strip width. Slab is trimmed at ends and reheated before rolling on the continuous bar and strip mill. The reheated slab is discharged upon the mill table, which carries the slab to the bar mill. The bar mill may consist of four to six sets of rolls arranged in tandem! each succeeding roll reducing the thickness, and turning slightly faster. These rolling mills reduce the slab to a plate ranging from $\frac{3}{8}$″ to $\frac{3}{4}$″ in thickness. Plates can be removed beyond the last bar mill stand when plates of such thickness are desired.

Proceeding from the bar mill the steel passes to the strip mill, consisting usually of five to six stands of rolls, also arranged in tandem, which roll the plates ($\frac{3}{8}$″ to $\frac{3}{4}$″ thick) to thinner gauges such as ·0625″ to ·100″. These are delivered on a mill table beyond the last mill at surface speeds ranging from 1.000 to 2,000ft. per minute. The finished hot strip travels approximately 350ft. to a coiling machine that winds the strip into coils to facilitate handling for storage and further processing.

The coils may be cut up into units for rolling into lighter sheets or tin plate on the conventional hand-operated hot mill, or may further be reduced in gauge on the cold-reduction tandem mill. The wide tandem cold mill has now come into general use for producing tin plate and sheets and strip in the range of 14 to 32 gauge. Before the hot strip is delivered to the cold mill for further reduction, hot mill scale is removed in a strip pickler. The strip is passed through a sulphuric acid solution, washed, dried, oiled, and recoiled.

The strip is now ready for the cold-reduction mill, which consists of three or more roll stands arranged in tandem and a .spool-type coiling machine beyond the last stand. The operation here is much the same as described for the hot mill. except that the strip is under considerable tension between the mills and between the last mill and the coiling machine. Rolling under tension improves the gauge and flatness, and also gives a high finish texture to the sheets. The strip is either finished and marketed in coils or cut into sheet lengths as ordered; yet in either case the finishing process is the same. The sheets or strip are annealed in a controlled atmosphere to relieve the strains caused by rolling and to provide a dead soft sheet, which is then temper rolled on a mill to produce such hardness or temper as is specified. On orders requiring a dead flat surface, such as for metal furniture, the sheets are stretched flat in a hydraulic machine. The product is inspected, resquared when necessary, and shipped.

Galvanizing. — If the sheets are to be galvanized they are coated with zinc in galvanizing pots. (See GALVANIZED IRON AND STEEL.) The speed of the exit rolls and the temperature of the zinc control the weight of coating. Zinc makes a very good coating for iron and steel because it forms an alloy bond with the iron.

Painting. — Paint is often used to cover galvanized iron. Once the common practice was to permit the zinc coating to weather several months. A quicker alternative was to treat the zinc with acetic acid, which etched the smooth surface. Both methods had obvious drawbacks. Now many galvanized sheets are rendered paint gripping by a special phosphate treatment at the mill. No zinc coating is lost; the galvanized sheets take paint readily; and no zinc compounds are left on the surface prematurely to dry out the paint. Bitumastic or asphalt coatings are sometimes applied to galvanized sheets and plates. They are especially valuable where erosion is encountered.

Uses. — In general, galvanized sheets are used in products and construction where corrosion is a factor. Among the important uses are culverts, roofing, air conditioning and general sheet-metal work. In the uncoated classification are the cold-rolled grades for products that require a fine finish, such as automobiles and metal furniture; enamelling iron for products to be finished with porcelain enamel; electrical sheet steel for motors and transformers, as well as hot-rolled sheets for a wide variety of consumer products and industrial applications.

(See TIN PLATE AND TERNEPLATE; GALVANIZED IRON AND STEEL.) (E. B. H.)

SHEFFIELD, a city, county and parliamentary borough in the West Riding of Yorkshire, Eng., 158 mi. N.N.W. of London, 38 mi. E.S.E. of Manchester and 52 mi. S.S.W. of York by road. Pop. (1961) 493,954. Area 61.9 sq.mi. It is in the extreme south of the county, at the foot of the Pennines and at the junction of the Don with its tributaries the Sheaf, Porter, Rivelin and Loxley.

At the time of the Domesday survey Sheffield (Escafeld) was a subdivision of the large manor of Hallam. At that time the Meersbrook, the Limb Dyke and the Sheaf, which had divided Mercia from Northumbria, were the boundary between Yorkshire and Derbyshire and continued to be so until 1900. After that, extensions of the city boundary carried Yorkshire several miles into Derbyshire.

Early in the 12th century, the Norman William de Lovetot built a castle at the confluence of the Sheaf and the Don. and a parish church. These two focal buildings were in, or near to, the submanor of Sheffield. and this was no doubt why the name of Sheffield soon superseded that of Hallam for the town and manor; though Hallamshire (Sheffield, Ecclesfield and Bradfield) continued to be an area of administration cut off from the rest of Yorkshire by the great moors north of Bradfield.

In 1297 Thomas de Furnival, then lord of Hallamshire, granted to his "Free tenants of the town of Sheffield" certain privileges as burgesses. These free tenants continued to be the body most concerned with local government until in the reign of Edward VI certain property which had been left to them in trust was forfeited to the crown under the Act for the Suppression of Colleges and Chantries. On their petition it was restored by Queen Mary in 1554, and as she preferred to separate the ecclesiastical from the civil duties she created by charter a body of 12 capital burgesses who discharged their functions side by side with the free tenants. Both are now charitable trusts — the Church Burgesses and the Town Trustees. Mary, queen of Scots, spent some time at the Manor lodge during the 14 years of her captivity at Sheffield castle.

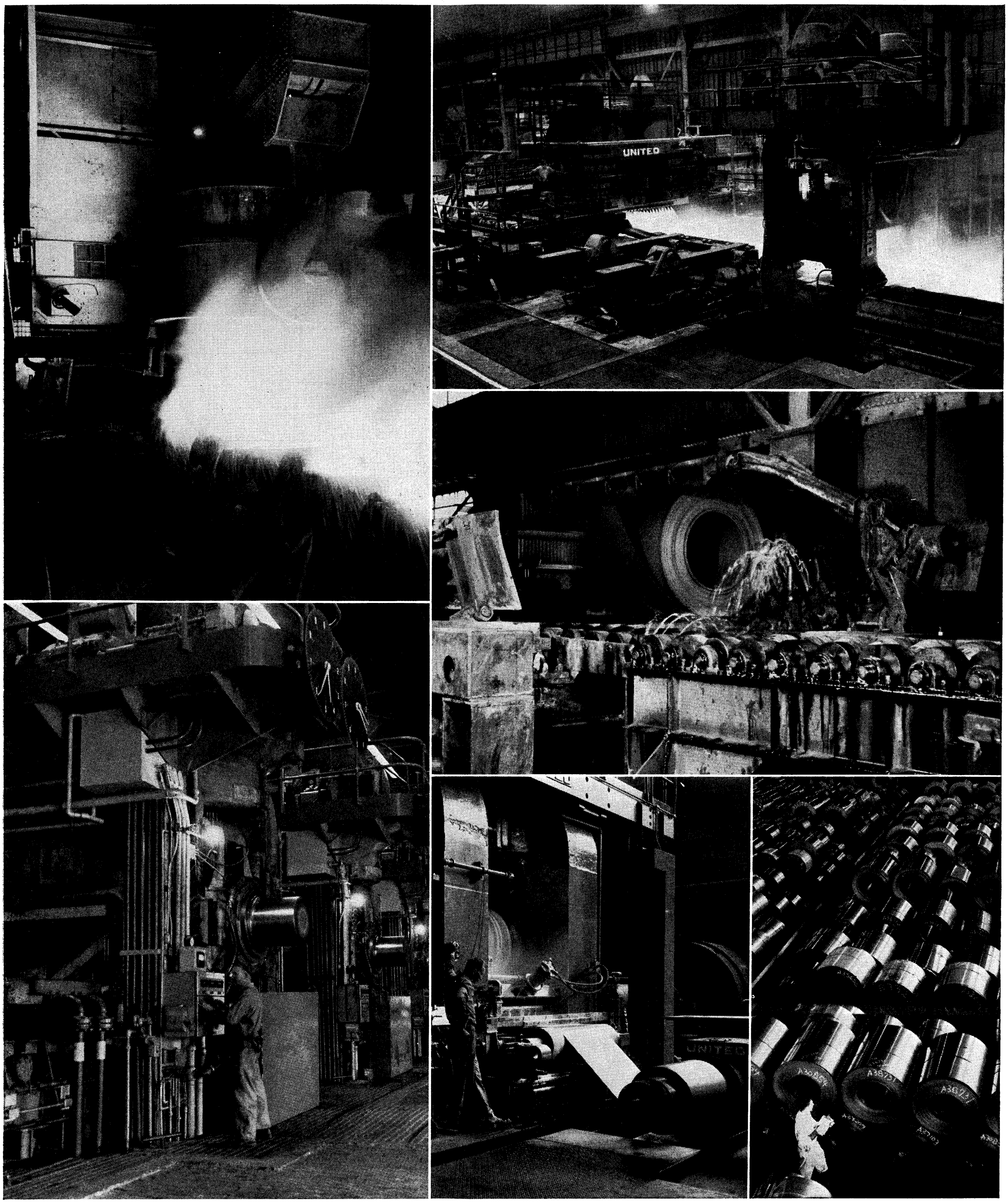
Industries. — The district is rich in sources for metalworking. From early times the local iron ore had been smelted by charcoal obtained from the abundant woodlands. Smiths, and probably cutlers, were active in the neighbourhood as early as the 14th century. The millstone grit of the district provided excellent grindstones During the 15th century the streams which converge on Sheffield began to be used for power for grinding and forging. Though the cutlery industry was for many years a rural one, carried on in a succession of water mills which packed the banks of the rivers from their sources on the moors to the boundary of Rotherham, the importance of Sheffield was established as the market town where the wares were finished and sold. This resulted in its emergence as the main provincial cutlery town and a powerful rival to the cutlery trade of London. By 1700 the London cutlers also were defeated; thereafter Sheffield enjoyed a monopoly of the English cutlery trade. The variety and quality of products reached a very high level in the late 18th and early 19th centuries — spring and table knives, razors. scissors, surgical and mathematical instruments, edge tools, saws, agricultural and joiners' tools, files and rasps of every grade and size. The introduction of steam grinding released the industry from its dependence on the rivers but until very recent times there was little change in the organization of an essentially small-firm industry.

The crisis of Sheffield's industrial history was reached about 1740, when Benjamin Huntsman moved from Doncaster to Handsworth (now within Sheffield) to experiment in the production of a steel harder and more even than could be made by the older methods of smelting and forging. The crown of his experiments was crucible steel. the reliable tool steel which marked the beginning of special steelmaking in England. By 1830 Sheffield was recognized as the centre of high-grade steel manufacture. Shortly afterward the opening of the first local railways made possible the movement, and therefore the manufacture. of really large castings. It followed naturally that when in 1856 Henry Bessemer invented his method of making inexpensive steel in large quantities, he should set up a works in Sheffield. During the remainder of the 19th century the heavy industries grew rapidly. aided by the development, by Sir John Brown *(q.v.)* and Charles Cammell, of the manufacture of armour plate for ships, and the discovery by Sir Robert Hadfield *(q.v.)* of a workable manganese steel. Development in alloy steels, including the perfection by Harry Brearley of noncorrosive ("stainless") steel, in 1912, went on apace. The area between Sheffield and Rotherham was quickly filled with the great works which clang and glow so impressively through the night in the Don valley.

About the same time that Huntsman was experimenting, Thomas Boulsover, a cutler, discovered the process of plating copper with silver by fusion which resulted in the beautiful ware known as old Sheffield plate. (See SHEFFIELD PLATE.) Factories for making it were established rapidly and played a large part in bringing to the town wealth which had eluded the older small-scale cutlery manufacturers. The discovery of the method of electroplating killed the more expensive plate trade almost overnight in 1850, and the surviving specimens have become museum pieces eagerly sought by collectors; but the silver and electroplating trades continue, and the city still has one of the few provincial assay offices (established 1773).

The cutlers organized their industry on craft guild lines very early; the first trade-mark known was granted in 1554. In 1624 they were incorporated as the Company of Cutlers in Hallamshire, with jurisdiction for six miles round Hallamshire as well. As a guild, the company relinquished most of its powers in 1812, but has since revived as a powerful influence in upholding the quality of Sheffield wares. By acts of 1883–88, the company has the right of registering trade-marks for all goods composed in whole or in part of any metal, wrought or unwrought, in its ancient area of jurisdiction, and its membership now includes the manufacturers of steel as well as cutlers.

Although the cutlery, steel and auxiliary trades still occupy the greater part of Sheffield's wage earners. there are important minor industries. Haft, handle and case making naturally accompany the cutlery trades. Sheffield has the largest type foundry in England and there are snuff factories, food factories, confectionary works. fruit and vegetable canning, iron and brass founding, paper manufacture, bookbinding and the making of optical instruments, bicycles, brushes, railway fittings, chemicals, paints and varnish.



BY COURTESY OF ARMCO STEEL CORPORATION

SHEET STEEL PRODUCTION

Top left: Ladles containing liquid steel being emptied into moulds where the steel solidifies as ingots
Top right: After the ingot has been reheated to proper temperature, a rolling mill reduces it to a slab about four inches thick
Bottom left: Four high mills further reduce the slab to a continuous ribbon of steel
Centre right: Coiled strip emerging from a coiler
Bottom centre: Cold reduction mill which produces the finished sheet, reduced to the desired thickness and with a smooth surface
Bottom right: Finished steel coils awaiting shipment

Communications. — Sheffield lies on no great lowland route or natural highway. To the northwest and south the valleys lead to Pennine dales and lofty moorlands. For many centuries the only ways were along steep and narrow tracks, except beside the Don from Rotherham.

In 1726 improvements were made in the navigation of the Don from Doncaster west to Tinsley, to help the trade of Sheffield; in 1814 a canal from the heart of Sheffield to Tinsley completed the outlet by nater. Ten turnpike roads made between 1756 and 1819 brought the town out of its isolation, but the gradients daunted the early railway engineers, and the first line, opened in 1835, only connected Sheffield with Rotherham, on the original Midland line.

The present main line through Chesterfield was not built until 1876, after the tunnelling of the Sheaf-Rother natershed. Long tunnels connect Sheffield by rail with the west and even in the 1950s relatively little of the trunk traffic of England passed through the city.

Later History. — During the period generally known as the Industrial Revolution the population expanded so rapidly that the ancient bodies of local government could not cope with the new problems of urban management. The first interest of the day nas in parliamentary reform and in 1832 Sheffield was allotted two members in the reformed parhament. The Municipal Corporations act of 1835, allowing named towns to apply for a charter of incorporation as boroughs of the modern type, nas adopted in 1843. In 1893 the borough was created a county borough and city and in 1897 its chief magistrate received the title of lord mayor. In 1911 the census returns showed that Sheffield had taken a place above Leeds as the largest city in Yorkshire. In this period the built-up area spread rapidly along the valleys: during the 20th century pleasant new suburbs were extended over the hillsides.

In 1914 the diocese of Sheffield was created from the see of York, the old parish church becoming the cathedral church of St Peter and St. Paul. Only the tower and chancel of the 15th-century building (which replaced two earlier ones) remain, but the present building has some fine alabaster monuments and some interesting modern stained glass

In 1897 the university college was created by the amalgamation of the medical school (founded in 1828), the technical school (1886) and Firth college (1879), a university extension venture for which Mark Firth, a steel manufacturer, had provided the building. In 1905 the college received its charter as the University of Sheffield. Although it provides ample opportunities for a broad cultural education, the university especially developed branches of study and research in glass and fuel technology, metallurgy, mining and engineering. Sheffield was one of the first towns to provide secondary education; at mid-20th century there mere eight grammar schools, including King Ednard VII school, formed in 1905 by the union of the old Royal Grammar school and two private schools, administered by the municipality. There were also colleges of arts and crafts, and commerce and technology.

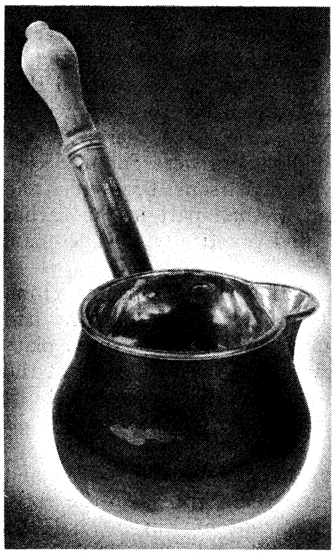
The town hall, opened in 1897, is a good example of Victorian Gothic housing the municipal offices. Twentieth-century buildings include the city hall (1932) for concerts and meetings; the city museum (1937) with excellent collections of cutlery, plate and Derbyshire antiquities. and the central library and Graves art gallery (1934) The library is a fine one, well known for material on ferrous metallurgy and for collections of local archives. In Meersbrook park uas the Ruskin museum (closed 1952) containing John Ruskin's collection of works of beauty lent to Sheffield from St George's guild by his desire.

Sheffield's growth and appearance have been adversely affected by the lack of large commercial undertakings in earlier periods, by the necessarily dirty nature of its major industries and by two heavy air raids sustained in Dec. 1940. Nevertheless, finely sited on a hill-and-valley system of great beauty, Sheffield is a pleasant and in some ways a beautiful city. There are open spaces and tree-lined streets less than a mile from the city centre, and the purple moors of the Pennines and the deep wooded dales of Derbyshire sweep up to the very edge of the residential area.

See A. Gatty, *Sheffield: Past and Present* (1873); *Handbook and guide to Shefield*, pub. for Brit Ass. (1910); *M. Walton, Shefield; Its Story and Its Achievements*, 3rd ed. (1952). (My. W.)

SHEFFIELD PLATE is the term applied to articles produced from copper and coated with silver by the process of fusion.

History. — About the year 1742 Thomas Boulsover, a Sheffield, Eng.. cutler, while undertaking repairs to the haft of a knife observed that by the application of heat a piece of silver and the copper to which it accidentally adhered had become fused and could be dealt with as one metal and that the two metals behaved as one when subjected to hammering. This caused him to experiment, with the result that he eventually produced buttons and boxes with a copper foundation coated with silver which had the appearance of being made entirely of the more precious metal. Joseph Hancock. who served his apprenticeship with a relative of the inventor, realized the wider possibilities of the discovery and was the first to apply the process to making saucepans, coffeepots, candlesticks and other large articles for domestic service: closely resembling in their detail hallmarked silver specimens.


BY COURTESY OF SHEFFIELD CITY MUSEUM
SAUCEPAN. BY JOSEPH HANCOCK, MADE ABOUT 1755, SHEFFIELD, ENG.

These pioneers were soon followed by other cutlers who added the production of Sheffield plate to their other undertakings. Two factors were necessary for the complete success of the new invention. viz, capital and skilled labour.

The money required was readily obtained locally, but the highly trained assistance of London silversmiths was also essential and ultimately nhen their services were enlisted the success of the undertaking was assured.

The excellent appearance and relative cheapness of these plated productions caused a widespread demand. Henry Tudor, a local gentleman, having realized the great possibilities of the invention, appears to have been the first to seek the assistance of a London silversmith, and about the year 1760 entered into partnership with Thomas Leader, and as Tudor and Leader they founded the first Sheffield plate and silver manufactory on an extensive scale. Boulsover apparently did not embark on this new phase of the industry. but turned to the rolling of metals, still however, carrying on his lucrative plated button manufactory.

Hancock appears to have carried on the making of Sheffield plate from about the year 1750 until 1765. He then interested himself chiefly in the production of plated materials required by manufacturers of the finished articles. Originally beaten out into sheets by hand the fused metal was subsequently manipulated by rollers turned by hand; the application of horse and water poner followed, and eventually steam was employed to drive the mills.

The establishment of Leader in Sheffield raised the artistic standard of the craft, and from being content at first to copy contemporary London-made silver the Sheffield plate workers soon evolved a style of their onn and found much inspiration in the work of the Adam brothers and John Flaxman, particularly in the construction of candlesticks. So cunningly devised were some of their productions and so peculiarly marked that in the year 1773. the London silversmiths were successful in obtaining an injunction restraining the Sheffield plate makers from using marks on their wares.

Prominent amongst men of local origin who assisted in the advancement of design and workmanship in this new craft, and who themselves built up lucrative businesses. were John Winter, Thomas Law, Richard Morton and Joseph Ashforth, whose marks

BY COURTESY OF SHEFFIELD CITY MUSEUM

DUMMY MARK. USED BY MANY EARLY PLATERS. ON HOT-WATER JUG MADE ABOUT 1755; UNIDENTIFIED

are still to be found on old Sheffield plate made previous to 1773.

By the year 1784, after much agitation the Sheffield platers were authorized to use marks once again, but it was enacted that such marks should bear the name of the maker together with a distinctive device not used for silver. About the year 1790 the most prominent manufacturers and designers were Samuel Roberts, Nathaniel Smith, Daniel Holy, the Watsons, Bradburys and Creswicks. Birmingham played but a small part in the earlier history of the trade, being represented practically by one man, Matthew Boulton.

Though his workmanship, in association with his partner John Fothergill, is excellent and dates from the period 1760, he had many other interests, and articles made by him from fused plate of the first period are somewhat scarce. In the early part of the 19th century he and his successors carried on an increasing business, and their device, the sun, is still to be found on many old Sheffield specimens.

The manufacture of fused plate, though confined in England to Sheffield and Birmingham for many years, spread in the early part of the 19th century to the continent of Europe, but the articles made in France, Russia and Central Europe never bore comparison in quality or craftsmanship with those of the Sheffield makers.

Processes. — To produce the plated metal sheets, ingots of copper containing a slight alloy, $1\frac{1}{2}$ in. to $1\frac{1}{4}$ in. thick by 24 in. wide by 8 in, long, were cast, and the surfaces planed, then smoothed. A sheet of silver was cut to the size of the face of the ingot, about $\frac{1}{8}$ in. thick, also smoothed on the surfaces. The two prepared surfaces were cleaned of all impurities, placed together and firmly pressed. A copper plate dressed with solution of chalk was placed upon the silver and all three firmly secured together, and bound with iron wire.

The ingot was now placed in a furnace especially prepared, and most carefully watched until the silver melted slightly when it firmly adhered to the copper surface. After being withdrawn from the oven and allowed to cool, the copper plate and iron wires were removed from the ingot which after being well cleaned and trimmed was ready for the rolling mills.

At first plated on one side only, a new process was discovered about the year 1765 which enabled the makers to produce sheets with a coating of silver on both sides of the metal. The ingenious craftsmen were now not far off realizing their ambition. viz., to produce articles that were indistinguishable from those made in London of standard silver.

Plated Wire. — About the year 1768, plated wire was introduced. A strip of fine silver $\frac{1}{32}$ in, thick was bent to fit a round copper rod 5 in. long by 1 in. diameter. The two metals were then united by fusion and afterward drawn continuously through a "whortle" until they assumed the form of a wire. The repeated drawings brought the two silver edges together almost as one piece. This early method was improved upon and superseded some years later, though the original principle was adhered to in its general details.

Silver Edges.—The next e that marked a great advance in manufacture was the addition f silver lg , invented t George Cadman in 1788. Previous to this tl raw copper edges had been hidden with solder.

The method consisted oi drawing a hollow silver wire tl g a hole which corresponded in size exactly with the edges of the article it was intended to cover: at the same time this process shaped up the silver thread to a groove, thereby enabling the operation of soldering on these silver edges to be carried out more easily.

Silver Shields for Engraving.—The method of rubbing in silver shields by applied heat was evolved about the year 1810. Previous to this in order to carry out the engraving of crests, etc., it had been necessary to solder in extra heavily plated sections of metal.

This invention has been attributed to a man of the name of Wilks, who also improved the method of production of plated wire. Having hammered the surface onto which the shield was to be fixed, a piece of pure silver was cut suitable to the size of article to which it was to be made to adhere and heated lightly in a flame, it was flattened all over and chamfered on the edges, as thinly as possible.

After being cleaned of impurities the shield was secured to the centre of the plate and heated till it adhered to the metal, then quickly rubbed with a burnish until it was definitely sealed to the under surface. The blank was subsequently hammered until both silver shield and fused plated sheet were brought to one level.

With all these discoveries and inventions allied to their skill in technique and design, it is not surprising that early in the 19th century the Sheffield platers then at the height of their prosperity led the fashion in production of domestic silver as well as Sheffield plate.

By the aid of steel dies in which the delicate tracery of their conceptions could be stamped, they continued to produce on an elaborate scale new designs with which the London silversmiths found it difficult to compete.

End of the Industry. — Having for close on a century held the field for pre-eminence in design and workmanship, Sheffield plate was gradually superseded'by articles plated by the process of electrodeposition; though even as late as the 1851 exhibition the reports of the jurors were unfavourable to this new invention. "They desired to guard against being considered as expressing an opinion on the merit of the application of the electro process of silverplating to objects of domestic use."

By the year 1860 the firms in Sheffield which had declined to adapt themselves to this innovation were gradually dying out. Though the two processes had merged into each other gradually by the year 1865, the older method of plating by fusion for articles of domestic use had ceased to exist. The production of fused plated silver is still carried on for the making of buttons, it having been found that the rolling and hammering of the sheets is conducive of greater lasting properties for articles so continuously subjected to hard wear.

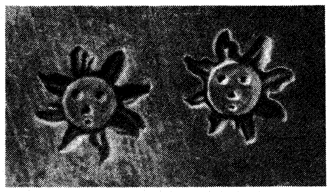
Old Sheffield Plate. — About 30 years after its disappearance as a commercial commodity, the acquisition of what was by then termed "old Sheffield plate" became a cult amongst collectors of antiques. It was evident that the process of manufacture might be classed as a lost art. The superb workmanship could not be disputed and was well nigh impossible of reproduction. Most of the older skilled craftsmen had by then passed away, and the younger ones had adopted other callings. The demand soon began greatly to exceed the supply. This state of affairs was folloned by the appearance on the market of many imitations electro-plated on copper, which were dishonestly described as "Sheffield plate." To so great an extent were these spurious articles sold as Sheffield plate that in the year 1911 prosecutions were undertaken by the Sheffield Cutlers company, when it was established in court that the term "Sheffield plate" could only legally be applied to articles made by the older method of plating

BY COURTESY OF SHEFFIELD CITY MUSEUM

J H. & CO., MARK OF JOHN HOYLAND, ON CANDLESTICK MADE ABOUT 1770, SHEFFIELD, ENG.

by fusion.

The tendency today has not been toward a general increase in values of all specimens of old Sheffield plate, but those of utility such as candlesticks, candelabra, waiters, trays, entrée dishes, tea services, salt cellars and mustard pots, coffeepots, and many original designs in pierced work have advanced greatly in value. For such articles in perfect condition almost as high a figure is occasionally paid as for contemporary hallmarked silver specimens.



BY COURTESY OF SHEFFIELD CITY MUSEUM

TWO SUNS, MARK OF MATTHEW BOULTON, ON CANDELABRUM MADE ABOUT 1815, BIRMINGHAM, ENG.

With regard to the large articles that, early in the 19th century, were so prominently displayed on sideboards and dining tables, these, under modern conditions of home life, are not now greatly in request, consequently they may frequently be purchased at a price which is under their original cost.

With regard to the future of the industry, the modern demands for a cheaper class of goods has led to a deterioration of design generally associated nith mass production. Possibly silver plated articles may eventually be superseded for domestic use by solid silver, which since the removal of duty in 1891 and decline in value of the raw metal has greatly grown in demand. Again, too, there has been a resuscitation of pewter for table use, which is treated more scientifically than formerly and bears a marked resemblance to a standard silver. Penter also has the advantage of practical immunity from tarnish, while the material is easily worked and very durable.

The manufacturers of best quality plated goods are today more concerned with the production of mares suitable for hotels, restaurants and clubs, than for domestic utility.

See also SILVERSMITHS' AND GOLDSMITHS' WORK.

(F. BRA.)

SHEHITAH (SHECHITAH) is the special method of slaughtering animals employed in preparation for kosher food; *i e.*, food prepared in consonance with the Jewish dietary laws. It consists of an incision made across the neck of the animal or fowl by a qualified person especially trained for ritual slaughter, with a special knife that is razor sharp and has a smooth edge with absolutely no nicks. The cutting must be made by moving the knife in a single swift and uninterrupted sweep, and not by pressure or by stabbing. The cut severs the main arteries, permitting the blood to drain from the body, as well as rendering the animal unconscious.

The slaughterer (shohet) recites a prayer before the act of shehitah.

Objection has sometimes been raised to this method of slaughter of animals on grounds of cruelty. The sight of the struggling animal aroused the concern of humane societies, and in some European countries this resulted in legislation forbidding shehitah. In other countries it brought about the use of special pens in which the animal was kept during the process. Scientific opinion indicates, however, that severance of the carotid arteries and the jugular vein by one swift movement results in almost immediate loss of consciousness, and the afterstruggle is reflex muscular action.

See also KOSHER.

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SHEIKH (SHAYKH), an Arabic title of respect. Strictly it means a venerable man, of more than 50 years of age. It is specially borne by heads of religious orders, chiefs of tribes and headmen of villages. Every village, however small, every separate quarter of a town, has a sheikh in whom is lodged the executive power of government — a power loosely defined, and of more or less extent according to the personal character and means of the individual who wields it..

For the Sheikh ul-Islam *see* MUFTI.

SHEKEL, originally a Jewish unit of weight ($\frac{1}{50}$ of a mina, and $\frac{1}{3000}$ of a talent) and afterwards a coin of the same weight (Heb. *shakal,* to weigh). The Biblical references to shekels must refer to uncoined ingots. In the time of Josephus it seems that tho *light* shekel weighed from 210 to 210·55 grains; the *heavy* shekel was twice that amount, corresponding to 1s. 4½d. and as. 9d. respectively in English silver. Jewish shekels were first coined by Simon the Hasmanean, probably in 139–138 B.C. These bear inscriptions in the archaic Hebrew and various emblems, such as the cup or chalice, the lily branch with three flowers, the candlestick, the citron and palm branch and so forth. They never bear the portraits of rulers or figures of animals. A later series of shekels, belonging to the Roman period, are tetradrachms, "which came from the mints of Caesarea and Antioch and were used as blanks on which to impress Jewish types." Hence in Matt. xvii, 23 the temple tax of half a shekel is called a didrachm (2 drams). In 2 Samuel xiv. 26 we read of "shekels after the King's weight." The Hebrews divided the shekel into 20 parts, each of which was called a *gerah.* (*See* also NUMISMATICS.)

See articles in *Ency. Bibl.* col. 4,442, and Hastings' *Dict.* of *the Bible,* ii. 417 *seq.;* F. W. Madden, Coins *of* the *Jews* (1881); T. Reinach, *Jewish Coins* (1903).

SHEKINAH, a Hebrew word meaning "that which dwells," or "the dwelling." An expression used in the Targums in place of "God." The word "Shekinah" is of constant occurrence in the Targums (*q.v.*). Great care was taken by the scribes to mitigate the anthropomorphic expressions applied to God in the Scriptures, and, by paraphrase, to prevent such expressions from giving rise to erroneous views in the popular mind as to God's personal manifestation. Thus, whenever any indication of local limitation or action of God was implied or expressed, in the Hebrew text, the Targumists were careful to substitute some expression involving the use of "Shekinah." Thus Ex. xxix. 45 is rendered in the Targum (Onkelos): "And I will cause my Shekinah to dwell," etc. All expressions implying God's *local* presence are similarly rendered: e g, Habak. ii. 20 "Jehovah was pleased to cause His Shekinah to dwell." "To see" God is similarly paraphrased. Thus Is. xxxiii. 17 is rendered "Thine eyes shall see the Shekinah of the king of the worlds." So "hiding the face," when used of God is regularly paraphrased "remove His Shekinah" (Is. lvii. 17, viii. 17, lix. 2). Closely connected with the idea of the Shekinah is that of "the glory of the Lord" "Glory," indeed, in this connection was conceived of as a property of the Shekinah (as, in fact, it is of God). For the divine "glory" as a property of the Shekinah, *ef., e.g.,* Is vi. 5 which is rendered "mine eyes have seen the glory of the Shekinah of the King," etc.

This Shekinah-glory is several times denoted in the New Testament by δόξα. The most notable passage is Rom. ix. 4, where St. Paul, enumerating the list of Israel's privileges, says: "whose is the adoption, *and the* glory" (ie., the Shekinah-glory); *cf*, Luke ii. 9. There is also an obvious allusion to the Shekinah in the description of the theophanic cloud of the transfiguration-narrative (St. Matt. xvii. 5 and parallels? the same verb being used as in the lxx. of Exod. xl. 34, seq There can be no doubt too, that the word rendered "tabernacle" (σκηνή) with the corresponding verb "to tabernacle" (σκηνοῦν) is used in St. John i. 14, and Rev. xii. 3, because of its likeness to the term "Shekinah." In St. John i. 14, there is an allusion to the Word (the *mēmrā* of the Targums) the Shekinah. and the Shekinah-glory, all of which the writer declares became incarnate in Jesus. Cf. also Heb i 3.

It is remarkable that the *mēmrā* (Logos or "Word") of the Targums almost entirely disappears in the Midrashic literature and the Talmud, its place being taken by Shekinah The Rabbis apparently dreaded the possibility of such terms becoming hypostasized into personal entities distinct from God. Against this they emphasized the Shekinah-idea. It Is safe to say that wherever Shekinah is mrntioned in Rabbinic literature it is God's direct action or activity that is thought of Independent personality is never imputed to it (Maimonides, however, regarded the Shekinah, like the *mēmrā* and "the glory" as a distinct entity) It is probable that the use of the term was often in Rabbinic writings polemical (against Jewish Christians or gnostic sects).

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SHELDON, CHARLES MONROE (1857–1946), U.S. preacher and inspirational writer, famous as the author of the best-selling novel. *In His Steps,* was born in Wellsville, N.Y., Feb. 26. 1857. He was educated at Brown university, Providence, R.I.. and Xndover theological seminary. Andover, Mass. In 1889 he founded the Central Congregational church in Topeka, Kans. His serial sermons attracted a congregation that attended both morning and evening services, and were equally popular when printed. The most successful, *In His Steps,* concerned the inhabitants of a town who pledged themselves to live for a year as Jesus would live. First published serially in 1896 and in book form in 1897, *In His Steps* is said to have sold more copies than any other book except the Bible. A more conservative estimate is 6,000,000 sales throughout the world of which 2,000,000 were in the C.S. Sheldon died at Topeka on Feb. 24, 1946.

Sheldon's other works include *Richard Bruce* (1892); *The Heart of the World* (1905); *Charles M. Sheldon: His Life Story* (1925) and *He Is Here* (1931). From 1920 to 1925 Sheldon edited the *Christian Herald.* Pacifist and Christian socialist tendencies are discernible in his writings.

See Frank Luther Mott, *Golden Multitudes* (1947).

SHELDON, EDWARD AUSTIN (1823–1897), U.S. educator. principal of the Oswego State normal and training school, which for over a generation was a powerful influence in U.S. lower schooling, was born near Perry Center, N.Y., on Oct. 4, 1823. He entered Hamilton college in 1844 to prepare for law, but ill-health forced him to withdraw in 1847. The following year, after having been admitted to the Auburn theological seminary, he was persuaded to run an Oswego charity school for underprivileged children. Thereafter he laboured in education in one capacity or other.

In 1853 Sheldon became school superintendent of Oswego, N.Y. There he introduced the educational methods of the Swiss educator, J. H. Pestalozzi. These stressed learning through the senses, and thus called for observation, the use of objects and the spoken word, and the subordination of memorizing and book learning. To acquaint his teachers with the new methods, Sheldon organized a special training class. Fiercely contested, Sheldon's ideas nonetheless prevailed, and in 1861 the city of Oswego opened a normal school to train prospective teachers in the new pedagogy. In 1865 the National Teachers association endorsed object teaching. Finally, in 1866, the school at Oswego was transformed into a state normal school with Sheldon in charge. There the Pestalozzian movement reached its height, setting the style for teacher training in the Cnited States. Sheldon died on Aug. 26, 1897.

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SHELDON, GILBERT (1598–1677), archbishop of Canterbury, was born at Stanton in the parish of Ellastone, Staffordshire, and educated at Oxford. He was ordained in 1622 and was appointed chaplain to Thomas Lord Coventry (1578–1640). Four years later he was elected warden of All Souls college, Oxford. In 1648 he was ejected from All Souls by order of parliament for his royalist activities, and imprisoned for some months, but he regained the wardenship in 1659. In 1660 he became bishop of London and master of the Savoy, and the Savoy conference was held at his lodgings. He was consecrated archbishop of Canterbury in 1663. He was greatly interested in the welfare of Oxford university, of which he became chancellor in 1667, succeeding Clarendon (1609–74). The Sheldonian theatre at Oxford was built (1669) and endowed at his expense.

See V. Staley, *The Life and Times of Gilbert Sheldon* (1913).

SHELDRAKE (SHELD-DRAKE) *(Tadorna tadorna),* a bird of the duck tribe, Anatidae, distinguished by its size and upright stature. and by its striking black, white and bay plumage. The head and neck are a very dark glossy green and the speculum, or uing spot bronze-green. The bill. which bears a fleshy knob at its base, is pale red. The female is smaller but very similar in coloration. The sheldrake inhabits sandy coasts in Europe, Asia and north Africa, penetrating inland in favourable localities. The nest is made under cover, usually in rabbit burrows; in the Frisian Islands the people supply artificial burrows to obtain the eggs and down for their own profit. The male assists in incubation and care of the brood. The allied *T. radjah* of Australia, Papua. and the Moluccas is less brightly coloured. and the head is white. *Casarca rutila,* the ruddy sheldrake, inhabits Barbary, southeastern Europe and central Asia; it is an almost uniform bay, but with some black and white markings and a green and purple speculum. Other species occur in various parts of Africa and Australia and also in New Zealand. In 1859, in the London Zoological Gardens, a male *T. cornuta* was mated with a female *C. cana* from Africa, the resultant offspring resembling the two Australasian species of *Casarca.* Related to the sheldrakes are the genera *Chenalopex,* including the Egyptian goose (C. *aegyptiaca)* and *Plectropterus,* the spur-winged goose of Africa.

SHELLAC: *see* RESINS: *Natural Resins.*

SHELLEY, MARY WOLLSTONECRAFT (1797–1851), English writer, only daughter of William Godwin and his wife Mary Wollstonecraft, and second wife of the poet Percy Bysshe Shelley, was born in London on Aug. 30, 1797. For the history of her girlhood and of her married life *see* GODWIN, WILLIAM, and SHELLEY, PERCY BYSSHE. When she was in Switzerland with Shelley and Byron in 1816 a proposal was made that various members of the party should write a romance or tale dealing with the supernatural. The result of this project was that Mrs. Shelley wrote *Frankenstein,* Byron, the beginning of a narrative about a vampire, and Dr. Polidori, Byron's physician, a tale named *The Vampyre,* the authorship of which later was frequently attributed to Byron himself.

Frankenstein, published in 1818, when Mary Shelley was at the utmost 21 years old, is a remarkable performance for so young and inexperienced a writer; its main idea is that of the formation and vitalization, by a deep student of the secrets of nature, of an adult man. who, entering the world thus under unnatural conditions, becomes the terror of his species, a half-involuntary criminal, and finally an outcast whose sole resource is self-immolation. This romance was followed by *Valperga, or the Life and Adventures of Castruccio, Prince of Lucca* (1823), a historical tale written with a good deal of spirit, and readable enough even now; *The Last Man* (1826), a fiction of the final agonies of human society owing to the universal spread of a pestilence—this is written in a very stilted style, but possesses a particular interest because Adrian is a portrait of Shelley; *The Fortunes of Perkin Warbeck* (1830); *Lodore* (183j), also bearing partly upon Shelley's biography, and *Falkner* (1837). Besides these novels there was the *Journal of a Six Weeks' Tour,* which is published in conjunction with Shelley's prose writings; and *Rambles in Germany and Italy* (1844) (which shows an observant spirit, capable of some true forecasts of the future); and miscellaneous writings.

After the death of Shelley, Mary in the autumn of 1823 returned to London. At first she had to live by her writings; but after a while Sir Timothy Shelley made her an allowance, which would have been withdrawn if she had persisted in a project of writing a full biography of her husband. In 1838 she edited Shelley's works, supplying the valuable notes She succeeded, by strenuous exertions, in maintaining her son Percy at Harrow and Cambridge; in 1840 his grandfather acknowledged his responsibilities and in 1844 Percy succeeded to the baronetcy. She died on Feb. 21, 1851.

See Richard Church, *Mary Shelley* (1928); R. G. Grylls, *Mary Shelley: A Biography* (1938); SHELLEY, PERCY BYSSHE: *Bibliography.*

SHELLEY, PERCY BYSSHE (1792–1822), English poet, was born on Aug. 4, 1792, at Field Place, near Horsham, Sussex. He was the eldest child of Timothy Shelley (1753–1844), member of parliament for Shoreham, by his wife Elizabeth, daughter of Charles Pilfold, of Effingham, Surrey.

In the character of Percy Bysshe Shelley three qualities became early manifest, and may be regarded as innate: impressionableness or extreme susceptibility to external and internal impulses of feeling; a lively imagination or erratic fancy, blurring a sound estimate of solid facts; and a resolute repudiation of outer authority or the despotism of custom. These qualities were highly developed in his earliest manhood, were active in his boyhood, and no doubt made some show even on the borderland between childhood and infancy. At the age of six he was sent to a day school at Warnham, kept by the Rev. Mr. Edwards; at ten to Sion House School, Brentford, of which the principal was Dr. Greenlaw, while the pupils were mostly sons of local tradesmen; at twelve (or immediately before that age, on the 29th of July 1804) to Eton. The headmaster of Eton. up to nearly the close of Shelley's sojourn in the school, was Dr. Goodall, a mild disciplinarian; it is therefore a mistake to suppose that Percy (unless during his very brief stay in the lower school) was frequently flagellated by the formidable Dr. Keate, who only became headmaster after Goodall. Shelley was a shy, sensitive, mopish sort of boy from one point of view—from another a very unruly one, having his own notions of justice, independence and mental freedom; by nature gentle, kindly and retiring—under provocation dangerously violent. He resisted the odious fagging system, exerted himself little in the routine of school-learning, and was known both as "Mad Shelley" and as "Shelley the Atheist." Shelley's first published work, a romance entitled "Zastrozzi" (1810), appeared shortly before he left Eton. This volume was followed quickly by "Original Poetry by Victor and Cazire" (1810) written in collaboration with his sister Elizabeth; and another romance "St. Irvyne or the Rosicrucian" (1811). In these early efforts Shelley played the sedulous ape to "Monk" Lewis, Ann Radcliffe, Rosa Matilda and other exponents of the "School of Terror," but worthless though they may be intrinsically, they are not without interest as having been written by the same hand that gave us "Prometheus Unbound," and "Hellas."

Oxford Life.—Shelley entered University College, Oxford, in April 1810. returned thence to Eton. and finally quitted the school at mid-summer, and commenced residence in Oxford in October. Here he met a young Durham man, Thomas Jefferson Hogg, who had preceded him in the university by a couple of months; the two youths at once struck up a warm and intimate friendship. Shelley had at this time a love for chemical experiment, as well as for poetry, philosophy and classical study, and was in all his tastes and bearing an enthusiast. He continued to write verse and published at Oxford a small collection entitled "Posthumous Fragments of Margaret Nicholson" (1810). The title was suggested by Hogg and is the only touch of the burlesque in what otherwise is a feeble attempt at serious poetry. Hogg was not an enthusiast, but he was a steady and well-read classical student. In religious matters both were sceptics; whether Hogg, as the senior and more informed disputant, pioneered Shelley into strict atheism, or whether Shelley, as the more impassioned and unflinching speculator, outran the easy-going jeering Hogg, is a moot point; we incline to the latter opinion. Certain it is that each egged on the other by perpetual disquisition on abstruse subjects, conducted partly for the sake of truth and partly for that of mental exercitation, without on either side any disposition to bow to authority or stop short of extreme conclusions. The upshot of this habit was that Shelley and Hogg, at the close of some five months of happy and uneventful academic life, got expelled from the university. Shelley—for he alone figures as the writer of the "little syllabus," although there can be no doubt that Hogg was his confidant and coadjutor throughout—published anonymously a pamphlet entitled *The Necessity of Atheism* (1811), which he sent round to bishops and all sorts of people as an invitation or challenge to discussion. It amounted to saying that neither reason nor testimony is adequate to establish the existence of a deity, and that nothing short of a personal individual self-revelation of the deity would be sufficient.

The college authorities heard of the pamphlet, identified Shelley as its author, and summoned him before them—"our master, and two or three of the fellows." The pamphlet was produced, and Shelley was required to say whether he had written it or not. The youth declined to answer the question, and was expelled by a written sentence, ready drawn up. Hogg was next summoned, with a result practically the same. The precise details of this transaction have been much controverted; the best evidence is that which appears on the college records, showing that both Hogg and Shelley (Hogg is there named first) were expelled for "contumaciously refusing to answer questions," and for "repeatedly declining to disavow" the authorship. Thus they were dismissed as being mutineers against academic authority, in a case pregnant with the suspicion—not the proof—of atheism; but how the authorities could know beforehand that the two undergraduates would be contumacious and stiff against disavowal, so as to give warrant for written sentences ready drawn up, is nowhere explained. Possibly the sentences were worded without ground assigned, and would only have been produced in *terrorem* had the young men proved more malleable.

Harriet Westbrook.—Shelley and Hogg came up to London, where Shelley was soon left alone, as his friend went to York to study conveyancing. Percy and his incensed father did not at once come to terms, and for a while he had no resource beyond pocket-money saved up by his sisters (four in number altogether) and sent round to him, sometimes by the hand of a singularly pretty school-fellow, Harriet Westbrook, daughter of a retired and moderately rich hotel-keeper. Shelley, in early youth, had a somewhat "priggish" turn for moralizing and argumentation, and a mania for proselytizing; his school-girl sisters, and their little Methodist friend Miss Westbrook, aged between fifteen and sixteen, must all be enlightened and converted to anti-Christianity. He cultivated the society of Harriet, being encouraged in his assiduity by her much older sister Eliza. Harriet fell in love with him; and he, though not it would seem at any time ardently in love with her, dallied along the pathway which leads to sentiment and a definite courtship. This was not his first love-affair; for he had but a very few months before been courting his cousin Harriet Grove, who, alarmed at his heterodoxies, finally broke off with him—to his no small grief and perturbation at the time. It seems that Shelley never indulged in any sensual or dissipated amour; and, as he advances in life, it becomes apparent that, though capable of the passion of love, and unusually prone to regard with much effusion of sentiment women who interested his mind and heart, the mere attraction of a pretty face or an alluring figure left him unenthralled.

After a while Shelley was reconciled to his father, revisited his family in Sussex and made the acquaintance of Miss Elizabeth Hitchener, a school-teacher at Hurstpierpoint with whom, for the space of one year he pursued an intimate and voluminous correspondence. He then stayed with a cousin in Wales, from whence he was recalled to London by Harriet, who wrote complaining of her father's resolve to send her back to her school, in which she was now regarded with repulsion as too apt a pupil of the atheist Shelley. He replied counselling resistance. "She wrote to say" (these are the words of Shelley in a letter to Hogg, dating towards the end of July 1811) "that resistance was useless, but that she would fly with me, and threw herself upon my protection." Shelley returned to London, where he found Harriet agitated and wavering; finally they agreed to elope, travelled in baste to Edinburgh, and there, on Aug. 28, were married with the rites of the Scottish Church. Shelley had by this time openly broken, not only with the dogmas and conventions of Christian religion, but with many of the institutions of Christian polity, and in especial with such as enforce and regulate marriage; he held—with William Godwin—that marriage ought to be simply a voluntary relation between a man and a woman, to be assumed at joint option and terminated at the after-option of either party. If, therefore, he had acted upon his personal conviction of the right, he would never have wedded Harriet, whether by Scotch, English or any other law; but as they were married without delay on their arrival in Edinburgh, it is probable that Harriet may have consented to the elopment on the understanding that Shelley would marry her.

Harriet Shelley was not only beautiful; she was amiable, accommodating, adequately well educated and well bred. She liked reading, and her reading was not strictly frivolous. But she could not (as Shelley said at a later date) "feel poetry and understand philosophy." She appears to have been a simple-minded affectionate girl who did her best to respond to her husband's somewhat nebulous ideas on sociology and politics. For nearly three years Shelley and she led a shifting sort of life upon an income of £400 a year, one-half of which was allowed (after his first severe indignation at the *mésalliance* was past) by Mr. Timothy Shelley, and the other half by Mr. Westbrook. The couple left Edinburgh for York and the society of Hogg; broke with him upon a charge made by Harriet, and evidently fully believed by Shelley at the time, that, during a temporary absence of his upon business in Sussex, Hogg had tried to seduce her (this quarrel was entirely made up at the end of about a year); moved off to Keswick in Cumberland, where they received kind attentions from Southey, and some hospitality from the duke of Norfolk, who, as chief magnate in the Shoreham region of Sussex, was at pains to reconcile the father and his heir; sailed thence to Dublin, where Shelley was eager in the good cause of Catholic emancipation, conjoined with repeal of the union; crossed to Wales, and lived at Nant-Gwillt, near Rhayader, then at Lynmouth in Devonshire, then at Tanyrallt in Carnarvonshire. All this was between September 1811 and February 1813.

Residence in Wales.—At Lynmouth an Irish servant of Shelley's was sentenced to six months' imprisonment, but released on his master's recognizances, for distributing and posting up printed papers, bearing no printer's name, of an inflammatory or seditious tendency—being a Declaration of Rights composed by the youthful reformer, and some verses of his named The Devil's *Walk.* At Tanyrallt Shelley was (according to his own and Harriet's account, confirmed by the evidence of Miss Westbrook, the elder sister, who continued an inmate in most of their homes) attacked on the night of Feb. 26 by an assassin who fired three pistol-shots It was either a human assassin or (as Shelley once said) "the devil." The motive of the attack was undefined; the fact of its occurrence was generally disbelieved, both at the time and by subsequent inquirers. A disclosure, some years later, proved that a shepherd close to Tanyrallt, named Robin Pant Evan, being irritated by some well-meant acts of Shelley in terminating the lives of dying or diseased sheep, did really combine with two other shepherds to scare the poet, and Evan was the person who played the part of "assassin." This was the break-up of the residence of the Shelleys at Tanyrallt; they revisited Ireland, and then settled for a while in London. Here, in June 1813, Harriet gave birth to her daughter Ianthe Eliza (she married a Mr Esdaile, and died in 1876). Here also Shelley brought out his first poem of any importance, Queen *Mab;* it was privately printed, as its aggressive tone in matters of religion and morals would not allow of publication. In July the Shelleys took a house at Bracknell near Windsor Forest, where they had congenial neighbours, Mrs. Boinville and her family. Early in the summer of 1814 Shelley paid his last visit to Field Place (during the absence of his father), to see his mother. Several attempts to arrive at a reconciliation with his father had failed, probably owing, among other circumstances, to the officious intervention of the family solicitor.

The **Godwin** Circle.—The speculative sage whom Shelley especially reverenced was William Godwin (*q.v.*); in 1796 he had married Mary Wollstonecraft, authoress of The Rights *of Woman,* who died shortly after giving birth, on Aug. 30, 1797, to a daughter Mary. With Godwin Shelley had opened a volunteered correspondence at the beginning of 1812, and he had known him personally since the winter which closed 1812. Godwin was then a bookseller, living with his second wife, who had been a Mrs. Clairmont; there were four other members of the household, two of whom call for some mention here—Fanny Wollstonecraft, the daughter of the authoress and Mr. Imlay, and Claire (Clara Mary Jane), the daughter of Mrs. Clairmont. Fanny committed suicide in October 1816, being. according to some accounts which remain unverified, hopelessly in love with Shelley; Claire was closely associated with all his subsequent career. It was towards May 1814 that Shelley first saw Mary Wollstonecraft Godwin as a grown-up girl (she was well on towards seventeen); he instantly fell in love with her, and she with him. Just before this, on March 24, Shelley had remarried Harriet in London, apparently with a view to strengthening his position in his relations with his father as to the family property; but, on becoming enamoured of Mary, he seems to have rapidly made up his mind that Harriet should not stand in the way. She was at Bath while he was in London. They had, however, met again in London and come to some sort of understanding before the final crisis arrived—Harriet remonstrating and indignant, but incapable of effective resistance—Shelley sick of her companionship, and bent upon gratifying his own wishes, which as we have already seen were not at odds with his avowed principles of conduct. For some months past there had been bickerings and misunderstandings between him and Harriet, aggravated by the now detested presence of Miss Westbrook in the house; more than this cannot be said, and it seems dubious whether more will be hereafter known. Shelley, and not he alone, alleged grave misdoing on Harriet's part—perhaps mistakenly. The upshot came on July 28, when Shelley aided Mary to elope from her father's house, Claire Clairmont deciding to accompany them. They crossed to Calais, and proceeded across France into Switzerland. Godwin and his wife were greatly incensed. Though he and Mary Wollstonecraft had entertained and avowed bold opinions regarding the marriage-bond, similar to Shelley's own, and had in their time acted upon these opinions, it is not clearly made out that Mary Godwin had ever been encouraged by paternal influence to think or do the like. Shelley and she chose to act upon their own responsibility—he disregarding any claim which Harriet had upon him, and Mary setting at nought her father's authority. Both were prepared to ignore the law of the land and the rules of society.

The three young people returned to London in September. In the following January 1815 Sir Bysshe Shelley died, and Percy, who had lately been in great money-straits, became the immediate heir to the entailed property inherited by his father Sir Timothy. This entailed property seems to have been worth £6,000 per annum, or little less. He came to an understanding with his father and, giving up certain future advantages, he received henceforth a regular income of £1,000 a year. Out of this he assigned £200 a year to Harriet, who had given birth in November to a son, Charles Bysshe (he died in 1826). Shelley, and Mary as well, were on moderately good terms with Harriet, seeing her from time to time. His peculiar views as to the relations of the sexes appear markedly again in his having (so it is alleged) invited Harriet to return to his and Mary's house as a domicile; an arrangement which did not take effect. He had, undoubtedly, while previously abroad with Mary, invited Harriet to stay in their immediate neighbourhood. Shelley and Mary (who was naturally always called Mrs. Shelley) now settled at Bishopgate, near Windsor Forest; here he produced his first excellent poem, Alastor, or *the* Spirit of Solitude, which was published soon afterwards (1816) with a few others. Thomas Love Peacock was one of his principal associates at Bishopgate.

With Byron in Switzerland.— In May 1816 the Shelleys left England for Switzerland, together with Claire Clairmont, and their own infant son William. They went straight to Sécheron, near Geneva; Byron, whose separation from his wife had just then taken place, arrived there immediately afterwards. A great deal of controversy has arisen as to the motives and incidents of this foreign sojourn. The clear fact is that Claire Clairmont, who had a fine voice and some inclination for the stage, had seen Byron, as connected with the management of Drury Lane theatre, early in the year, and an intrigue had begun between them in London. Prima facie it seems quite reasonable to suppose that she had explained the facts to Shelley or to Mary, or to both, and had induced them to convoy her to the society of Byron abroad; were this finally established as the fact, it would show no inconsistency of conduct, or breach of his own code, on Shelley's part. But documentary evidence shows that Mary was totally ignorant of the amour shortly before they went abroad. Whether or not they knew of it while they and Claire were in daily intercourse with Byron, and housed close by him on the shore of the Lake of Geneva, may be left unargued. The three returned to London in September 1816, Byron remaining abroad; and in January 1817

Claire gave birth to his daughter named Allegra.

The return of the Shelleys was closely followed by two suicides —first that of Fanny Wollstonecraft (already referred to), and second that of Harriet Shelley, who on Nov. 9 drowned herself in the Serpentine. The body was not found until Dec. 10. The latest stages of the lovely and ill-starred Harriet's career have never been very explicitly recorded. It seems that she formed a connexion with some man from whom circumstances or desertion separated her, and that she was treated with harshness by her sister during an illness of their father. She had always had a propensity to the idea of suicide, and she now carried it out in act. Shelley, then at Bath, hurried up to London when he heard of Harriet's death, giving manifest signs of the shock which so terrible a catastrophe had produced on him. So far from Shelley dismissing the subject from his mind it is more than probable that the memory of this tragedy was ever present to him, and especially so during his last days.

This was the time when Shelley began to see a great deal of Leigh Hunt. the poet and essayist, editor of the *Examiner;* they were close friends, and Hunt did something to uphold the reputation of Shelley as a poet—which, we may here say once for all, scarcely obtained any public acceptance or solidity during his brief lifetime. The death of Harriet having removed the only obstacle to a marriage with Mary Godwin, the wedding ensued on Dec. 30, 1816, and the married couple settled down at Great Marlow in Buckinghamshire. Their tranquillity was shortly disturbed by a Chancery suit set in motion by Mr. Westbrook, who asked for the custody of his two grandchildren, on the ground that Shelley had deserted his wife and intended to bring up his offspring in his own atheistic and anti-social opinions. Lord Chancellor Eldon delivered judgment on March 27, 1817. He held that Shelley, having avowed condemnable principles of conduct, and having fashioned his own conduct to correspond, and being likely to inculcate the same principles upon his children, was unfit to have the charge of them. He appointed as their curator Dr. Hume, an orthodox army-physician, who was Shelley's own nominee. The poet had to pay for the maintenance of the children a sum which stood eventually at £120 per annum; if it was at first (as generally stated) £200, that was no more than what he had previously allowed to Harriet. This is the last incident of marked importance in the perturbed career of Shelley; the rest relates to the history of his mind, the poems which he produced and published, and his changes of locality in travelling. The first ensuing poem was The Revolt of *Islam,* referred to near the close of this article.

Removal to Italy.—In March 1818, after an illness which he regarded (rightly or wrongly) as a dangerous pulmonary attack, Shelley, with his wife, their two infants William and Clara, and Claire Clairmont and her baby Allegra, went off to Italy, where the short remainder of his life was passed. Allegra was soon sent on to Venice, to her father, who, ever since parting from Claire in Switzerland, showed a callous and unfeeling determination to see and know no more about her. In 1818 the Shelleys—always nearly with Claire in their company—were in Milan, Leghorn, the Bagni di Lucca, Venice and its neighbourhood. Rome and Naples; in 1819 in Rome, the vicinity of Leghorn and Florence (both their infants were now dead. but a third was born late in 1819, Percy Florence Shelley, who in 1844 inherited the baronetcy and died in 1889); in 1820 in Pisa the Bagni di Pisa (or di San Giuliano), and Leghorn; in 1821 in Pisa and with Byron in Ravenna; in 1822 in Pisa and on the Bay of Spezia, between Lerici and San Terenzio.

The incidents of this period are but few, and of no great importance apart from their bearing upon the poet's writings. In Leghorn he knew Mr. and Mrs. Gisborne, the latter a once intimate friend of Godwin; she taught Shelley Spanish, and he was eager to promote a project for a steamer to be built by her son by a former marriage, the engineer Henry Reveley; it would have been the first steamer to navigate the Gulf of Lyons. In Pisa he formed an intimacy with the Contessina Emilia Viviani, a girl who was pining in a convent pending her father's choice of a husband for her; this impassioned but vague and fanciful attachment —which soon came to an end, as Emilia's character developed less favourably in the eyes of her Platonic adorer—produced the transcendental love-poem of *Epipsychidion* in 1821. In Ravenna the scheme of the quarterly magazine the Liberal was concerted by Byron and Shelley, the latter being principally interested in it with a view to benefiting Leigh Hunt by such an association with Byron.

In Pisa Byron and Shelley were constantly together, having in their company at one time or another Shelley's cousin and schoolfellow Captain Thomas Medwin (1788–1869), Lieutenant Edward Elliker Williams (1793–1822) and his wife, to both of whom the poet was very warmly attached, and Captain Edward John Trelawny, the adventurous and romantic seaman, who has left important and interesting reminiscences of this period. Byron admired very highly the generous, unworldly and enthusiastic character of Shelley, and set some value on his writings; Shelley half-worshipped Byron as a poet, and was anxious, but in some conjunctures by no means able, to respect him as a man. In Pisa he knew also Prince Alexander Mavrocordato, one of the pioneers of Grecian insurrection and freedom; the glorious cause fired Shelley, and he wrote the drama of *Hellas* (1821) with its magnificent choruses breathing of hope for the future of mankind.

Last Days.—The last residence of Shelley was the Casa Magni, a bare and exposed dwelling on the Gulf of Spezia. He and his wife, with the Williamses, went there at the end of April 1822 to spend the summer, which proved an arid and scorching one. Peacock describes Shelley as being disillusioned during his last days; there is certainly a trace of melancholy in his later lyrics and correspondence; a foreboding of some approaching fatality which, however, he appears to have attempted to divert. Shelley and Williams, both of them insatiably fond of boating, had a small schooner named the "Don Juan" (or more properly the "Ariel"), built at Genoa after a design which Williams had procured from a naval friend, but the reverse of safe. They received her on May 12, found her rapid and alert, and on July 1 started in her to Leghorn, to meet Leigh Hunt, of whose arrival in Italy he had just been notified. After doing his best to set things going comfortably between Byron and Hunt, Shelley returned on board with Williams on July 8. It was a day of dark, louring, stifling heat. Trelawny took leave of his two friends, and about half-past six in the evening found himself startled from a doze by a frightful turmoil of storm. The "Ariel" had by this time made Via Reggio; she was not to be seen, though other vessels which had sailed about the same time were still discernible. Shelley, Williams and their only companion, a sailor-boy, perished in the squall. The exact nature of the catastrophe was from the first regarded as somewhat disputable. The condition of the "Ariel" when recovered did not favour any assumption that she had capsized in a heavy sea--rather that she had been run down by some other vessel, a felucca or fishing-smack. In the absence of any counter-evidence this would be supposed to have occurred by accident; but a rumour, not strictly verified and certainly not refuted, exists that an aged Italian seaman on his deathbed confessed that he had been one of the crew of the fatal felucca, and that the collision was intentional, as the men had plotted to steal a sum of money supposed to be on the "Don Juan," in charge of Lord Byron. In fact there was a moderate sum there, but Byron had neither embarked nor intended to embark. This may perhaps be the true account of the tragedy; at any rate Trelawny, the best possible authority on the subject, accepted it as true. He it was who laboriously tracked out the shore-washed corpses of Williams and Shelley, and who undertook the burning of them, after the ancient Greek fashion, on the shore near Viareggio, on Aug. 15 and 16. The great poet's ashes were then collected, and buried in the new Protestant cemetery in Rome. He was, at the date of his untimely death, within a month of completing the thirtieth year of his age

Character.—The character of Shelley can be considered according to two different standards of estimation. We can estimate the original motive forces in his character; or we can form an opinion of his actions, and thence put a certain construction upon his personal qualities We will first try the latter method. It cannot be denied that his actions were in some considerable degree abnormal, dangerous to the settled basis of society, and marked by headstrong and undutiful presumption. Rut it is remarkable that, even among the censors of his conduct, many persons are none the less impressed by the beauty of his character; and this leads us back to our first point — the original motive forces in that. Here we find enthusiasm. fervour. courage (moral and physical), an unbounded readiness to act upon what he considered right principle, however inconvenient or disastrous the consequences to himself, sweetness and indulgence towards others, extreme generosity (he appears to have given Godwin, though sometimes bitterly opposed to him, between £4,000 and £5,000), and the principle of love for humankind in abundance and superabundance. He respected the truth, as he conceived it, in spiritual or speculative matters, and respected no construction of the truth which came to him recommended by human authority. No man had more hatred or contempt of custom and prescription; no one had a more authentic or vivid sense of universal charity. The same radiant enthusiasm which appeared in his poetry as idealism stamped his speculation with the conception of perfectibility and his character with loving emotion.

In person Shelley was attractive, winning and almost beautiful, but not to be called handsome. His height was nearly 5 ft. 11; he was slim. agile and strong. with something of a stoop: his complexion brilliant. his hair abundant and wavy, dark brown but early beginning to grizzle: the eyes. deep blue in tint, have been termed "stag-eyes" — large, fixed and beaming. His voice was high-pitched and wanting in richness and suavity; his general aspect, though extremely variable according as his mood of mind and his expression shiited. was on the whole youthful. The only portrait of Shelley. from which some idea of his looks used to be iormed. is that painted by an amateur. Miss Curran. in 1819; Mrs. Shelley, later, pronounced it to be "in many things very like." This is now in the National Portrait Gallery, together with a quasi-duplicate of it painted by Clint. chiefly from Miss Curran's likeness. and partly from a water colour (now lost) by Lieutenant Williams. In 1905 (*Century Magazine*) another portrait was brought forward: a pencil sketch taken in the last month of the poet's liie hy an American artist. William E. West. followed by an oil-painting founded on that sketch. The two works differ very considerably, and neither of them resembles Miss Curran's portrait: yet we incline to believe that the sketch was really taken from Shelley.

Place in European Literature. — If we except Goethe (and leave out of count living writers. whose ultimate value cannot at present be assessed). we must consider Shelley to be a supreme poet of the new era which. beginning with the French Revolution, remains continuous into our own day. Victor Hugo shares his lofty poetic stature. and might for certain reasons be even preferred to him; Byron and Wordsworth also belong to the same great period, and later. Tennyson and Browning. The grounds, however, on which Shelley's eminence is based are mainly three. He is unexcelled in his ideality. unexcelled in his music and unexcelled in his importance. By importance we here mean the direct import of the work performed, its controlling power over the reader's thought and feeling. the contagious fire of its white-hot intellectual passion, and the long reverberation of its appeal. Shelley is emphatically the poet of the future. In his own day an alien in the world of mind and invention, and in our day but partially a denizen of it, he appears destined to become, in the long vista of years, an informing presence in the innermost shrine of human thought. Shelley appeared at the time when the sublime frenzies of the French revolutionary movement had exhausted the elasticity of men's thought — at least in England — and had left them flaccid and stolid: but that movement prepared another in which revolution was to assume the milder guise of reiorm. conquering and to conquer. Shelley was its prophet. As an iconoclast and an idealist he took the only position in which a poet could advantageously work as a reformer. To outrage his contemporaries was the condition of leading his successors to triumph and of personally triumphing in their victories. Shelley had the temper of an innovator and a martyr; he united speculative keenness and humanitarian zeal in a degree for which we might vainly seek his precursor. We have already named ideality as one oi his leading excellences. This Shelleian quality combines, as its constituents, sublimity, beauty and the abstract passion for good. Perhaps no outstanding English poet, and he was essentially an English poet, has used a greater variety of forms and measures than Shelley. In the pure lyrics the rapture, the music and the emotion are in exquisite balance. and the work has often as much of delicate simplicity as of fragile and flower-like perfection. Great as Shelley's fame is now, it should be remembered that it was entirely posthumous. He practically received no encouragement during his lifetime. and died believing that the world had rejected his poetry.

Works. — Some of Shelley's principal writings have already been mentioned above; we must now give a brief account of others. *Alastor* (1816) was succeeded (1817) by *The Revolt of Islam,* a poem of no common length in the Spenserian stanza, preaching bloodless revolution: it was written in a sort of friendly competition with Keats (who produced *Endymion*) and is amazingly fine, but as a whole somewhat long-draw* and exhausting. This transcendental epic (for such it may be termed) was at first named *Laon and Cythna, or the Revolution of the Golden City*, and the lovers of the story were then brother and sister as well as lovers — an experiment upon British endurance which the publishers would not connive at. The year 1818 produced *Rosalind and Helen,* a comparatively weak poem, begun in England and finished in Italy, and *Julian and Maddalo,* a very strong one. written in the neighbourhood of Yenice — demonstrating in Shelley a singular power of seeing ordinary things with directness, and at once figuring them as reality and transfiguring them into poetry. In each of these two poems Shelley gives a quasi-portraiture of himself: and in the latter one may perhaps trace a veiled description of Harriet's tragic end. The next year. 1819, was his culmination. producing as it did the grand tragedy of *The Cenci* and the sublime ideal drama *Prometheus Unbound,* composed partly on the ruins of the Earhs of Caracalla in Rome. This last we have no hesitation in calling his masterpiece. It embodies, in forms of surpassing imagination and beauty: Shelley's deepest and most daring conceptions. Prometheus, the human mind and will, has invested with the powers proper to himself Jupiter, the god of heaven: who thereupon chains and torments Prometheus and oppresses mankind: in other words, the anthropomorphic god of religion is a creation of the human mind, and both the mind of man and man himself are enslaved as long as this god exercises his delegated but now absolute power. Prometheus. who is from of old wedded to Asia, or Nature. protests against and anathematizes the usurper enthroned by himself. At last the anathema (although Prometheus has revoked it by an act of self-conquest) takes effect: Eternity. Demogorgon, dismisses Jupiter to unending nothingness. Prometheus is at once unbound, the human mind is free: he is reunited to his spouse Nature, and the world of man passes from thraldom and its degradation into limitless progression. or (as the phrase goes) perfectibility, moral and material. This n-e regard as in brief the argument of *Prometheus Unbound.* It is closely analogous to the argument of the juvenile poem *Queen Mab*, but so raised in form and creative touch that. whereas to write *Queen Mab* was only to be an ambitious and ebullient tiro, to invent *Prometheus Unbound* was to be the poet of the future. *The Witch of Atlas* (1820) is the most perfect work among all Shelley's longer poems, though it is neither the deepest nor the most interesting. It may be rated as a pure exercise oi roving imagination—guided. however, by an intense sense of beauty, and by its author's exceeding fineness of nature.

The elegy on Keats. *Adonais*. followed in 1821. The translations—chiefly from Homer. Euripides. Calderon and Goethe—date from 1819 to 1822. and testify to the poetic endowment of Shelley not less absolutely than his own original compositions; there are also prose translations from Plato.

Shelley. it will be seen. was not only a prolific but also a versatile poet. Works so various in faculty and in form as *The Revolt of Islam*, *Julian and Maddalo*, *The Cenci*, *Prometheus Unbound*, *Epipsychidion*, and the grotesque effusions of which *Peter Bell the Third* is the prime example. added to the consummate array of lyrics. have seldom to he credited to a single writer — one. moreover, who died before he was thirty years of age. In prose Shelley could be as admirable as in poetry. His letters to Thomas Love Peacock and others, and his uncompleted *Defence of Poetry,* are the chief monuments of his mastery in prose; and certainly no more beautiful prose—having much of the spirit and the aroma of poetry, yet without being distorted out of its proper essence—is to be found in the English language.

The chief original authorities for the life of Shelley (apart from his own writings, which contain a good deal of autobiography, if heedfully siited and collated) are—(I) the notices by Mrs. Shelley interspersed in her edition of the *Poems;* (2) Hogg's amusing, discerning and authentic, although in some respects exaggerated, book; (3) Trelawny's *Records;* (4) the *Life* by Medwin; and (5) the articles written by Peacock. Some other writers, especially Leigh Hunt, might be mentioned, but they come less close to the facts. Among biographical books produced since Shelley's death, by authors who did not know him personally, the leading work is the *Lije* by Professor Dowden (2 vols., 1886), which embodies important materials imparted by the Shelley family. *The Real Shelley,* by *J. C.* Jeaffreson (1885), is controversial in method and decidedly hostile in tendency, and tries a man of genius by tests far irom well adapted (in our opinion) to bring out a right result; it contains, however, an ample share of solid information and sharp disquisition. The memoir by W. M. Rossetti, prefixed to an edition of Shelley's *Poems* in two forms of publication (1870 and 1878), was an endeavour to formulate in brief space, out of the then confused and conflicting records, an accurate account of Shelley—admiring, but not uncandidly one-sided. There' is valuable material in Lady Shelley's *Shelley Memoriuls,* and in Dr. Garnett's *Relics of Shelley;* and the memoir by J. Addington Symonds, in the *English Men of Letters* series, is characteristic of the writer. *Shelley in England* by Roger Ingpen contains new facts respecting Shelley's relations with his family, his expulsion from Oxford and some unpublished facts about Harriet's death. One of the handiest editions of Shelley's poems was edited by Thomas Hutchinson (Clarendon Press. 1905), which includes the emendations, &c., published by Mr. C.D. Locock (1903) from examination of the MSS. in the Bodleian Library. Mr. Locock edited in 1911 an excellent and fully annotated edition of the Poems, with some new material. A full edition of Shelley's letters was edited by Roger Ingpen in 1909, reprinted with additions in 1911 and 1916. The most complete collection of Shelley's Poems, Prose works and Correspondence is the *Julian Edition* edited *by* Roger Ingpen and W. E. Peck (1927–1929). France has by no means neglected Shelley. A. Koszul's *"La Jeunesse de Shelley"* (1910), is a valuable study of the subject, while André Maurois has written a popular romance in his *"Ariel ou la vie de Shelley"* (1923). Mr. Buxton Forman's earlier and excellent edition includes the writings in prose as well as in verse. (W. M. R.; R. I.)

SHELL MONEY: *see* CURRENCY, PRIMITIVE.

SHELL MOUNDS (KITCHEN MIDDENS; Dan. KJÖKKENMÖDDING), prehistoric refuse heaps or mounds, found in all quarters of the globe, which consist chiefly of the shells of edible mollusks mixed with fragments of animal bones and implements of stone, bone and horn. They may sometimes, as in the Strait of Magellan, be seen in process of formation. Many, of prehistoric origin, have been examined. notably on the eastern coast of Denmark. These were at first thought to be raised beaches, but a cursory examination at once proved their artificial construction. Further investigation proved these shell mounds to belong to the early part of the Neolithic age *(see* ARCHAEOLOGY: *Prehistory).* These mounds contained the remains of quadrupeds. birds and fish, the food of the prehistoric inhabitants. Among the bones were those of the wild bull or aurochs, beaver, seal and great auk, all now extinct or rare in this region. Moreover. shell mounds contain full-sized shells of the common oyster. which cannot live at present in the brackish waters of the Baltic except near its entrance. the inference being that the shores where the oyster at that time flourished were open to the salt sea. Thus also the eatable cockle, mussel and periwinkle abounding in the kitchen middens are of full ocean size. whereas those now living in the adjoining waters are a third of full size as a result of the want of saltness. This extension of the North sea is called the "Littorina sea"; and it existed about 4000–3000 B.C., the end of Brooks's Maritime period. The debris is in some places 10-20 ft. thick.

The men of the kitchen middens had seemingly no knowledge of agriculture. no traces of grain of any sort being found. The only vegetable remains were burned pieces of wood and some charred substance. possibly a sea plant used in the production of salt. Flat stones blackened with fire, forming hearths. were also found. That periods of scarcity must have been frequent is indicated by the discovery of bones of the fox, wolf and other carnivores, which would hardly have been eaten from choice. The kitchen middens of Denmark mere not mere summer quarters: the ancient fishermen appear to have stayed in the neighbourhood for two-thirds if not the whole of the year, since by examination of the bones of the wild animals it is often possible to tell the time of year when they were killed. Thus the remains of the wild swan (*Cygnus musicus*), a winter visitor, leaving the Danish coast in March and returning in November, are found in abundance. Additional proof is afforded among the mammalian remains by two periodical phenomena, the shedding of the stag's antlers and the birth and growth of the young. The flint implements found include flakes, axes, awls, slingstones or net weights and rude lance heads. A fragment of one polished ax was found, at Havelse, which had been worked up into a scraper. Small pieces of coarse pottery are also met with, the typical vessel having a pointed base.

The Danish kitchen-midden men were not cannibals. They seem to have resembled the Lapps, small men with heavy overhanging brows and round heads.

At Omori. Jap., in the Aleutian Islands, in British Columbia, Oregon and California shell mounds were explored, and always proved that the present populations had been preceded by ruder tribes of great antiquity. On the Atlantic coast. of Brazil shell mounds, which must have taken thousands of years to accumulate, are now overgrown with dense forests.

Shell mounds also occur round the coasts of Britain, at Chark near Gosport, inland at Blashenwell farm, Dorset, at Harlyn bay in Cornwall and in Cork harbour, but there is no reason to suppose all these deposits to be contemporary. The shell mounds on the west coast of Scotland are often associated with raised beaches.

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SHELLS AND SHELL COLLECTING. Shells of mollusks, because of their bright colours, rich variety of shapes and designs, and abundance along sea shores, have probably from the earliest times attracted the attention of man. He used them for ornaments, tools and coin, and dined on the mollusks that formed them. Aristotle and Pliny wrote extensively about them. In the ruins of ancient Pompeii and in a crypt in a Mayan pyramid in Yucatan shells were found that may well be the remains of ancient collections.

Shell collecting as we understand it today, however, on the same plane as coin. stamp and china collecting. is of quite recent origin. Shell collecting reached its apex in England during the late 18th and early and middle 19th centuries. This was the period of the burgeoning Pacific and China trade; new islands were being discovered and the shells found there were first imported as'curiosities, later as specimens for the collectors among the newly rich merchant princes. This period reached its highest point in the 1850s and '60s when shell auctions became a common occurrence and relatively high prices were paid for particularly rare and perfect specimens. There followed a period of relative decline, probably because many formerly rare shells suddenly became common as their haunts were discovered and exploited. The shells were then dumped on the market and the prices suffered a sudden decline An example is *Voluta junonia* of Florida nhich fetched $50 or $60 for choice specimens nhen that state was still relatively unexplored and difficult of access. Then when Florida became one of the nation's winter playgrounds and *V. junonia* was collected in large quantities the price fell rapidly until superb specimens brought no more than $5. This drop happened in hundreds of other cases too.

Nevertheless. shells are so strikingly interesting and beautiful in themselves that the hobby nas rapidly revived The U.S.

troops stationed on lonely islands in the Pacific after the fighting had moved on learned to gather shells to while away the time. Stay-at-homes became interested in shells and soon the hobby began to rival stamp and coin collecting in popularity. Shells, because of their beauty and exotic points of origin, will long cause large numbers of persons to be interested in them.

The shell itself is the exoskeleton (external skeleton) of a soft bodied animal that secretes it to serve as protection as well as support for its various organs. The animal is bound securely to the shell and can no more survive separation from it than we can from our bony framework. After a mollusk has died other marine animals may become occasional inhabitants of the shells. Such an animal is the hermit crab, which makes use of the shell as a temporary abode. Most marine mollusks are able to shut themselves off completely from their watery world when they find themselves in danger, by closing their aperture by a horny or calcareus door, or operculum. The careful collector makes it a point to preserve the door with the shell in his collection.

The rarest, the most valuable, and in many senses the most beautiful shells are those that are found in the sea, but large numbers of species live only on land or in fresh water. The aristocrats of the shell world are the various members of the families Cypraeidae (cowry shells), Conidae (cone shells), Volutidae (volute shells), and Muricidae (rock shells). One of the rarest and most desirable single species is *Conus gloria maris,* the glory of the sea. This is a handsome cone shell, of which only about 30 exceptionally beautiful specimens have ever been known. They alnays command a very good price on the market—$1,250 in 1957. It is also the only shell known to have been stolen from a large museum.

The question might be asked: why are some shells rare, others relatively common, and still others exceedingly abundant? The answer is intimately bound up with the habits of mollusks. Many species can tolerate only the conditions of life that are found in the intertidal zone on sandy or rocky shores. Such shells are most easily collected, since one need only wait for a low tide to begin gathering them. In the intertidal zone some very handsome shells are found, *e.g.,* the glistening, richly coloured Olividae (olive shells), the Naticidae (moon shells), and Strombidae (strombs) as well as Terebridae (augur shells) and many bivalves (clams) that burrow in water soaked sand. On the rocks and under them are found Littorinidae (periwinkles), Turbo (turban shells) and limpets, as well as the Chitonidae (pill bug or coat of mail shells) that have the curious habit of curling up like the land crustacean (pill bug) for which they are popularly named.

Other shells live only in the shallow water below the extreme low tide line. These shells are washed up on the beach after storms. Since luck and some degree of effort—dredging or straining—is involved in capturing them, they tend to be scarcer and more costly than the intertidal species.

The really rare shells are species that can live only in deep water. There live the rarest and costliest volutes, cones, cowries and rock shells. They can be obtained only by expensive and difficult deep-sea dredging operations from specially designed ships. Such shells would be quite unavailable to the average collector if he had to depend only upon these sources for his specimens. Luckily, however, they are frequently obtained as a side line in shrimp or fish dredging. Many fishermen, especially in Japan, have discovered that selling shells can supplement their regular incomes. They keep the shells on board instead of discarding them with the muck that their dredges bring up and sell them to dealers or collectors. Some of our greatest rarities, such as *Busycon coarctatum* (the turnip shell) are obtained in this manner.

Another source of deep-water shells are fish stomachs. Many ground-feeding fish species such as haddock and cod are frequently caught with their stomachs full of nicely cleaned and faultless shell specimens. A few rare shells such as the costly *Cypraea fultoni* (Fulton's conry shell) are known only from this sort of "habitat," ex *pisce* as the scientist puts it. SCUBA and skin divers bring up many rare specimens from depths up to 30 ft. Many shells that hide regularly in coral crevices can be collected in no other manner.

Although most mollusks live in the sea, many colourful species are air-breathing land dwellers. These shells are found everywhere that their few simple requirements of shade, moisture and food (usually plant or fungi) are satisfied. The largest majority are tiny (some only a few millimetres in size) and quite plain looking. They excite the interest of only the dedicated scientist or the enthusiastic amateur collector who makes a specialty of the shells of special regions. Some of these shells, however, are brightly coloured, large and quite showy. Best known are the *Liguus* (tree snail) of southern Florida and Cuba, *Papuina* of Papua, *Helicostyla* of the Philippines and the very large *Achatina* of Africa. These shells are not so popular among most enthusiasts as are marine shells because few collectors are willing to undergo the discomforts and dangers of collecting them. The tree snail of Florida shares its habitat with diamondback rattlers and cottonmouths, as well as voracious mosquitoes; *Papuina* and *Helicostyla* are found on trees in hot malarial regions haunted by savage headhunters; the ground-dwelling *Achatina* of Africa frequently live in the very heart of the continent.

The shells that live in fresh water are even less popular with collectors, chiefly because none of them are colourful, and only very few have any claim to beauty. The river mussels of the midwestern United States have a beautiful internal pearllike covering, or nacre, and are sometimes handsomely ornamented with tubercles and wavy ridges. They are often sold in bulk to button manufacturers. Few if any command a respectable price per specimen. Their slight claims to beauty are further in-paired by the erosion of the shell caused by acids in solution. Fresh-water snail shells are of considerable interest to the student of tropical diseases. since some snails serve as unwilling hosts of severe human and animal diseases.

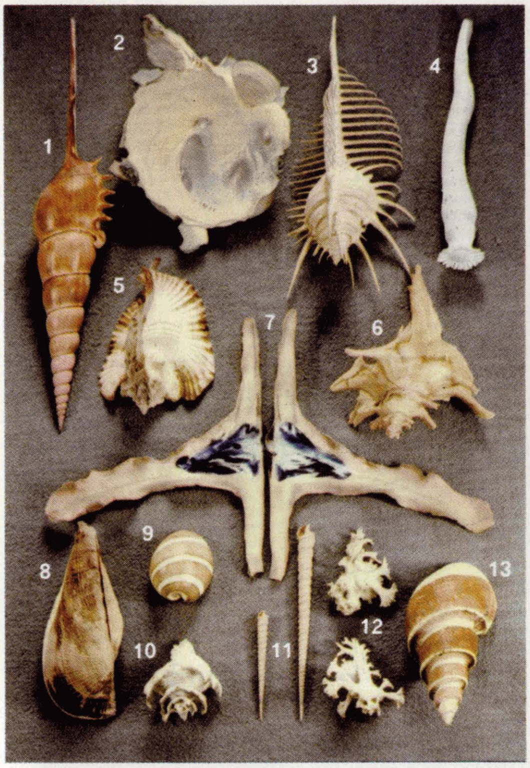
One of the pleasantest aspects of shell collecting is that the shells need little service to be stored. They do not require the careful attention and handling necessary in a butterfly, beetle or herbarium collection. They are not as heavy as minerals They are not subject to insect or fungus attack. Once the shell is reasonably well cleaned and provided with a complete label, it can remain unaltered for years in the drawer or cabinet to which it has been consigned.

Most collectors tend to specialize, since they realize very soon that their chance of obtaining even a fair proportion of the about 100,000 shell species known is very slight. Most collectors confine their interest to the aristocrats mentioned earlier. Others limit themselves to localities, collecting only the shells of Florida or California or even more immediate locales. Such specialists frequently contribute valuable scientific data in the form of exact locality records and observations on life habits of many mollusks. Another type of collector gathers only specimens of the type genus of shells, that is the single species of a shell that characterizes a particular genus. Such a collection is a valuable lesson in taxonomy and evolution and gives a perspective view of the entire field of conchology, the study of shells.

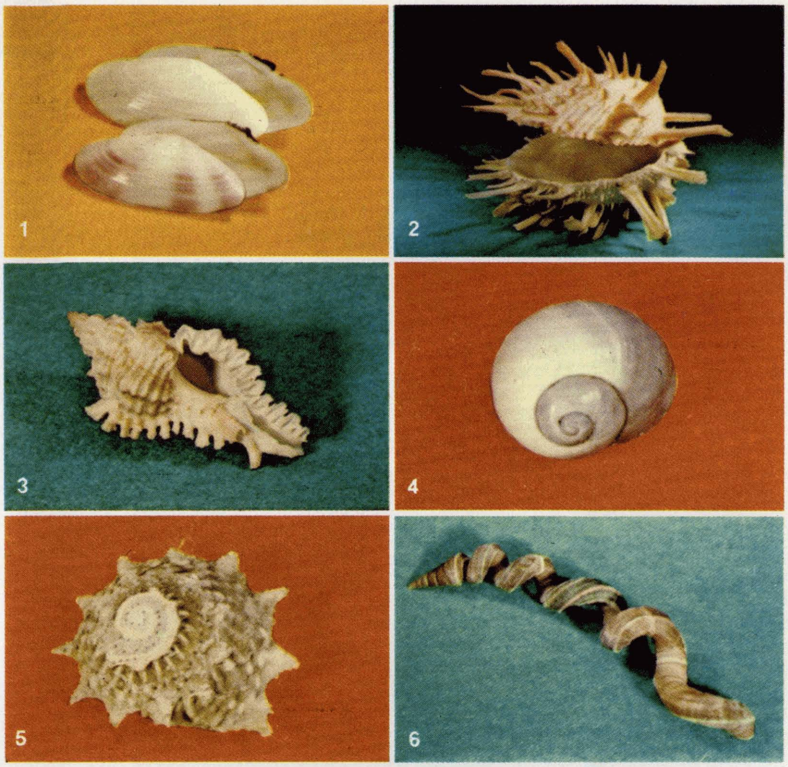
There are also specialists in land shells. Land shells have the virtue of being less bulky than marine shells and lend themselves to easier storing. They are also less expensive than marine shells, and complete family or generic collections can be made at low cost. The *Liguus* enthusiasts are a class apart, and in their zeal for completeness of their collections are sometimes ready to pay respectable prices for particularly desired specimens.

Shell collecting also can form the base for many interesting studies. All stamps and coins of the same type are machine made and therefore identical; however, like all living organisms, no two shells are exactly alike. Many an amateur has become interested in the variations of a single species and has often accumulated so much data that he could prove that what were considered two distinct and valid species are actually only the extreme variations of a single species. This aspect adds an element of excitement to shell collecting that is not found in many other collecting hobbies. In fact, many of the best-known scientists in the field of conchology began as amateur shell collectors.

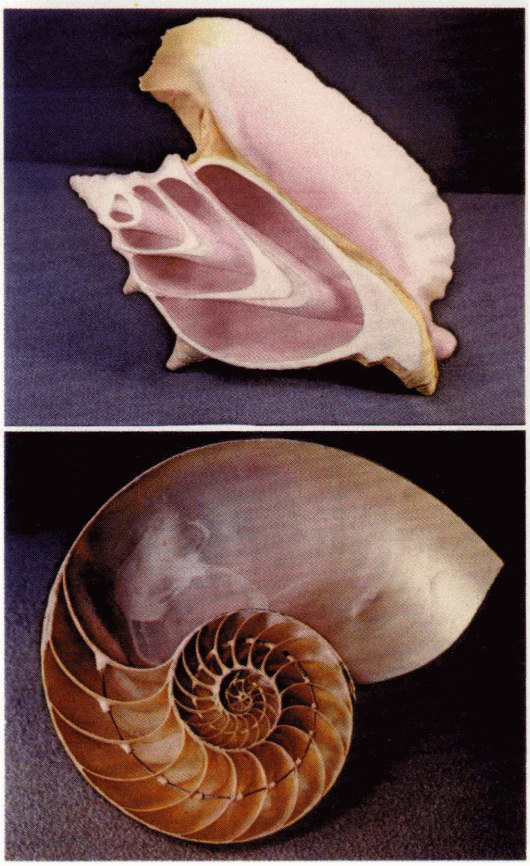
A word might be said about the equipment of the shell collector. All that most collectors use are a basket or a small quan-



Shells of **unusual shapes:** (1) **Spindle** shell, *Tibia fusus* (Philippines); (2) ***Xenophora pallidula*** (Japan); (3) ***Murex tenuispina*** (Ryukyu Islands); (4) ***Brechites radix*** (Torres strait); (5) ***Murex bednalli*** (Australia); (6) ***Trophon triangulatus*** (California); (7) ***Malleus albus*** (Japan); (8) ***Arca tortuosum*** (China); (9) Bubble shell, ***Hydatina albocincta*** (China); (10) ***Latiaxis deburghiae*** (Japan); (11) ***Terebra triseriata*** (Japan); (12) ***Murex pele*** (Hawaii); (13) ***Ancistrolepis hirasei*** (Japan)

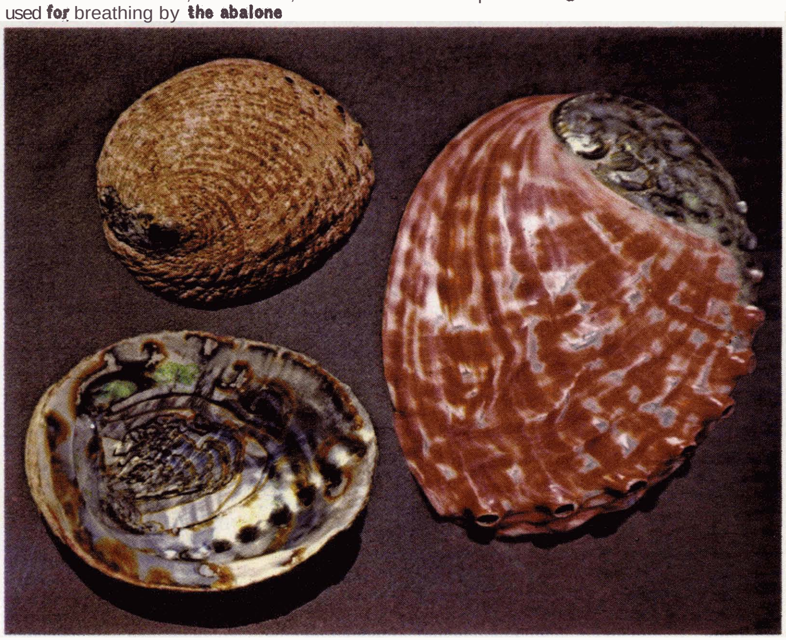


Florida shells: (1) Sunrise tellin, *Tellina radiata;* (2) Thorny oyster, *Spondylus americanus;* (3) Lace murex, *Murex florifer;* (4) common sea snail, *Janthina janthina;* (5) Long-spined star-shell, *Astraea longispina;* (6) Fargo's worm shell, *Vermicularia fargoi*



Left: **Cross sections** of the oommon giant conch, ***Strombus gigas*** (above) **and the chambered** nautilus, ***Nautilus pompilius***

Below: The ear shell or abalone, ***Haliotis,*** found on the California **coast.** Exterior **of** shell Is shown at **top left; polished** exterior after outer **coating has** been **removed is** shown **at** right. The **inside** of the shell, bottom left, **shows** the mother-of-pearl **lining. Holes in** the shell are used **for** breathing by **the abalone**

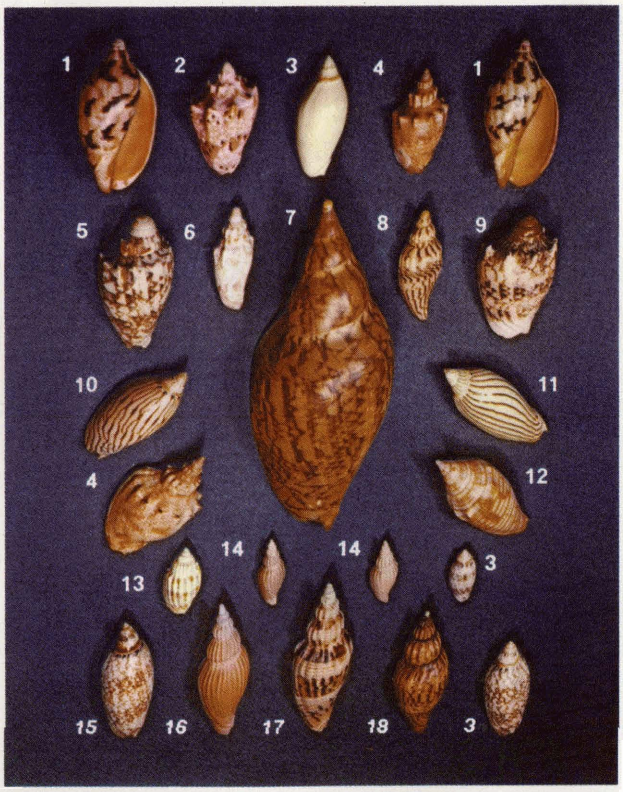


PHOTOGRAPHS, (TOP LEFT, BOTTOM LEFT, BOTTOM RIGHT) RUTHERFORD PUTT, (OTHERS) SHERMAN—PHOTO RESEARCHERS FROM PUBLIX

SHELLS AND SHELL COLLECTING

Snails: (1) ***Umbonium giganteum*** (Japan); (2) ***Epitonium pretiosum*** **(China)**; (3) ***Ancilla rubiginosa*** (China); (4) ***Pyramidella maculosa***; (5) ***Trochus maculatus*** (Oceania); (6) ***Cancellaria nodulifera*** (Japan); (7) ***Phasianella australis*** (Australia); (8) Sundial **shell,** ***Architectonica maximum*** (China); (9) *Babylo a japonica* (Japan); (10) ***Voluta fulgetrum*** (Austral ta); (11) ***Murex*** *bicolor* **(Gulf of** California); (12) ***Oliva irisans*** (Japan)

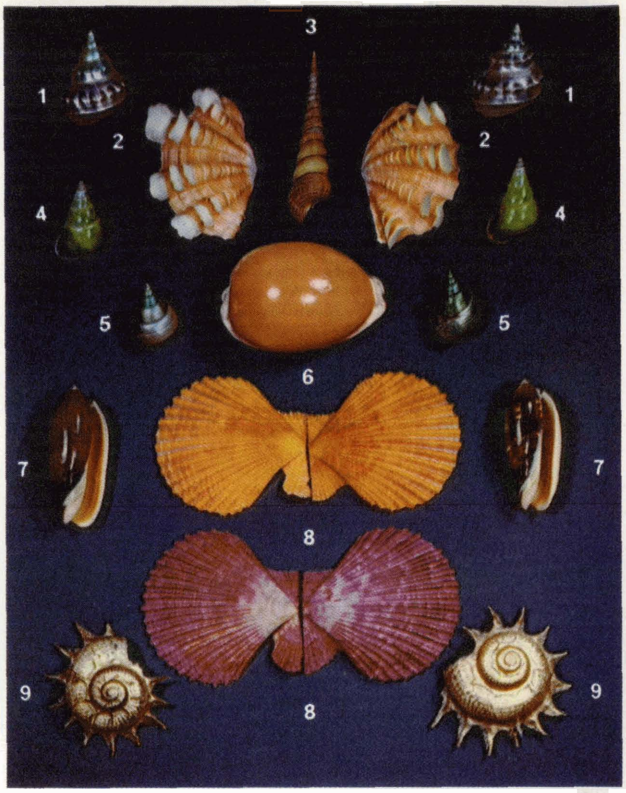
Chitons, mollusks of the **class *Amphineura* with shells consisting of eight transverse plates. The somewhat** flat, **elongate shape shown** in the **specimens** in the photograph Is **typical. Chitons** are found in shallow littoral **waters throughout** the world



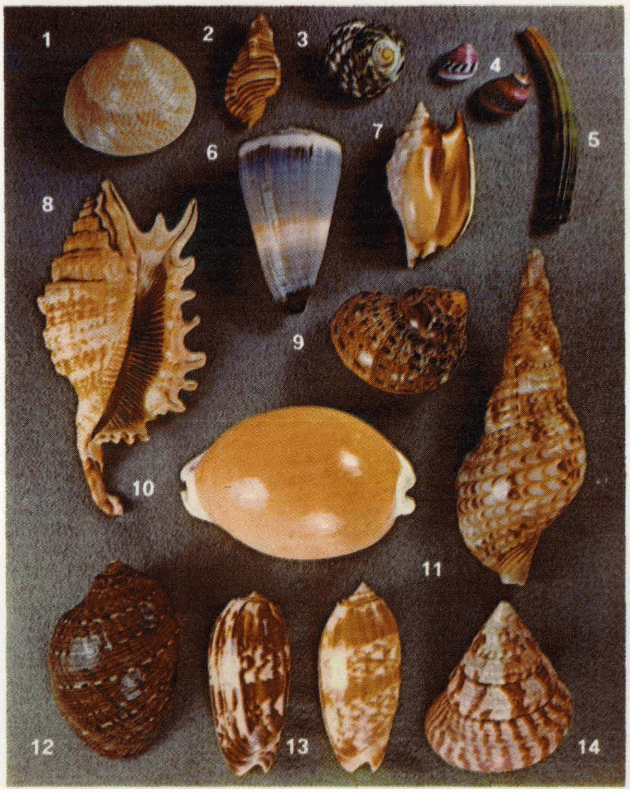
Volutes (genus *Voluta*): (1) *V. piperita* **(Solomon Islands); (2)** ***V. pulchra* (Australia)**; (3) ***V. damoni*** (Australia); **(4)** ***V. ponsonbyi*** (South **Africa**); **(5)** V. ***rossiniana*** (New **Caledonia**); **(6)** *V. thatcheri* (New **Caledonia**); (7) ***V. ericusa*** (Australia); **(8)** ***V. hamillei*** (Japan); **(9)** ***V. imperialis*** **(Sulu** sea); (10) *V. gatliffi* (Australia); (11) ***V. ellioti*** (Australia); (12) ***V. vexillum*** (Ceylon); (13) ***V. costata*** **(Mauritius)**; (14) ***V. delicata*** (Japan); (15) ***V. reticulata*** **(Australia)**; (16) ***V. hirasei*** (Japan); (17) ***V. daviesi*** (Japan); (18) *V. prevostiana* (Japan)

Cones **(genus *Conus*)**, a sample of the 400-500 known **species.** Common inhabitants of **tropical coral** reefs, many feed on living worms, and a few **species** oapture **living fish.** They are among the shells most prized by **collectors**

PHOTOGRAPHS, RUTHERFORD PLATT



Rare and **colourful Pacific** shells: (1) ***Bathybembix argenteonitens*** (Japan) ; (2) *Tridacna noae* (East **Indies**) ; (3) ***Turritella*** *terebra* (Philippines) ; (4) *Papuina pulcherrima* (Admiralty Islands) ; **(5)** *Cantharidus* ***opalus*** (New **Zealand**) ; (6) *Cypraea* ***aurantium*** (Fiji) ; (7) *Oliva tigrina* (western Pacific) ; (8) ***Chlamys senatorius nobilis*** (Philippines) ; (9) *Astraea heliotropium* (New **Zealand**). *P. pulcherrima* is a land snail; others are marine shells



Pacific marine shells: (1) ***Calliostoma cunninghami*; (2) *Cymatium rubecula*;** (3) *Turbo* ***undulatus*;** (4) *Neritina* ***communis*;** (5) Elephant's tooth, ***Dentalium elephantinum*;** (6) ***Conus lividus*;** (7) *Strombus* ***auris-dianae*** *aratrum*; *(8)* ***Lambis*** *millepeda*; (9) *Turbo* ***petholatus*;** (10) Qolden cowry, *Cypraea* ***aurantium*;** (11) Triton's trumpet, ***Charonia tritonis*; (12)*Purpura persica*;** (13) ***Oliva sericea miniacea*;** (14) ***Trochus*** *acutangulus*

Fine specimen **shells** from the F. A. Constable **collection:** (1)***Conus victoriae*** (Australia) ; (2) ***Guildfordia*** *triumphans* **(Hong Kong)** ; **(3)** ***Conus*** *rhododendron* (Australia) ; (4) ***Conus geographicus mappa*** (Paoific islands) ; (5) ***Ranella pustulosa*** **(Pacific** ocean) ; (6) *Voluta* ***lyraeformis*** (east Africa) ; (7) ***Mactra violacea*** (China) ; **(8)** ***Corculum cardissa*** (Philippines) ; *(9) Fusinus* ***ustulatus*** (West **Indies**) ; (10) ***Cypraecassis testiculus*** **(West Indies)** ; (11) *Voluta* ***sclateri*** **(Tasmania)**

Collection from New **Caledonia,** except where noted: (1) Chambered **nautilus,** *Nautilus* ***pompilius*** (Indo-Pacific) ; (2) *Trochus niloticus;* **(3)** Scorpion shell, ***Lambis*** *rugosa;* (4) *Amusium pleuronectes;* (5) ***Mitra*** *episcopalis;* *(6) Turbo petholatus;* ***(7) Cellana testudinaria;*** *(8) Cypraea talpa:* *(9) Cypraea* ***mappa;*** (10) *Cypraea* ***mauritiana*** (Moluccas) ; (11) *Charonia* ***tritonis***

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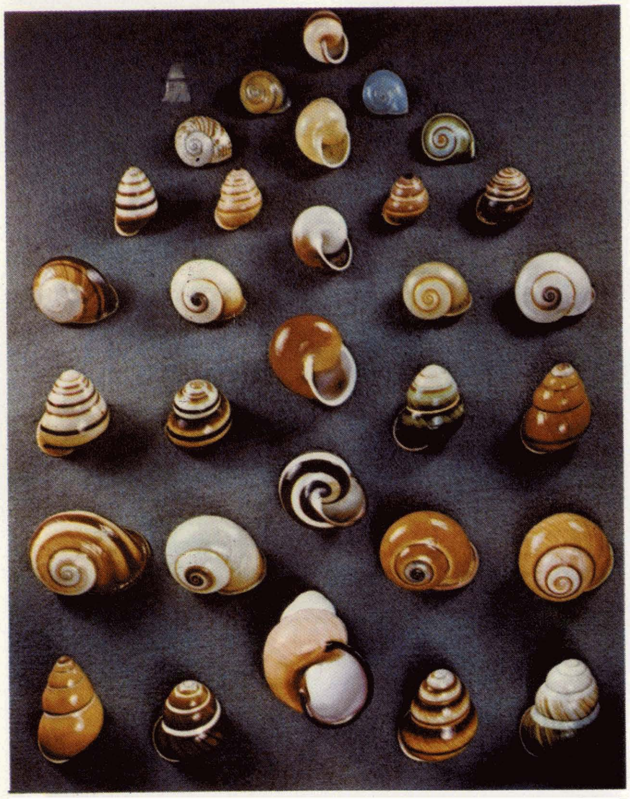
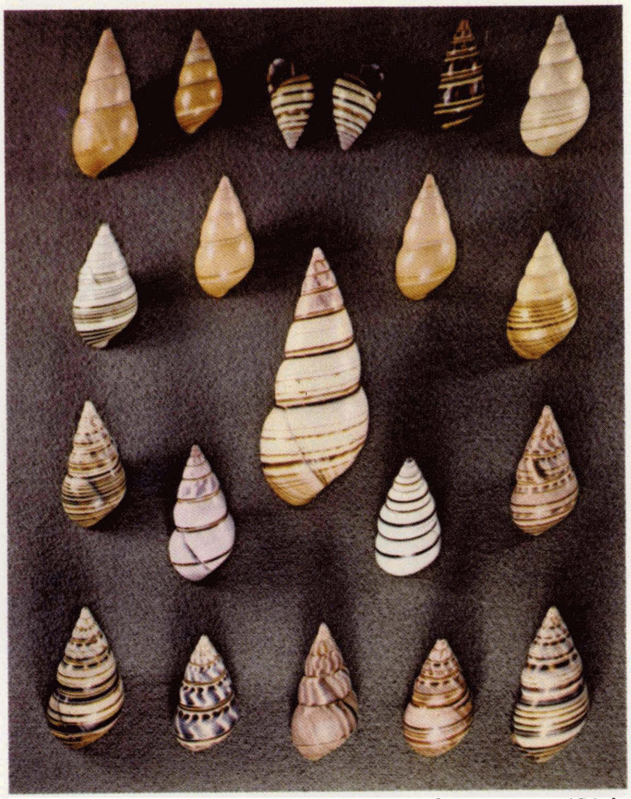
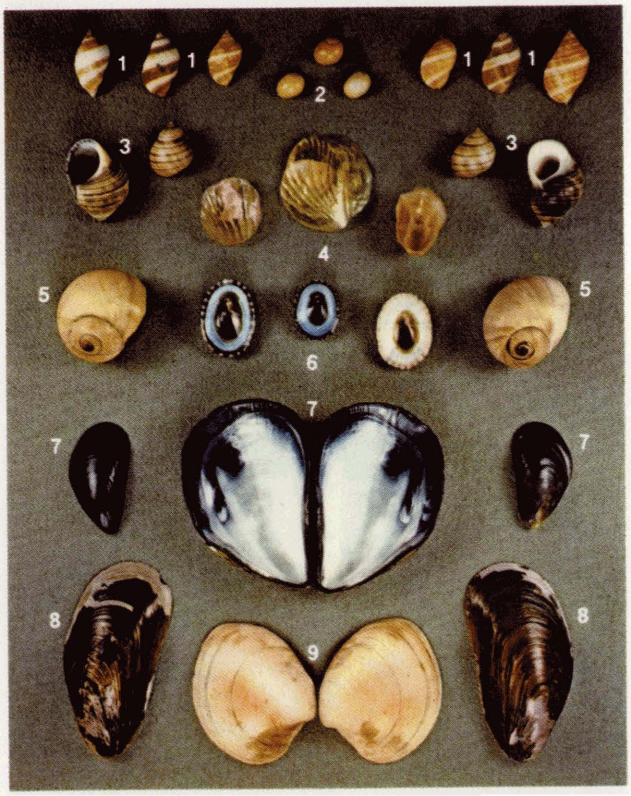


Philippine forest mails. Many of the more than 1,000 varieties are fbund on only a **single** mountain or on a single small Island. **Occasionally** the **soft** parts of some **species** are eaten



Cuban tree **snails** belonging to the **genus** ***Liguus***. ***L. poeyanus*, which is** shown In two views **at** top **centre, is** a **rarity in** that **some shells coil** to **the** right and **others to** the **left**

Rare **Florida marine** shells: (1) ***Chlamys mildredae;*** (2) *Chlamys imbricatus;* (3) ***Murex cabritii;*** (4) ***Tellina magna;*** (5) ***Terebra taurina;***(6) **Golden** panama, ***Oliva sayana;*** (7) **Lion's** paw, ***Lyropecten*** *nodosus:* (8) ***Conus regius;*** (9) ***Conus sozoni;*** (10) Carrier shell. *Xenopbora* ***conchyliophora;*** (11) ***Scaphella junonia***



New **England marine mollusks: (1) *Thais lapillus;* (2) *Littorina obtusata;* (3) periwinkles, *Littorina littorea;*** (4) **Jingle shell, *Anomia*** *simplex:* (5) **Moon shell, *Lunatia*** *heros;* **(6) limpets, *Acmaea testudinalis;*** (7) Blur mussels, ***Mytilus edulis;* (8) *Volsella modiolus;*** *(9)* **Quahog clam, *Mercenaria mercenaria***

PHOTOGRAPHS, RUTHERFORD PLATT

tity of bags and small boxes; some sort of tool to scrape away the sand or leaves; a knife to detach rock clingers from their perches; a hammer and chisel to remove rock borers from their nests; a sieve to strain out specimens from shallow water; a notebook to record locality and ecological data and a stout back ior much stooping. In addition there should also be a library of books on shells, limited only by financial means and availability of the classics of the shell world. These books, together with recourse to museum collections, are the only sources of the proper Latin names for shell species.

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SHELTON, THOMAS (fl. 1612–1620), English translator of *Don Quixote,* seems to have been employed by Theophilus Howard, 2nd Baron Howard de Walden and afterward earl of Suffolk, to whom he dedicated *The History of the Valorous and Wittie Knight-Errant Don Quixote of the Mancha* (1612). In his dedication he states that he did the work "in the space of fourty dayes" at the request of "a very deer friend." Shelton did not use the original edition of Cervantes (1605) but that published at Brussels in 1607. On the appearance of the Brussels reprint of the second part of *Don Quixote* in 1616 he translated that into English also, and published it in 1620 with a revised version of the first part. Shelton's version is the happiest English translation of the great Spanish classic, combining robust vigour with grace and ease. It is possible that the translator was the Thomas Shelton who wrote the sonnet prefixed to *A Restitution of Decayed Intelligence* by Richard Verstegan (1605).

Shelton's *Don Quixote* was edited by J. F. Fitzmaurice-Kelly. 4 vol. (1896), A. W. Pollard (1900) and F. J. H. Darton (1923).

See also Edwin B. Knowles, *Four Articles on Don Quixote in England* (1941). (V. DE S. P.)

SHELTON: *see* ANSONIA.

SHEM was the eldest of Noah's three sons (Gen, v, 32; x, 1). In the Old Testament genealogical tables tracing the origins and connections of the various peoples, the Hebrews, Aramaeans and Arabs are counted among the descendants of Shem, and from the name is derived the adjective Semitic (*see* SEMITIC LANGUAGES). Certain other peoples (as the Elamites) are referred to also as his descendants, on a geographical or political rather than linguistic basis.

Roughly speaking, the nations supposed to share Shem as their ancestor lie geographically between the descendants of his brothers Japheth (*q.v.*), on the north, and those of Ham (*q.v.*) on the south.

SHENANDOAH NATIONAL PARK, in Virginia, U.S., was established in 1935 to preserve 193,473 ac. in the Blue Ridge mountains. The most easterly of the Appalachian ridges, the Blue Ridge is geologically ancient, and has been eroded to its present elevation through countless thousands of years. (*See* APPALACHIAN MOUNTAINS.)

In general, mountain profiles are rounded, but rocky outcrops and precipitous ledges appear in a few places, such as on the highest point. Hawksbill mountain, 4,049 ft. above sea level, on Old Rag mountain and at Franklin cliffs.

The park is noted for its scenery. which affords some of the widest views in the eastern states. Skyline drive runs the length of the park, minding among the summits, dipping through highland valleys and gaps for about 105 mi., from the town of Front Royal on the north to Jarman gap on the south.

Except for a few grassy meadows along the crest, the park is heavily forested with hardwood trees, including black gum, yellow, gray and black birches, linden. tulip tree and several species of oak. Among the conifers are eastern hemlock, Virginia, white, Table mountain and pitch pines, red spruce and, on the highest peaks, Eraser fir. Wild flowers typical of eastern woodlands are abundant.

In spring, from April to June, there is a succession of blooms —redbud, flowering dogwood, azalea and mountain laurel—and in autumn a display of brilliant foliage.

White-tailed deer, bobcat, red and gray fox, and gray and flying squirrels inhabit the park, and the greatest number of bird species occurs in spring, when such migrants as rose-breasted grosbeak, brown thrasher, towhee, scarlet tanager and numerous warblers arrive to make their summer homes.

This park is joined to Great Smoky Mountains National park (*q.v.*) by the 470-mi. Blue Ridge parkway. (DX. B.)

SHENANDOAH VALLEY, in Virginia, U.S., extending southwest from the vicinity of Harpers Ferry on the Potomac river, lies between the Blue Ridge mountains and the Alleghenies. It is a part of the Great valley of Virginia. In a narrow sense the Shenandoah valley embraces only the nine counties drained by the Shenandoah river: Berkeley and Jefferson in West Virginia, and Frederick, Clarke, Shenandoah, Warren, Rockingham, Page and Augusta in Virginia.

In popular usage, however, the Shenandoah valley extends to the James river and includes Rockbridge county: it is approximately 100 mi. long and averages 25 mi. in width. From the floor of the valley near Harrisonburg rises Massanutten mountain which stretches to the northwest for 50 mi.; it divides the two forks of the Shenandoah river. Among the historic passes through the Blue Ridge are Swift Run gap and Rockfish gap.

The valley was once inhabited by Indians of the Tuscarora and Shawnee tribes whose Indian road ran the length of the valley. The road became the famous Valley pike, a main artery in the westward movement, and is now a U.S. highway. In 1707 Louis Michelle explored the lower valley, and in 1716 Gov. Alexander Spotswood led an expedition over the Blue Ridge to the Shenandoah river. Settlement of the valley by white men began about 1730; at this time buffalo and elk abounded. Most of the early settlers, German Lutherans and Scotch Irish Presbyterians, came from Pennsylvania, though some English came across the Blue Ridge. The various national groups usually settled in separate communities. In ante-bellum days the Shenandoah valley was a region of family-operated farms and few slaves. During the Civil War ".Stonewall" Jackson won immortality by his "Valley campaign." Near the end of the conflict the valley was devastated by Federal forces.

The backbone of the valley's economy is agriculture, with emphasis upon purebred cattle, sheep, poultry and dairy farming. Harrisonburg is a turkey capital and Winchester is noted for its apple orchards. Industry has enjoyed a remarkable growth with carpets, chemicals, cutting instruments, electric appliances and rubber goods being particularly important. The native limestone is suitable for building.

The labour force tends to commute from rural areas instead of moving to mill towns.

Colleges in the valley include Madison in Harrisonburg, Mary Baldwin in Staunton, and Virginia Military institute and Washington and Lee university in Lexington. There are numerous military preparatory schools in the area and many summer camps.

Large numbers of tourists are attracted by the Skyline drive and Blue Ridge parkway on the crest of the Blue Ridge, the Shenandoah National park (*q.v.*), the Natural Bridge, near Lexington, and many limestone caverns. (G. M. BE.)

SHENANDOAH VALLEY CAMPAIGNS. In the American Civil War (1861–65) the Shenandoah Valley was often the scene of military operations; at two points in the war these operations rose to the height of separate campaigns possessing great significance in the general development of the war. From a military point of view the Shenandoah Valley was valuable to the army which controlled it as a requisitioning area, for in this fertile region crops and cattle were plentiful. There were, moreover, numerous mills and factories. For the Confederates the Valley was also a recruiting area. A macadamized road from Lexington via Staunton and Winchester to Martinsburg gave them easy access to Maryland and enabled them to cover Lynchburg from the north. By a system of railways which united at Gordonsville and Charlottesville troops from Richmond and Lynchburg were detrained within easy distance of five good passes over Blue Ridge, and as Strasburg in the Valley lies almost due west of Washington it was believed in the North that a Confederate army thereabouts menaced a city the protection of which was a constant factor in the Federal plan of campaign.

In the spring of 1862 the immense army organized by Gen. McClellan advanced and threatened to sweep all before it. The Confederates, based on Richmond, were compelled to show a front westward to the Alleghanies, northward to the Potomac and eastward to the Atlantic. The main armies were engaged on the Yorktown peninsula and the other operations were secondary. Yet in one instance a Confederate detachment that varied in strength between 5,000 and 17,000 contrived to make some stir in the world and won renown for its commander. Gen. Thomas J. Jackson with small means achieved great influence on the course of the war in the main theatre. The Valley operations in 1862 began by a retrograde movement on the part of the Confederates, for Jackson on March 12 retired from Winchester, and Banks at the head of 20,000 men took possession. Banks pushed a strong detachment under Shields on to Strasburg a week later, and Jackson then withdrew his small division (5,000) to Mt. Jackson. Banks,. however, recalled Shields in accordance with orders from Washington, Jackson conceived that he was bound to follow Shields, and, when Shields stood at bay at Kernstown on March 23, with 7,000 men, Jackson at the head of 3,500 attacked and was badly beaten.

The proof thus afforded by Jackson of his inability to contend with Shields seems to have been regarded by the Federal authorities as an excuse for reversing their plans; Shields was reinforced by Williams's division, and with this force Banks undertook to drive Jackson from the Valley. A week after the battle of Kernstown, Banks moved to Strasburg with 16,000 men, and a month later (April 29) was at Newmarket, after much skirmishing with Jackson's rear-guard which burnt the bridges in retiring. Meanwhile Jackson had taken refuge in the passes of Blue Ridge, where he too was reinforced. Ewell's division joined him at Swift Run Gap, and at the beginning of May he decided to watch Banks with Ewell's division and to proceed himself with the remainder of his command to join Edward Johnson's brigade, then beset by Gen. Milroy west of Staunton. Secretly moving by rail through Rockfish Gap, Jackson united with Johnson and in a few days located Milroy at the village of McDowell. After reconnaissance Jackson concentrated his forces on Setlington Hill and proposed to attack on the morrow (May 8), but on this occasion the Federals (Milroy having just been joined by Schenck) took the initiative, and after a four hours' battle Jackson was able to claim his first victory. The Confederates lost 500 out of 6,000 men and the Federals 250 out of 2,500 men.

Meanwhile the army under Banks, now at Strasburg, had been largely sent elsewhere. Jackson's opportunity had come to destroy Ranks's force completely. The Confederates numbered 16,000, the Federals only 6,000 men. Jackson availed himself of the Luray Valley route on the eastern or "blind" side of the Massanutton range to surprise the post at Front Royal as a preliminary to falling upon Banks. He captured the post, but failed to intercept Banks who escaped northwards by the turnpike road and covered his retreat across the Potomac by a rear-guard action at Winchester on May 25. On May 31 Frémont had reached Cedar Creek. McDowell was at Front Royal and Jackson had retired to Strasburg, where he was compelled to wait for a detachment to come in. This rejoined on the evening of June 1.

Ewell's division held Frémont back until Jackson was on his way to Newmarket, McDowell had sent Shields up the Valley by the Luray route. But Jackson gained Newmarket in safety and destroyed the bridge up to Port Republic by which Shields could emerge from the Luray Valley to join Frémont, who was left to cope with Jackson single-handed. Jackson's rear-guard impeded Frémont's advance, although a week later (June 7) Frkmont at Harrisonburg located his enemy at Cross Keys and next day he attacked with 10,500 men. Shields was still at Luray. Jackson held Frémont with Ewell's division (8,000) and with the remainder moved to the left bank of the Shenandoah near Port Republic to await developments, for Shields had pushed forward a strong advanced guard under Tyler, whose vanguard (two squadrons) crossed the river while Frkmont was engaged with Ewell. Tyler's cavalry was driven back with heavy loss. Jackson retained possession of the bridge by which Tyler and Frémont could unite, and next day he crossed the river to attack Tyler's two brigades. The engagement of June 9 is called the battle of Port Republic. Jackson with 13,000 men attacked Tyler with 3,000 men, and Tyler retired with a loss of some 800 men, leaving as many Confederates *hors de combat.*

A few days later Jackson received orders to quit the Valley and join the main army. before Richmond, and President Lincoln simultaneously discovered that he could not afford to keep the divisions of Frémont, Banks and McDowell engaged in operations against Jackson; so the Valley was at peace for a time.

In stricter connection with the operations of the main armies in Virginia, the Confederates brought off two great *coups* in the Valley—Jackson's capture of Harper's Ferry and Martinsburg in the autumn of 1862 and Ewell's expulsion of Milroy from Martinsburg and Winchester in June 1863. The concentration of the Federal forces in north Virginia in May 1864 for the campaign which ultimately took Grant and Lee south of the James involved a fresh series of operations in the Valley. At first a Union containing force was placed there under Sigel; this general, however, took the offensive unwisely and was defeated at Newmarket. Next Hunter, who superseded Sigel in command in West Virginia and the Valley, was to co-operate with the Army of the Potomac. Grant detached Sheridan to join Hunter at Charlottesville, but Lee sent Hampton's cavalry by a shorter route to intercept Sheridan, and a battle at Trevillian Station compelled Sheridan to return and leave Hunter to his fate.

Meanwhile on June 13 Early added his command to the Confederate forces in the Valley. Early succeeded in interposing between Hunter and Lynchburg, and within a week drove Hunter out of Virginia by the Kanawha river route. Early then moved down the Valley turnpike unmolested. Expelling Sigel from Martinsburg on July 4, and crossing the Potomac opposite Sharpsburg, he soon appeared before Washington. Early, after creating serious alarm, retired, on July 13, by Leesburg and Snicker's Gap into the Valley at Winchester. Early soon after sent a detachment into Maryland to burn the town of Chambersburg. The alarm in the North for the safety of Washington was only quieted by the appointment of Sheridan to command in the Valley.

Sheridan's Campaign.—He arrived on the scene early in August. His mission was to drive Early up the Valley or, if the Confederates crossed into Maryland, to intercept their return, and in any case he was to destroy all supplies in the country which could not be consumed by his own army. Sheridan made Harper's Ferry his headquarters and concentrated at Halltown. Early retained his position about Bunker Hill, destroyed the Ohio railroad, and held the main road up the Valley until Sheridan moved out in force on Aug. 10. Early then retreated up the Valley to Fisher's Hill (Strasburg), where he expected to be joined by Anderson's corps from Richmond. Sheridan had followed Early, but hearing of this reinforcement to the enemy. he decided to take up a defensive line at Halltown—the only paint in the Valley which did not favour flanking operations—and await the arrival of adequate reinforcements. For a month the two armies had manoeuvred between Halltown and Strasburg, each commander hoping for such an increase to his own or decrease of his enemy's numbers as would justify attack. The Valley operations were aided indirectly by assaults and sorties about Petersburg. Grant aimed at preventing Lee sending reinforcements to Early until Sheridan's plans had been carried out. Meanwhile Early had been gathering up the harvests in the lower Valley. hut on Aug. 20 Sheridan was able to report "I have destroyed everything that was eatable south of Winchester, and they will have to haul supplies from well up to Staunton." Sheridan in September could put 23.000 infantry and 8,000 cavalry into action. and he was visited by Grant, who encouraged his subordinate to seize an opportunity to attack.

The first encounter of Sheridan and Early took place on Sept. 19, about 2 mi. E. of Winchester. Sheridan had crossed the Opequan and found the enemy in position astride the Winchester-Berryville road. Early was outnumbered and outfought. but he attributed his defeat to the enemy's "immense superiority in cavalry." and in fact Sheridan depicts Merritt's division as charging with sabre or pistol in hand and literally riding down a hostile battery, taking 1.200 prisoners. Early then retreated through Strasburg, but at Fisher's Hill behind Tumbling Run. where the Valley was entrenched on a front of 3 mi. between the Shenandoah river and Little North mountain, he rallied his forces and again detailed his cavalry to protect his left from a turning movement. But Sheridan repeated his manoeuvre, and again on Sept. 22 Early was attacked and routed. Gen. Crook's column having outflanked him by a détour on the western or Back road. Early now retreated to Mt. Jackson, checked the pursuit at Rode's Hill. and, evading all Sheridan's efforts to bring him again to battle. reached Port Republic on Sept. 25. In the first week of October Sheridan held a line across the Valley from Port Republic along North river to Back road. and his cavalry had advanced to Waynesboro to destroy the railroad bridge there, to drive off cattle, and burn the mills and all forage and breadstuffs. Early had taken refuge in Blue Ridge at Rockfish Gap, where he awaited Rosser's cavalry and Kershaw's division (Longstreet's corps), for Lee had resolved upon again reinforcing the Valley command. and upon their arrival Early advanced to Mt. Crawford and thence to Newmarket. The Federals retired before him, but his cavalry was soon to suffer another repulse. for Rosser and Lomax having followed up Sheridan closely on Oct. 9 with five brigades, the Federal cavalry under Torbert turned upon this body when it reached Tom's brook (Fisher's Hili) and routed it. Sheridan burned the bridges behind him as he retired on Winchester. and apparently trusted that Early would trouble him no more and then he would rejoin Grant at Petersburg.

Sheridan at Winchester was now free to detach troops to aid Grant. or remain quiescent covering the Ohio railroad. or move east of Blue Ridge. He had resisted the demand of the Government, which Grant had endorsed. that Early should be driven through the Blue Ridge back on Richmond. Sheridan pointed out that guerrilla forces were always in his rear, that he would need to reopen the Alexandria railroad as a line of supply, that he must detach forces to hold the Valley and protect the railroads, and that on nearing Richmond he might be attacked, by a column sent out by Lee to aid Early.

Early, however, showed great enterprise in following Sheridan down to Strasburg on Oct. 13 "to thwart his purposes if he should contemplate moving across the Ridge or sending troops to Grant." But as his forward position at Fisher's Hill could not be long maintained for want of forage, he resolved to attack Sheridan, who was in a defensive position along the line of Cedar Creek, and on the night of Oct. 18 he sent three divisions under Gordon to gain the enemy's rear: while Kershaw's division attacked his left and Wharton's division and the artillery engaged him in front. The attack was timed to begin at 5 A.M. on Oct. 19, when Rosser's cavalry was to engage Sheridan's cavalry and that of Lomax was to close the Luray Valley. This somewhat complicated disposition was entirely successful, and Early counted his gains as 1,300 prisoners and 18 guns after routing the Federal corps VIII and XIX and causing Wright's corps (VI) to retire. Yet before nightfall Early's force was in turn routed and he lost 23 guns. Sheridan had been called to Washington to consult Halleck, the "chief of staff." on Oct. 16, in reference to his future movements; for Halleck claimed to control Sheridan and pften modified Grant's instructions to his subordinate. Before Sheridan could rejoin his army on Oct. 19 Early had attacked and routed it. but Sheridan met the fugitives and rallied them with the cry: "We must face the other way." He resolved to attack as soon as his troops could be reorganized, but. disturbed by reports of Longstreet's corning by the Front Royal road to cut him off at Winchester, hesitated for some hours; however. at 4 P.M. he attacked and drove back the Confederates. recovering all the ground lost and recapturing his abandoned guns and baggage.

After the battle of Cedar creek. Early again retreated. The Federal Government had agreed to Sheridan's proposal to fortify a defensive line at Kernstown and hold it with a detachment while Sheridan rejoined Grant with the main body. In Feb 1865 the infantry remaining on each side was less than a strong division Sheridan seized the opportunity to advance with 10,000 cavalry. Early delayed this advance aith his cavalry. while he evacuated Staunton: he called up a brigade to defend Lynchburg and proceeded to Waynesboro to await developments. Sheridan feared to advance on Lynchburg, leaving Early on his flank. and decided to attack Early at Waynesboro; and on March 2 he was rewarded by decisive victory, capturing 1,600 Confederates and their baggage and artillery Early himself escaped and his cavalry dispersed to their homes in the Valley; all organized resistance in the Shenandoah Valley came to an end (G. W R.)

SHENSI (SHEN-HSI SHENG), is a northwest province in the loesslands of China between Kansu and Shansi provinces. It was one of the earliest seats of Chinese civilization, the site of a historic capital centred in the vicinity of Sian (*q.v.*), the present provincialseat. Area 74,131 sq.mi.; pop. (1953) 15,881,281.

Topographic barriers and the fertile productivity of the well-watered Wei Ho (river) plain supported its command over strategic gateways to central Asia in the northwest, Inner Mongolia in the north, Szechwan across the Tsinling Shan (*q.v.*) in the south, and the Yellow plain in the east. Shaped in a slender wedge 300 mi. long east and west! the Wei Ho plain begins with a width of about 1 mi. at Pao-chi in the west and widens near Sian to 30–40 mi., continuing thus to the fortress city of T'ung-kuan at the Yellow river elbow. Northward the land rises through a region of deeply gullied badlands to plateau remnants 3,000–6.500 ft. high near the Ordos desert and eastern Kansu. Halfway between the Wei Ho and the Ordos desert lies the town of Yenan, the Chinese Communist capital from 1935 to 1949. In the east, the land overlooks the deep gorge of the Yellow river which drops turbulently here and is only about 330 ft. wide through much of its course until Lung-men is reached. From there to T'ung-kuan the river broadens to 1–2 mi., then turns and leaves the province to flow eastward. Southward of the Wei Ho, the northern front of the Tsinling Shan rises abruptly from the plain, mantled with the same yellow loess on its northern slopes as that covering northern Shensi. Southern Shensi comprises the south slopes of the Tsinling Shan and the north slopes of the Ta-pa Shan and represents an entirely different landscape. Between them in the Han Shui valley lies the Han-chung basic, about 50 mi. long by 6 mi. wide.

North and south Shensi have greatly differing climates. The Tsinling Shan blocks the cold winter minds from moving south, while it greatly reduces the moisture in summer winds moving north. Thus in winter the Han-chung basin is mild and damp, while northern Shensi is cold and dry. Precipitation reaches a yearly average of 30 in. south of the Tsinling Shan, where the annual average temperature is 59.5° F., similar to that of Szechwan. By contrast, the Wei Ho plain gets under 20 in., while in the north this is reduced to as little as 4 in. The January average at Sian falls to 31.1° F., while at Yu-lin in the extreme north it falls to 17.5" F. July averages at these two cities are 82° F. and 75" F. respectively. The autumn rainfall concentration is combined with great fluctuations in annual amounts and seasonal occurrences, presenting great farming hazards. Canal and well irrigation is practised where possible.

The Wei Ho plain, the economic heart of the province, is especially noted for winter wheat and summer cotton production. In the north, spring wheat and millet are significant crops. Beans, kaoliang, corn and tobacco also are grown. In the Han-chung basin, paddy rice in summer is followed by winter wheat. Fruits grown include pears, apples, apricots and grapes. Farm sidelines include the raising of sheep, horses, donkeys, mules, goats and pigs. Forest remnants exist in the heights of the Tsinling Shan, but north Shensi is rather barren and brown. Sand encroachment from the Ordos desert in the north is countered with planted shelter belts.

Shensi has important coal deposits which are largely located in the drainages of the Ching and Lo rivers. Petroleum is being exploited in the Yen-ch'uan and Yen-ch'ang districts. Oil shale occurs in the Han-chung basin. Alluvial gold is panned in the streambeds of the upper Chia-ling Chiang and the south-slope rivers of the Tsinling Shan. Salt is obtained from lakes in the Wei Ho plain. Manganese and graphite also are mined in the province.

Cotton manufacturing is an important industry at the chief cities of Sian, Hsien-yang, Pao-chi and Han-chung. Sian is the major industrial, cultural and political centre. The Lunghai railroad from Honan follows the Wei Ho plain westward into Kansu. From Pao-chi on this line, a railroad crosses the Tsinling Shan to Szechwan. Highways radiate from Sian to Yenan and Yu-lin in the north, Kansu in the west and Honan in the southeast. A highway also crosses the Tsinling Shan from Pao-chi. Much industrial progress has taken place since the Communists consolidated their power and took control. In the early *1960s* output of electric power, coal and crude oil was reportedly to be much higher than before *1949*. Many other new industries were introduced, including textile plants, flour mills and brick factories.

(H. J. Ws.)

SHENSTONE, WILLIAM (*1714–1763*), English poet, son of Thomas Shenstone and Anne, daughter of William Penn of Harborough hall, Hagley, was born at the Leasowes, a property in the parish of Halesowen, now in Worcestershire but then included in the county of Shropshire. At school he began a lifelong friendship with Richard Jago, and at Pembroke college, Oxford, where he matriculated in *1732,* he made another firm friend in Richard Graves, the author of *The Spiritual Quixote*. In *1742* he published anonymously a revised form of *The Schoolmistress, a Poem in imitation of Spenser. . . .* The original was Sarah Lloyd, teacher of the village school where Shenstone received his first education. He inherited the Leasowes estate and retired there in *1745* to undertake what proved the chief work of his life, the beautifying of his property. He embarked on elaborate schemes of landscape gardening which gave the Leasowes a wide celebrity but sadly impoverished the owner. He corresponded with many of the literary people of the day, especially with Jago, Dodsley. Lady Luxborough and Bishop Percy. Shenstone first suggested to Percy the collection of the *Reliques*. Shenstone died on Feb. 11, *1763.*

His works were first published by his friend Robert Dodsley. 3 vol. *(1764–69).* The second volume contains Dodsley's description of the Leasowes. The last, consisting of correspondence with Graves, Jago and others, appeared after Dodsley's death.

See *The Letters,* ed. by M. Williams (1939), and ed. by D. Mallam (1939); for his life, *see* A. R. Humphreys, *William Shenstone* (1937).

SHEPPARD, JOHN (JACK) (*1702–1724*), English criminal, was born at Stepney. near London, in Dec. *1702,* and was brought up in the Bishopsgate workhouse. He was apprenticed to a carpenter, and at the end of *1723* was arrested as a runaway apprentice. Thenceforward: he says, "I fell to robbing almost every one that stood in my way," Joseph Blake, known as "Blueskin," being a frequent confederate. In the first six months of *1724* he twice escaped from jail, and toward the end of that period he was responsible for an almost daily robbery in or near London. Eventually. however. his independent attitude provoked the bitter enmity of Jonathan Wild, who procured his capture at the end of July.

Sheppard was tried at the Old Bailey and condemned to death, but. largely thanks to his accomplice. "Edgeworth Bess," he escaped from the condemned cell and was soon back in his old haunts. In September he was rearrested and imprisoned in the strongest part of Newgate, being actually chained to the floor of his cell. but he escaped through the chimney to the roof of the prison, nhence he lowered himself into the adjoining house After a few days he was rash enough to reappear in the Drury Lane quarter. He nas captured. hopelessly drunk in a Clare Market tavern and reimprisoned, his cell being non watched night and day *On* Nov. *16, 1724,* he was hanged at Tyburn. He uas then not quite *22.*

Sheppard has been a hero of romance, notably in Harrison Ainsworth's novel, *Jack Sheppard (1830).*

See R. W. Postgate, *Murder, Piracy and Treason* (1926).

SHEPPEY, an island off the Kentish coast of England. the largest of several low islands separated from the mainland by the ramifying creeks about the mouth of the Medway. The Kingsferry road and rail bridge over the Swale is the only direct link with the mainland. Pop. *(1951) 28,384.* Area *35* sq.mi. Sheppey is $10\frac{1}{2}$ mi in extreme length from east to west, and 5 mi. wide at its broadest point.

It is low lying with a small elevation near the north coast which presents slight cliffs toward the shallow sea. There are occasional incursions from the sea but protective measures have been taken to prevent further erosion and flooding. Except for the higher ground, the island is treeless but very fertile, producing grain and vegetables; its name, meaning the "island of sheep." is still appropriate. Leysdown and Minster are rapidly developing as holiday camping resorts. On the west are the ancient borough and port of Queenborough and the naval establishment of Sheerness (*qq.v.*).

SHEPSTONE, SIR THEOPHILUS (*1817*–1893), British South African statesman, who was largely responsible for the peaceful development of Natal (*q.v.*), was born at Westbury near Bristol on Jan. *8, 1817.* He migrated to Cape Colony in *1820.* In his early life on his father's mission station he acquired the fluency in Kaffir languages and insight into the Kaffir mind which made him an outstanding administrator. He served (1834–38) in the Cape headquarters as interpreter and during *1838–39* accompanied the forces which occupied Port Natal (Durban). In *1839* he was appointed British resident in Kaffraria.

Shepstone became agent for the tribes in Natal in *1845;* captain general of native levies *(1848)*; judicial assessor in native causes *(1855);* and from *1856,* when Natal became a crown colony. until *1877* he was secretary for native affairs and a member of the executive and legislative councils. Two of his achievements are clear. The death of Dingaan in *1840* was the signal for the return of tribal remnants dispersed by the Zulu reign of terror. With only one resort to force, Shepstone resettled them on locations and restored a species of tribal structure so successfully that the only subsequent major risings in Natal were those of *1873* and *1905.* His policy was based on security of tribal tenure and the custom based on that tenure, both subject to his own authority as supreme chief. This policy mas to be accompanied by progressive civilization for which, as happened, funds and possibly his own enthusiasm, were inadequate. Secondly. apart from the crisis of *1873.* he kept Natal tribes from being involved in frontier wars.

On two occasions he moved into Zululand (*q.v.*) on political errands. In *1861* he persuaded Panda formally to recognize Cetywayo as his successor: in *1873* he crowned Cetywayo and made him smear to rule without illegal violence. In *1874* he was consulted by the secretary of state for colonies in London and in *1876* attended the conference on South African affairs to discuss how to achieve a federal approach to native problems. He returned empowered, if the majority of the inhabitants so desired: to annex the Transvaal (*q.v.*). This he did in April *1877.* But he failed to get a clear majority in the *Volksraad,* was outwitted and obstructed in the Transvaal and ill-supported by the Cape and colonial office. In Jan. *1879* his position as administrator of the Transvaal was temporarily taken over by Sir Owen Lanyon, and he retired, though he was commissioned in *1883* to supervise the restoration of Cetywayo. During his retirement he was the victim of controversy, not least because he opposed the grant of responsible government to Natal in case native policy should become the shuttlecock between two political parties. The Zulus still regard him as "Somtseu." the father of his people. He died in Pietermaritzburg on June *23, 1893.*

See C. J. Uys, *In the Era of Shepstone* (1933); E. H. Brookes, *History of Native Policy in South Africa* (1924). (W. A. ML.)

SHER ALI KHAN (1825–1879), amir of Afghanistan, was born in 1825. one of the sons of the amir Dost Mohammed, whom he succeeded in *1863.* During the viceroyalties of Lord Lawrence and Lord Mayo in India, Sher Ali remained on good terms with the British government; but after the rebellion of his son Takub Khan he leaned toward Russia and welcomed a Russian agent at Kabul in 1878, at the same time refusing to receive a British mission. This led to long negotiations and ultimately to war, when the British forced the Khyber pass in Nov. 1878 and defeated the amir's forces on every occasion. Sher Ali fled from his capital and. taking refuge in Afghan Turkistan, died at Mazar-i-Sharif on Feb. 21, 1879.

SHERANI or SHIRANI, a Pathan tribe on the Dera Ismail Khan border of West Pakistan, who occupy the country and the Takht-i-Suliman, thence eastward down to the border of Dera Ismail Khan district. Sheranis are generally of middling stature, thin. but hardy and active. They have bold features, high cheekbones. and are wild and manly. Their chief occupation is agriculture. but they carry on an extensive trade in Dera Ismail Khan district. There are two well-defined branches called Bargha and Largha, or the Highlands and the Lowlands.

Marriage is adult. Dowry is paid and divorce is usually a repurchase of the woman for half the sum (less the dowry) received for her.

SHERATON, THOMAS (17; 1–1806), English furniture designer, was born at Stockton-on-Tees, County Durham, the son of a working cabinetmaker; an obituary notice in *The Gentleman's Magazine* (ii, 1082. London, 1806) states that he "worked for many years" at that trade. He settled in London probably about 1790, and his trade card gives his address as Wardour street, Soho, where he "teaches perspective. architecture and ornaments. makes designs for cabinet-makers, sells all kinds of drawing-books." Nothing is said of him as a maker of furniture, and all he tells us in his works is that "having possessed a strong attachment for carving in my youth, I was necessarily inclined to make attempts in this art . . . and was employed in the County occasionally in it."

Supporting himself "mainly by his exertions as an author" Sheraton published in four parts between 1791 and 1794 *The Cabinet-Maker and Upholsterers' Drawing Book,* by far his most important undertaking. The first part. which throws a curious sidelight on the author's mentality, is devoted to verbose dissertations on perspective, architecture and geometry. which strike the reader as a naïve attempt to display the author's learning. But the notes on the plates are much fuller than in any other comparable publication and reveal sound technical knowledge. They leave no doubt that Sheraton's primary aim was "to exhibit the present taste in furniture"; as he puts it himself. "I have made it my business to apply to the best workmen in different shops, to obtain their assistance in the explanation of such pieces as they have been most acquainted with." In one or two instances he even informs the reader where specialized pieces of furniture may be obtained: a worktable is "taken from one executed by Mr. McLean in Marylebone Street . . . who finishes these small articles in the neatest manner." It is on the designs in the second part of the *Drawing Book* that Sheraton's reputation (in a great measure misleading) is certainly based. Throughout they are admirable in draftsmanship, rarely at fault in form or proportion, while the distribution and propriety of the ornament may be explained in part by the author's "strong attachment and inclination for carving."

In 1803 Sheraton brought out his *Cabinet Dictionary* (with plates), containing *an Explanation of all Terms Used in the Cabinet, Chair and Upholstery Branches With Dictionary for Varnishing, Polishing and Gilding.* It does not fulfill the promise of the title: the selection of terms is arbitrary and eclectic, suggesting that the author's marked tendency to eccentricity was on the increase. It is however sober and informative compared with Sheraton's final project. the *Cabinet-Maker, Upholsterer and General Artists' Encyclopaedia,* of which only one volume covering A to C appeared in 1805, the year before his death (in Soho, Oct. 22, 1806). The text warrants the inference that he suffered at least from mental instability, while the garish colour plates may be said almost to travesty the prevailing Regency style so marked is the eccentricity of some of the designs.

Adam Black, a Scottish publisher and politician who was employed by Sheraton in connection with the encyclopaedia refers to the latter's "painfully humble circumstances" and describes his house as "half shop, half dwelling-house"—firsthand evidence which should alone have sufficed to refute the legend that Sheraton was a fashionable cabinetmaker. Even now. however. pieces are often described as "by Sheraton" in catalogues and press reports of sales. There are several examples which are either virtually identical with, or closely resemble, a Sheraton design, but this affords no presumption that he was the maker. Hundreds of cabinetmakers and joiners were among the subscribers to the *Drawing* Book; it was in fact a trade catalogue, the plates of which were reproduced throughout the country with varying degrees of accuracy.

Though doubtless Sheraton borrowed what served his turn, there is good reason to suppose that the bulk of the plates in his publications were engraved from his own designs. The version of the neo-classical style represented in Hepplewhite's *Guide,* which appeared only three years earlier than the *Drawing Book,* conveys a general impression distinctly different from that associated with Sheraton. The style in the earlier book, simple. elegant and notably free from extravagance and eccentricity, as interpreted by Sheraton becomes more refined and feminine in character; the eccentricity so conspicuous in Sheraton's later works is as yet scarcely perceptible. The designs bear the mark of a single controlling intelligence, eclectic and even now and again ready to reproduce existing models. but gifted with an innate sense of proportion and style. Much of what he borrowed he adapted and improved upon. The term "Sheraton" has been recklessly bestowed upon vast quantities of late 18th-century painted and inlaid satinwood furniture, but properly understood and used in a generic sense it is an appropriate recognition of the most powerful source of inspiration behind the furniture of the century's closing years. Sheraton writes slightingly of Hepplewhite's *Guide* in his preface, and it is significant that in the 3rd edition of the *Guide* (1794) the designs for chairs are drastically amended, some of those with square backs newly introduced being scarcely distinguishable from the chairs illustrated by Sheraton.

See R. Edwards and M. Jourdain, *Georgian Cabinet-makers,* 3rd ed. (London. 1955). (R. ED.)

SHERBORNE, a market town and urban district in the West Dorset parliamentary division of Dorset. Eng., 15 mi. N.N.W. of Dorchester by road. Pop. (1951) 5,987. Area 2.6 sq.mi. It lies near the border of Somerset on the southern slope of a hill overlooking the river Yeo, in a fertile, well-wooded district. In 1951 traces of Romano-British occupation were found in the southern part of the town, dating from the 2nd–3rd century A.D. Other sites include a large Roman settlement, 10 ac. in extent. overlying occupation of the British (Belgic) period. It is first mentioned in 705 as the place where St. Aldhelm fixed his bishop-stool for the new diocese of Western Wessex. In 1075 the see of Sherborne was transferred to Old Sarum and the cathedral of Sherborne became the abbey church of St. Mary the Virgin. Roger de Caen, bishop of Old Sarum from 1107 to 1139, replaced the Saxon church by a Norman building. parts of which remain today. Pre-Norman work appears in the western wall. and there are an Early English chapel and some Decorated windows. The church, however, was almost entirely reconstructed in the Perpendicular period; the colour decorations in the choir, and the stone-vaulted roof with fan tracery being particularly fine. The completion of this work in 1490 gave existence to the Pack Monday fair, which is still held annually on the first Monday after Oct. 10. Of the original building of the old castle, also built by Bishop Roger, only the gatehouse, portions of the curtain wall, the chapel, the keep, and certain domestic buildings remain. In 1139 the castle was seized by Stephen and remained with the crown until 1355, when it was returned to the bishops and retained by them until 1599 when it was given by Elizabeth I to Sir Walter Raleigh who built the present castle, now used as a museum. During the Great Rebellion the old castle was twice besieged, Cromwell himself being present in 1645 when it fell to Gen. Thomas Fairfax after a defense lasting 16 days. The almshouse of St. John Baptist and St. John the Evangelist was refounded in 1437 and retains a Perpendicular chapel. hall and other portions. The town is an educational centre. Sherborne boys' school now occupies the site of the school for which Edward VI granted a charter in 1550. There are also Sherborne girls' school and Lord Digby's school for girls. founded in 1743. Silk weaving was introduced by Huguenots in 1740 and the town also specializes in glove making and agriculture. It has a milk factory; light engineering and printing works and a brewery.

SHERBROOKE, ROBERT LOWE, VISCOUNT (1811–1892), British statesman. was born on Dec. 4, 1811. at Bingham. Nattinghamshire. He was educated at Winchester and University college. Oxford, and elected fellow of Magdalen college in 183j after a distinguished undergraduate career. Vacating his fellowship on marriage. Lowe became renowned as the outstanding tutor of his day, a savage examiner and an energetic controversialist. Called to the bar in 1842, he emigrated to New South Wales. where he was soon prominent in the courts and in the legislative council as a supporter of efficient but representative government. In 1850 Lowe returned to England, "with a tolerable fortune and a detestation of democracy," and became a familiar figure in society, noted for his caustic wit. He began writing leaders for the *Times* in 1851, and throughout J. T. Delane's editorship his influence remained considerable. Entering parliament in 1852.Lowe was appointed secretary of the board of control for India by Lord Aberdeen in December. and was later both vice-president of the board of trade and vice-president of the council for education under Lord Palmerston. In these minor offices he helped to establish competitive entry to the Indian civil service; his acts of 1856 and 1857 facilitated the formation of joint-stock companies. accepting the principle of limited liability; and he introduced the revised code of "payment by results" in elementary education, opposition to which caused his resignation in 1864.

Lowe proved an effective speaker and a capable administrator; but his brusque manner and sarcastic contempt for both vested interests and eager reformers gave much offence. An albino. and almost blind, he ascribed his faults to "physical rather than moral deficiencies." However. there can be no doubt of his intellectual arrogance, confidently and lucidly expressed, nor of the rigour with which he applied his harshly Benthamite views, stressing the sole tests of merit for the individual and of utility and economy for the actions of the state. Fortified by experience in both England and Australia. and his American observations. Lowe regarded democracy as the enemy of good government, which should be based upon a limited, informed electorate; and was satisfied with Palmerston's benign conservatism. tempered by Gladstonian efficiency. In 1866.by a series of shrewd and brilliant speeches. he turned the commons' distaste for Lord John Russell's Reform bill into hostility which brought down the ministry. In this "swan-song of the old constitutionalism" the case was never better stated. even by Walter Bagehot; and few men have more completely (or unexpectedly) dominated the house.

As leader of the "Adullamites" (the group of antireform Liberals, so-called by John Bright). Lowe's influence attained its zenith; yet his very success stimulated the demand for parliamentary reform and thus helped to produce Disraeli's more drastic measure, the Second Reform act. Despite the mutiny of 1866, Gladstone made Lome chancellor of the exchequer in 1868, admiring his talents and trusting his opinions on finance; and Lowe gave the reforms of a notable administration his regular support. Maintaining Gladstone's tradition at the treasury, Lowe was at first a success; but after 1871 his old maladroitness returned and he became a liability. He was transferred to the home office in 1873, but his active political life came to an end with the ministry's defeat in the following year. Failing powers forced him gradually into seclusion, enlivened by occasional journalism and a pioneer's enthusiasm for the bicycle and the typewriter. Cpon the Liberal victory in 1880,Lowe, already almost forgotten, was raised to the peerage as a viscount. saved from "the ruck of official barons" by Gladstone's insistence that his moment of greatness should be adequately recognized.

See Asa Briggs, *Victorian People* (London, 1954; Chicago, 1955).

(A F. T.)

SHERBROOKE, a city and port of entry of Quebec. Can., and capital of Sherbrooke county, 101 mi. E. of Montreal and 30 mi. from the U.S. boundary at Darby Line. Vt. It is situated at the confluence of the Magog and St. Francis rivers, and on the Canadian National. Canadian Pacific and Quebec Central railways, and is known as the commercial metropolis of the Eastern Townships. Pop. (1961) 66,554. It is the seat of a Roman Catholic bishopric and of the district courts. and contains manufactories of woollen, silk and cotton goods; leather, rubber, and wood products; mining and pulp-mill machinery; also saw and grist mills. It derives its name irom Sir John Coape Sherbrooke(1764–1830), who from 1816 to 1818 was governor general of Canada.

SHERIDAN, FRANCIS (1724–1766), wife of Thomas Sheridan (1719–1788) (*see* below) and mother of the dramatist Richard Brinsley Sheridan (*q.v.*) was the daughter of Philip Chamberlaine of Dublin. When only 15 years of age she wrote a story. *Eugenia and Adelaide,* published after her death in two volumes. She took Sheridan's part in the Kelly riots. writing some verses and a pamphlet in his defense. This led to her marriage in 1747 with the unpopular manager. It was by Richardson's advice that she wrote the *Memoirs of Miss Sidney Bidulph.* It was issued anonymously in 1761 with a dedication to Richardson, and had great success, both in England and France. A second part (2 vol.) was published in 176;. Two of her plays were produced in 1763 at Drury Lane. *The Discovery* and *Tlze Dupe.* The former was one of Garrick's stock pieces, and Sir Anthony Branville one of his favourite characters. *The Dupe* was a failure and was only played once. Her last work was an oriental tale, *Nourjahad,* written at Blois, where she died on Sept. 26.1766.

SHERIDAN, PHILIP HENRY (1831–1888), U.S. soldier, was born at Albany, N.Y., on March 6.1831. His parents, who had recently migrated from Ireland, moved to Perry county, O., a year after Philip's birth. Obtaining through his own endeavours an appointment to West Point, he graduated in 1853. He had gained some experience in fighting Indians on the frontier when the Civil War began in 1861. A first lieutenant at the time, he was soon promoted to captain, and in the spring of 1862 became colonel of the and Michigan cavalry under Halleck in Tennessee. In July he was raised to the rank of brigadier general of volunteers as a result of his skilful conduct in the battle of Boonville (July 1). He was in charge of the 11th division of the Army of the Ohio under Buell in the battle of Perryville (Oct. 8); and under Rosecrans at Stone's river (Dec. 26) he won promotion to the rank of major general of volunteers. In the summer of 1863 he effectively supported Rosecrans in manoeuvring the Confederates under Bragg out of middle Tennessee. Following the latter into northern Georgia in September, Rosecrans met with a signal defeat at Chickamauga (*q.v.*) on the noth, his army being driven in confusion back to Chattanooga, Tenn. Sheridan's cavalry division, though driven back in the course of the battle, helped to cover the retreat. In the subsequent fighting around Chattanooga (*see* CHATTANOOGA, BATTLE OF) Sheridan won considerable distinction, especially in his daring and brilliant charge up Missionary ridge (Nov. 25). This attracted the notice of Gen. Grant, who. when he became lieutenant general (March 1864) and assumed command of the Army of the Potomac in Virginia. placed Sheridan in charge of his cavalry. He proved himself the most able cavalry leader on the Union side. His corps were active in the battles of the Wilderness (*q.v.*) and Spottsylvania Court House (May 5–21). While the latter was still in progress he was sent on a raid toward Richmond. in the course of which he cut the Confederate communications by destroying railroads and cutting telegraph wires. He returned to the main army in time to participate in the battle of Cold Harbor (*q.v.*). Soon afterward he set out upon a raid toward Charlottesville (June 7–20) to co-operate with Gen. David Hunter in the Valley.

The success of these expeditions led to his appointment (Aug. 7) to the command of a newly formed Army of the Shenandonh with instructions to clear the Valley of the Confederates This was the greatest opportunity of his military career, and he proved himself fully equal to it. His campaign was brilliant and decisive He defeated Gen. Early at Winchester (Sept. 19) and again at Fisher's Mill (Sept. 22). Then followed an act concerning which he has often been severely censured. In order to make the region useless to the Confederates, he destroyed all means of subsistence; so that one of the most fruitful regions in the South was left in utter desolation with non-combatants on the verge of starvation. At this time Sheridan was given the rank of brigadier general in the regular army. When a few weeks later (Oct. 19) the main body of his army was thrown into confusion by a surprise attack from Gen. Early at Cedar Creek, Sheridan, some 20 m away, made his famous ride, rallied his troops, and turned defeat into victory. He was then commissioned (Nov. 8) major general in the regular army. He made another raid (Feb. 27–March 24) from Winchester to Petersburg, again destroying supplies and means of communication and defeating Early at Waynesboro. In April he turned Lee's flank at Five Forks and forced him to retreat toward Appomattox where he surrendered to Grant on April 9, 1865.

A month later Sheridan was placed in command of an American force on the Mexican border to watch the struggle between Maximilian, who had been set up as emperor of Mexico by Napoleon III. in 1864, and the Liberals seeking his overthrow. His presence greatly added to the effectiveness of American diplomatic protests to the French Government, thus hastening the collapse of that ill-starred venture. In the spring of 1867 Sheridan was placed in command of the Fifth Military district embracing Louisiana and Texas and stationed at New Orleans. Himself an advocate of cxtrcme measures in dealing with the conquered South he soon came into conflict with President Johnson who opposed such policies. His unconciliatory measures led to his removal in Sept 1867. He was then placed in charge of the Department of the Missouri. In the winter of 1868–69 he conducted a successful campaign against the Indians. In the latter year he was made lieutenant general by President Grant. During the Franco-German war of 1870 he accompanied the headquarters of the German army as the guest of the king of Prussia. In 1883 he was given chief command of the US. army, and five years later, shortly before his death, was raised to the rank of general. He died at Nonquitt, Mass., on Aug. 5, 1888.

In physical appearance Cen. Sheridan was short and stout, and rather harsh-featured To those opposed to his policies, in peace as in war, he seemed gruff and needlessly severe, but to his friends he was kindly. Exceptionally gifted with personal magnetism, he was very popular with his troops. As a military leader he combined brilliant courage with careful, vigilant tactics. He was a devout Roman Catholic. In 1875 he married Irene, daughter of Gen. D. H. Rucker, U S A.

Sheridan's *Personal Memoirs* (z vols.) were published in 1888. *See* also Davirs, *General Sheridan* (1895); Newhall, *With General Sheridan in Lee's Last Campaign* (1866), Channing, *History of the United States*, vol. vi. (1925); W. G. Shotwell, *The Civil War in America* (192j). **(A. M A.)**

SHERIDAN, RICHARD BRINSLEY BUTLER (1751–1816), third son of Thomas and Frances Sheridan, was born in Dublin on Oct. 30, 1751. At the age of 11 he was sent to Harrow school, where he spent six years.

After leaving Harrow he kept up a correspondence with a school friend N. B. Halhed who had gone to Oxford, and between them they published (1771) a metrical translation of Aristaenetus. They also wrote a farce entitled *Jupiter*, which was refused by Garrick and Foote and remained in MS It contains the same device of a rehearsal which was afterwards worked out in *The Critic.* Some of the dialogue is very much in Sheridan's mature manner. The removal of the family to Bath in 1770–1771 led to an acquaintance with the daughters of the ccmposer Thomas Linley. The eldest daughter, Elizabeth Ann (b. 1754), a girl of sixteen, the *prima donna* of her father's concerts, was exceedingly beautiful. Her portrait, by Gainsborough, hangs at Knole, Kent. She had many suitors, among them Sheridan, N. B. Halhed and a certain Major Mathews. To protect her from this man's persecutions, Sheridan escorted Miss Linley, in March 1772, to a nunnery in France, having secretly gone through the ceremony of marriage with her near Calais. He returned and fought two duels with Mathews, while Mr. Linley brought his daughter back to Bath. Sheridan was sent to Waltham Abbey to continue his studies He was entered at the Middle Temple on April 6, 1773, and a week later he was openly married to Miss Linley.

Although he had no income, and no capital beyond a few thousand pounds brought by his wife, he took a house in Orchard Street, Portman Square, furnished it "in the most costly style," and proceeded to return on something like an equal footing the hospitalities of the fashionable world. His first comedy, *The Rivals*, was produced at Covent Garden on Jan. 17, 1775. It is said to have been not so favourably received on its first night, owing to its length and to the bad playing of the part of Sir Lucius O'Trigger. But at the second performance (Jan. 28) it at once took that place on the stage which it has never lost. His second piece, *St. Patrick's Day, or the Scheming Lieutenant,* a lively farce, was written for the benefit performance (2nd of May 177j) of Lawrence Clinch, who had succeeded as Sir Lucius. In November 1775, with the assistance of his father-in-law, he produced the comic opera of *The Duenna,* which was played 75 times at Covent Garden during that season. Sheridan now began to negotiate with Garrick for the purchase of his share of Drury Lane, and the bargain was completed in June 1776. The sum paid by Sheridan and his partners, Thomas Linley and Dr. Ford, for the half-share was £35,000; of this Sheridan contributed £10,000. The money was raised on mortgage, Sheridan contributing only £1,300 in cash. *(See* B. Matthews's 1885 ed. of Sheridan's Comedies pp. 29–31.) Two years afterwards Sheridan and his friends bought the other half of the property for £35,000.

The direction of the theatre seems to have been mainly in the hands of Sheridan. In February 1777 he produced his version of Vanbrugh's *Relapse,* under the title of *A Trip to Scarborough.* This is printed among Sheridan's works, but he has no title to the authorship. His task was to remove indecencies; he added very little to the dialogue. *The School for Scandal* was produced on May 8, 1777. Mrs. Abington, who had played Miss Hoyden in the *Trip,* played Lady Teazle, who may be regarded as a Miss Hoyden developed by six months' experience of marriage and town life. The lord chamberlain was only persuaded on grounds of personal friendship with Sheridan to license the play. There are tales of the haste with which the conclusion of *The School for Scandal* was written and of a stratagem by which the last act was got out of him by the anxious company, but we know from Sheridan's sister that the idea of a "scandalous college" had occurred to him five years before in connection with his own experiences at Bath. His difficulty was to find a story sufficiently dramatic in its incidents. The dialogue is so brilliant throughout, and the auction scene and the screen scene so effective, that the construction of the comedy meets with little criticism. *The School for Scandal,* though it has not the unity of *The Rivals*, nor the same wealth of broadly humorous incident, is universally regarded as Sheridan's masterpiece.

The Critic was produced on Oct. 29, 1779, *The School for Scandal* meantime continuing to draw larger houses than any other play every time it was put on the stage. In *The Critic* the laughable infirmities of authors, actors, patrons and audience are touched off with the lightest of hands; the fun is directed, not at individuals, but at absurdities that grow naturally out of the circumstances of the stage. It seems that he had accumulated notes for another comedy to be called *Affectation,* but his only other play was *Pizarro,* produced in 1799—a tragedy in which he made liberal use of the arts ridiculed in the person of Mr. Puff. He also revised for the stage Benjamin Thompson's translation, *The Stranger,* of Kotzebue's *Menschenhass und Reue*.

He entered parliament for Stafford in 1780, as the ally of Charles James Fox. He is said to have paid the burgesses five guineas each for the honour of representing them. His first speech in parliament was to defend himself against the charge of bribery, and was well received. Congress recognized his services in opposing the war in America by offeringhim a gift of £20.000 which, however, he refused. Under the wing of Fox he filled subordinate offices in the short-lived ministries of 1782 and 1783. He was under-secretary for foreign affairs in the Rockingham ministry, and a secretary of the treasury in the Coalition ministry. In those heated days of parliamentary strife he was almost the only man of mark that was never called out, and yet he had no match in the weapon of ridicule.

Sheridan found his great opportunity in the impeachment of Warren Hastings. His speeches were by the unanimous acknowledgment of his contemporaries among the greatest delivered in that generation of great orators. The first was on Feb. 7, 1787, on the charges brought against Hastings with regard to the begums or princesses of Oude. Sheridan spoke for more than five hours, and the effect was such that it was unanimously agreed to postpone the final decision till the House should be in a calmer mood. Of this, and of his last great speech on the subject in 1794, only brief abstracts have been preserved; but the second, the four days' speech delivered in his capacity of manager of the trial, in Westminster Hall, on the occasion so brilliantly described by Macaulay, is given in Gurney's verbatim reports of the speeches on both sides at the trial, published at Sir G. Cornewall Lewis's instigation in 1859. There are passages of gaudy rhetoric, loose ornament and declamatory hyperbole; but the strong common sense, close argumentative force and masterly presentation of telling facts enable us to understand the impression produced by the speech at the time.

From the time of the break-up of the Whig party on the secession of Burke he was more or less an "independent member," and his isolation was complete after the death of Fox. When Burke denounced the French Revolution, Sheridan joined with Fox in vindicating the principle of non-intervention But when it became apparent that France under Napoleon would interfere with the affairs of its neighbours, he employed his eloquence in denouncing Napoleon and urging the prosecution of the war. One of his most celebrated speeches was delivered in support of strong measures against the mutineers at the Nore. He was one of the few members who actively opposed the union of the English and Irish parliaments. When the Whigs came into power in 1806 Sheridan was appointed treasurer of the navy, and became a member of the Privy Council. After Fox's death he succeeded his chief in the representation of Westminster, and aspired to succeed him as leader of the party, but this claim was not allowed, and thenceforward Sheridan fought for his own hand. When the prince became regent in 1811 Sheridan's private influence with him helped to exclude the Whigs from power. Throughout his parliamentary career Sheridan was one of the boon companions of the prince, and his champion in parliament in some dubious matters of payment of debts. But he always resented any imputation that he was the prince's confidential adviser or mouthpiece. A certain proud and sensitive independence was one of the most marked features in his parliamentary career.

His last years were harassed by debt and disappointment. At the general election of 1807 he stood again for Westminster and was defeated, but was returned as member for Ilchester, at the expense apparently of the prince of Wales. In 1812 he failed to secure a seat at Stafford. As a member of parliament he had been safe against arrest for debt, but now his creditors closed in upon him. It may be regarded as certain, however, that the description of the utter destitution of the last weeks of his life given in the *Croker Papers* (i. pp. 288–312, ed. L J. Jennings) is untrue. It was not without reason that his grand-daughter Mrs. Norton denounced the unfairness of judging the real man from unauthenticated stories; and against reports of his reckless management of his affairs we must set the facts that he had no source of income but Drury Lane theatre, that he bore from it for thirty years all the expenses of a fashionable life, and that the theatre was twice rebuilt during his proprietorship. Enough was lost in this way to account ten times over for all his debts. The records of his wild bets in the betting book of Brooks's Club date from the years after the loss, in 1792, of his first wife, to whom he was devotedly attached. He married again in 1795, his second wife being Esther Jane, daughter of Newton Ogle, dean of Winchester. He died on July 7, 1816, and was buried with great pomp in Westminster Abbey

Sheridan's only son by his first marriage, THOMAS SHERIDAN (1775–1817), was a poet of some merit. He became colonial treasurer at the Cape of Good Hope.

BIBLIOGRAPHY.—*Memoirs of the . . . Life of . . . R. B. Sheridan, with a Particular Account of his Family and Connexions* (1817), by John Watkins made many false statements. The *Memoirs, etc.* (1825), compiled by Thomas Moore did not make full use of the papers submitted by the family. William Smyth *(Memoir of Mr. Sheridan,* 1840) who had been a tutor in Sheridan's house, was responsible for many of the scandalous stories connected with Sheridan's name. Of modern works and critical stories *see* W. Fraser Rae, *Wilkes, Sheridan, Fox* (1874), the *Letters and Journab* of Byron (especially vol. v. p. 411 *seq.*, ed. Prothero, 1901); Mrs. Oliphant, *Sheridan* (1883) in the "English Men of Letters" series; Percy Fitzgerald, *Lifes of the Sheridans* (2 vols., 1886); and the *Life of* R. *B. Sheridan* (1890) by Lloyd C. Sanders in the "Great Writers" series and W. Fraser Rae, *Sheridan: a Biography* (2 vols., 1896). The *Life of R. B. Sheridan* by Walter Sichel (1909) is the best account now available.

Among the numerous modern editions of Sheridan's plays, of which only *The Rivals* was published by the dramatist himself, may be mentioned: *Sheridan's Plays now printed as he wrote them* (1902), edited by W. Fraser Rae; *The Plays of R. B. Sheridan* (1900), edited by A. W. Pollard; and *Sheridan's Comedies* (Boston, U.S.A., 1885), with a valuable introduction by Brander Matthews. For further details consult the bibliography by J. P. Anderson in the *Life* by Lloyd C. Sanders.

SHERIDAN, THOMAS (1687–1738), grandfather of the dramatist, Richard Brinsley Sheridan *(see* above), was born at Cavan and educated at Trinity College, Dublin. He married Elizabeth, heiress of Charles MacFadden, and thereby restored to the Sheridan family Quilcagh House, which they had forfeited by their Jacobite sympathies. When Swift came to Dublin as dean of St. Patrick's, Sheridan was a schoolmaster of high repute, and the two men were soon close friends. Sheridan was his confidant in the affair of *Drapier's Letters;* and it was at Quilcagh House that *Gulliver's Travels* was prepared for the press. Through Swift's influence he obtained a living near Cork. His correspondence with Swift and his whimsical "Art of Punning" make clear from whom his grandson derived his high spirits. He was no mean scholar, and translated the *Philoctetes* of Sophocles (1725), the *Satires* of Perseus (1728), and the *Satires* of Juvenal (1739). His latter days were not prosperous. He offended Swift by fulfilling an old promise to tell the dean if he ever saw signs of avarice in him, and the friends parted in anger. He died in poverty on Oct. 10, 1738.

SHERIDAN, THOMAS (1719–1788), son of Thomas Sheridan (1687–1738; *see* above), was born in Dublin in 1719. His father sent him to Westminster; but he completed his education at Trinity college, Dublin, where he took his B.A. in 1739. Then he went on the stage, and wrote a play, *Captain O'Blunder,* or *the Brave Irishman,* which became a stock piece, though it was never printed. His first appearance in London was at Covent Garden in March 1744, when he acted for three weeks in a succession of leading parts, Hamlet being the first. In October he appeared at Drury Lane, playing Horatio in Rowe's *Fair Penitent,* and subsequently as Pierre in Otway's *Venice Preserved,* and in Hamlet and other parts. In 1747 he became manager of the Theatre Royal, Dublin, and married Frances Chamberlaine, the novelist. He conceived a scheme of British education, and to push this he lectured at Oxford and Cambridge, being incorporated M.A. in both universities. But the scheme did not make way, and in 1760 he was acting under Garrick at Drury Lane. As an actor, he is placed by Churchill *(Rosciad* 1. 987) in the second rank, next to Garrick, but there is no hint of possible rivalry, and he is described as one whose conceptions were superior to his powers of execution, whose action was always forcible but too mechanically calculated, and who in spite of all his defects rose to greatness in occasional scenes. Through Sheridan's efforts Samuel Johnson had been given a pension, and so impressed was Lord Bute with Sheridan's own scheme for a *Pronouncing Dictionary* that he granted him a pension of £200 a year.

In 1764 he went to live in France, partly for Mrs. Sheridan's health, partly to study the system of education. His wife died in 1766 and soon afterwards he returned to England. In 1769 he published a matured *Plan of Education for the Young Nobility and Gentry,* and in 1780 his *General Dictionary of the English Language* (2 vols.). After his son's brilliant success he assisted in the management of Drury Lane, and occasionally acted. His *Life of Swift,* a very entertaining work in spite of its incompleteness as a biography, was written for the 1784 edition of Swift's works. He died at Margate on Aug. 14, 1788.

SHERIFF or **SHIRE-REEVE,** often called "high sheriff," the English and Irish executive authority in a county, or other place, often called his "bailiwick." The office also exists in about 20 ancient cities and boroughs, among which may be named London, Norwich, York, Bristol, Oxford, Lincoln, Chester and Canterbury in England, and Dublin, Cork, Limerick and other places in Ireland. In most of these the office is of an honorary nature. The office is at present an annual one, though this has not been always the case. Three names are put on the list by the chancellor of the exchequer and the judges of king's bench division on the morrow of St. Martin, Nov. 12, and the first name is usually pricked by the king in council in the February or March following. City and borough sheriffs are usually appointed by the corporations on November 9. London and Middlesex are specially provided for by the act of 1887, s. 33, and the sheriffs of the counties of Cornwall and Lancaster are separately appointed, the act not applying to them.

The shrievalty was at one time an important office. The appointment appears to have been originally by popular election, a right confirmed by 28 Edw. I. c. 8, but ultimately vested in the crown except where the office was hereditary. At one time contributions to the expense of the office were made by the magistrates and others of the county. "Sheriff-tooth" was a tenure on condition of supplying entertainment to the sheriff at the county court. Up to the 19th century "riding with the sheriff" was an incident of the assizes, the riders being some of the principal men of the shire who brought with them wine and victuals in order to assist the sheriff in showing hospitality to the judges.

To-day the duties of the sheriff depend on numerous statutes beginning with 2 Edw. III. c. 3 (1328). The most important is the Sheriffsact 1887, mainly a consolidating act applying to England only. The person nominated is usually a magistrate for the county, but anyone is eligible if he has land in the county. Exempt are peers, clergy, officers in active service, practising barristers and solicitors and others. Poverty is also a ground of exemption. The sheriff appoints his undersheriff. The duties of the office are both administrative and judicial. He attends on the judges at assizes and election petitions and is responsible for the execution of writs and of the sentence of death, acts as returning officer at parliamentary elections, prepares the panel of jurors for assizes and is liable for the safe custody of prisoners. He or his deputy sits to assess damages under the Lands Clauses Act 1845, and also in cases sent to the sheriff's court for the assessment of damages. The expenses of the office are partly met by the Treasury. A sheriff cannot during his year of office act as a magistrate for the county of which he is sheriff.

See Sir M. Hale, A *Short Treatise Touching Sheriff's Accompts* (1683); W. Greenwood, *Bouleuterion* (1685); *The Compleat Sheriff* (1696); F. Pollock and F. W. Maitland, *Hist. Eng. Law* (1898); W. S. Holdsworth, *Hist. Eng. Law* (1903); P. E. Mather, *Compendium of Sheriff and Execution Law* (1903); W. S. McKechnie, *Magna Carta* (1905).

Scotland is divided into 15 territorial sheriffdoms in each of which a sheriff exercises administrative and judicial functions; his administrative functions being partly statutory, partly the result of custom. He is Returning Officer in Parliamentary elections for constituencies within his sheriffdom. The appointment, tenure of office and judicial duties of a sheriff are fixed by the Sheriff Court (Scotland) Acts, 1907 and 1913. The sheriff, in his judicial aspect, is one of the judges of the Sheriff court of the sheriffdom. That court, exercising an extensive local jurisdiction, in matters civil and criminal, comprises, on its civil side, a court of first instance and an appellate court, but on its criminal side it has no general appellate jurisdiction. The sheriff sits as the single appellate judge in the Appeal court.

The original jurisdiction of the Sheriff court is, generally speaking, exercised by the salaried sheriff-substitutes attached to the sheriffdom. At the present day the sheriff and salaried sheriff-substitutes are appointed by the Crown on the recommendation of the secretary of State for Scotland. The sheriff, to be appointed, must be an advocate or a salaried sheriff-substitute of five years' standing. He is removable by order of secretary of State for Scotland proceeding upon a report of the Lord President of the Court of Session and the Lord Justice Clerk declaring the sheriff, by reason of inability, neglect of duty or misbehaviour, to be unfit for his office. The order of the secretary of State must lie before both Houses of Parliament for four weeks before it becomes operative. The qualification for appointment as salaried sheriff-substitute is that he shall be an advocate or a law agent in Scotland of five years' standing. The salaried sheriff-substitute is removable from office by the secretary of State for Scotland *de plano* upon a report by the Lord President and the Lord Justice clerk for inability or misbehaviour.

Honorary sheriff-substitutes are appointed by writing under the hand of the sheriff and they hold office during his pleasure.

Besides the sheriffs of counties, there is a sheriff of Chancery appointed by the Crown whose duties are confined to the service of heirs.

See W. J. Lewis. *Sheriff Court Practice* (1923).

Ireland. — The sheriff has much the same duties as in England His position is defined by numerous statutes, beginning with 53 Geo. III. c. 68 (1817).

United States. — The office of sheriff is generally elective. The sheriff has administrative and limited judicial authority. He sometimes serves for combined counties, as in England for Cambridge and Huntingdon. (J. WA.)

SHERIFFMUIR, a battlefield near the western end of the Ochil hills, in the parish of Dunblane, Perthshire, Scot., and $2\frac{1}{2}$ mi. E. by N. of the town. It was the site of a drawn battle (Nov. 13, 1715) between the Jacobites, about 12,000 strong, under John Erskine, earl of Mar, and 4,000 Hanoverians, under John Campbell, 2nd duke of Argyll. About 500 men were lost on each side. Both armies claimed the victory, but Mar felt it prudent to withdraw, and the encounter, occurring one day before the final defeat of the English rising at Preston, was fatal to the Jacobite cause. (G. S. P.)

SHERLEY (SHIRLEY), SIR ANTHONY (1565–c. 1635), English traveler, was educated at Oxford and gained some military experience with the English troops in the Netherlands and also during an expedition to Normandy in 1591 under Robert Devereux, earl of Essex. In 1596 he conducted a predatory expedition along the western coast of Africa and across to Central America, but as a result of a mutiny he returned to London in 1597. In 1598 he led a few English volunteers to Italy to take part in a dispute over the possession of Ferrara; this, however, had been accommodated when he reached Venice, and he decided to journey to Persia to promote trade between England and Persia and to stir up the Persians against the Turks.

He was well received by the shah, Abbas the Great, who made him a mirza, or prince, and granted certain rights to all Christian merchants. Then, as the shah's representative, he visited Moscow, Prague, Rome and other cities, but the English government would not allow him to return to his own country. In 1605 he went to Prague and was sent by the emperor Rudolph II on a mission to Morocco; afterward he went to Lisbon and Madrid. He wrote *Sir Anthony Sherley: His Relation of His Travels Into Persia* (1613). He died at Madrid sometime after 1635.

SHERMAN, JAMES SCHOOLCRAFT (1855–1912), U.S. politician, was born near Utica, N.Y., on Oct. 24, 1855. He graduated from Hamilton college, Clinton, N.Y., in 1878 and was admitted to the bar in 1880. He was elected mayor of Utica in 1884. In 1886 he was elected to the U.S. house of representatives and was returned continuously until 1908, excepting the term 1891–93.

Sherman was chairman of the Republican state convention in 1895, 1900 and 1908; and chairman of the Republican national committee in 1906. At the Republican national convention of 1908 he was nominated vice-president and was elected on the ticket with William Howard Taft. Four years later he was renominated, but he died at Utica, on Oct. 30, 1912, shortly before the elections.

SHERMAN, JOHN (1823–1900), U.S. financier and statesman, a younger brother of Gen. W. T. Sherman, was born at Lancaster, O., on May 10, 1823. He began the study of law at Mansfield, O., and was admitted to the bar in 1844. For ten years he practised his profession with success, and with only casual interest in politics, but upon the repeal of the Missouri Compromise by the Kansas-Nebraska bill in 1854, he joined the great popular movement in Ohio against the policy represented by this bill, and was elected to Congress in the autumn of that year as an "Anti-Nebraska" man. In the summer of the next year he took an active part in the formal organization of the Republican Party in the State, and at the opening of Congress in December began a long career of public service. As a member of the House (1855–61) he quickly manifested the qualities which characterized his whole political life. Though a thorough and avowed partisan, he was within the party the counsellor of moderate rather than extreme measures, and thus gained on the whole a position of great influence. He was a member of the committee sent by the House in 1856 to investigate the troubles in Kansas, and drafted the report of the majority. In March of 1861 he took his seat in the Senate in which he sat continuously until he became secretary of the Treasury in 1877. His interest and efficiency in financial legislation in the House led to his appointment on the Senate committee of finance, and after 1867 he was chairman of this influential committee. He thus became associated with the enactment of all the great fiscal laws through which the strain of war and of reconstruction was sustained. He gave earnest support to the Legal Tender Act, and the substitution of the national for the State banking system. The Resumption Act of 1875, which provided for the return of specie payments four years later, was largely his work, and his appointment to the head of the Treasury department by President Hayes in 1877 enabled him to carry the policy embodied in the law to successful execution.

At the end of the Hayes administration he was again elected to the Senate from Ohio and held his seat until 1897. During this period he was largely concerned in the enactment of the Anti-Trust Law of 1890, and of the so-called Sherman Act of the same year, providing for the purchase of silver and the issuing of Treasury notes based upon it. In 1880 and 1888 he aspired actively to the Republican nomination for the Presidency, but failed to obtain the requisite support in the Convention. During the last years of his senatorial career he was chairman of the Senate committee on foreign affairs. Upon the accession of President McKinley in 1897, he became secretary of State; but under the tension of the war with Spain the duties of the office became too exacting for his strength at his age, and in April 1898 he resigned and withdrew into private life. He died at Washington on Oct. 22, 1900.

A selection from the correspondence of John Sherman and his brother Gen. W. T. Sherman was published as *The Sherman Letters* in 1894. Sherman published *Recollections of Forty Years in the House, Senate and Cabinet: an Autobiography* (Chicago, 1895). A volume of *Selected Speeches* was published in 1879. See *Life,* by T. E. Burton (1906).

SHERMAN, ROGER (1721–1793), American political leader, a signer of the Declaration of Independence, was born in Newton (Mass), on April 19, 1721 (Old Style). He removed with his parents to Stoughton in 1723, attended the country school there, and learned the cobbler's trade in his father's shop Removing to New Milford (Conn), in 1743, he worked as county surveyor, studied law, and in 1754 was admitted to the bar. He was treasurer of Yale college in 1765–76, a delegate to the Continental Congress in 1774–81 and again in 1783–84, a member of the Connecticut committee of safety in 1777–79 and in 1782, mayor of New Haven in 1784–93, a delegate to the Federal Constitutional Convention of 1787 and to the Connecticut ratification convention of the same year, and a member of the Federal House of Representatives in 1789–91 and of the U.S. Senate in 1791–93.

He was on the committee which drafted the Declaration of Independence, and also on that which drafted the Articles of Confederation. His greatest public service, however, was performed in the Federal Constitutional Convention In the conflict between the large State party and the small State party, he and his colleagues played the rôle of peacemakers. In the Federal Congress (1789–93) he favoured the assumption of the State debts, the establishment of a national bank and the adoption of a protective tariff policy. He was strongly opposed to slavery. He died in New Haven on July 23, 1793.

Lewis H. Boutell's *Life of Roger Sherman* (Chicago, 1896), based on material collected by Senator Hoar, is a careful and accurate work.

SHERMAN, WILLIAM TECUMSEH (1820–1891), American general, was born on Feb. 8, 1820, at Lancaster, O. He was descended from Edmond Sherman, who emigrated from England to the Massachusetts bay colony in 1634. His father, Charles R. Sherman, a judge of the supreme court of Ohio, died suddenly in 1829, leaving his widow with a family of young children William was adopted by Thomas Ewing, a close friend of the father, sometime a senator of the United States and a member of the national cabinet. In 1636 he entered West Point, and on graduating near the head of his class he was appointed second lieutenant. His first field service was in Florida against the Seminole Indians The usual changes of station and detached duty made him acquainted with the geography of all the Southern states. He also employed much of his time in the study of law. When the war with Mexico began in 1846 he asked for field duty, and was ordered to join an expedition going to California by sea. He was made executive officer in administration of local government till peace came in 1848 and the province was ceded to the United States. In 1850 he married Ellen Boyle, daughter of Thomas Ewing, then secretary of the interior.

In 1853 he resigned from the army and returned to California to conduct at San Francisco a branch of a St. Louis banking-house. He continued successfully in the management of this business until 1857. Afterwards for a short time he was engaged in business at New York and in 1858 practised law at Lenvenworth, Kansas In 1859, the state of Louisiana proposing to establish a military college, Sherman was appointed its superintendent. This institution was opened on Jan. 1, 1860, and here Sherman remained until the spring of 1861, when it was evident that Louis. iana would join the states seceding from the Union. He thereupon resigned the superintendency and returned to St. Louis. Though his brother John Sherman was a leader in the party which had elected Lincoln, William Sherman was very conservative on the slavery question, and his distress at what he thought an unnecessary rupture between the states was extreme. Yet his devotion to the national constitution was unbounded, and he offered his services as soon as volunteers for the three years' enlistments were called out.

On May 14, 1861, Sherman was appointed colonel of a new U S infantry regiment, and was soon assigned to command a brigade in Gen McDowell's army in front of Washington, serving uith it in the first battle of Bull Run. Promoted brigadier-general of volunteers. Sherman was in August sent to Kentucky to serve under Gen Robert Anderson In October he succeeded to the command of the department. Within a month he reported that 200,000 men would be required for the Kentucky campaign He was relieved of his post soon afterwards in consequence, but the event justified Sherman's view. He was soon re-employed in a minor position, and, at the head of a division of new troops, accompanied Grant's army to Pittshurg Landing At the battle of Shiloh Sherman's gallant conduct gained him promotion to major-general. He took part in Halleck's advance on Corinth. Miss., and at the close of 1862 led the Mississippi column in the first Vicksburg campaign He suffered defeat at Chickasaw Bayou, hut the capture of Fort Hindman, near Arkansas Post, compensated to some extent for the Vicksburg failure. In Grant's final Vicksburg campaign Sherman commanded the right of the line.

After the surrender (July 4, 1863) Sherman was sent to oppose Gen Johnston in the country about Jackson, Miss In July he was made a brigadier-general in the regular army When after Rosecrans's defeat at Chickamauga, Grant was placed in supreme command in the west. Sherman succeeded to the command of the Army of the Tennessee, with which he took part in the battle of Chattanooga (q v). In March, 1864, when Grant became general-in-chief Sherman was made commander of the military division of the Mississippi, including his Army of the Tennessee, now under McPherson, the Army of the Cumberland, under Thomas, and the Army of the Ohio, under Schofield. Making detachments for garrisons and minor operations in a theatre of war over 500m. wide, he assembled, near Chattanooga, his three armies, aggregating 100,000 men, and began (May 1864) the invasion of Georgia. After a famous campaign of careful manoeuvre and heavy combats (*see* AMERICAN CIVIL WAR), Sherman finally wrested Atlanta (*q.v.*) from the Confederates on Sept. 1.

His able opponent Johnston had been removed from his command, and Hood, Johnston's successor, began early in October a vigorous movement designed to carry the war back into Tennessee. After a devious chase of a month Hood moved across Alabama to northern Mississippi. Sherman thereupon, leaving behind Thomas and Schofield to deal with Hood, made the celebrated "March to the Sea" from Atlanta to Savannah with 60,000 picked men. After a march of 300m. Savannah was reached in December. Railways and material were destroyed, the country cleared of supplies, and the Confederate government severed from its western states. In Jan. 1865 Sherman marched northwards again, once more abandoning his base, towards Petersburg, where Grant and Lee were waging their final campaign. Every mile of his march northwards through the Carolinas diminished the supply region of the enemy, and desperate efforts were made to stop his advance. Gen. Johnston was recalled to active service but his forces were inadequate. Sherman defeated him and reached Raleigh, the capital of North Carolina, on April 13, having marched nearly 500m. from Savannah. Lee's position in Virginia was now desperate. Hood had been utterly defeated by Thomas and Schofield, and Schofield (moved 2,000m. by land and sea) rejoined Sherman in North Carolina. With 90,000 men Sherman drove Johnston before him, and when Lee surrendered to Grant Johnston also gave up the struggle.

Sherman had the good fortune to learn the art of command by degrees. At Bull Run his brigade was wasted in isolated and disconnected regimental attacks, at Shiloh his division was completely surprised owing to want of precaution; but his bravery and energy carried him gradually to the front at the same time as he acquired skill and experience. When therefore he was entrusted with an independent command he was in every way fitted to do himself justice. At the head of 100,000 men he showed, besides the strategy which planned the Carolinas march and the skill in manoeuvre which finally gained Atlanta, the strength of will which sent his men to the hopeless assault of Kenesaw to teach them that he was not afraid to fight, and cleared Atlanta of its civil population in the face of a bitter popular outcry. He is justly regarded as one of the great generals of the Civil War.

When Grant became full general in 1866 Sherman was promoted lieutenant-general, and in 1869, when Grant became president, he succeeded to the full rank. General Sherman, after serving as commanding general of the army for 15 years, relinquished command in Nov. 1883 and retired in Feb. 1884. He died at New York city on Feb. 14, 1891.

Sherman's *Memoirs* were published in 1875. *See* also Rachel Sherman Thorndike, *The Sherman Letters* (1894); *Home Letters of Gen. Sherman* (1909), ed. by M. A. De Wolfe Howe; S. M. Bowman and R. B. Irwin, *Sherman and His Campaigns: a Military Biography* (1865); W. F. Johnson, *Life of William Tecumseh Sherman* (1891); Manning F. Force, *General Sherman* in the "Great Commanders Series" (1899); B H Liddell Hart, *Sherman* (1929).

SHERMAN-DENISON, twin cities of Grayson county in northern Texas, U S. Sherman, the county seat, is 65 mi. N. of Dallas; Denison is 15 mi. from Sherman and 4 mi. from the Red river. The Butterfield stage line, from St. Louis to San Francisco, passed through both cities and since that time both have continued to be important transportation centres. The Sherman-Denison area is an important agricultural region and also one of extensive and diversified manufactures. Within the area is Lake Texoma, an outstanding recreational area. Sherman. incorporated in 1895 and named in honour of Gen. Sidney Sherman, commander of cavalry at the battle of San Jacinto, is the location of Austin college (coeducational. Presbyterian, 1849) and Perrin air base. Denison, incorporated in 1891, is the birthplace of Dwight Eisenhower. For comparative population figures *see* table in TEXAS: *Population.* (V. M. S.)

SHERRINGTON, SIR CHARLES SCOTT (1857–1952), English neurophysiologist pre-eminent for discoveries on limb movement by reflex action, who in 1932 received (with E. D. Adrian) the Nobel prize for medicine for discoveries regarding the functions of neurons, was born in London on Nov. 27, 1857. While at Caius college, Cambridge, he was invited to assist in unraveling the anatomy of nerve paths between the brain and spinal cord, but later he turned to the physiology of the spinal cord after isolation from the brain and proved the presence of sense organs in skeletal muscles, thus ending the ancient controversy about "muscle sense." Next, he showed how complex was spinal reflex action in the scratch reflex; the varying latency before response, but unvarying rhythm of response; the reciprocal activity of antagonistic muscles; the long afteraction; facilitation between distant receptive skin areas; central inhibition; postinhibitory rebound; and other characteristics. He interpreted his results with unparalleled insight and suggested that the lability of reflex nerve centres came from physicochemical states in the points of contact between nerve cells, which points of adjunction he called synapses.

In 1891 Sherrington became Brown professor of pathology. London, in 1895 Holt professor of physiology, Liverpool, and was Waynflete professor of physiology, Oxford, 1913–35. His Silliman lectures at Yale university, published as *The Integrative Action of the Nervous System* (1906), established his world-wide reputation and marked out new fields for physiological research, as well as guiding psychologists and clinicians. The remainder of his life was spent on still closer scrutiny of the working of spinal nerve centres. Sherrington died at Eastbourne, Sussex, on March 4, 1952.

See J. F. Fulton in J. *Neurophysiol.*, 15:167 (1952); E. G. T. Liddell in *Obit Not. Roy. Soc.*, 8:241 (1952). (E. G. T. L.)

SHERRY is a fortified and blended wine made from white grapes nhich are grown around the town of Jerez de la Frontera, in Andalusia, Spain. The area where sherry may be produced is about 100 sq.km. and is defined in Spanish law. "Sherries" from other countries, such as South Africa or Australia, declare their country of origin on the label.

Wine from southwest Spain has been imported into England since the 14th century, and possibly before; it is probable that the present method of vinification was developed in the 18th century. A third of all Spanish wine is sherry and Great Britain is the largest importer (about 600,000 gal. a year), while the United States is second largest (about 85,000 gal.).

Some 12 varieties of grapes are used, but the main types are the *Palomino*, a medium-sized grape, and the *Pedro Ximenez*, an expensive golden grape of great sweetness. The soil in which the vines are grown may be one of three main types: *albariza*, a firm chalky soil. of a whitish colour, which produces the finest wines; *burros*, which is less chalky and darker in colour, whose wine is less distinguished; and *arena*, a yellow sandy soil which produces poor quality wine. The sherry vintage normally begins in the first fortnight of September, and the Andalusians sing while they tread the grapes in specially strong *zapatos*, or shoes.

Sherry may be ideal as an apéritif, as a table wine or as a dessert wine, for it may be very dry, medium sweet or rich. The variety which may be obtained by judicious blending is infinite, but the unblended wine will resemble one of three main types. *Fino* is a straw-coloured wine, dry, sometimes very dry; in Spain it is drunk at a lower alcoholic strength than other Jerez wines. *Oloroso* is fuller in colour and richer in body, becoming drier with age; it finishes with distinct richness on the palate. *Amontillado* is neither as rich as the *oloroso* nor as light as the *fino;* in alcohol and in colour it is also in between.

Cream sherry is a fine *oloroso* blended with some rich *Pedro Ximenez* wine; the best has been kept for many years. Brown sherry is similar although even richer. Both these sherries can be produced more quickly by blending with a cheap *vino de color* instead of *Pedro Ximenez* wine. *Manzanilla* is a *fino* which has been matured on the sea coast near Sanlucar de Barrameda and has thus acquired a delicious, fresh, salty tang. East India sherry is an *oloroso* which originally traveled as ballast to the east, a journey which was supposed to improve it; the name, but not the practice, has survived. Finally, *Montilla* is not a sherry since it comes from the Cordoban hills and not from the Jerez area. It is, however. a dry fortified wine, similar to a *fino,* with a little more body, and an attractive nutty flavour.

There is no such thing as vintage sherry because the continuous quality of any wine is guaranteed by using wines from several years in its production. This is done by means of the *solera* system. which is simple although laborious. A *solera* is a series of butts, the wine in each of which is at a slightly different stage of maturity; a *solera* may consist of as few as 4 stages or as many as 20. There may, of course, be more than one butt in a stage, but each stage in a particular *solera* will contain an equal number of butts. Only wine from the most mature butt may be drawn off, and not more than a third of it at a time; this third is thereupon replaced from the butt next to it, and so on, until the first butt (containing the youngest wine) is replenished from a stock of wine held in the *criadera* or nursery. Wine is kept in the *criadera* for about two years after each vintage and here different blends of young wine are prepared to suit the characteristics of each *solera.* So long as not more than three withdrawals are made from the *solera* each year, its age (as well as the flavour of the blend) mill remain constant. (C. C. H. F.)

'S HERTOGENBOSCH, the capital of the province of North Brabant, the Netherlands, at the confluence of the Dommel and Aa rivers, which unite to form the Dieze, and a junction station 29½ mi. S.S.E. of Utrecht (also known as 'sBosch, or den Bosch, French *Bois-le-Duc*). Pop. (1957 est. mun.) 67.394. The Roman Catholic cathedral of St. John, the Janskerk, with its interior in a state of preservation rare in Holland, is one of the finest in the country. The grammar school was once attended by Erasmus.

SHERWOOD, MARY MARTHA (1775–1851), English author, was born at Stanford, Worcestershire, on May 6, 1775, the daughter of the Rev. George Butt. D.D., then rector of Stanford. In 1803 she married her cousin, Capt. Henry Sherwood, an officer in the British army, and subsequently accompanied him to India, where she devoted herself to charitable work and to writing. Her Indian story, *Little Henry and his Bearer,* was translated into many languages. Her best-known work, however, is *The History of the Fairchild Family* (3 pts., 1818, 1842 and 1847). Mrs. Sherwood wrote nearly a hundred stories of a religious type and tracts. mainly for the young. She died on Sept. 22. 1851.

SHERWOOD, ROBERT EMMET (1896–1955), U.S. author whose plays reflect the gradual shift of the intellectual position of his generation — from irresponsible detachment to responsible involvement in human problems. He was born in New Rochelle, N.Y., April 4, 1896. In 1917. he left Harvard to join the Canadian expeditionary forces in World War I and was wounded in France. Back in New York, he edited (1920–28) the humour magazine *Life.* His first play, the urbanely witty historical *The Road to Rome* (1927), criticizes war as pointless. The heroes of *The Petrified Forest* (1935) and *Idiot's Delight* (Pulitzer prize, 1936) begin as detached cynics but realize their own bankruptcy and sacrifice themselves for their fellow men. In *Abe Lincoln in Illinois* (Pulitzer prize. 1939) and *There Shall Be No Night* (Pulitzer prize. 1941), in which his pacifist heroes decide to fight, Sherwood shows that only by losing his life for other men can a man make his own life significant.

During World War II, Sherwood worked for the U.S. Office of War Information, where his help in writing some of President Roosevelt's speeches did much to make ghost writing for public figures an accepted procedure. From this wartime association with Roosevelt came much of the material for *Roosevelt and Hopkins,* for which he received a Pulitzer prize in 1949. Except for his Academy-award-winning film *The Best Years of Our Lives* (1946), Sherwood's theatrical work after World War II was negligible. Sherwood died in New York, Nov. 14, 1955. (Js. T. N.)

SHERWOOD FOREST, one of the ancient English forests, in Nottinghamshire. It extended from Nottingham northward to Worksop, being over 20 mi. long by j to 9 mi. broad. Though subject to forest law. it is not mentioned in Domesday Book because it was not liable for tax. Sherwood, a crown forest from the time of Henry I. is traditionally noted as the retreat of the outlaw Robin Hood. It once contained vast numbers of deer. Today about 12.500 ac. are under national ownership, administered by the Forestry commission as productive plantations. mostly of pines; many veteran oaks remain and there is some birch and beech and much bracken. The forest is on the Bunter sandstone and much of the ground is too poor for agriculture. but in the 18th century great parks. with extensive woodlands. were laid out to form the "Dukeries." Deep-lying coal seams have been extensively developed and colliery settlements built. Mansfield (*q.v.*) is the main town. (H. L. Ed.)

SHETLAND or Zetland, as it is often described officially, is a group of islands lying about 130 mi. to the north of the Scottish mainland, constituting the most northerly county of Scotland. The main island. Mainland, is much the largest, being, though narrow. about 50 mi. long. The total area of land in the county is 550.5 sq.mi. Lerwick, the county town, lies about a third of the way up Mainland on the east side.

The scenerv of Shetland is wild and in places verv fine. Its most distinct characteristics are perhaps the voes or sea lochs which indent all the coasts, often enclosed by steep hills and giving fine views over sea and coast. The common and gray seal is abundant in the Shetland waters, especially between Lerwick and the north isles. Brilliant red and purple sea urchins occur along the shores, due to the presence of the Atlantic drift.

The geological character of the islands resembles that of northern Scotland. Old Red Sandstone, red grits. sandstones and marls and conglomerate occur in a narrow belt on the east side of Mainland. The remainder of the island is occupied by metamorphic schists and gneisses with which are associated dikes and masses of intrusive igneous rock.

The Inhabited **Islands.**—Mainland is almost cut in half just north of Brae. The northern portion. Northmaven, is sparsely inhabited. It contains Ronas hill, the highest point in the islands (1.475 ft.). The western parishes. stretching out to Walls and Sandness. are also thinly populated. Tingwall, the site of the ancient "Ting" or Norse parliament, lying directly north of Lerwick, is the most fertile part of the island and contains one or two sizable farms. South of Lerwick in Dunrossness there is some good land and the districts are more thickly populated.

Of the islands. Yell (pop., 1951, 1.483), which lies just north of Mainland. is the largest. It is about 1; mi. long and largely covered in peat. There are piers and a safe anchorage at Cullivoe and Mid Yell. To the northeast of Yell lies Unst (pop. 1.101), the next largest and most populous and the most northerly of the islands. At Muness are the ruins of a 16th-century castle and at the north the Muckle Flugga lighthouse. the most northerly point of Britain. The name means "Eagle's Island." presumably from the sea eagle n-hich used to frequent the cliffs. In Unst were knitted the finest Shetland scarves, so fine that they could be drawn through a wedding ring. Only two or three people remain who spin their own wool and knit these scarves. Fetlar (pop. 161) lies to the east of Yell and southeast of Unst. It has some good soil but a small population. Off the east and northeast coasts of Mainland lie many small uninhabited islands. Whalsay (the "whales island")) sometimes called "The Bonnie Isle" (pop. 859), though only about j mi. by 2½ mi., has a comparatively large population engaged in fishing. Beyond Whalsay to the northeast lie Out Skerries (pop. 1joi and also fishing islands. Opposite Lerwick and protecting its harbour lies Bressay (pop. 335). Off the western seaboard lie a great number of uninhabited islands and five or. if Muckle Roe (the "great red island") now joined to Mainland by a bridge. be included, six inhabited islands. Of them Papa Stour (pop. 68) lies about 1½ mi. from Sandness. It has some very fine caves, one of which is ¾ mi. long. Vaila. which lies almost landlocked off Walls, has only two inhabited houses, one of which. however, is one of the finest mansions in the county. Off Scalloway, and reached by regular boat sailings from that town. lies Trondra (pop. 54) and Burra Isle (pop. 645) — really two islands. Burra Isle, like Whalsay, is largely inhabited by fishermen and has a village, Hamnavoe. at its northern end.

Farther out from the main group of islands are Foula and Fair Isle. Foula (pop. 75), "the edge of the world." lies in the Atlantic

16 mi. from the west mainland of Shetland. It is a high, rocky island with fine cliffs. The landing place is very exposed and for months in winter the islanders are cut off. Fair Isle (pop. 73) gives its name to "Fair Isle" knitwear, though that is now made generally throughout Shetland. There are two lighthouses and an ornithological observatory under the Fair Isle trust. Visitors may stay at the observatory where a wide variety of birds on migration are trapped and ringed each year. The island lies about 20 mi. S. of Sumburgh head, the most southerly part of Mainland and almost midway to North Ronaldsay.

History. — The word Shetland is a modernized version of the old Norse name *Hjaltland*. The original inhabitants were probably a primitive people who lived in rough. sunken dwellings. Various stone circles survive and brochs of Pictish origin. In the 7th or 8th century the islanders began to be converted to Christianity by priests of the Celtic Church from Ireland or the west of Scotland. although the work was not completed until later. In the 8th and 9th centuries the islands were invaded by the Norsemen who ruled them until the 1jth century. The Norsemen left a heavy imprint on the people and the local place names, most of which are Norse in origin. The language. Norn, survived don-n to the 18th century and various sea birds and parts of boats are generally known by their Norse names. In 1468 the islands. together with Orkney, were given as a pledge for the dowry of Margaret, princess of Norway, betrothed to James III of Scotland. The pledge was never redeemed and the islands were eventually annexed to the Scottish crown. Large tracts of land were granted to Scottish nobles and from the 16th century began a steady influx of Scots which. since many of them came as oppressive lairds, was by no mean; always popular with the native Shetlanders. For several centuries the islands have been famous for wool and knitwear. and fish. The origins of the "Fair Isle" patterns are disputed. They are probably native, although it has been suggested that they came from the crew of a Spanish Armada galleon which was wrecked on the Fair Isle. Development of herring fishing. which at one time supported stations in almost every voe and packed Bressay sound and Baltasound with ships. was largely due to the Dutch in the 18th century; but the Shetlanders have always been great seamen. Many local customs, mostly of Norse origin. survive, such as Up Helly 'aa, the winter festival. The islands on the whole have stood outside the main-stream of Scottish history.

Population. — The population in 1951 was 19,352, showing a decline of 2.069 after 1931; of these 9.001 were males and 10,351 females. In 1861 the population was as high as 31,670. Lerwick (pop.. 1951, 5.538) is the capital and main port of the county. It is a small burgh. The old part of the town is built on a hill falling down to the sea and is intersected by a narrow main street from which even narrower lanes give access to the top of the hill. The old town is surrounded by new buildings of orthodox Scottish layout and design. There are the remains of a fort dating from the time of Cromwell. The only other town is Scalloway, the ancient capital. which lies almost opposite Lerwick on the west coast. It is a considerable fishing centre. In the town stand the ruins of a castle built by Patrick Stewart. one of the most notorious of the Scottish landlords.

Shetland unites with Orkney to return a member to parliament. The island is divided into six districts. It forms a sherriffdom with Orkney and Caithness. and there is a resident sheriff-substitute at Lerwick.

Agriculture and Industries. — The soil of Shetland except in certain districts is poor and the climate inimical to many kinds of agriculture. The system of land tenure is mostly crofting. The main source of the crofters' income is wool. The Shetland breed of sheep produces a light fleece of very fine wool which is knitted by the crofters' wives and daughters into gloves, pull-overs. socks, berets, etc.. in the patterns known as "Shetland" or "Fair Isle." But many of the crofts do not yield a sufficient income for a family and the Shetland men often seek supplementary means of livelihood. usually at sea by fishing or in the navy. merchant service or antarctic whaling expeditions. Efforts were made to break out more land from the hill and increase the number of cattle, the native breed of which gives fair supplies of milk and, though light. the beef is of good quality. However. Aberdeen-Angus and crossbred cattle have to some extent taken their place. Shetland ponies which once did all the work on the crofts are found in considerable numbers, especially in Unst. But demand for both croft and farm work and for the mines has much diminished.

Lerwick is an important herring port; boats arrive there from the east coast of Scotland and England to join the local boats for the summer fishing. At Scalloway. too, considerable quantities of herring are landed early in the season. There is a fish-meal plant on the island of Bressay and a quick-freezing factory at Lerwick as well as facilities for curing fish. Most of the herring stations in the countryside and the outlying islands have, however, been closed. All the year round white fish of all kinds. principally haddock and whiting, are caught by seine nets. The main fishing centres are Whalsay, Burra Isle, Lerwick and Scalloway. White fishing is also carried on, however, from several districts, notably Out Skerries, Cullivoe, Baltasound and Voe. Many crofters keep small boats from which they catch haddock, whiting or piltock for their own use. Fishing boats of other nations frequently call at Shetland harbours. Whales are occasionally seen around the Shetland coast, but whaling locally has ceased.

Apart from agriculture, wool, knitting and fishing, the main native source of livelihood is a small amount of weaving. The stone in Unst is also quarried for talc.

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SHEVKET, MAHMUD (1858–1913), Turkish pasha. From 1901 to 1903 he was military governor of the Hejaz, in Arabia, then in what amounted to a state of war. He next went in a like capacity to Uskub (Skoplje), and there came in contact with the Young Turk movement. which had its headquarters in Salonika. In the spring of 1909 the Old and Young Turks were struggling for supremacy. 4 powerful Old Turk counter-revolution was prepared. but. in mid-April. the jrd army corps, under Hussein Husni Pasha, marched from Salonika against Constantinople. At San Stefano Mahmud Shevket took over the command, and, after heavy fighting. on April 4 entered Constantinople.

Impressed by his victory, the national assembly no longer dared to oppose the will of the Young Turks, and on April 26 voted the deposition of Abdul-Hamid. Mahmud Shevket was the hero of the day. But he did not cnre for politics, which he considered had been the ruin of the Turkish corps of officers, and preferred to confine his activities to purely military matters. The next few years afforded him plenty of opportunities. In 1910–11 he put down a revolt of the Malissors with great energy. and in 1912 fought against the rebels in Albania. In the summer of 1912 he became minister of war. and in Jan. 1913 succeeded Kiamil as grand vizier. He took a very active part in army reforms. but he came into conflict with the Cnion Libérale. which took its orders from Sherif I'asha in Paris, and he was murdered by one of its members on June 11, 1913.

SHIBARGHAN, a town and khanate of Afghan Turkestan. The town lies some 60 m. W. of Balkh. It has a citadel, but is not otherwise fortified. and is surrounded by good gardens and excellent cultivation. The khanate was allotted to the Afghans by the Anglo-Russian boundary agreement of 1873.

SHIBBOLETH, a Hebrew word meaning an ear of corn or a stream or river, used by Jephthah, probably in the second sense with reference to the river Jordan. as a test word to distinguish the Ephraimites. who were unable to pronounce the *sh*, from the men of Gilead. at the passage of the Jordan (Judges xii). The word *ciceri* was similarly used in the massacre of the French known as the Sicilian Vespers, and other "shibboleths" are known to history. The term is used of a watchword. catchphrase or cry. to which the members of the party adhere even after any significance which it may have had has disappeared.

SHIDEHARA, KIJURO, BARON (1872–1951), Japanese diplomat and statesman. was born in Osaka on hug. 11, 1872. Graduating from the Imperial university at Tokyo in 1895, he entered the diplomatic service four years later, and after holding consular appointments in Korea and Belgium became successively counselor in Washington, D.C., and London. In 1914 he was appointed minister at The Hague. returning to Tokyo as vice-minister of foreign affairs the following year. He was ambassador to the United States. 1919–22, and a delegate to the Washington conference on limitation of armament; he was created baron in 1920. He held the portfolio of foreign affairs during 1924–27 and 1929–31. Shidehara's name was always associated with policies of peace. notably toward China, but his liberal outlook was not generally popular. He became prime minister for several months after the occupation of Japan in 1945, and later speaker of the house of representatives—a position he held at the time of his death (March 10, 1951). (F. S. G. P.)

SHIEL, LOCH, a lake near the Atlantic seaboard of Scotland, lying between the district of Moidart in Inverness-shire and the districts of Ardgour and Sunart in Argyllshire. The boundary line between the two counties is continued down the river Shiel to the sea. The loch is 17 mi. long and varies in width from 200 yd. to 1 mi.. and is only $11\frac{1}{2}$ ft. above the sea. The maximum depth is 420 ft. with a mean depth of $81\frac{1}{2}$ ft. Loch Dilate lies $1\frac{1}{2}$ mi. E. of Loch Shiel, into which it flows by the Polloch. It is $1\frac{1}{2}$ mi. long at its maximum, with a maximum depth of 55 ft. It receives the Finnan and other small streams and discharges by the Shiel to the salt-water Loch Moidart.

SHIELD FERN, the name applied to ferns of the genus *Dryoptevis,* embracing, in a broadly inclusive sense, about 1,000 species, widely distributed throughout the world. The name is given because of a shield-shaped indusium which, in many species,

RUTRERFORD PLATT

SHIELD FERN (DRYOPTERIS)

covers the spore-producing structures (sporangia) borne on the undersurface of the fronds These plants are also called wood ferns and, in England, buckler ferns. Many segregates from the inclusive genus have been proposed. In North America and Europe occur species of *Thelyptevis* (marsh fern group), *Gymnocarpium* (oak fern group) and true *Dryopteris* (male fern group).

SHIELS, ROBERT (?–1753), Scottish writer, was born in Roxburghshire shortly before 1700. Moving to London, where he was a printer, he was employed by Samuel Johnson as an amanuensis on the *Dictionary.* When this work nas completed Shiels, with others, began the compilation of a five-volume *Lives oj the Poets,* published shortly before his death. Although this work bore the name of Theophilus Cibber (1703–58), playwright and actor, it was actually Shiels who did most of the writing. Shiels also wrote a poem, "Marriage," in blank verse; "Musidorus," an elegy of James Thomson; and several other pieces. He died in London Dec. 27, 1733.

See J. Boswell, ed. by *G.* B. Hill, rev. by L. F. Powell, *Life of Johnson,* vol. iii, 6 vol. (1934–40).

SHIFNAL, a market town in the Wrekin parliamentary division of Shropshire, Eng., 17 mi. E.S.E. of Shrewsbury. Pop. (1951) 13.548. The town was known as Idesall in 1591 when a fund was raised by royal favour to restore it after a disastrous fire. The 12th-century church of St. Andrew is cruciform, combining examples of every period from late Norman to late Perpendicular. Trade is mainly agricultural. with some engineering. Nearby Tong castle, now demolished, shared with Tong castle in Kent the legend of the Saxon Hengest and the British chieftain Vortigern (*q.v.*). Tong church, early Perpendicular, contains a series of ornate tombs, of the 15th and 16th centuries: of the Vernon and Stanley families, former owners of the castle. Boscobel mansion is famous as the hiding place of Charles II after his defeat at Worcester in Sept. 1651 and the secret chamber which hid him is preserved. A tree close to the house bears the name of "Charles's oak" and is claimed to be the original tree in which he hid. White-ladies was a Cistercian nunnery founded about 1186 and dissolved in 13'38.

SHIGA, prefecture (Ken) northeast of Kyōto in South Honshu, Japan. Area 1,551 sq.mi. Pop. (1955) 853,734. Biwa-ko (*q.v.*), the largest lake in Japan, and the surrounding mountainous district form Biwa-ko recreational park and occupy about 25% of the total area of Shiga. The percentage of paddy fields is the highest in Japan. Ōmi cows are famous as beef cattle. The textile industry at Ōtsu, Hikone and Nagahama owes its development in part to the chemical qualities of the lake water. Ōtsu. the prefectural capital, is also an important tourist centre. The tomb of Bash6 (1644–1694), greatest *haiku* poet, is at Shiga. From Otsu boats provide tours to the scenic "Eight Views" and other points on Biwa-ko. (R. B. H.)

SHIH HUANG TI (259–210 B.C.), "First Sovereign Emperor," is the title assumed in 221 B.C. by King Cheng of the Chinese state of Ch'in (in northwest. China) when he completed Ch'in's conquest of the other independent states into which China was then divided, thereby creating the first unified Chinese empire. It is from the state and empire of Ch'in that the name China probably derived.

The first emperor was born in 259 B.C., allegedly the natural son of a rich merchant and Ch'in statesman, Lu Pu-wei, though this story is possibly a slanderous invention. He ruled as king of Ch'in from 246 to 221 and thereafter as first emperor of all China until his death in 210. Major innovations instituted in and after 221 included: (1) abolition of the formerly independent Chinese states with their landed aristocracy and replacement of them by an administrative system of 36 (later 42) *chun* or provinces, subdivided into lesser *hsien* or prefectures and all governed by centrally appointed, nonhereditary, salaried officials; (2) simplification and standardization of the Chinese script according to the written characters current in Ch'in; (3) extension of the Ch'in system of laws, weights and measures throughout the empire; (4) completion of the Great Wall as a barrier between China and its nomadic neighbours to the north and northwest; and (5) the "burning of the books," a governmental proscription of literature ordered in 213 to suppress Confucianism and other dissident schools of thought in favour of Legalism and to make the Ch'in version of past history the accepted one. These innovations, though formally ordered by the first emperor, were largely inspired by his prime minister, Li Ssŭ (*q.v.*).

The first emperor was a mighty conqueror, Machiavellian schemer, bold innovator and at the same time a superstitious megalomaniac whose fear of death caused him to be searching for the Taoist elixir of immortality when he died in 210. His harsh reign was followed within a year by rebellion, leading to the collapse of the Ch'in dynasty and its replacement by that of Han (206 B.C.–A.D. 220). Though the Confucian historians reviled him as a ruthless tyrant, the first Emperor's reign was crucially important for bringing China's feudal age to an end and inaugurating norms of empire that persisted until the founding of the Chinese republic in 1912. *See* also CHINA: *History*.

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man, Patriot, and General in Ancient China (1940); E. Chavannes, *Les Mémoires historiques de Se-ma Ts'ien,* 5 vol. (1895–1905), especially vol. xi, ch. 6. (D. Be.)

SHIHKIACHWANG (Shih-chia-chuang, Shih-men), an industrial. rail junction-terminal city in west Hopeh province, China. Pop. (1957 est.) 598.000. In the 1920s it was only a small village near the old city of Chenting close to the Peking-Hankow railway. It lay at the junction of a branch line built to T'ai-yuan, Shansi, in the 1900s. The village became a terminal point and grew into a city of 217,000 by 1935. A rail link built to Te-chou, Shantung, during World War II increased Shihkiachwang's importance. The Chinese Communists, by the early 1960s, had developed the city into a modern regional industrial, transport and trade centre. with an airport, rail yards, cotton mills and many new agricultural processing plants. (J. E. Sr.)

SHI'ISM is a branch of the religion of Islam (*q.v.*). distinguished from the majority Sunnism. One of the factions which disputed power over the early Moslem community and its vast conquests supported the claims of 'Ali (*q.v.*), who was nominated fourth caliph. and then of his descendants. From a political faction this gradually developed into a religious movement, Shi'ism (*tashayyu'*), which deeply influenced all Sunni Islam and also produced a number of important sects, to which especially the term Shi'a ("the party of 'Ali") is applied. In the mid-20th century, perhaps one-tenth of all Moslems were Shi'ites: *i.e.*, about 40,000.-000. Shi'ism is the majority faith in the Iranian plateau and Iraq and perhaps Yemen, and is found in Syria, Lebanon, east Arabia. northern India (especially around Lucknow), in the Deccan and Bombay and elsewhere.

'Ali was a first cousin and son-in-law of Mohammed, father of Mohammed's two grandsons, Hasan and Husain, by his daughter Fatima. 'Ali was noted for his devoted piety and his valour in war. Raised to the caliphate (656) with the support of the murderers of the third caliph (another son-in-law of Mohammed), he never received the allegiance of all the Moslems, but had to wage increasingly unsuccessful civil wars. When he was murdered (661), his chief opponent. Mu'awiya, was generally acknowledged caliph: for some time 'Ali was officially cursed from the pulpits of Islam. But many Moslems. especially at Kufa in Iraq, 'Ali's headquarters. hoped for an Alid restoration. On Mu'awiya's death they invited Husain, 'Ali's son, to become caliph. But they failed to support him at the crisis and he and his little band were cut down (680) near Kufa at Karbala, now a pilgrimage spot. The Kufans thereupon bewailed penitently the death of Mohammed's grandson and swore vengeance against the triumphant Islamic government. Repeatedly they supported insurrections by members of 'Ali's family. but without success.

The Alid cause soon gained support from other groups nhich opposed the Islamic *status quo*—for instance, from the aristocratic Moslem families of Medina. who eventually established a tradition of Alid rule in the holy cities: from pious men protesting against a too worldly interpretation of Islam; and from non-Arab Moslems. especially in Iraq. who demanded an equality refused them by the ruling Arabs. The Alids never won power (though it was initial Shi'ite help which set up the Abbasid dynasty [750], descended from another cousin of Mohammed). Yet 'Ali was rehabilitated as a major hero of Sunni Islam, and his descendants by Fatima have received a privileged status as sayyids and sherifs. (See also Caliphate.)

But the Shi'ites were not satisfied with this. Some, called Zaydis, whose principles were worked out in the 9th century. demanded sword in hand that the ruler must be whichever descendant of Hasan or Husain proved qualified, at a given time. by his knowledge and his practical ability: though otherwise they differed little from the Sunnis. They set up several small states along the Caspian and in Yemen, and rule in Yemen now. Other Shi'ites. called Imamis, asserted a more exalted religious role for the Alid claimants. They insisted that, in power or not, a given descendant of 'Ali was the divinely appointed imam, sole authority in his time on all matters of faith and law. The more speculative among them. called Ghulat ("extremists"), sometimes paid the imams practically divine honours. The more moderate came in time to claim at least that a supernatural "Mohammedan light," embodied in them. gave them superhuman knowledge and power, and that their sufferings mere means of divine grace to their devotees. Love of the imams and of their persecuted cause became equally obligatory with belief in God's oneness and in Mohammed's mission. Every year during the month Muharram, when Husain was killed, the Shi'ites mourned his death (sometimes with bloody self-lacerations) and condemned the guilty Sunnis. Under bigoted Sunni rule, they felt, they might have to protect themselves from persecution by dissimulating their faith (*taqiyya*); but in the end the imam. as mahdi, the "well-guided," would deliver the faithful and punish their enemies.

Several sects acknowledged as imams the line of Mohammed ibn al-Hanafiyya. a son of 'Ali not by Fatima. but these died out in the 9th century. Most Shi'ite sects have acknowledged one of two lines stemming from Husain's great-grandson Ja'far al-Sadiq (d. c. 765). One is that of the Ismailis. who developed a unique religious system and for a time established a powerful Fatimid caliphate, and are represented by the modern Khojas and Bohras, merchant communities of India and east Africa; from them split the Druzes of Syria. (See Druze.)

The majority of modern Shi'ites acknowledge a younger line down to a 12th imam, Mohammed al-Muntazar, supposed to have gone into hiding in 878 and expected to return as mahdi before the Last Judgment to establish justice in the earth. Among these are the Nusayris or 'Alawites of northern Syria. with a secret faith of complex origin; the 'Ali-Ilahis or Ahl-e Haqq, scattered peasants and herdsmen of Kurdistan. Turkey and Iran; and the Sufi order of Bektashis in Turkey and Albania. But most who acknowledge the 12 imams belong to the Ithna 'ashari or "Twelver" sect (in Syria, Mutawali).

Despite occasional Shi'ite rulers: the Shi'a remained almost everywhere a minority faith till at the start of the 16th century the Safawi dynasty made it the sole legal faith of their empire, embracing the Turks of Azerbaijan, the Persians of Iran and the Arabs of Iraq proper; these have since been all overwhelmingly Twelver Shi'ites. and have given that sect a vigorous modern life. Usulis. claiming the primacy of legal principle. have debated with Akhbaris. attached to established texts; with the speculative Shaykhis; and especially with the Babis and Bahais of the 19th century. At the Shi'ite pilgrimage places, especially Najaf near Kufa in Iraq, scholars qualified to make independent judicial decisions, mujtahids. regarded as representatives of the hidden 12th imam, expound Islamic law according to the school of Ja'far, which differs in some particulars from each of the Sunni schools. They also have a political role as popular authorities, especially in Iran.

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SHILLING, an English token coin of the nominal value of 12 pence, denoted after a numeral by s. (from Lat. solidus). The origin of this Teutonic word is somewhat obscure. There was an Anglo-Saxon coin termed *scilling,* or *scylling,* worth about fivepence. which is said to be derived from a root. skel, to divide, + *ing* on the analogy of farthing (*q.v.*) (cf. Du. *schelling*). The silver shilling was first struck in 1504; in Charles II's reign the edges were first milled; and in George IV's reign were issued the so-called "lion shillings." bearing the royal crest. a crowned lion on a crown. a design reverted to in the coinage of Edward VII. A shilling is token money merely: it is nominally in value $\frac{1}{20}$ of a pound. but after 1921, when the silver content was reduced from $\frac{37}{40}$ to $\frac{20}{40}$, one troy pound of silver was coined into 66 shillings. The design of the shilling was altered in 1937; the reverse side after that consisted of either the royal crest of England or the royal crest of Scotland, with an inscription. See also Numismatics.

SHILLONG, the capital of Assam. India, and the headquarters of the United Khasi and Jaintia Hills district. It is on a plateau 4,978 ft. above the sea, 63 mi. by road south of Gauhati. Pop.

(1951) 53.756. Shillong in effect dates from 1864, when the district headquarters were transferred from Cherrapunji. It was chosen as the seat of government in 1874, when the province of Assam was constituted. It contains a cantonment (pop. 4,756), the Pasteur institute and research laboratory (for antirabies treatment) and four colleges connected nith Gauhati university. Its climate and surroundings make Shillong a popular resort.

The city was devastated by the great Assam earthquake of June 12, 1897.

SHILLUK: *see* NILOTES.

SHILOH, a town of Ephraim, where for three centuries after the Israelite conquest of the Holy Land it was the depository of the Tabernacle and Ark of the Covenant. In its sanctuary the boy Samuel had his vision. With the removal of the Ark Shiloh's glory departed and by the time of Jeremiah (vii, 12) it was a heap of ruins. Its identification with modern Seilūn, 2 mi S.E of El-Lubban (Lebonah) on an isolated hill affording an ideal site for a sanctuary and fortress, is not disputed. (E Ro.)

SHILOH, BATTLE OF. This, the second great battle in the American Civil War, also called the battle of Pittsburg Landing, was fought on April 6 and 7, 1862, between the Union forces under Gen. U. S. Grant and Gen. D. C Buell and the Confederates under *Gen A S. Johnston* and *Gen. P G. T. Beauregard.* In Feb. 1862 Grant had taken Ft. Henry on the Tennessee river and Ft. Donelson on the Cumberland. The Confederates had acknowledged the importance of these forts by abandoning their strong position at Columbus. Ken.. and evacuating Nashville on the upper Cumberland. Grant then sought to extend his advantage by an amphibious move up the Tennessee to attack the line of the Memphis and Charleston railroad, which followed the line of the upper river. High water frustrated these early efforts at raids from the river as a base He then disposed his five divisions in camps around Pittsburg Landing on the Tennessee river near Corinth, Miss. There *Johnston,* commanding Confederate forces in the west, and *Beauregard* were collecting a force aimed at recovering some of their recent losses. Buell's army mas marching somewhat leisurely across the country from Nashville to join Grant in an attack upon Corinth. Since they were planning for an offensive the Union troops had not fortified their camps. *Johnston,* to their surprise, seized the initiative and decided to attack Grant before Buell could arrive. Accordingly he led his army from Corinth against Pittsburg Landing early on Sunday morning, April 6.

This battle was fought by inexperienced troops on both sides. Gen. W. T. Sherman was holding the most exposed position at Shiloh church about 2 mi. W. of the Landing with recently recruited raw troops. The other Union divisions were scattered in several camps out of sight of each other. Sherman's men received the first assault and the two advanced divisions were swiftly driven in on the others, who had only a little more time to prepare themselves. Confederate leaders in the woods were unable to control and maneuver their untrained and excited men. But the Confederates continued to push each isolated Union division fighting hard toward the Landing. Thus the day passed in confused and savage scuffles between raw troops.

By late afternoon, Grant. who had come up from his headquarters at Savannah 9 mi. down the river, had rallied his troops. With one brigade of Buell's leading division, which had arrived on the previous evening, he formed a defense line in a naturally strong position barely 600 yd. from the Landing. Earlier in the afternoon *Johnston* had been killed, a sore and irreparable loss to the Confederate cause. At sunset *Beauregard,* as was customary, suspended the attack.' During the night Buell brought up 25,000 troops and he and Grant took the offensive early the next day. *Beauregard* thereupon decided to extricate his hard-pressed army and to retire fighting toward Corinth. A strong rear-guard action under *Gen. Braxton Bvagg* repulsed the attacks of Grant and Buell at Shiloh church for six hours and the Union forces succeeded in doing little more than reoccupying the camps they had lost the day before while the Confederates returned to Corinth. It was a Confederate failure but not a Union victory and, each side being weakened by about 10.000 men, neither made any movements for the next three weeks. See also AMERICAN CIVIL WAR.

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SHIMANE, a prefecture *(ken)* in southwest Honshu, west Japan. Area, including the island group of Oki-gunto, 2,558 sq mi. Pop (1960) 888.886. It is located on the Sea of Japan, distant from the central part of the country. Because of this location and its unfavourable natural conditions. Shimane's culture. notable in ancient times, and its industry have become retarded. Forests cover most of the land, and forestry and stock breeding are well developed. However, agriculture supports most of the population. Paddy fields, chiefly of the one-crop type, are scattered throughout the prefecture. Matsue (*q.v.*), the prefectural capital. is known to the west through the writings of Lafcadio Hearn. The ancient shrine at Izumo is justly famous. (R. B. H.)

SHIMOGA, a municipality, with taluka (administrative subdivision), and a district in Mysore, southern India. The town is on the Tunga river, at the terminus of a branch railway and 152 mi. N.W. of Bangalore. It has cotton-ginning and pressing factories and iron- and steelworks. Pop. (1951) : town 46,524; taluka (409 sq.mi.) 96.620.

SHIMOGA DISTRICT has an area of 4.066 sq.mi. Pop. (1961) 1.014.723. In the east the Tunga. Bhadra and Varada rivers unite to form the Tuagabhadra, which ultimately falls into the Kistna and so into the Bay of Bengal, while in the west a few minor streams flow to the Sharavati, which near the northwestern frontier bursts through the Western Ghats at the Falls of Gersoppa (*q.v.*).

The western half of the district is mountainous and covered with magnificent forest, and is known as the Malnad or hill country, some of the peaks being 4.000 ft. above sea level. The general elevation of Shimoga is about 2,000 ft. Toward the east it opens out into the Maidan or plain country, part of the general plateau of Mysore. The soil is loose and sandy in the valleys of the Malnad, and in the northeast the black cotton soil prevails. Shimoga presents much variety of climate. The southwest monsoon is felt in full force for about 25 mi. from the Ghats, but the rainfall gradually diminishes to 31 in. at Shimoga station and to 25 in. or less at Chennagiri. Rice is the staple crop; next in importance is sugar cane; areca nuts are also extensively grown; other crops include vegetables, fruits and pepper. The mineral products of the district include iron ore and laterite. Manganese is worked. Next to Shimoga the largest town is Bhadravati (42.451).

During the Mohammedan usurpation of Mysore from 1761 to 1799, the whole country was in constant turmoil. After the restoration of the Hindu dynasty. Shimoga became the scene of disturbances caused by the maladministration of the Deshast Brahmans. These disturbances culminated in the insurrection of 1830, which led to the direct assumption of the administration by the British.

SHIMONOSEKI, largest city of Yamaguchi prefecture in extreme western Honshu, Japan. Pop. (1960) 246.941. Its strategic location on the Straits of Shimonoseki brought it to transportation and commercial prominence. The city was formerly called Akamagaseki or Bakan. Modern development began in 1905 with the opening of railroad .ferry service with Moji in Kyushu; more recent links include a 2.3 mi. railroad tunnel (1942') and a vehicular-pedestrian tunnel (1958) under the straits. Shimonoseki became a heavy industrial centre after 1942 and in 1910 its port was formally amalgamated with Moji (*q.v.*) and Kokura ports into the single port of Kammon.

The Straits of Shimonoseki (Shimonoseki-kaikyō), renamed Kammon straits, are the narrow western passageway between Japan's Inland sea and east Asian waters. Although about 2,200 ft. wide at the narrowest point and partially blocked by Hiko Island at the western end, the straits are 40–65 ft. deep and are easily navigable. (J. D. EE.)

SHINGLES. Shingles (herpes zoster) is a common virus infection which attacks various nerve trunks and the areas of the skin which these nerves supply. While shingles appears most frequently on the thorax or abdomen, it also occurs elsewhere. The infection may occur at any time of life, but is most common in adults and rare in infants. Before the appearance of the typical lesions of shingles on the skin, there is ordinarily a short period of mild to marked neuralgic pain or of increased sensitivity of the skin in the area involved. The skin lesions then appear as characteristic clusters of tense blisters on areas of red inflamed skin. In a typical case the groups of lesions extend from the midline of the back, partially or completely around one side of the chest or abdomen. If one of the branches of the fifth cranial nerve is involved, lesions may first appear in the scalp and then extend over the region of the eye. In this form, there is definite danger of involvement of the eye itself.

The symptoms and skin changes produced by shingles vary greatly, but tend to be more severe in older people. In some patients there may be an intense boring neuralgic pain which persists for many months after the skin lesions have subsided. The changes produced in the skin may vary considerably from mild to severe.

There is good evidence to indicate that the virus of shingles is the same as that which causes chicken pox (varicella). There are numerous recorded instances of patients who developed shingles after contact with a patient with chicken pox, or vice versa. In general, an adult is more liable to develop shingles from the virus, and a child to develop chicken pox, though this is by no means an absolute rule. Studies of material obtained from the skin lesions of chicken pox and of shingles and examined with the electron microscope demonstrate that the virus of these diseases is identical in appearance. If an adult has had shingles, a second attack is unlikely to develop. However, chicken pox in childhood seems to confer little immunity against shingles in adult life.

There is no specific method of treatment of shingles. Treatment will be dependent somewhat upon the severity of the disease; in mild cases the patient is often little inconvenienced. However, when pain is severe, or if there is any possibility of the lesion spreading to the eye, or if the inflammatory changes of the skin are marked, the disease may be quite disabling. The skin lesions heal best if a drying lotion rather than an ointment is used during the first few days after the appearance of the lesions.

(D. M. P.)

SHINNECOCK, a North American Indian tribe of Algonkin stock which formerly inhabited the eastern half of Long Island, N.Y. A few survivors of the tribe occupy a reservation on Shinnecock Neck, near Southampton on the southern shore of Long Island. The rest, with remnants of other Algonkin tribes of the vicinity, formed the Brotherton tribe late in the 18th century, and many of them migrated to Wisconsin.

SHINTO, which literally means the way or teaching of the gods (kami) is a loosely organized, indigenous religious cult of Japan. This designation arose in order to distinguish the traditional religion of Japan from Buddhism when the latter was introduced there in the 6th century A.D. While Shintō has no founder, no official sacred scriptures and no dogma, it has preserved its ethos throughout the ages. In the modern period it has been used as a tool of ethnocentric nationalism and chauvinistic militarism, and is often thought of in these terms by outsiders.

Primitive **Shintō.**—The official chronicles of Japan are characterized by a smooth transition from the mythical past to the historical period. Though according to legend the first emperor of Japan was enthroned in the 7th century B.C.. most modern scholars agree that the historical period of Japan started about 1,700 years ago. Even before the historical period, of course, the inhabitants of Japan had some kind of religion but the origins of the ancient Japanese religious cult that gradually developed and was later referred to as Shinto are unknown. The ancient Japanese people mere an admixture of various groups who had migrated to the Japanese islands from the Asian continent, and their religion also betrayed northern and southern Asian influences. It took several centuries for these ethnic groups and peoples to become assimilated under the leadership of the so-called Yamato clan around the 4th century A.D At any rate, the early Japanese myths, many of which are unrelated and often contradictory, indicate that they were in part the legacy of the dominant Yamato clan and in part the sacred traditions of other clans and peoples that were subjugated by the Yamato.

The early Japanese by and large did not draw a sharp distinction between the celestial and earthly domains. They had only a vague notion about the life to come, and the veneration of ancestors that characterized the religious life of the later period was hardly known. Their religion was a simple polytheistic nature worship, emphasizing gratitude to the beneficent forces of nature: while also to some degree appeasing the malevolent forces. These forces of nature were indiscriminately called kami which is usually translated as "gods" or "deities." The term kami, however, meant "above," "superior" or "divine," and it signified anything that was the object of reverence and respect. Accordingly, all the heavenly and earthly forces, great men both living and dead, and many animate and inanimate beings such as plants, rocks, birds, beasts and fishes as well as earthquakes, thunder, water, sun and moon were kami. The early myths spoke of 800 myriads of kami, usually divided into heavenly kami (those who resided in the heavenly abode known as Takama-ga-hara) and earthly kami (those who resided on earth). In this connection it is necessary to remember that the Japanese did not regard spirit as superior to matter; rather, they believed that the two coexisted on an equal footing. *Kami* were thus regarded as inseparable from shintai (kami- or god-body) or *mitama-shiro* (visible representations of kami).

The religious rites of the early Japanese were mostly fertility cults. Purification in a ceremonial sense was emphasized. Disease, wounds, death, sexual intercourse and menstruation were considered displeasing to the kami, and those who were thus polluted could not participate in the rites. Three kinds of persons performed religious rites: (1) the heads of families or clans, considered priests de facto; (2) shamans, men and women with occult powers who performed divination, sorcery and lustration; and (3) hereditary lines of priests and shamans, known to have existed in at least some clans. These three types of priests and priestesses sometimes existed side by side, and in some cases one of them combined features of the others. In time, the Yamato clan overpowered other clans and its hereditary priest-king (Tennō or "emperor") acquired supreme prestige. Significantly. the function of the throne was to take charge of both religious rites (*Matsuri*) and political administration (*Matsuri-goto*) which were regarded as inseparable.

With the ascendancy of the Yamato clan its myths began to provide foundations for political theories. The prominent feature of the Yamato myths was the divine origin of the Yamato people. Briefly stated, a male deity named Izanagi ("He who invites") married a female deity named Izanami ("She who is invited"), and they bore mountains, rivers, seas, plants, animals and human beings, as well as kami. Among the kami thus born were the sun-goddess (Amaterasu Omikami), the moon ruler (Tsuki-yomi-no-mikoto) and the ruler of the nether regions (Susa-no-6-110-mikoto). The most important of these was the sun-goddess who sent her grandson Ninigi-no-mikoto to pacify the Japanese islands. Ninigi's grandson is said to have been the first emperor. Jimmu Tennō, the earthly ancestor of the imperial family. The sun-goddess was later enshrined at the Grand Shrine of Ise which became both the tutelary shrine of the imperial family and the central shrine of the whole nation. Eventually the myth of the solar ancestry of the imperial clan was widely accepted among the various clans including many clans of Chinese and Korean descent. The sun-goddess was worshiped side by side with other clan deities and nature deities all of which comprised the rich Shinto pantheon. While in the history of Japan the political authority of the throne was often precarious it never lost its bond with the masses through Shinto which was rooted both in the religious tradition of the Yamato imperial clan and in the sacred memories of other clans.

Foreign Influences. — With the introduction of Chinese civilization in the 5th century A.D., the religious and cultural situation in Japan became complex. Confucianism not only provided Japan with systematic theories of social and political institutions but also with ethical norms for individuals in a hierarchical society. Together with Confucianism came Taoism and the Yin-Yang philosophy, and they too contributed philosophical concepts. Gradually, Confucian moral virtues began to be attributed to Shintō deities and imperial edicts stressed such Confucian virtues as uprightness, sincerity and honesty as the guiding moral principles. The concepts of filial piety and the veneration of ancestral spirits were soon adopted by the Japanese.

Buddhism, introduced to Japan in the 6th century A.D., also had far-reaching influence. Buddhism initially penetrated the upper strata of Japanese society and with the encouragement and support of Prince Regent Shōtoku (593–621), Buddhism became for all practical purposes the state religion. Shinto, however, retained its prestige and influence among the masses, a fact the government could not ignore. Shortly after the death of Shōtoku the government established the department of Shinto which managed and controlled the festivals and rites at the imperial household as well as at the tutelary and ancestral shrines of powerful clans. The cause of Shintō was greatly enhanced by the compilation in the 8th century of the Kojiki ("Records of Ancient Matters") and the *Nihongi* or *Nihon-shoki* ("Chronicles of Japan") in which the ancient oral traditions mere assembled and recorded for the first time. Since Chinese script was used the myths and legends were inevitably influenced by Chinese thought; nevertheless, these records are an important storehouse of early Japanese myths and they are often considered as quasi-sacred scriptures of Shinto, although Shintō has no concept of scripture comparable to the Bible of Christianity or the Koran of Islam.

Coexistence of Buddhism and **Shintō.**—Buddhism began to overshadow Shinto during the Nara period (8th century A.D.), especially in the capital city of Nara, but it had to come to terms with the deeply rooted Shintō beliefs and practices of the people. Even the construction of the Tōdaiji, the national cathedral of Buddhism at Nara, required the blessing of the Shintō deities communicated to the throne by means of oracles; and emperors and empresses who considered themselves humble slaves of Buddha could not neglect the Shinto rites altogether. Buddhism and Shintō did not attempt to exterminate each other. What emerged was a pattern of coexistence that is often referred to with some exaggeration as the "amalgamation of Shinto and Buddhism."

This pattern of coexistence developed gradually. For example, wealthy landowning Buddhist monastic institutions found their tenants deriving solidarity from Shinto deities and Shinto cults; by allowing Shinto shrines to remain, the Buddhist institutions were protected by the Shinto taboos. Eventually. Shintō shrines found their way into the sacred premises of Buddhist temples and monasteries and in turn Buddhist chapels were built near Shintō shrines. During the Iiara period Buddhism became so powerful in the court that Shinto had nothing to lose by allying itself with the cause of Buddhism. Even the popular Shintō deity Hachiman came to be known as *Daijizaiten-bosatsu* (*Bodhisattva*).

When the capital was moved from Nara to Heian-Kyō (the present Kyoto) toward the end of the 8th century, ostensibly to be freed from the political pressure of Buddhist institutions, the pattern of coexistence persisted. As early as 794, Buddhist sacred scriptures (sutras) were recited at some Shintō shrines. Two new Buddhist schools, Tendai and Shingon, inaugurated in the 9th century not only welcomed an alliance with Shinto but also attempted to provide theoretical justification for coexistence. The Shingon Buddhist theory of coexistence was called Ryōbu ("Two Aspects") Shinto, the Tendai theory. Ichi-jitsu ("One Reality") Shinto. Both interpreted Shinto deities as manifestations or incarnations of the Buddha. and both attempted to incorporate Shintō into their frameworks of Buddhism. Shinto priests became dominated by the powerful and influential Buddhist ecclesiastics and were content to play only a minor role even in Shinto rites. Shintō continued to enjoy favour among the masses in the outlying districts and the folk elements of the Shintō tradition were represented in the Shugen-dō (order of Mountain Priests), but during the middle of the Heian or Fujiwara period the Shugen-dō also allied itself with the powerful Tendai and Shingon schools and came to be known as the Tendai Shugen-dō and Shingon Shugen-dō respectively.

Shintō Reaction Against Buddhism. — During the Kamakura period which succeeded the Heian, a Shintō reaction to the predominance of Buddhism gradually developed. The corruption of the Fujiwara oligarchy that had dominated the political scene during the Heian period resulted in the establishment of a feudal regime (bakufu) ruled by warrior-statesmen (*shōgun*) during the Kamakura period. The elegance of the court in Kyōto gave way to the austere culture of warriors; moreover, after centuries of peace and tranquility, Japan was threatened by the Mongols. The Kamakura period, however, with its social and political disruption, was an age of spiritual awakening in Japan, and this awakening was reflected in Shintō which tried to emancipate itself from the domination of the Tendai and Shingon schools. The spokesmen for Shintō were hereditary priests of the Watarai family who served at the Outer Shrine of Ise; hence the movement was called the Ise Shinto. Buddhism was too deeply rooted to be rejected altogether, and recognizing this, the spokesmen of the Ise Shintō movement attempted to reverse the Buddhist claim that Shintō deities were incarnations of the Buddha; they taught instead that Buddhas and Bodhisattvas were manifestations of the great kami nature of Shinto. By the middle of the Kamakura period the five-volume work *Shintō Gobushō* ("Shintō Pentateuch") was completed, proclaiming this type of Shinto apologetics.

The decline of the Kamakura feudal regime was followed by a period of imperial rule known as the Restoration of the Kemmu uhich greatly encouraged the Ise Shinto movement. A famous loyalist, Kitabatake Chikafusa (d. 1354), wrote in his work *Jinnō-shōtō-ki* ("Records of the Valid Succession of Divine Emperors"): "Great Yamato is a divine nation. It is only our land whose foundations were first laid by the divine ancestor. It alone has been transmitted by the sun-goddess to a long line of her descendants." He regarded the three imperial insignia—a mirror, a bead and a sword—as the symbols of the three Shintō virtues of veracity, mercy and justice.

The short-lived imperial rule of the Kemmu was followed by the Ashikaga feudal regime which saw the development of arts and culture, spurred on by political unrest and greatly inspired by Zen Buddhism. Shintō was again at a low ebb, with. however, notable exceptions. Ichijō Kanera (d. 1481) formulated a monotheistic view of Shinto. Also during this period Yoshida Kanetomo (d. 1511), deeply influenced by Taoist metaphysics, initiated a movement called Yoshida or Yui-itsu ("One and Only") Shinto, which taught that one unique *kami*-nature is the underlying substance of all Shintō deities and Buddhas. The influence of Shintō, however, was negligible during the Ashikaga period and the "dark age" that followed it. The country was in a state of political chaos until order was re-established in the late 16th century.

Confucian **Shintō.**—Japanese unification was completed with the establishment of the Tokugawa feudal regime, which ruled Japan from 1615 to 1868. While the Tokugawa rulers gave financial support and certain prerogatives to both Buddhist and Shinto clergy the ecclesiastics were strictly governed by the "commissioner of temples and shrines" appointed by the regime. The guiding ideology of the Tokugawa regime was the Chu Hsi school (Shushi-gaku) of Neo-Confucianism (see CHU HSI; CONFUCIANISM). Curiously enough it was the Confucian scholars of this period who allied themselves with the cause of Shinto, and eventually brought about the Shinto revival. Hayashi Razan (d. 1657), the noted Neo-Confucian scholar, held that Shinto is the way of the ruler, and the way of the ruler is the way of Confucius; thus Confucianism and Shinto are one He criticized the historic coexistence of Buddhism and Shintō from the Neo-Confucian point of view. Iiakae Tōju (d. 1648). on the other hand. tried to interpret Shintō in terms of the Wang Yang-ming school (*Yōmei-gaku*) of Neo-Confucianism.

Shinto leaders, such as Deguchi (Watarai) Nobuyoshi (d 1690) and Kikkawa (Yoshikawa) Koretaru (d. 1694), welcomed such an alliance with Neo-Confucianism which provided the cosmology that nas lacking in traditional Shintō. Deguchi Nobuyoshi attempted to interpret Shintō according to *I-ching* ("The Book of Change") Kikkawa Koretaru identified the 'Supreme Ultimate" (*T'ai* Chi) of Chu Hsi nith a Shinto deity, Kuni-tokotachi whose name now meant the Cosmic Lord and the Reason of Heaven. Meanwhile under the leadership of Yamazaki Ansai (d 1682), a former Buddhist monk and Confucian scholar, a new movement called Suika Shintō emerged. This school identified the Supreme Ultimate of Neo-Confucianism with two Shinto deities—Kunitokotachi (recorded in the Nihongi) and Ameno-minaka-nushi (recorded in the Kojzki); these two deities are essentially one reality which is both the substance of the universe and the source of morality, and the sun-goddess is their incarnation Yamazaki Ansai taught the importance of devotional prayer and the virtue of honesty and advocated an extreme respect for the emperor. Similar emphasis on respect for the emperor was taught by the Mito school of Neo-Confucianism which also laid the foundation for the loyalist movement in the later period.

Shintō Revival.—The revival of Shinto studies developed gradually in the 18th century along with the study of the Japanese classics. The scholars of the *Kokugaku* ("Japanese Studies") took keen interest in the *Manyōshū*, a collection of ancient poems compiled in the 8th century. Stimulated by the philological research in ancient Japanese poetry Kamo Mabuchi (d. 1769) dedicated his whole life to the study of the *Manyōshū* and *Norito*, a collection of old Shintō liturgies. Rejecting both the Buddhist- and Confucian-centred interpretations that characterized Shinto studies of his time, Kamo tried to restore the pre-Buddhist and pre-Confucian meaning of Shinto. Unconsciously espousing the Taoist ideal, he stressed pure simplicity in accordance with the order of heaven and earth as the best morality.

Kamo's disciple Moto-ori Norinaga (d. 1801) rejected his master's Taoist-oriented interpretation of Shinto, and insisted that Shintō was based on the revelation of *Takami-musubi-no-kami* ("August Producing Deity") transmitted by the sun-goddess. Moto-ori is credited with the most systematic interpretation of the concept of kami as "anything whatsoever which was outside the ordinary, which possessed superior power or which was awe-inspiring." In 1898 he completed his voluminous commentary on the Kojiki, which has remained the authoritative interpretation of the theoretical aspects of Shinto.

Another noted Shinto scholar, Hirata Atsutane (d. 1843), was a Confucian scholar before he was influenced by Moto-ori's writings. He tried to systematize Shintō "theologically" by holding *Ame-no-minaka-nushi* ("Heavenly Central Lord") as the creator god viewed above the sun-goddess. He also developed an eschatological concept within the Shintō framework. His *Hongyō-gaihen* ("Supplemental Compilation of Shinto," 1806) is divided into two parts: one based on the T'ien Chu Shih I ("True Doctrine of the Heavenly Lord") and other writings of the Jesuit Matteo Ricci (*q.v.*), who wrote in Chinese; the other based on selections from the Chi *Ko* Ta Ch'uan ("The Seven Books of the Seven Victories"), a manual of Christian ethics written in 1614 by another Jesuit missionary in China, Didace de Pantoja. Hirata's thought was to have a great influence on the development of modern Shinto.

Toward the end of the Tokugawa period, the folk elements of Shinto began to break through its traditional framework. The Konotabi movement, inaugurated by an illiterate peasant woman, Kinō (d. 1826), the Tenrikyō movement, founded by another peasant woman, Miki (d. 1887), and the Kurozumi-kyō movement, initiated by an obscure Shintō priest, Kurozumi Munetada (d. 1849), were but a few examples of this dynamic religious awakening among the poor and oppressed. They were destined to play important roles in subsequent periods. Meanwhile, these messianic movements among the peasantry were looked down upon as impure Shintō by the hierarchy and scholars of orthodox Shinto.

Shintō as the National Faith.—In 1867 the prerogative to rule the nation was returned to the throne by the last of the Tokugawa rulers. Thus began the modern age in Japan. The Meiji regime that followed the Tokugawa feudal regime had two diametrically opposed aims—the revival of the ancient Japanese pattern of *Saisei-itchi* (unity of religion and the state) and the modernization of Japan.

In 1868 the department of Shintō (Jingi-kan or Shingi-kan) was established; it immediately issued the separation edict in an attempt to abolish the age-old pattern of Shintō and Buddhist coexistence. Buddhist priests who had been connected with Shintō shrines were given the choice of either returning to lay life or being reordained as Shinto priests. The traditional custom of burying the Shintō priests according to Buddhist funeral rites was forbidden. and a nea Shinto burial office was introduced. In 1849 the department of Shinto was made independent of the cabinet and placed above the grand council of state. In 1871 Shinto was proclaimed the national religion and Shinto shrines were decreed to be the place of worship for all subjects of the emperor. The appointment of Shinto priests of all the shrines a-as to be made by the government. In order to counteract movements to restore the feudal regime, the government began to advocate emperor worship. But the measures taken to uphold the supremacy of Shinto at the expense of Buddhism failed for Buddhism was too deeply imbedded in the fabric of Japanese life.

The department of Shinto mas replaced in 1872 by the ministry of religion and education (*Kyōbu-shō*), which was given jurisdiction over both Shintō and Buddhism; it was abolished in 1877. In 1873 the edict banning Christianity was lifted. Recognizing the impossibility of suppressing the growing tide of spontaneous folk religious movements, the government in 1882 decided to classify them as Sect Shinto to be differentiated from Shrine Shinto, which had about 200,000 large and small shrines throughout the nation. The constitution promulgated in 1889 included a clause guaranteeing freedom of religious belief, but the government continued to favour Shintō not so much as a religion but as a national cult. Since the constitution separated religion from the state, the government felt the need for a nonreligious guiding principle to unify the nation. The result was the Imperial Rescript on Education issued in 1890. In 1900 shrines and religions mere placed in separate bureaus and in 1913 the religious bureau was transferred to the ministry of education.

In a real sense, modern Japan mas caught between its two objectives. One of these, to re-establish the ancient system of *Saisei-itchi*, drove Japan to assert the centrality of Shintō as the national religion. The second, modernization, however, drove it to pay lip service to freedom of religious belief. Toward the end of the 19th century an uneasy compromise was worked out, based on the theory that Shinto was not a religion but a suprareligious national cult, and as such could be superimposed on the nation. The emperor cult was almost arbitrarily devised and a course in *shūshin* ("Moral Teaching") was made the basis of compulsory education. Beginning with the Chinese-Japanese War (1894–95), Japan followed an expansionist policy, and from that time until the period of World War II Shinto was manipulated by the militarists and jingoistic nationalists as the spiritual weapon for mobilizing the nation to guard the prosperity of the throne.

Shintō After World War 11.—The disestablishment of State Shinto, effective immediately after World War II, had a far-reaching effect on the future of Shinto. Orders from the supreme commander for the Allied powers to the Japanese government stated explicitly that:

> The sponsorship, support, perpetuation, control, and dissemination of Shintō by the Japanese nation, prefectural, and local governments, or by public officials, subordinates, and employees acting in their official capacity are prohibited and will cease immediately; all financial support from public funds and all official affiliation with Shintō and Shintō shrines are prohibited and will cease immediately.

Equally drastic was the abolition of *shushin* from the school curriculum and the emperor's public statement:

> The ties between Us and Our people have always stood upon mutual trust and affection. They do not depend upon mere legends and myths. They are not predicated upon the false conception that the emperor is divine and that the Japanese people are superior to other races and are fated to rule the world.

Although the emperor cult was thus abolished, the time-honoured tradition of imperial family Shinto continues. Historically, four shrines have been set aside for the imperial household rites, the most important among them is the *Kashiko-dokoro*, dedicated to the sun-goddess, which is a branch of the Grand Shrine of Ise.

With the disestablishment of State Shinto, Shinto shrines were emancipated from government control and by the same token lost their financial subsidies from public funds. Of about 110,000 shrines governed before the war by the home ministry, over two-thirds came to belong to the Association of Shintō Shrines (Jinja *Honchō*): the rest are either independent or belong to a number of small local associations.

Many Shintō priests come from hereditary priesthoods, but anyone with proper training can become a priest. The main training centre is Kokugakuin university in Tokyo. From the Meiji period until the end of World War II, Shinto priests were government officials, graded into several ranks. After the war they were no longer on government payrolls and had to be supported by income from their shrines and other special offerings from the laity. Each shrine has *Ujiko* (parishioners), whose representatives act as a governing board for the shrine affairs. In addition, *Sūkeisha* (worshipers who are not regular parishioners) are welcome to participate in the ceremonies at any time. Many shrines have started various kinds of social welfare work and Shintō wedding rites are popular and widespread.

There are numerous types and kinds of shrines from the Grand Shrine of Ise with its 14 subsidiary shrines to small obscure roadside oratories that are not attended by any priest. Before the disestablishment of State Shintō, shrines were classified as national, special national, governmental, prefectural and district or village shrines, besides about 63,000 shrines "without rank." Most of the special national shrines enshrine the spirits of those who made conspicuous contributions to the nation. Most shrines are dedicated to some deities known in the Shinto, but some are dedicated to historical figures such as Emperor Meiji and General Nogi. Genealogies of deities enshrined in rural Shinto shrines reveal varied backgrounds.

The shrines assume various forms, but most of them are built in scenic surroundings. The two main units of a shrine are an inner sanctuary (*honden*) and an oratory (*haiden*). According to Shinto, deities are present in the *shintai* (kami- or god-body) or in the *mitama-shiro* (visible representation of kami) nhich is kept in the inner sanctuary. If a shrine is dedicated to the deities of a mountain or a forest, however, there is no need for an inner sanctuary. Usually, only the priests and their attendants are permitted to approach the inner sanctuary nhere they recite prayers. In larger shrines, there are other buildings, besides the two main units mentioned, such as a hall of reciting prayers (*Norito-den*), a hall of offerings (Hei-den) and a hall of liturgical dance (*Kagura-den*).

The entrance to the shrine is marked by a torii, a simple gate marking off the sacred compound of the shrine from the rest. Worshipers go through the *torii* to the ablution basin (*Te-mizu-ya*), nhere they wash their hands and rinse their mouths. They then approach the oratory bowing reverently to the inner sanctuary and clapping their hands. A small offering to the deities is usually made. On special occasions they ask the priests to perform a simple rite of purification (Harai) in which a branch of the sacred tree (*Eurya ochnacea*) is waved three times before them. Then they make offerings and secure charms at the shrine office.

The parishioners (*Ujiko*) are families that belong hereditarily to certain shrines in the sense that the deity of a given shrine is the tutelary *kami* for all members of the *Ujiko*. But the priests of the shrine have no pastoral relation with the *Ujikos*. The main duty of the priest is to perform his priestly functions of serving the deities and offering prayers. Shinto prayers (*norito*) are based on the ancient belief that the spoken word has a spiritual potency; therefore the prayers must be recited reverently. Prayers usually include, in elegant classical language, words of praise for the deities, lists of offerings and certain petitions. The norms of Shintō rituals and prayers are found in the *Engi* Shiki ("Ritual Notes"), a 50-volume work compiled in the 10th century.

Throughout its history Shinto has been conspicuously indifferent to any theoretical systematization of its beliefs. Theories have been advanced but they have been greatly influenced by Buddhist, Confucian and Taoist concepts. Though there exist movements to formulate a coherent theological system, no normative system has been widely accepted. Such central concepts as Kami (deity), *Musubi* (creating and harmonizing power), Makoto (truthfulness) and *Harai* (purification) are integrated into the total Shintō way of life and worship Probably the genius of Shintō lies in its refusal to formulate a *summa* theologica. An ancient Japanese poem well expresses the nebulous but genuine religious sentiment of Shintō: "Unknown to me who resideth here; tears flow irom a sense of unworthiness and gratitude."

The religious activities of Shinto, however, are not confined to the shrines. The traditional Japanese family performs a simple daily rite before the family kami-shelf (kami-dana) which is dedicated to the tutelary deity of the family. Before 1945 most of the national holidays were based on Shinto festivals: New Year's day when at the imperial court and elsewhere people worshiped in the four directions; the Empire Foundation day (Feb. 11) or the day when the first emperor, Jimmu, is supposed to have been enthroned; the Spring Season Imperial Spirit festival (spring equinox); the Anniversary of the Death of Jimmu (April 3); the Autumn Season Imperial Spirit festival (autumn equinox); the Festival of the Presentation of First Rice to the Deities at the Grand Shrine of Ise (Oct. 17); and the Autumn Thanksgiving festival (Nov. 23). After 1945 some of these national holidays lost their religious meaning but they remained holidays. For example, Nov. 3. previously set aside to commemorate the great achievement of Emperor Meiji became the "National Day of Arts and Culture," while Nov. 23, the traditional day of the Shintō festival at the sanctuary of the imperial household became the Japanese counterpart of Labor day.

Sect **Shintō (Kyōha** Shinto).— Throughout its long history, the nontheological Shinto has been supported by the folk piety of the masses. who were totally disinterested in complicated concepts and theories of religion. Although the masses did not take part in the culture of the aristocracy and gentry they developed arts and crafts to a high degree, and they had a vivid poetical sense and pious imagination for appreciating the mystery of life and the universe. Living close to the rhythms of nature they invoked deities of all sorts, depending on their physical and spiritual needs. Divination, spirit possession, protection from misfortune and disease and magical formulas for other benefits played important roles in the beliefs and practices of the masses, and they have infiltrated into official Shintō and Buddhism as well. In times of social unrest or natural calamity this folk piety was often intensified and supported various kinds of Shintoist, Confucianist and Buddhist messianic movements. More often than not these movements became established in the course of time and eventually were assimilated into Shinto or Buddhism.

The 19th century, a period of social upheaval and transition, witnessed the emergence of many such messianic movements. The Meiji government, in its determination to reshape Shinto into a suprareligious national cult, decided to separate these dynamic religious movements from Shinto and in 1882 created a new category for them known as Sect (Kyōha) Shintō. Between 1882 and 1908 the 13 Sect Shintō denominations were recognized as "churches" (*Kyōha* or *Kyōkai*), which, like Buddhist sects and Christian denominations, were dependent on nongovernmental, private initiative for their propagation, organization and financial support. Although the government arbitrarily included the 13 denominations in the category of Sect Shinto not all of them were Shintō in origin or in ethos.

Usually they are classed as follows: (1) Pure Shintō sects based primarily on certain aspects of Shintō beliefs and practices and emphasizing loyalty to the throne and gratitude to ancestors; (2) Confucian sects, which blend Confucian moral doctrines and certain Shintō beliefs; (3) Mountain sects, which hold that their deities reside in certain sacred mountains; (4) Purification sects, which stress mental and physical purification from evil and contamination; and (5) Utopian or Faith-Healing sects. Actually, the 13 Sect Shintō denominations have very little in common. Some of them worship certain deities of traditional Shinto and add some of their own; the Konkō-kyō sect, however, has no Shintō deities, and the god of Tenrikyō is not included in the Shinto pantheon. Most active among the 13 denominations is the Tenrikyō which boasts of more than 500 overseas churches in addition to its well-organized ecclesiastical institution in Japan. Most adherents of the Sect Shinto often sought worldly benefits such as cures for sickness, protection from disasters and misfortunes. wealth and success in life, which traditional Shintō as well as Buddhism failed to offer and which these Sect Shintō denominations promised. Gradually, however, the new denominations tended to become institutionalized and less concerned with the immediate needs of their adherents. The people began to look for new formulas of incantations and new prophets and shamans, thus creating a number of small splinter groups within the denominational framework. These small splinter groups were emancipated from their parent bodies after World War II and initiated the postwar boom of "New Religious Cults" (*Shinkō Shukyō*). An extremely precarious relationship exists between the Sect Shintō denominations, now organized as the Federation of Sect Shintō and the New Religious Cults. *See* also JAPAN : *History* and *Religion.*

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SHIP, the vehicle by means of which man conveys himself and his goods by water; more precisely, the larger and more seaworthy of such vehicles, the smaller and simpler being boats To merit classification as a ship or boat it is necessary for the vessel to support weight, not merely because of the buoyancy of the material of which it is made, but because of its displacement of water. Structures depending simply on their inherent buoyancy are rafts, or, in their simplest form, floats. These must. however, be considered as the most remote ancestors of the ships of the present day.

After a discussion of the kinds of shipbuilding and the delimitations of this article, it is divided into the following sections:

I. Early Craft
1. Origins
2. Galleys
II. Mediterranean and Northern Vessels
1 Mediterranean Craft
2. Northern Craft
III. Medieval Ships
1. Caravel and Galleon
2 Notable Ships
IV. 17th and 18th Centuries
1. The Frigate
2. Improvements in Rigging and Equipment
V. The 19th Century
1. Clipper Ships
2. Last of the Sailing Ships
VI. Introduction of Steam and Iron
1. The First Steamboats
2. Atlantic Crossing
3. Regular Atlantic Passages
4. Long-Distance Steamers
5. The Screw Propeller
6. Atlantic Development
7. "Himalaya"
8. "Great Eastern"
9. Steam Colliers
10. The Compound-Expansion Engine
11. Water-Tube Boilers
12. Twin Screws
13. Turbine Ships
14. Introduction of Steel
VII. Motor Ships
1. The Still Engine
2. Electric Drive
VIII. Steamers for Special Purposes
1. Tugboats
2. Train Ferries
3. Steam Trawlers
4. Icebreakers
5. Tankers
6. Packet Steamers
7. Standardized Ships
8 The Cabin Liner
9. Fast Cargo Liners
10. High-Pressure Steam
11. Gas-Turbine Propulsion
12. Express Luxury Liners
13. New Design and Development

For the practice and theory of modern shipbuilding, *see* SHIPBUILDING (MERCHANT AND NAVAL). *See* also SHIPPING, HISTORY OF, and SHIPPING INDUSTRY. For ships in naval history, *see* such articles on types of craft as AIRCRAFT CARRIERS, DESTROYER, etc.; articles on battles and wars, and sections on history in articles on countries. *See* also separate articles on types of ships, such as CANOE, GALLEY, etc.

All kinds of shipbuilding, from the most primitive to the most modern and elaborate, can be classified under six heads: (1) rafts (floating logs or bundles of reeds, etc., either singly or connected to form a platform); (2) dugouts (hollowed trees); (3) canoes of bark or skin with an internal framework; (4) canoes or boats formed from planks stitched together; (j) vessels with planking nailed together and with a framework inserted; (6) vessels of which the framework is first set up and the planking (or plating) attached afterward. These classes sometimes shade into one another. but in a general way any form of raft. canoe, boat or ship can be ascribed to one of the six

Rafts were no doubt used in all parts of the world at a certain stage of local culture. As seagoing craft in modern or comparatively recent times they are best known from the catamarans of India and the balsas of South America. The Ecuadorian balsa was a large sailing raft fitted with something like the modern centreboard. Its seaworthiness was sufficiently proved in 1947, when a party of Norwegian scientists, wishing to test a theory with regard to the peopling of the Pacific islands, built a similar raft. the "Kon-Tiki," at Callao. Peru. and succeeded after a voyage of three and one-half months in reaching the islands east of Tahiti. Dugouts are still characteristic of East Indian and Polynesian uaters, bark canoes are (or were) chiefly North American, skin boats belong to the arctic, building with seun planks is still practised in the East Indies. The two last classes correspond to the clinker building and carvel building of modern European small craft.

In the following survey it is proposed to deal only with what may, for want of a better name, be called European ships though it must be understood that this has to include the whole of the Mediterranean and. in later times, the shipping of North America. Eastern. far eastern (especially Chinese) and Polynesian craft form subjects of their own. *See* BOAT. *Existing Types of Boats.*

The more or less standardized European full-rigged sailing ship was produced in the 15th century by the combination in a single vessel of characteristics derived from tno almost distinct lines of descent, one having had its home in the Mediterranean and the other in the waters of northern and western Europe. Roughly speaking, construction came from the south and rig from the north. After this combination—from about 1460 to the last days of deepwater sailing ships—the European ship, in spite of a constant process of modification and improvement, remained unchanged in essentials.

It must be remembered that the southern line was very much older than the northern, or at least that it had reached a stage of comparative maturity much earlier. At the beginning of the Christian era the Mediterranean ship had a history of about 3,000 years and its builders had been producing more and more elaborate vessels for many centuries, while their fellow craftsmen in the north had only just evolved the method of building with keel, stem, sternpost and planks and in so doing passed the line separating the mere canoe from the potential ship.

I. EARLY CRAFT

1. Origins.—The earliest knowledge of boats and ships comes from Egypt. where as early as 4000 B.C. boats were already far advanced from the primitive form from which they must have been derived, in this case probably a bundle of reeds. It has been claimed that "naval architecture is an Egyptian art and that the main lines of the history of ship-building for the whole world were laid down in Egypt towards the end of the 4th millennium B.c." (Elliot Smith, *Ships us Evidence* [1917]). There is, however, at least one extremely weighty objection to this sweeping claim, the fact that the Egyptian method of construction was not transmitted to the neighbours and successors of that kingdom. Egyptian vessels were essentially built-up dugouts (to use a contradiction in terms); they had no keel. stem or sternpost and no internal framing, but consisted simply of a heavily built skin formed of many pieces of timber doweled or dovetailed together. With regard to matters of equipment such as mast and sail or steering gear, the claim is more easily substantiated.

Unfortunately, comparatively little is known of the ships of the Cretans, who were the dominant sea power in the eastern Mediterranean about 1500 B.C., or of the Phoenicians, who took their place; but that little suggests that both nations had begun to differentiate between the fighting vessel and the merchantman and between the rowing galley and the sailing ship. The few representations of Phoenician vessels (about 700 B.C.) do, however. illustrate two striking developments. the arrangement of oars in two banks at different levels and the fitting of a ram bow in galleys intended for fighting. It is possible that the ram was an Egyptian invention. and something of the sort is shown in action as early as 1200 B.C., but it was in Phoenician. Greek and Roman galleys that its importance was most clearly emphasized.

With the ships and galleys of the Greeks firmer ground is reached, though there is still much that remains a subject of controversy. One thing seems certain — Greek vessels were built on a system entirely different from that of Egypt. having keel. stem, sternpost and internal framing with the planks attached edge to edge on the sixth method mentioned above, practically the carvel building of modern times. In all probability the true Greeks. who were originally a race of nomadic shepherds. learned this from their predecessors in the Aegean, but how or where these first evolved so advanced a method of construction is still unknown.

2. Galleys. — The galley, an oar-propelled fighting vessel. is also included under the definition at the head of this article. At the time of the siege of Troy the normal large Greek rowing vessel seems to have been a 50-oared boat with a single row of 25 oars on each side, but we can already see suggestions of still larger vessels, which must have had their oars arranged in some nay which allowed more men to work in a given length. and it was this development which produced the bireme and began the process which led to the many-banked galleys of about 300 B.C.

Since galleys were always narrow, shallow craft, there was a very definite obstacle to increasing their length to any great extent because of the weakness of such a vessel against "hogging" or "sagging" strains tending to break it in half. Thus. the number of oars in a single simple row could not be increased very much and it became necessary to find some other method of getting greater power. It would seem the obvious course to put two or more men on each oar, but it was not until much later that the Mediterranean peoples did this. What was done was to arrange the oars in two staggered rows, the uppermost high enough to clear the heads of the lower rowers and their greater length allowing the upper rowers to sit far enough inboard for their legs to be clear of the ends of the lower oars. Another method was to have two oars quite close together at the same level with their two rowers sitting side by side! the foremost oar of a pair being the shorter. This plan was common in medieval times and was apparently employed to some extent in classical or postclassical times also, but it was the first kind of bireme from which the classical trireme and the later many-banked galleys were derived.

The Phoenician vessels of about 700 B.C. mentioned above were biremes of this type. and the trireme followed a little before 500. Its design is still to some extent a subject of dispute, but the view generally accepted is that its third set of rowers sat roughly above the lowest and at about the same level as the second, and that their oars worked on the outer edge of a long outrigger running almost the full length of the hull. This outrigger, once introduced, remained an almost invariable feature of the Mediterranean galley to the very last. Probably the trireme was invented in Greece or in one of the Greek colonies, and it was the Greeks of the last few centuries B.C. who produced the many-banked galleys which have still to be satisfactorily explained.

Galleys carried a mast and sail but were primarily rowing vessels, whereas the merchantman of Greece and Rome was a sailing ship pure and simple. It was much deeper and no doubt also much wider than the galley, without a ram and with stem and sternpost curving down to a comparatively short keel. Both ends rose well above the general level of the sides, but this was more pronounced at the stern, where the chief accommodation was situated. By Roman times, and probably before. the hull was what we should now call carvel-built, but one noticeable feature was that the ends of the deck beams usually projected through the side planking, as they had done in ancient Egypt.

The sail was what is called a square sail, set on a yard slung horizontally from the mast and carried more or less across the ship's fore-and-aft line. In early Egyptian vessels the mast had been like a narrow inverted V, but this had been replaced by a single stick long before classical times. At first there was only the one mast and one sail, but by the beginning of the Christian era Mediterranean merchantmen had a second much smaller sail on a mast projecting over the bows and could also set a triangular topsail or topsails above the main yard. Some representations show the foresail a good deal larger and its mast more nearly upright, but the other arrangement was probably the more usual. The steering gear was inherited from Egypt, at least in principle, and consisted of a large paddle-shaped rudder on each quarter, held to the ship's side, but free to rotate on its axis and worked by a thwartship tiller. This side rudder. which was found in galleys as well, had obviously been evolved from a mere steering oar, free to move in any direction, and that step had been taken in Egypt before. 1500 B.C.

II. MEDITERRANEAN AND NORTHERN VESSELS

1. Mediterranean Craft. — It will be convenient to take the story of Mediterranean sailing ships down to about A.D. 1300 before turning to parallel developments in the north. Actually, there was surprisingly little change as far as hulls were concerned, but there was a complete transformation in rig by the substitution of the lateen for the square sail. The lateen belongs to the family of fore-and-aft sails, carried so as to receive the wind on either side but to keep the same edge forward. whereas the square sail does just the reverse. It is triangular in shape and is set on a long yard coming down nearly to the deck forward and rising well above the mast-head at the other end. Evidence which came to light in 1955 showed that this sail was in use in the eastern Mediterranean at least as early as the and century A.D. Where it was first used is uncertain, though the probabilities seem to point to Egypt or the Persian gulf; in any case it is clear that the tide of Arab and Moslem conquest was mainly responsible for its spread. Even in modern times the area in which the lateen is the typical sail of local craft is much the same as that over which Moslem control once extended or threatened to extend.

The rig of a medieval lateener comprised two masts and two sails, the larger forward, and this rig was carried on a carvel-built hull with flush planking attached to a framework of keel, stem. sternpost and ribs. The deck beams still often projected through the side planking and the steering gear was still a semi-permanent oar-shaped rudder on either quarter. Except for a certain increase in the accommodation aft and a consequent widening and raising of the stern, the hull was not much different from that of a Roman ship.

2. Northern Craft. — Northern vessels of the 13th century had developed on different lines from their southern rivals and had, as has been said, a much shorter history. but in their own way they were no less efficient. while in one respect — that of steering gear — they were distinctly superior. Everything goes to show that they had descended from simple dugouts, and many such craft have been unearthed in various countries; but it has not been possible to say with confidence that any of these are actually older than the first of the more advanced types which have been discovered, while early attempts at depicting northern vessels are too crude to show much.

The earliest-known specimen of an actual northern boat is believed to date from about 300 B.C. and was found in Als, Den., in 1921. Its dugout ancestry is clearly shown by the way in which its two ends are carved from solid blocks. but between them it is formed of five planks overlapping in clinker-built fashion and sewed together. These planks, which must have been worked with an adze, have projecting cleats left on the inside at intervals of rather more than three feet and bent timbers are tied to holes in these cleats and kept in shape by passing through slots at the ends of the thwarts and in another series of transverse timbers beneath them. This boat is about 45 ft. long.

The remains of two vessels discovered at North Ferriby in Yorkshire in 1937 show a different form of development from the primitive dugout, or perhaps from the raft. In their case there is a flat bottom formed from three planks curving upward at the end with the side planks curving round to meet it. The planks are much heavier than those of the Xls boat and are fitted edge to edge with a sort of rudimentary tongue-and-groove joint; they also are sewed together and have internal battens covering the seams The bottom planks have internal cleats, but the short, straight transverse timbers run through holes in these instead of being lashed to them; how the side planking was supported is uncertain. The date of this find is believed, on geological evidence, to lie somewhere between 200 B.C and A.D. 100.

As far as can be judged, this type of construction was a dead end, perhaps merely local; certainly later developments in northern Europe followed more on the lines of the Nydam boat, found near Flensburg in Schleswig in 1863. In this 75-ft. vessel. dating from about A.D. 250 or a little later, one of the chief problems of the primitive shipbuilder, the treatment of the ends, was solved by the use of an almost modern-looking stem and sternpost, though there is still no true keel, but only a centre plank rather heavier than the others. The planks, too, are nailed together in modern clinker-built fashion, but the ribs—cut to shape instead of bent—are still lashed to cleats on their inside. This vessel shows another feature which remained characteristic of northern ships for almost another 1,000 years, the single side rudder on the starboard (steer-board) quarter.

The remains, or rather the traces. of a similar, rather larger boat dating from the early part of the 7th century were found at Sutton Hoo in Suffolk in 1939. Many objects of great interest were found in the excavation, but the actual wood of the boat had entirely disappeared, though changes in the sand where it had lain made it possible to determine the vessel's shape and even details of its construction, which was almost the same as that of the Nydam boat.

Both these last two boats were purely rowing craft, but those unearthed at Gokstad and Oseberg in Norway in 1880 and 1903 were definitely sailing ships. though still using oars as well. They date from about A.D. 900 and 800. respectively, and are built on much the same system as that from Nydam, clinker-built with ribs lashed to cleats and double ended. with the stern almost exactly similar to the bow. They were the picturesque Viking ships with simple square sails.

This double-ended type of ship remained in use for several centuries, but the method of lashing the ribs to cleats was superseded by nailing. and the keel plank was replaced by a true keel. This stage had been reached by the boats found in 1933–34 at Ohra near Danzig and believed to date from about 1000; the abandonment of internal cleats was perhaps due to the use of saws instead of adzes for shaping the planks.

The ships used by William I in 1066 (shown in the well-known Bayeux tapestry) had probably reached the same state of development. Some of them have their masts supported by shrouds and this suggests that by the time the tapestry was made—probably not earlier than 1150—northern ships were able to sail with the wind at least abeam. Roman ships had used shrouds centuries before, but this is their first appearance in the north; after this they are almost invariably shown in ships on seals and elsewhere.

From the evidence of such representations it can be said that there was little change during the 12th century apart from the fitting of light "castles" at either end of the larger vessels; but at the end of that period came one of the great steps in the history of sailing ships, the introduction of the stern rudder. When or where this first appeared is uncertain, but the date cannot have been far removed from 1200 and the place was probably the Netherlands or thereabouts. The step was important, not only for the increased efficiency it gave, but also for the fact that it was followed—almost necessarily—by a differentiation between bow and stern and the transformation of the double-ended northern ship into something far more like that of its contemporaries in the Mediterranean. When at length the nations of southern Europe recognized the superiority of the new type and adopted both the stem rudder and the square sail, a standard European ship was not far off. though there was still the distinction between the clinker-built northerner and the carvel-built southerner. This was about 1300 or a little later. See also RUDDER.

III. MEDIEVAL SHIPS

With the invention of gunpowder and the first use of guns on board ship soon after 1350 there began a process which caused the sailing man-of-war to become more and more distinct from the merchantman. Otherwise the 14th century brought little change, but developments in the 1 jth more than made up for this. In 1400 ships still had one mast and one sail; before 1450 some of them had three masts and three sails; by the end of the century the largest had four masts and eight sails. Meanwhile, carvel building had spread from the Mediterranean to the north and the ships of all Europe had become similar in both hull and rig, though there were still national or even local variations of type.

In view of the great importance of this short period it must be treated in some detail. The change from one mast to three was very rapid, but was not accomplished in a single step; there was an intermediate two-masted stage, at least in some instances. In inventories of the ships of the Royal Navy in 1410–12 may be found one ship, and only one, with "1 mast magn" and "1 mast parv"—one big mast and one small Whether this second mast was before or abaft the mainmast is still only a matter of opinion, but the ship in which it was carried was apparently southern in origin and thus more likely, because of her lateen-rigged ancestry, to have had her smaller mast aft rather than forward. In any case, the two-masted stage was so brief that the point need not be laboured; by 1435 or thereabouts the third mast had definitely come to stay.

One at least of the ships in these inventories of the early 15th century was surprisingly large. Henry V had a ship under construction at Bayonne in 1419 that measured 112 ft. on the keel, 186 ft. from stem to sternpost and 46 ft. in beam. This ship was never finished, but the "Grace Dieu," built at Southampton in 1418, was even larger. Investigation of her remains, resting in the mud of the neighbouring Hamble river, in 1933 established the fact that her keel uas more than 125 ft. long and her beam probably not far short of 50 ft. They also showed that she was clinker-built, as would be expected, but that each strake was made up of three thicknesses. Such a method of construction had not previously been suspected, but a later study of accounts for building a number of so-called galleys in England in 1295 suggested that these were of two-layer clinker work and the same may well have been the case in many of the larger vessels of the 14th and 15th centuries.

It is possible, in fact probable, that the "Grace Dieu" had three masts. though neither the foremast nor the mizzen would have been of much size or at all elaborately rigged. The foresail would undoubtedly have been a square sail, but the mizzen is more likely to have been a lateen; certainly it became the rule within the next few years for the third mast (and afterward the fourth) to carry a sail of that kind. This was one of the two essentially southern features of the nenly developed full-rigged ship; the other. carvel building with flush-fitting planks attached to frames previously erected, reached the north a little later. It may be that it had been used on the west coast of France as long ago as the time of Julius Caesar, who fought a naval battle on the Loire in j6 B.C and described the ships of his opponents, the Veneti, in some detail nithout suggesting that their construction was in any way radically different from that of Mediterranean ships. In any case. Brittany seems now to have been the centre from which the new method of building began to spread, but it was soon almost universal for large ships, whether men-of-war or merchantmen.

Toward the end of the 15th century ships of moderate size had three masts and five sails. main, fore, mizzen, main topsail and the spritsail under the bowsprit; these were, for instance, the sails carried by the "Santa Maria" in 1492. Considering that bowsprits had been present for more than 200 years, the spritsail was surprisingly late in appearing, as it did, at about the same time as the main topsail in the third quarter of the 15th century.

The original function of the bowsprit is, indeed, somewhat doubtful; it has usually been supposed that it was to give a better lead for the bowlines, which controlled the windward edge of the mainsail, and it is certain that it was afterward used for a similar purpose. but there is much to be said for a suggestion that the first bowsprits were used in connection with the anchors.

Besides the sails just mentioned. the largest and most elaborately rigged ships of about 1500 would carry a fore-topsail, a main topgallant sail above the topsail and perhaps a lateen topsail above one or both of the two lateen mizzens, the aftermost of which was usually called the bonaventure. They were still armed for the most part with a great number of small guns disposed in the towering structures which had grown from the two castles of the 13th century. but the time had almost come for larger guns to be carried and for them to be mounted between decks and to fire through openings in the main hull, as they did until the last days of sailing men-of-war and even later. The invention of these gun ports is traditionally ascribed to a French shipbuilder in 1501, and the date, at least, is approximately correct.

1. Caravel and Galleon. — Another change came about now in the shape of the stern. Starting from the pointed shape produced by giving the double-ended ship a straight sternpost, to carry the rudder. the stern had gradually had its upper part widened more and more by means of a transverse timber, the transom, on which the aftercastle was based, and as a result the lines of the stern had become fuller and fuller, until the shape of its lower part was not far from being a quarter of a sphere. In the new form, which probably originated in the south and in a comparatively small type of vessel, the caravel, the attempt to make the planking conform to the required shape was abandoned and the stern from a little below the water line to the transom was given a flat finish, while the lines below this were made much finer.

The true caravel was a lateen-rigged vessel with three masts. the largest forward. Being a southerner she was carvel-built and it is more than likely that the two words were connected. At all events. they soon became hopelessly confused. The "Santa Maria" is often said to have been a caravel, but this is incorrect; she was definitely a ship, though her two companions were caravels, at least in the shape of their hulls.

Then came the galleon, in which the general principles of the design of sailing men-of-war were finally established. As the name implies, she had something of the galley about her; though she was still purely a sailing ship. The Mediterranean galley had retained the ram of her classical predecessor. but had raised it from the water line and lengthened it into a long beak, and this feature with a square-ended forecastle rising abaft it was incorporated in the galleon in place of the triangular overhanging forecastle of the previous carrack type. At the same time. the hull was made longer, so that the keel became about three times the beam instead of two and a half times or less. while the number of heavy guns between decks was increased until they ran in one or two tiers for the full length of the broadside. This last change was well shown when the famous "Henry Grace a Dieu" of 1514 was rebuilt in 1j36. though in shape she remained a carrack rather than a galleon, as did most other large northern ships for another 40 years or more.

2. Notable Ships. — Competition among various countries in the first half of the 16th century produced a number of outstanding ships such as the Scottish "Great Michael," the English "Henry Grace a Dieu" (or "Great Harry"). the Portuguese "São João" and others, but none of these was as large as the "Grace Dieu" of 1418 and after their time there came a reaction. The biggest ship of Elizabeth I's reign. the "Triumph" of 1561, was only 100 ft. on the keel and 40 ft. in beam. while a Portuguese vessel captured in 1592 and then believed to be the largest ship in the world was still about 25 ft. shorter and 3 ft. narrower than the "Grace Dieu" of nearly 200 years before.

Some idea of the size of merchantmen at this time can be obtained from the list of the fleet which met the Spanish Armada in 1588. The largest of the privately owned vessels was of 400 tons, the smallest 20. Of these some of the larger were really private men-of-war built as such, while the smaller were mere coasters of no fighting value. The average tonnage of the 30 ships equipped by the city of London was 150, which would correspond to a keel length of 60 ft. at the most.

By this time. however, the opening of the sea route to India had led to the building of large state-owned merchantmen in Portugal, the ship just mentioned being one of these, and when the English and Dutch began at the opening of the 17th century to force their way into the same waters, they too began to use larger merchantmen than before. This was particularly the case in Netherlands, where for some time East Indiamen were larger than any man-of-war.

IV. 17TH AND 18TH CENTURIES

The first half of the 17th century saw the culmination of the galleon type in the "Prince Royal" of 1610, the "Sovereign of the Seas" of 1637 and her French contemporary, the "Couronne." The two English ships were three-deckers and the "Sovereign" was the first ship to carry what was for nearly a century the standard armament of a first rate, 100 guns. The "Couronne," though of almost the same size as the "Sovereign," was a two-decker of 72 guns. an early example of the French tendency to build ships very large for their armaments. The same period also saw certain noticeable changes in sail plan. The fourth mast (the bonaventure or after mizzen) disappeared, the lateen mizzen topsail was replaced by a square sail, the spritsail topmast appeared, standing upright on the end of the bowsprit, and royals above the topgallants became at least a possibility, though probably seldom actually set.

1. The Frigate. — Then came the frigate, not the well-known type of Nelson's day, but her 17th-century namesake. Originally the fregata was a small member of the galley family used in the Mediterranean chiefly as a dispatch boat. The name was then applied by the Spaniards to the small fast vessels used to bring treasure from America and from them passed to the ships of the semipiratical privateers of Dunkirk, from which the first English frigates were copied. The exact essentials of such a frigate are by no means clear, but they certainly included an increase in length (or a decrease in beam) and a reduction in top hamper. Soon, however, the name ceased to mean much more than a ship of modern design, since even three-deckers were occasionally called frigates, at least in England.

The chief reason for the growth of the frigate was no doubt the fact that the second half of the 17th century was a time of frequent naval fighting between well-matched opponents and of many hard-fought actions between enormous fleets. Experience soon showed that ships armed almost solely on the broadside should fight in line ahead in a prearranged order and this in its turn led to the conclusion that the ships in such a line must be of a certain minimum strength, 40 guns or more. Such was the origin of the term ship of the line or line-of-battle ship — abbreviated later to battleship.

2. Improvements in Rigging and Equipment. — Just before the appearance of the 17th-century frigate, somewhere about 1630, English shipbuilders had made a change in the shape of the stern by rounding off the sudden turn between the side planking and the flat stern of the galleon type sufficiently to admit of working the planking round to the sternpost and transom while maintaining the fine lines below water. Although the flat stern continued to occur at intervals almost to the last days of sailing men-of-war, especially in the smaller vessels, the new form of stern was more or less a distinguishing feature of English ships for at least 50 years; it was not imitated by other countries until the end of the 17th century or the beginning of the 18th.

By then the French navy had become important, not only because of its great expansion under Jean Baptiste Colbert, but also because of the quality of its ships. This was not merely a matter of increased dimensions, though French ships were, as has been mentioned. usually much larger than English or Dutch of the same number of guns; another reason was the greater attention paid in France to the scientific side of naval architecture. Because of these two factors the French, and at a later date the Spaniards, built ships more efficient, class for class, than anything produced in England. The first half of the 18th century was. indeed, a period of comparative stagnation in English shipbuilding. at least as far as men-of-war were concerned. It was the period of "establishments" laying down standard dimensions for ships of each class and thus cramping the initiative of the various builders. Each successive establishment certainly allowed some increase in size. but this was never enough to overtake what was being done on the continent.

The chief interest of the period lies in its developments in rig and equipment. Staysails had been in use for 50 years or more. and there were already such sails on the three stays leading to the bowsprit, but in 1700 or thereabouts a new sail of the same kind—the jib—was introduced, carried between the fore-topmast head and the jib boom. which was a small spar fitted as a prolongation of the bowsprit. Obviously this sail demanded the removal of the spritsail topmast. but an attempt was made for at least another 25 years to carry both together; then the spritsail topmast vanished and its sail was shifted to beneath the jib boom. The bobstay. to hold down the bowsprit, seems to have come just before the jib. Why it should have taken so long to produce so apparently essential a piece of rigging is hard to say, but no trace of a bobstay earlier than 1690 has yet been found. Bowsprit shrouds came a little later. At the other end of the ship the part of the lateen mizzen before the mast was done away with and. though the biggest ships kept the whole yard for a long time, it was gradually replaced by a gaff such as was carried in the 19th century; by 1800 the long mizzen yard was a thing of the past.

The introduction of the steering wheel was a less conspicuous but extremely important change. From the middle of the 16th century to the end of the 17th the tiller had been worked by means of the whipstaff, a vertical lever acting on its inboard end and passing through a pivot in the deck above, a device which must have been much less efficient than the wheel with its ropes leading to the end of the tiller. In England the wheel was first used about 1705; there is a suggestion that something of the sort may have been tried in France somewhat earlier, but other countries seem to have waited a few years before adopting it.

By 1750 the smallest ships considered fit for the line of battle were 64s or 60s, though there were still smaller two-deckers of 50 and even 40 guns. After them came the 24-gun ships, which were really small two-deckers with only four ports on the lower deck. and it was these which developed into the frigates of Nelson's time, where the lower deck, though still called in England the gun deck, carried no guns at all. The first of these new-type frigates were built in England in 1756 and in France a few years sooner; they carried 28. 32 or 36 guns. but soon grew, until the largest of them actually mounted as many as 56 guns, though classed, because of the peculiarities of official rating, as 44s One of these heavy frigates, the U.S.S. "Constitution" of 1797, has been more or less restored to her appearance in the War of 1812; while in England the 100-gun "Victory," built in 1765, is preserved in dry dock as she was at Trafalgar in 1805.

At the time of her launching the "Victory" was the largest British ship afloat, but even so she was hardly larger than the "Grace Dieu" of 1418 and no English (or British) ship in the meantime had been as large. She was 186 ft. on the gun deck and 52 ft. in beam, whereas her Spanish contemporary. the "Santissima Trinidad." measured 204 ft. by j3.8 ft. and the French "Commerce de Marseille" of 1790 was 208.6 ft. by 54.8 ft. Before the end of sailing men-of-war the beam of the largest ships had risen to as much as 60 ft.; but the length never went beyond the 210 ft. of the U.S.S. "Pennsylvania" of 183;. and about 205 ft. was usually the maximum. The reason for this was the tendency of long wooden ships with guns all along the broadside to "hog" or drop at the ends. Merchantmen did not present quite the same difficulty and in their case with improved methods of construction it proved possible to make the length much greater.

V. THE 19TH CENTURY

In merchantmen the increase of length. both actually and in relation to the beam, was associated with the rise and development of the clipper ship in the middle of the 19th century. At the time of the Napoleonic wars the largest and finest merchantmen afloat were those in the service of the East India company, heavily built vessels not unlike men-of-war and actually used as such on occasion. The largest of them. the 1.200-ton class. measured about 16j ft. by 42 ft. With the ending of the company's monopoly of trade with the east in 1833, the various owners who had supplied it with ships began trading on their own account and were at once driven by mutual competition to employ ships of greater efficiency as speedy carriers of cargo. The first of these were comparatively small. but by 1842 they were back at 1,200 tons with the "Prince of Wales" measuring 179.4 ft. by 39.; ft., much longer and at the same time narrower than the older type.

1. Clipper Ships. — By then the clipper was coming to the fore. It is a matter of controversy which was the first clipper ship and what were the essential characteristics dividing her from her predecessors, but on the whole the U.S. "Ann McKim" of 1833 seems to have the best claim to the title. In any case, it was a matter of gradual evolution rather than sudden change, since she was little more than a slightly enlarged version of the existing Baltimore clipper type. well-known as successful privateers and slavers. though she was rigged as a ship instead of as a schooner or a brig. Other claimants are the British "Glentanar" of 1842, developed from the schooner "Scottish Maid" of 1839, and the U.S. "Rainbow" of 1845. In the case of the "Scottish Maid" and her Aberdeen-built successors, it is possible that the most obviously revolutionary feature of the design, the long overhanging bow, was primarily a means of cheating the existing rule for measuring tonnage and that the increased speed it gave was to some extent a by-product. However this may be, clippers, in the strictest sense of that ill-defined and very elastic term, were being built in ever-increasing numbers on both sides of the Atlantic by the end of the 1840s.

They were chiefly employed in the tea trade from China, in carrying passengers from the eastern part of the C.S. to San Francisco after the discovery of gold in California in 1848, in similar voyages from Great Britain to Australia a few years later and finally in the Australian wool trade. On the whole, the U.S. clippers were larger and more powerful ships than the British and therefore capable of greater maximum speeds, but in the matter of all-round performance there was little to choose between the two types. The American "Lightning" of 1854 is believed to have made the best day's run ever recorded by a sailing ship. 436 mi., but the palm for consistently fast passages in all conditions should probably be given to two of the last British tea clippers, the "Thermopylae" and "Cutty Sark" of 1868–69.

Apart from their finer lines as compared with ships of an older type and the relatively greater spread of canvas which they carried. the clippers owed much of their speed to a further increase in length as compared with beam. The process had, as has been said. begun with the first successors of the old East Indiamen, but was taken much further in the clippers. The "Rainbow" had a length about 4 times her beam, as had been the rule toward the beginning of the century, but in the "Lightning" the ratio reached 5.6. British builders went in for ships still longer and narrower; the usual standard, from the "Stornoway," built three years before the "Lightning," to the "Cutty Sark." was about 6 beams to length, and this was sometimes exceeded, as in the "Lord of the Isles" of 1853 with 6.4 and the "Queensberry" of 1856 with the extreme figure of 7.2. This increase of length was to a great extent made possible by the advent of steam, which allowed these comparatively unhandy ships to be towed in and out of harbour.

Meanwhile. there had been many improvements in construction and rig. Even with new methods of framing introduced soon after the beginning of the 19th century it was still difficult to build wooden ships beyond a certain length. The use of iron did away with this difficulty and the "Lord of the Isles" was an iron ship, but this was found to be bad for a tea cargo and a compromise was effected by means of the composite method of building with wooden planking on iron frames. In the matter of equipment the great step was the introduction of wire in place of hemp for standing rigging in the early 1850s, soon followed by the invention of the double-topsail rig, which, though perhaps no more efficient, was much easier to handle than the large single sails previously carried.

2. Last of the Sailing Ships.—By the time these changes took place, the sailing man-of-war was rapidly becoming more and more obsolete. There had been paddle steamers in the British fleet from 1822 and some of the last of these had been ships of considerable importance, but it was not until the adoption of the screw in the 1840s that it became possible to combine steam propulsion with the complete broadside armament of the larger classes. When once this stage had been reached, ship after ship was given engines of steadily increasing power, till by 1850 no more purely sailing men-of-war were being built. Masts and sails were retained for a long time, but gradually the two systems of propulsion exchanged roles, and the man-of-war, instead of being a sailing ship with an auxiliary engine, became a steamship with auxiliary sail.

In the case of merchantmen the distinction between steamships and sailing ships was made much sooner and more definitely. It is true that unsuccessful attempts to give deepwater sailing ships auxiliary steam power were made before 1840 and that steamers, especially those employed on long voyages, continued to have masts and sails, though they seldom had anything like full ship rig; but on the whole the sailing merchantman was one thing and the steamship another almost from the first.

In one trade after another. particularly those where perishable cargoes had to be carried, steamers began to take the place of sailing ships. The opening of the Suez canal in 1869 was a heavy blow to the sailing ship, since, besides shortening the route to the east, it reduced the distance between coaling stations and so allowed steamers to devote more space to cargo. After this the surviving China clippers turned for the most part to the Australian wool trade and it was in this that such ships as the "Thermopylae" and "Cutty Sark" made their reputations. Then came grain from Australia and nitrate from the west coast of South America, till at length the Panama canal, opened in 1915, gave steamers the advantage even there.

For nearly 250 years the standard rig of men-of-war and of the larger ocean-going merchantmen had been that of the full-rigged ship with three masts all carrying square sails. When the square mizzen topsail was first introduced, the long yard of the lateen mizzen beneath it had made it impossible to carry a square course or lower sail; the yard spreading the foot of the topsail, the "crojack" in English, was in fact called in French the *vergue sèche* or "barren yard," because it set no sail of its own. One would have expected a square mizzen course to appear as soon as the long lateen yard was done away with, but actually this did not happen till about 50 years later, in the middle of the 19th century.

Meanwhile, many smaller vessels, in particular the collier harks of the North sea, had carried no square sails on their mizzenmasts. It is probable that originally the term bark as opposed to ship marked a distinction in size and in form of hull rather than in rig; but when large ships began once more to do without square sails on the mizzenmast, they were called barks or barques, the French form of the word being for some reason usually preferred. This became the fashion soon after the clipper ship era, when it was necessary for sailing ships to reduce their crews, and thus their running costs, to meet the competition of steam.

At the same time the need for greater cargo-carrying capacity produced ships both larger and fuller bodied, though the increased length and power did a good deal to compensate for the loss of the finer lines of the clippers. Composite building had only a short life, and iron (and afterward steel) ships became the rule; while with the increase of length it was found desirable to add a fourth mast, the result being the four-masted ship or four-masted barque, according to the rig of the aftermost or jigger mast. Four-masted square-rigged vessels had been almost unknown since about 1630, but not entirely so; the French privateer "L'Invention" of 1801 had been a four-masted ship in the strictest sense of the term, while the famous "Great Republic" of 1853, the largest of the U.S. clippers, 325 ft. long, had been a four-masted barque. On the whole, the barque rig proved the more satisfactory and at the beginning of the 20th century the four-masted barque could be considered the standard type, though there were some noteworthy exceptions.

For the most part this final development of the sailing merchantman was in the hand of British. French and German builders. In the U.S., which had taken so conspicuous a place in the days of the clippers, the building of square-rigged vessels declined rapidly after 1860; but as some compensation for this there came a boom in large fore-and-aft rigged vessels, the original two-masted schooner of the 18th century becoming by degrees three-masted, four-masted and even six- and seven-masted, the climax being reached in the "Thomas W Lawson" of 1902. At the same time, many square-rigged vessels bought from foreign owners were re-rigged as many-masted schooners.

French shipowners had the benefit of a system of bounties which are said to have been high enough to allow sending a ship round the world in ballast, without cargo, and still making a profit on the voyage, the result being that some very large ships were to be found under the French flag toward the end of the sailing-ship era. The five-masted barque "France" of 1890, with a length of 361 ft., was built in Scotland, but the next ship of the name, the largest sailing ship ever built, was launched at Bordeaux in 1911. She, too, was a five-masted barque and was 418 ft. long with a gross tonnage of 5,633. This ship was wrecked in 1922; her predecessor had been lost at sea in 1901.

In the same way the first of the German five-masters. the "Maria Rickmers," was built in Scotland in 1890 and was of about the same size as the first "France"; but the "Potosi" (1895), "Preussen" (1902) and "R. C. Rickmers" (1906) were all built in Germany and each was larger than the one before, the last being 410 ft. long and measuring 5.548 tons. All save the "Preussen" were rigged as barques, but she was a five-masted ship, the only such vessel ever built. She was wrecked in 1910.

World War I caused the loss of many sailing ships and it was no longer financially practicable to replace them. The Germans built a few curious five-masted vessels with auxiliary motors, rigged as schooners with square topsails on the first and third masts; uhile the Danish East Asiatic company had a large auxiliary five-masted barque, the "Kobenhavn," built in Scotland in 1921, but she was intended primarily for a training ship. She, too, was unfortunate, being lost at sea in 1929. Meanwhile, the survivors of the days of sail mere lost or laid up, until in 1929 the last British square-rigged sailing ship left in service was also lost; this was the "Garthpool," built as the "Juteopolis" in 1891. A few, mainly German in origin, passed into Finnish ownership and except for a break caused by World War II continued to bring grain from Australia as late as 1949. In 1950 the last two of these were for sale. (RR C. AN.)

VI. INTRODUCTION OF STEAM AND IRON

A revolution in the history of the ship may be said to have occurred with the changes from sails to steam engines for propulsion and from wood to iron for construction. These proceeded together, but at first slowly. There was still much ignorance of the principle of flotation by displacement, and it was urged by the unenlightened that iron would not float and was therefore unsuitable for ship construction. Even among those who realized the fallacy of this argument it was asserted that an iron ship would be far more easily damaged in the event of her touching the ground than a wooden one, while there existed the real difficulties of preserving the bottom from the action of the sea and fouling by weeds and barnacles, and of compensating the compass for the errors produced by local attraction. With regard to the strength of the ship, experience showed that iron construction was better able to withstand rough usage than was wood, and examples, such as the "Garry Owen" in 1834, were not lacking of iron and wooden ships being stranded together by the same gale and under similar circumstances and the iron ship getting off little the worse. while the wooden ship became a total wreck. Another remarkable instance of the endurance of iron ships was that of the "Great Britain," which, in 1846, ran ashore in Dundrum bay in Ireland and settled on two detached rocks; she remained aground for 11 months, was subsequently got off. and afterward did good service. In due course a suitable composition was discovered for painting the underwater surface oi iron ships; while trials carried out in the "Rainbow" at Deptford and the "Ironsides" at Liverpool went far toward providing the solution ior correcting the compass.

One of the earliest iron craft on record was a boat apparently intended for passenger service, built on the banks of the Foss river in Torkshire in 1777. In 1787 a canal lighter was constructed with a shell of iron plates. and for many years iron and wood were used in conjunction for the construction of what were known as composite ships.

For warships iron was at first objected to because it was thought that the enemy's shot would cause more serious damage to them than it would to a wooden ship. but this again was proved to be a fallacy. 'The first iron steamer was the "Aaron Manby," built at Horsley in 1821 and assembled in London.

1. The First Steamboats.— One oi the earliest proposals for a steam-driven boat was made in 1690 by Denis Papin. In 1707 he built a paddle boat and tried it on the Fulda; but the paddle wheels were turned by man power. not by steam. In 1736 Jonathan Hulls, of Gloucestershire, patented a steam tugboat. but it was never tried. The first experimental steamboat to be built. in France, by Comte J. B. d'Auxiron in 1774, foundered before it could be tried. In 1775, however, Jacques C. Perier contrived, for the first time in history, to move a small boat by steam power on the Seine at Paris. After unsuccessful experiments with a 43-ft. steamboat and palmipede or "duck-foot" paddles, on the Doubs in 1778, the Marquis Claude de Jouffroy d'Abbans built his "Pyroscaphe" of 182-tons displacement, fitted with double-ratchet mechanism to produce continuous rotation of the paddle wheels. In 1783 this vessel, the first really successful steamboat. mounted the Saône near Lyons. In 1787 James Rumsey drove a boat on the Potomac four miles an hour by means of a power pump. About the same time John Fitch produced his oar-driven steamboats.

A more practicable device was to be the paddle wheel. The "Charlotte Dundas," constructed by William Symington in Scotland in 1802, was one of the earliest of these vessels. She proved her utility for towing work on the Forth and Clyde canal. Robert Fulton. having witnessed the success of this craft, in 1807 constructed the "Clermont" on the Hudson river in the U.S. The engines for the vessel were made by Boulton and Watt in England. She proved popular as a passenger boat between New Tork and Albany. The first steamer to make a regular sea voyage was the "Phoenix" which, in 1809, steamed from Hoboken, S. Jto, Philadelphia, Pa. In 1812 Henry Bell produced his steamer "Comet," which carried passengers between Glasgow, Greenock and Helensburgh. She was 43 ft. long. 11 ft. broad and 5½ ft. deep and was driven by a one-cylinder engine. The success of these early steamers soon produced others. In 181j the "Margery" of 38 tons, built on the Clyde, was brought through the Forth and Clyde canal and then down the east coast to the Thames. In 1816 this same vessel, renamed the "Elise," was the first steamer to cross the channel to France.

In Great Britain the steamship was first used only as a passenger carrier and tug along rivers and canals. but gradually increased competition forced the steamer to seek other spheres and in doing so she found herself able to perform short coasting voyages. She then became a passenger carrier along the coast to the various holiday resorts, her novelty being her principal attraction. It was not long before it was realized by the owners that the steamship was capable of much more than this and vessels were built to cross the North sea, the Straits of Dover and the Irish sea. They were all modeled on the sailing ships that they replaced and 'all carried auxiliary sail either on masts or on their funnels: as the low-pressure machinery was wasteful and incapable of giving any considerable speed. The various methods of propulsion which had been experimented with in the 18th and earliest years of the 19th centuries, including a rudimentary screw propeller and jet propulsion. gave way to the side paddle wheel which remained in favour for many years.

2. Atlantic Crossing.— It was not long before steamship owners aspired to cross the Atlantic by steam. The sailing packet "Savannah." which had been designed to run on the service between New York and Le Havre, was given auxiliary steam machinery and crossed the Atlantic from Savannah, Ga., in May and June 1819. She only used her engines for about 8j hours of the voyage, but arrived off Ireland with her coal consumed. Afterward she visited the Baltic. where she aroused great interest. Although this is generally recorded as the first steam Atlantic crossing, the vessel returned to the U.S. under sail alone.

The first to use steam power on the Atlantic in a westerly direction was the "Rising Star" of 428 tons, built at Rotherhithe in 1821 for Thomas Cochrane, earl of Dundonald. She had internal paddle wheels. and in 1821–22 crossed from Gravesend to Valparaiso, Chile. In 1824–25 the "Caroline." first steamer in the French navy. crossed from Brest. France, to Cayenne, French Guiana.

The steamer "Curacao." built at Dover in 182j, a wooden paddler of 438 tons, was purchased by the Dutch government as a man-of-war but was employed on the mail service to the Dutch West Indian colonies. She left Rotterdam on her first passage to the West Indies in April 1827 and took 28 days to do the voyage, after which she made the regular sailing each year, until she was required as a warship during the troubles in Belgium in 1830, after which she never returned to the mail service.

The first transatlantic steamer of the Royal Navy was the "Rhadamanthus" of 813 tons, which crossed from Plymouth to Barbados in 1832. The next steamer to perform the feat n-as the "Royal William," whose performance was particularly remarkable because of the fact that she was built in Quebec with the idea of running from that port to Haliiax. Samuel Cunard, who afterward founded the great Atlantic company, was one of her owners. Trade depression and an epidemic oi cholera spoiled her chances in the trade for which she was designed and she did no better as a tug. Her owners. being forced to consider her sale and thinking that they would get a better price for her in Europe than in Canada. sent her across the Atlantic in 1833. She took 2j days to do the passage and burned 324 tons of coal. Afterward she was sold for £10,000 and later served in the Portuguese navy as a transport and in the Spanish navy as a warship until she was finally condemned in 1840.

3. Regular Atlantic Passages.— These early steamship passages across the Atlantic were more or less haphazard. but it soon became the object of the owners to provide a regular service. Pending the construction of suitable tonnage the 703-ton steamer "Sirius." which had been built for the Irish sea service, was chartered in 1838 by the British and American Steam Navigation company. She was considered a big steamship in her day and was one of the first steamers to be fitted with a surface condenser, patented by Samuel Hall in 1834. instead of using salt water in her boilers; this represented one of the milestones of steam engineering at sea. She sailed irom London to New York by way of Cork with 40 passengers and although she was grossly overloaded to modern ideas she made the passage in safety. Within a few hours of her arrival in New York a very much bigger and finer steamer, the "Great Western:" which had been constructed with the idea of continuing the Great Western railway across the Atlantic, arrived after a crossing of 1j days from Bristol. She had a tonnage of 1,320 and was regarded as the finest steamship of her day.

After this several other Atlantic liners were built but all the services were irregular and maintained by a heterogeneous collection of ships, suitable and unsuitable. It mas when Samuel Cunard founded his transatlantic line in 1840 that a new policy in shipping produced a revolution in shipbuilding— the construction of sister ships. He started operations with iour transatlantic ships and one small feeding steamer, the "Unicorn," in Canadian waters.

The sister ships "Britannia." "Acadia," "Columbia" and "Caledonia" were wooden steamers built on the Clyde, their tonnage according to the rule then in use being about 1,150 on dimensions 207 ft. by 34 ft. 2 in. by 22 ft. 2 in. depth of hold and their two-cylinder side-lever paddle engines of 740 i.h.p. (indicated horsepower) being sufficient for an average speed of nine knots in favourable circumstances. Charles Dickens crossed on the "Britannia" in 1842. The coal supply of these ships was the chief anxiety of their designers, and their passenger accommodation was not equal to the sailing packets which they rivaled, but the regularity of their passages compensated for the fact that they were frequently beaten by the sailing ships in a fair wind. They were barque-rigged and had a considerable area of canvas which was set whenever circumstances were favourable.

4. Long-Distance Steamers. — In the meantime, although the North Atlantic crossing had attracted popular attention to the exclusion of most other services, great progress was being made in the long-distance routes. When the General Steam Navigation company was founded in 1824 its promoters had the intention of running steamship services all over the world as material improved, and had every confidence that this would come about.

In 1825 the steamship "Enterprise" had proved that it was possible for a steamer to reach India, although at the same time she proved that it was not a commercial proposition. It had been suggested in 1822 to establish a company for the purpose of maintaining a steam service to India and a naval officer was sent out to arouse popular enthusiasm. Within two years 80,000 rupees had been raised in Bengal by public subscription, to which the government of India added 20,000 rupees and announced that the whole sum would be given as a prize to the first steamer that could contrive two round voyages between Great Britain and India before 1826, the stipulated time for each passage being 70 days.

This prize caused a syndicate to purchase the paddle steamer "Enterprise" of 470 tons when under construction on the Thames and to fit her out with a fore-and-aft rig to compete for the prize. Her dimensions were 122 ft. by 27 ft. and she had an engine of 120 nominal horsepower which was designed for nine knots speed but which could be relied upon for six or seven only. She sailed from Falmouth on Aug. 16, 1825, and reached Calcutta 113 days out, including 10 days spent coaling at St. Thomas and the Cape of Good Hope. The government of India awarded her half the promised prize and then purchased her as a warship.

The improvement and finally the real practicability of the overland route was brought about by the Peninsular and Oriental Steam Navigation company, which started in 1834 to maintain a mail service between Great Britain and the Spanish and Portuguese ports in competition with the sailing mail packets maintained by the government. It was then the Peninsular service, but in 1840 the service was extended to Alexandria to connect with the East India company's steamers and the company became the Peninsular and Oriental Steam Navigation company. It was not until 1854 that the East India company abandoned its end of the service, although its irregularities and the poor steamships employed on it were the cause of constant complaint.

Steamships of a type practically identical with those of the Cunard line, but of rather greater tonnage varying from 1,700 to 1,900, were built in 1841 for the West Indian mail service for which the Royal Mail Steam Packet company had obtained a royal charter. At that period the British West Indian colonies were of much greater importance than in more modern times, and the service was heavily subsidized in order to overcome the great difficulties of coal supply on the route. This service was afterward extended to the Brazilian coast and the Rio de la Plata, causing a steady increase in the size of the ships, although they were long built on the same principle.

5. The Screw Propeller. — Private shipowners who were untrammeled by the conditions of their subsidies were anxious to improve on the paddle wheel and in 1836 both Francis Pettit Smith, an Englishman, and Capt. John Ericsson, a Swede, patented practical screw propellers although the principle was not new. The year 1839 saw a ship built to each of these principles, the "Archimedes" to Smith's patent and the "Robert F. Stockton" to Ericsson's. Neither was a large vessel, but they both proved the superior economy and power of the screw and led to more important ships being built.

The most important of these steamers was the "Great Britain," which was laid down in dry dock at Bristol in 1839 and floated out in 1843. She was noteworthy not only because of her dimensions, which were 322 ft. by 51 ft. by 32 ft. 6 in. depth of hold, which gave her a tonnage of 3,270 according to the old burden measurement, but also because she was constructed of iron in spite of the great prejudice of the navy against that material. She was designed by I. K. Brunel, whose intention was originally to make her a paddle steamer. But he was so greatly impressed by the performance of the "Archimedes" on a cruise round the British coast that he altered the "Great Britain" and fitted screw machinery, reinforced by a big sail area on six masts.

Her machinery consisted of a simple engine with four cylinders each 88 in. in diameter, with a stroke of 72 and with indicated horsepower of about 1,500 at 15 lb. per square inch pressure, a speed of 11 knots being obtained on trial. Her stranding on the Irish coast in 1846, when she had to withstand the gales of a whole winter in an exposed position, finally convinced shipowners that iron construction was both strong and practical.

6. Atlantic Development. — In 1847 the U.S. brought out its first transatlantic steamers, the "Hermann" and "Washington," run by the Ocean line between New York and Bremen by way of Southampton in return for a heavy subsidy. They were ships of 1,750 tons each with paddle engines of 1,100 i.h.p. giving them a speed of 11 knots, their hulls being on the lines of the less extreme Atlantic sailing packets. They maintained their service with fair success until the reversal of the United States subsidy policy in 1857, when they were sent to end their days in the Pacific. In 1850 a second U.S. transatlantic service between New York and Le Havre was started with the "Humboldt" and "Franklin."

The straight stem of these two ships made them differ greatly in appearance from their British rivals and was an American conception adopted by E. K. Collins when he started the Collins line (U.S. Mail Steamship company) in 1850. The first fleet consisted of the wooden paddle steamers "Atlantic," "Arctic," "Baltic" and "Pacific," practically sister ships of 2,860 tons, with side-lever engines of 2,000 i.h.p. They were a great improvement on the existing material and although they were so well built and extravagantly fitted that it was necessary to obtain an additional subsidy they were the most noteworthy ships on the Atlantic in their day. In 1856 they were joined by the "Adriatic," of 3,670 tons gross with engines of about 3,600 i.h.p. designed for a speed of $13\frac{1}{2}$ knots, which marked the high-water mark of U.S. paddle-steamer construction on the Atlantic. When the subsidy on which the company relied was suddenly withdrawn after two disasters the service collapsed and although Cornelius Vanderbilt constructed somewhat similar ships to maintain U.S. interest on the Atlantic they were soon withdrawn and for more than 30 years U.S. steamship development was practically confined to the rivers and coasts of the country and to the Pacific trade.

While these big paddle steamers were being built the screw propeller was being introduced into European Atlantic companies, beginning seriously with the foundation of the Inman line in 1850. This company, which was intended to improve the emigrant service, began with iron screw steamers — the first of less than 2,000 tons — barque-rigged and still maintaining a full spread of canvas. Its example was soon followed. The North German Lloyd (Norddeutscher Lloyd) and Hamburg-American (Hamburg-Amerika Linie) companies in Germany, and the Compagnie Generale Transatlantique in France, saw the opportunities of the great continental fields of emigration with up-to-date steam tonnage and were soon encroaching on the third-class traffic which was the last stronghold of the sailing packet.

The Cunard line was endeavouring to carry on in its traditional way, in spite of the fact that by then the naval conditions were considerably relaxed, but it was gradually being forced into line. For its mail ships it remained faithful to the paddle until the early 1860s, the "Scotia" of 3,871 tons which was launched in 1861 being the last and finest of the type. It had, however, changed from wood to iron with the "Persia" of 1855 The first Cunard screw steamer was the "China" of 2,529 tons, built in 1862, which in spite of her smaller size showed her advantages in competitive service trials.

7. "Himalaya." — In 1853 the Peninsular and Oriental line, although not destined to abandon the paddle for several years afterward, built the iron screw steamer "Himalaya," which was the biggest vessel of her type in the world, having a gross tonnage of 3,438 on dimensions 340 ft. by 46.2 ft. by 34.9 ft. depth of hold.

Her trunk engines gave her a speed of 13.9 knots on trial, and yet were sufficiently economical to permit her to stow enough fuel to undertake long voyages under steam which showed a profit. After one or two voyages on her owners' service she was taken up as a transport for the Crimean War and so impressed the admiralty that they bought her and employed her as a naval trooper until the 1890s. She was then converted into a coal hulk for use at Portland, where she was destroyed in the air raids of World War II.

8. "Great Eastern." — The "Great Eastern" was one of the most discussed steamships ever built, and the most historic failure. She was originally conceived by I. K. Brunel on the success of the "Great Britain." and in 1851 a company was floated for the purpose of building her and trading to the east. At that period steam navigation to the east and Australia was greatly handicapped by the lack of coaling facilities, and the "Great Eastern" was specially designed to ply between England and either Calcutta or Colombo, where smaller steamers and sailing vessels could pick up her cargo and passengers and distribute them to various destinations. Her dimensions of 692 ft. on the upper deck by 82.5-ft. beam and 30-ft. draft gave her a gross tonnage of 18.914, and it became necessary to take particular precautions that her hull should have the requisite strength. She was, therefore, given not only a double bottom but a tubular upper deck and was one of the strongest ships ever built. The hull and the paddle engines were built by Scott Russell and company on the Thames, while James Watt and company of Birmingham built the screw engines, for Brunel had decided to provide alternate methods of propulsion, the greatest fault in the original design. Scott Russell of the building firm designed the details of her hull and gave her the wave-line principle in which he believed. The paddle engines had 3,411 i.h.p., while the screw engines which drove a four-bladed propeller had 4.886 i.h.p. Altogether 6.500 sq.yd. of canvas were set on her six masts and she was fitted with ample bunker accommodation for a long voyage, in addition to large holds and passenger accommodation.

Fearing for the narrowness of the river, Brunel insisted that she should be launched broadside on and was so anxious to avoid the huge mass taking charge that he checked her too soon on the ways and she stuck fast for three months. This delay, and the subsequent work of launching her, drove the original company into liquidation and she was purchased for use on the North Atlantic, a service for which she was not designed and was most unsuitable. The result was that she was a most expensive failure except for the excellent work that she did in laying the Atlantic cable.

9. Steam Colliers. — By this time the screw steamer was invading most of the trades of the world. including the coastal. The U.S. was building up a fine coasting fleet, differing very materially from European ideas of design. Most of the European nations were following suit, while steam colliers were even invading the coal trade between the northeast coast of England and the Thames, which was regarded as the stronghold of the sailing ship. The first was the 273-ton "Q.E.D.," which was really an auxiliary, schooner rigged, with the smoke from her low-powered screw machinery carried up through her mizzenmast. This vessel made her appearance in 1844. Eight years later, however, the first real iron steam collier was put into service, the "John Bowes." This steamer had dimensions 151 ft. 9 in. by 26 ft. 3 in. and was one of the first ships to be fitted with tanks for water ballast. Rebuilt out of all recognition, she was later transferred to the Spanish coasting trade as the "Valentin Fierro."

An important result of the success of the "John Bowes" was that it caused the introduction of the steam tramp, a cargo vessel which was open to charter on any trade instead of running to a definite schedule. Before that time all steamers were built for definite services and chartering for bulk cargoes was unusual, this business being left almost entirely to the sailing ship.

10. The Compound-Expansion Engine. — Increased economy was still the aim of the engineer, and this led to the introduction of the compound-expansion engine, in which the steam was used in a second cylinder at a lower pressure after it had done its work in the first. It was an invention of James P. Allaire, U.S. engineer, in the year 1824, but at that time it failed because of the low pressure used. As steam pressure increased John Elder, the head of what later became the Fairfield Shipbuilding and Engineering company on the Clyde, brought out his compound engine, which employed the steam in two stages and which did much to overcome the disadvantages of the steamship on long routes on which coaling stations were rare.

The first vessel to be so fitted was the "Brandon" of 1854, a screw steamer designed for the trade between London and Limerick and fitted with a vertical engine having the cranks diametrically opposite to one another. Her coal consumption on trial was returned as $3\frac{1}{4}$ lb. per indicated horsepower per hour, as compared with the 4 to $4\frac{1}{2}$ lb. which was the utmost economy to which the simple engine could aspire. Although built for a short-distance service, she was employed as a transport in the Crimean War and her success caused the compound engine to be generally adopted, while the steam pressure steadily increased. The first Atlantic steamship to be fitted with compound-expansion engines was the "Holland" of the National line in 1869.

As pressures still increased it became possible to add a third stage to the engine and triple-expansion machinery came into being. In France this system was sponsored by Benjamin Normand of the famous firm of Le Havre shipbuilders, who took out a patent in 1871 and installed his first set two years later. In England a patent was taken out by A. C. Kirk, a colleague of John Elder. who tried a triple-expansion engine and machinery first in 1874 in the 2,083-ton steamer "Propontis."

11. Water-Tube Boilers. — The original installation of the "Propontis" was fed by water-tube boilers, in which the water passed in tubes through the flame instead of the flame passing in tubes through the water as in ordinary mercantile practice. These boilers, which were later generally adopted in all navies and in many merchant ships, had already been introduced in France but had given much trouble. Those installed in the "Propontis" were no more satisfactory than those of French men-of-war which had been so fitted in the 1840s, and she is generally described as a failure. but when new boilers were installed with reduced pressure she continued to work satisfactorily for many years.

In 1881 the "Aberdeen" of 3.616 tons. designed to run on the Australian trade in which economy was more obviously necessary than in any other, was fitted with Kirk's triple-expansion engines. On trial she reduced her coal consumption to 1.28 lb. per indicated horsepower per hour and was a most satisfactory vessel on service, although this abnormally small consumption was naturally increased under working conditions. Her success caused a large number of steamers of all kinds, which had originally carried compound engines, to be tripled by the addition of a third cylinder during the 1880s and 1890s.

At the end of the 19th century steam expansion was taken one stage further, to obtain the best economy with steam pressures above about 180 lb. per square inch, and quadruple-expansion engines were built for marine use. Such engines were fitted in 1904 on the twin-screw "Caronia" of 19,687 tons, which was the last Cunard liner to be fitted with reciprocating engines. Her sister-ship, the "Carmania" (19,524 tons) of 1905, marked the transition of the Cunard line to turbine propulsion.

12. Twin Screws. — In 1862 the first full-powered twin-screw steamer. apart from certain experiments in the earliest days of steam. was built on the Thames. She was the 400-ton "Flora" and although her builders. the Dudgeons, made a specialty of twin-screw steamers and built the far larger "Ruahine" in 1865 for the Panama, New Zealand and Australian Royal Mail company, the idea did not attract the liner companies until the "Notting Hill" of 1881 proved the advantages of the system on the North Atlantic. Even so the single screw was not abandoned at once and as late as 1896 first-class liners were built with one shaft only, in spite of the uneasiness caused by several serious accidents.

13. Turbine Ships. — The experimental "Turbinia," built at Wallsend on the Tyne in 1894 and given turbine engines invented by Sir Charles Parsons, revived one of the earliest principles of generating power and proved that it was capable of being used at sea. Her dimensions were 100 ft. by 9-ft. beam by 3-ft. draft. her displacement being $44\frac{1}{2}$ tons. The original machinery installation consisted of three steam turbines, totaling 2,000 s.h.p. (shaft horsepower) and each driving a shaft csrrying three screws in order to overcome the disadvantages of high propeller speed. During the Diamond Jubilee naval review of 189; she was taken down to Cowes secretly and suddenly dashed out among the assembled ships at what was then the astounding speed of $34\frac{1}{2}$ knots. Naturally she caused a great sensation and the admiralty built two turbine destroyers which unluckily came to grief. the one by stranding and the other because of her light construction. There was a tendency to blame the machinery, which had nothing to do with either mishap, and it was some time before Parsons could persuade commercial shipowners to take an interest in his invention.

The "King Edward" of 1901 was the first merchant steamer to be given turbine machinery. a Clyde passenger steamer which ran for a considerable time after material alterations. She was followed by the cross-channel packet "The Queen" of 1903, which proved herself greatly superior in speed and far more economical than the reciprocating-engined steamers which had preceded her on the service between Dover and Calais. The next important ships to be fitted with turbines were the Allan liners "Virginian" and "Victorian" of 1904, ships of about 10,750 tons gross each with a trial speed of nearly 20 knots. With all these ships there was a certain amount of trouble in the early days, but the turbine made progress and proved its reliability in the Cunard liner "Carmania." whose success resulted in the turbine's being adopted for the Cunard steamers "Mauretania" and "Lusitania" which were the biggest and fastest liners in the world when they were built in 1906. The "Mauretania" held the blue riband of the Atlantic for 22 years.

The 22-ft. steam launch "Charmian" was the first vessel in which intermediate gearing between the turbine and the propeller was tried, the experiments taking place on the Tyne as early as 189; and being practically contemporary with similar experiments carried out on the continent. It had long been realized that the efficient speed of the turbine was far too great for the propeller, which was the reason why multiple screws were fitted to the shafts of the early passenger steamers. In 1909 these experiments had produced sufficient promise to warrant the cargo steamer "Vespasian" having her old triple-expansion engines taken out and turbine machinery with single-reduction mechanical gearing substituted. The great increase in speed and economy which was immediately obtained drew attention to the possibilities of the turbine for cargo as well as fast passenger vessels, and from this it became evident that the gearing, whether it was single or double reduction, was of the greatest advantage even at the maximum speed so that the direct coupled turbine came to be regarded as obsolete at sea.

14. Introduction of Steel.— Improvements in the hulls of steamers were introduced steadily while machinery was being improved, principally with the idea of increasing the strength and carrying capacity and reducing the weight of hull necessary. Iron had shown itself to be superior to wood in these respects, and the next step forward was the introduction of steel for shipbuilding. The first steel-hulled vessel to cross the Atlantic was the paddle steamer "Banshee" of 32j tons, built at Liverpool in 1862 for use as a blockade runner in the American Civil War. In 1876 a small steel paddler was built for river service in Burma and in the following year the Royal Navy built two fast dispatch vessels, the "Iris" and "Mercury." The first sizable merchant ship to be so built was the "Rotomahana," a ship of 1.777 tons built by William Denny on the Clyde for the Union Steamship company of New Zealand in 1879. Within a few months she was followed by a much bigger and more important ship, the Allan liner "Buenos Ayrean" of 4,005 tons, for the Canadian mail service. Although it was recognized that steel offered advantages in every direction except, possibly, durability, to begin with its general adoption was checked by the difficulty of obtaining supplies; but in the early '80s this was overcome and many steel ships were laid down.

The form of the hull was also the subject of numerous experiments in the constant effort to increase the carrying capacity on the same or smaller tonnage, and for this reason several revolutionary designs were brought forward. One of the most striking and permanent of these was the turret deck steamer which was evolved and built by the Doxford shipyard of Sunderland. In this type a curve in the side above the water line gave a narrow deck with a broad extreme beam, and for some time it permitted a great economy in dues.

The "Turret" of 1892 was the first ship of this type and was laid donn by the Doxford shipyard on speculation but bought by Peterson Tate and company for the Canadian trade. Other steamship lines took up the turret deck steamer enthusiastically, particularly the Clan line, but many of its advantages were negatived by the amendment of port and canal regulations, and although these steamers were capable of carrying a large cargo and were excellent sea ships if properly treated, in inexperienced hands they were apt to give trouble and they gradually fell out of favour.

Welded steel-hull construction was tried about 1516, and the first sizable merchant ship to be all welded, without any rivets in her hull. was the M.S. "Fullagar," built at Birkenhead in 1920.

VII. MOTOR SHIPS

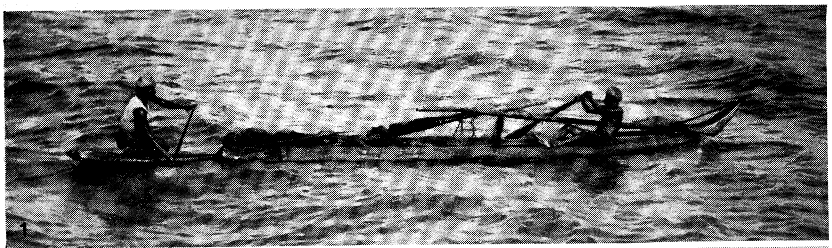
The Caspian steamer "Wandal," which was built by the firm of Nobels in 1903, was the first sizable ship to be given an internal-combustion engine. but in her case it was used to generate electricity for the main drive.

Engines in which the charge was exploded by a hot bulb or an electric spark were found suitable for small craft soon after they had become general in automobiles on land, but their size was strictly limited. In the year 1892 Rudolf Diesel took out his patent for an engine in which the charge was exploded by raising its temperature by compression while it was still inside the cylinder, and ships propelled by such units, built up to large sizes and considered by many to be preferable to steam plants, are invariably termed diesel-engined.

The "Randal" was followed in 1906 by the "Venoge." a motor barge on Lake Geneva, and in 1910 the motor tanker "Vulcanus" of 1,179 tons marked a great improvement in size. One year later the motor ship "Selandia" was commissioned by the East Asiatic company, Ltd., of Denmark, one of the principal advocates of the diesel engine, and ran successfully until 1942. Her dimensions were 370 ft. by j3.2 ft. by 27.1 ft. depth of hold. her gross tonnage being 4,950. She was a twin-screw ship, each shaft being driven by an eight-cylinder four-stroke-cycle engine with cylinders $20\frac{7}{8}$ in. in diameter by $28\frac{3}{4}$ in. stroke, totaling a brake horsepower of 2,450 at 140 r.p.m. and driving her at a speed of 11 knots. She was rigged as a three-masted schooner and the absence of funnel attracted general attention. Most shipowners continued preferring to run the exhaust from the engines up through funnels and make their motor ships practically indistinguishable from steamers.

After the success of the "Selandia," for although all the early diesel-engined ships had a certain amount of difficulty with their machinery she was a distinct success and economical, a series of ships was built steadily improving in size, efficiency and economy. World War I practically held up experimental work in that connection as far as merchant ships were concerned, but the diesel improved rapidly in submarines and the Germans brought it to a high pitch of perfection. In Great Britain the results of admiralty experiments were also placed at the disposal of the mercantile engineers at the end of the war. Several submarine diesels were fitted into German cargo ships after the war, their speed being geared down to the efficient speed of the propeller as in the case of the turbine, with satisfactory results.

To begin with, the diesel engine was more or less confined to the cargo vessel, but after World War I it was seen that its adoption in large passenger vessels would mean a considerable saving in space and running costs, although the first costs were considerably higher than in the case of the steamer. After several trials in comparatively small ships, in 1924 the "Xorangi" of 17,491 tons was built at the Fairfield yard on the Clyde for the Union Steamship company of New Zealand and proved most successful on the service between Vancouver and Australia. She was followed in 1925 by the "Gripsholm" of the Swedish American line, a ship of 18.134 tons designed for service between Sweden and the United States. There was considerable doubt as to the wisdom of building this ship, for the diesel shows to its best advantage on long runs,



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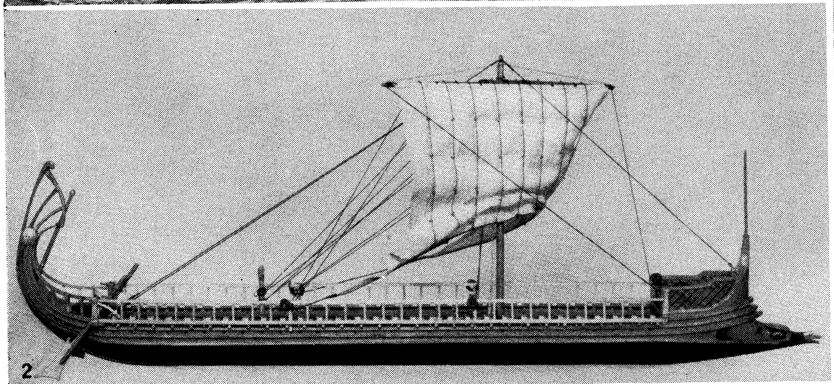

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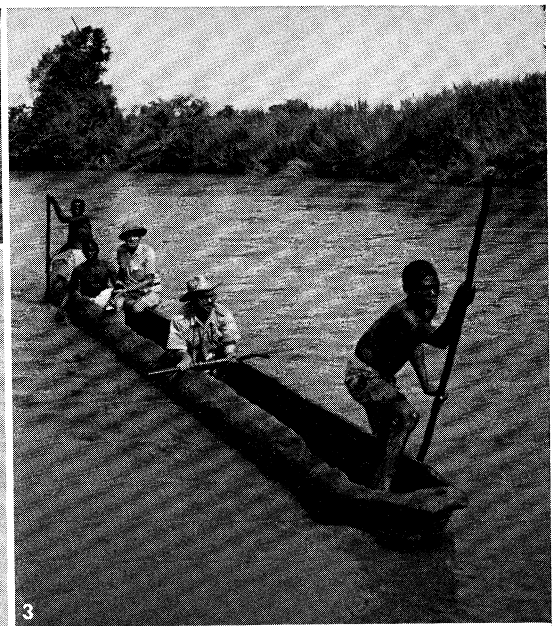

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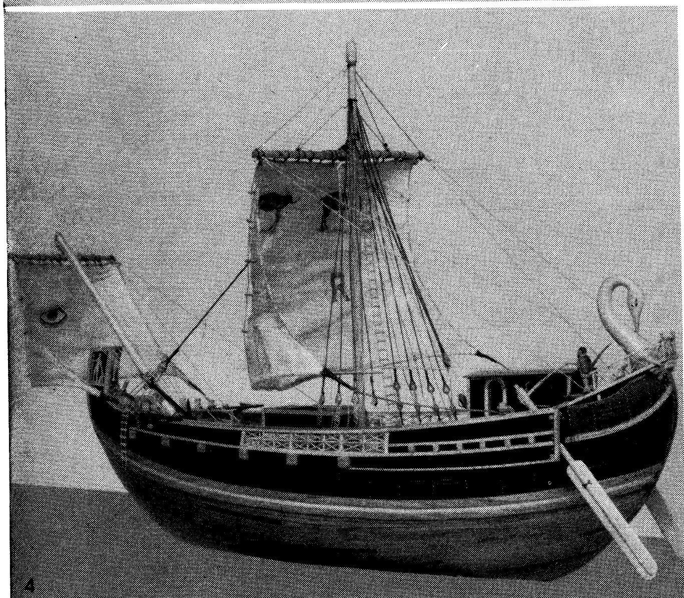

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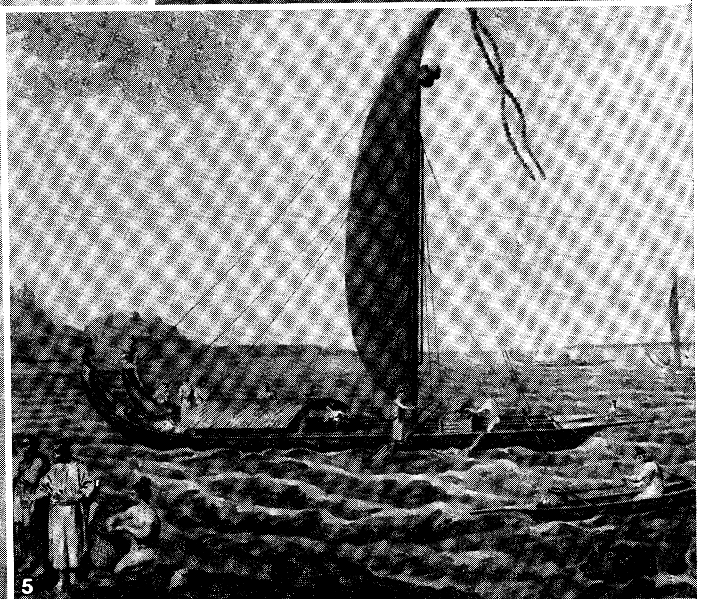

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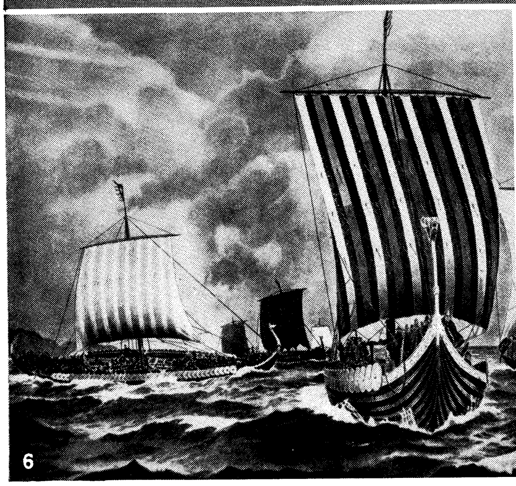

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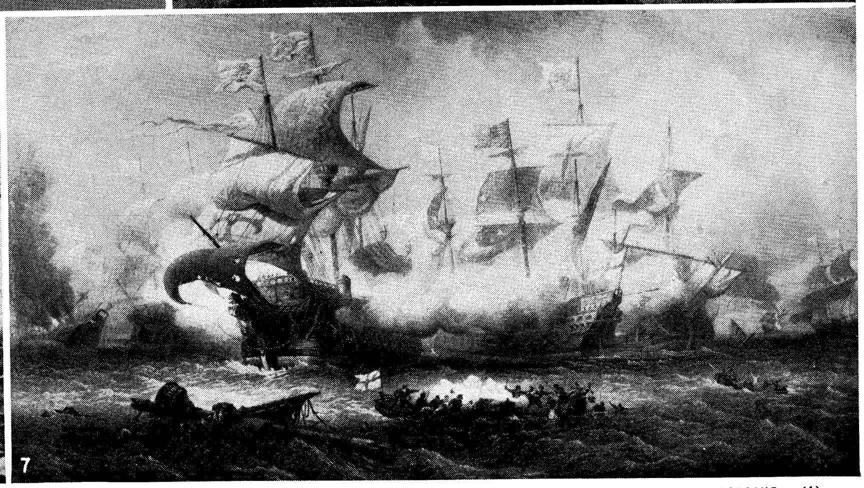

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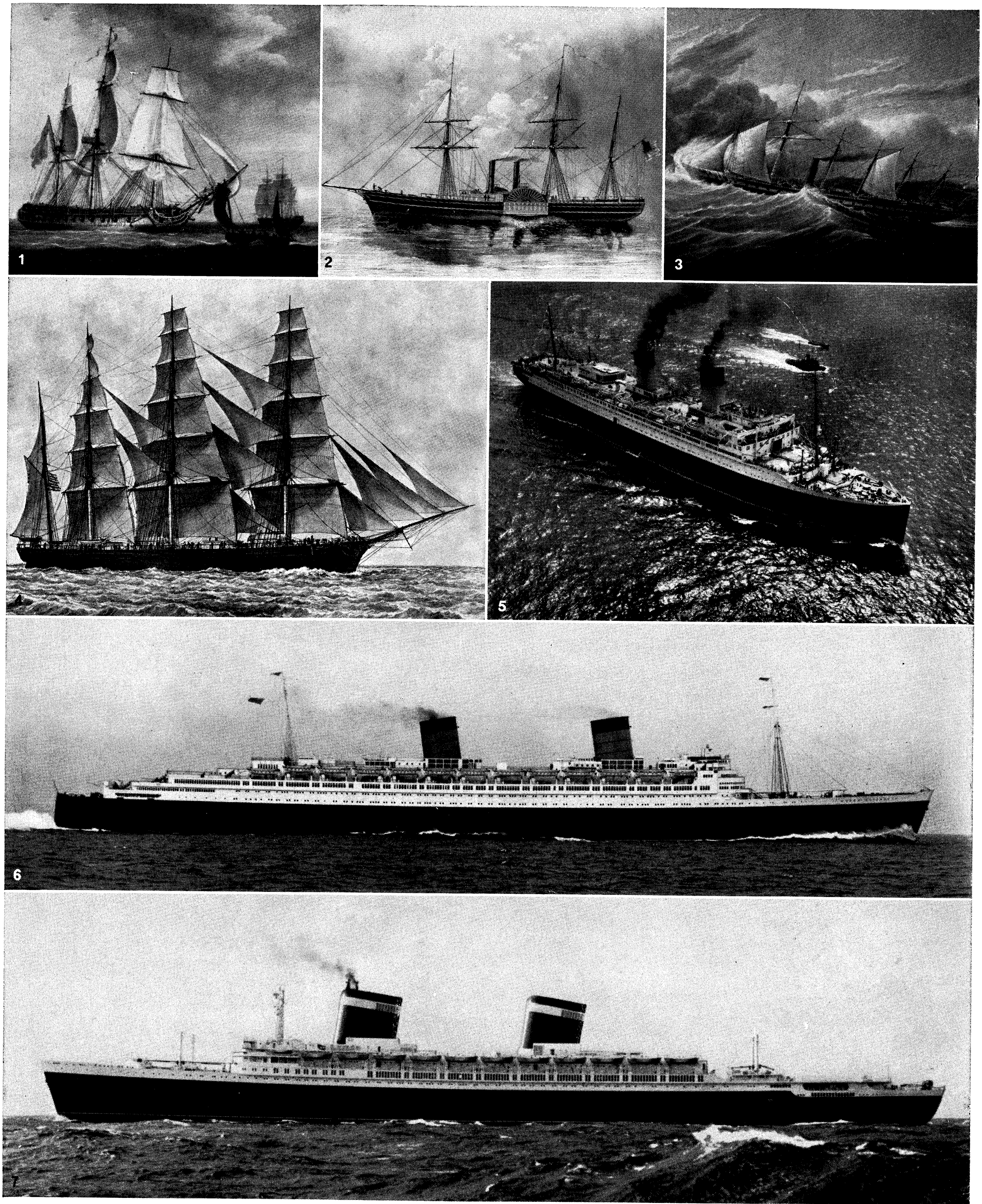
BY COURTESY OF (2, 4) THE DIRECTOR OF THE SCIENCE MUSEUM, SOUTH KENSINGTON, (5, 7) NATIONAL MARITIME MUSEUM, GREENWICH, ENGLAND; PHOTOGRAPHS, (1) NAUTICAL PHOTO AGENCY, SUFFOLK, (3) JOE COVELLO FROM BLACK STAR, (6) EWING GALLOWAY

PRIMITIVE SEA CRAFT AND EARLY SHIPS

1. Catamaran of India, essentially a floating log
2. Greek galley with two oar banks, carrying mast and sail; about 400 B.C.
3. Dugout canoe of the Belgian Congo
4. Roman merchant sailing ship, 2nd century
5. Double canoe. Illustration from Capt. James Cook's account of his visit to the Society Islands, 18th century
6. Viking ships showing the use of the square sail when the ship is moving with the wind abeam (left) and abaft (right)
7. Spanish galleons of the Armada engaged in a close-quarter battle with English ships in 1588

SHIP



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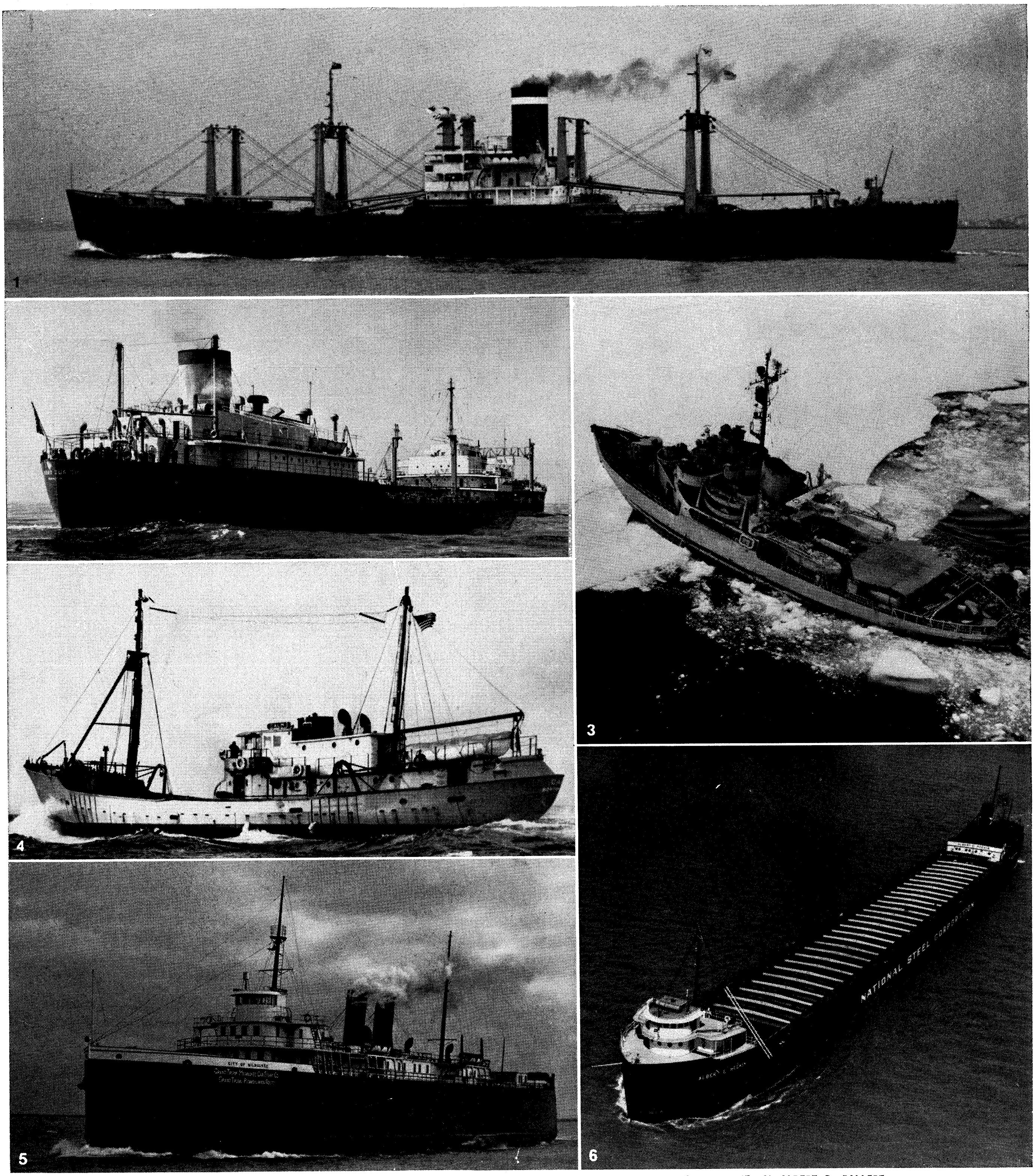
LATER DEVELOPMENT OF THE SHIP

1. English frigate
2. Paddle wheel steamer
3. Early English screw steamer
4. Clipper under sail
5. French liner S.S. "Ile de France"
6. R.M.S. "Queen Elizabeth"
7. S.S. "United States"



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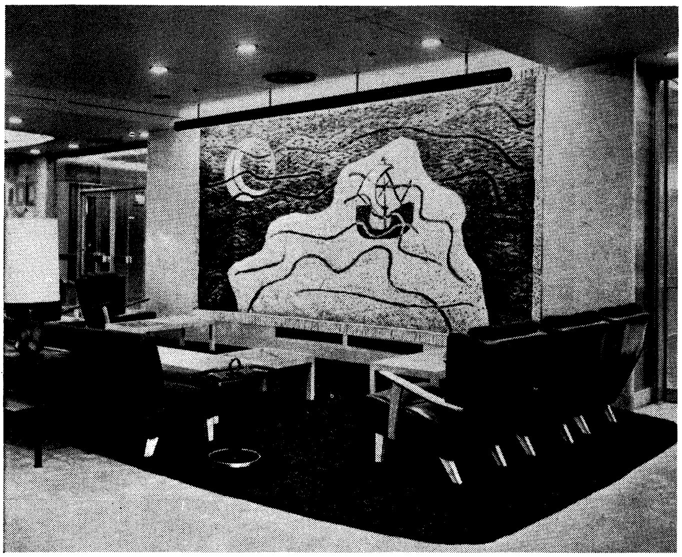
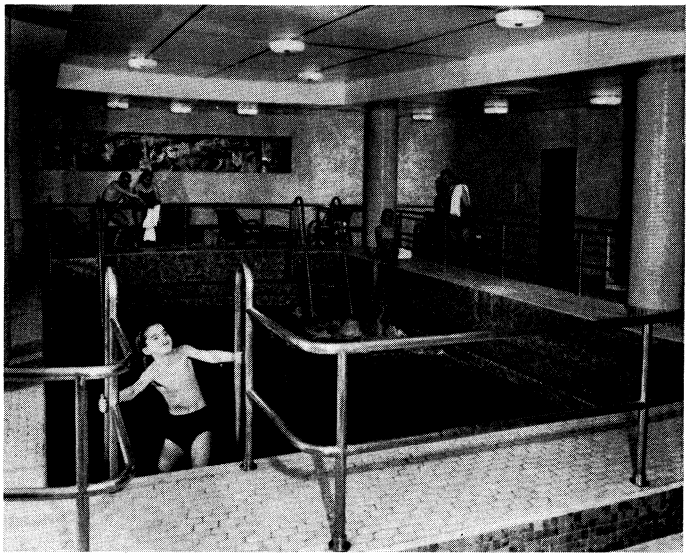
SPECIAL SERVICE VESSELS

1. Cargo liner
2. Oil tanker
3. Icebreaker
4. Fishing trawler
5. Automobile ferry
6. Inland ore boat





BY COURTESY OF (TOP LEFT) CUNARD STEAM-SHIP CO. LTD., (TOP RIGHT, BOTTOM LEFT) UNITED STATES LINE, (CENTRE LEFT) ITALIAN LINE, (CENTRE RIGHT) SWEDISH AMERICAN LINE, (BOTTOM RIGHT) HOLLAND-AMERICA LINE

PASSENGER ACCOMMODATIONS ABOARD OCEAN LINERS

Top left: **First class bedroom. R.M.S. "Queen Elizabeth"**
Top right: **Tourist class cabin, S.S. "United States"**
Centre left: **First class lounge, S.S. "Cristoforo Colombo"**
Centre right: **Indoor swimming pool, M.S. "Gripsholm"**
Bottom left: **Children's playroom, S.S. "United States"**
Bottom right: **First class dining room, S.S. "Nieuw Amsterdam"**

but she proved an unqualified success. In the same year a great advance in tonnage was made with the 22.048-ton "Xsturias," built at Belfast for the Royal Mail Steam Packet company, and the diesel-engined passenger liner became firmly established. Harland and Wolff, Ltd., the builders of the "Asturias," specialized in a big double-acting diesel built on the lines of Burmeister and Wain of Copenhagen, one of the earliest diesel builders, and developed high powers.

The "Augustus" of 30.418 tons was built for "Italia," Societa Anonima di Navigazione, in 1927. In deference to public opinion all these large passenger motor ships n-ere given funnels, the majority of them two, but the builders evolved a typical diesel funnel, short and stout. which does much to obviate the echo which can prove exceedingly troublesome when the exhaust is carried through a funnel of ordinary design. particularly in fog.

1. The Still Engine. — In the Scott-Still engine. first fitted in the Blue Funnel liner (A. Holt and company) "Dolius" of 5,507 tons in 1924, an effort was made to combine the steam and diesel systems, but although a certain economy was obtained, the system did not become a commercial success.

2. Electric Drive. — Electric propulsion at sea. with power generated by the internal-combustion engine, was first tried by Nobels in the "Wandal" on the Caspian in 1903, a vessel that has already been mentioned as the first motor ship. The German navy adopted it in the case of the submarine salvage vessel "Vulcan" in 1907 and it was also tried in 1913 in a Canadian lake vessel. the "Tynemount," where the current was generated by two diesel engines of 250 b.h.p. (brake horsepower). She was followed by the Swedish "Mjolner." in which the current was generated by two turbines of qjo s.h.p. each. The U.S. navy, which later brought the system up to its highest pitch of perfection, first tried it in the steam collier "Jupiter" of 20.000 tons displacement, in which the turbine generator was of the Curtiss type and where the results were so successful that the system was adopted in the latest and biggest battleships. The "Jupiter" later became the aircraft carrier "Langley." For cruisers and destroyers, however. the United States naval authorities found mechanical gearing better.

After World War I there was a growing tendency to favour electric propulsion for merchant ships, particularly in the U.S., and with the benefit of the experience gained in the U.S. navy it was possible to install large powers with perfect success. The most striking case was the Panama-Pacific liner "California." employed on the intercoastal trade between New York and California. She was a ship of 20,325 tons built in 1928, her electric machinery generated by turbines giving her a speed of 18 knots. A similar installation was chosen for the Peninsular and Oriental liner "Viceroy of India," launched on the Clyde in 1928. and the French liner "Normandie" was fitted in 1932 with turboelectric drive of 160,000 h.p.

VIII. STEAMERS FOR SPECIAL PURPOSES

1. Tugboats. — The use of steam power for tugboats was considered from the earliest times. In 1736 Hulls patpnted his proposal for a steam-propelled tugboat to carry vessels into and out of harbour in a calm. This he described in considerable detail; the vessel was to have a Newcomen steam engine of 30-in. cylinder diameter, fitted with ratchet gear to produce rotative movement of a paddle wheel at the stern. This scheme, so far in advance of its time. met with derision and never had a practical trial.

The first practical tugboat was the "Charlotte Dundas" of 1802, tried on the Forth and Clyde canal, but condemned because the canal owners feared that the wash from her paddles would cause damage to the canal banks.

The first steam tugboat on the Thames was put into service in 1816; and the first steam vessels in the British navy, from about 1822 onward, were used as tugboats, to tow the sail warships in and out of harbour. Screw propulsion for tugboats was first tried in the United States about 1850 and soon came into general use. In 1875 triple-screw tugs were in service on British inland waterways.

In the course of World War II a class of ocean tugboat was developed for rescue and salvage work. One notable vessel of this class was the "Turmoil" of 1,800 tons displacement, built in 1944 for the British admiralty. Her dimensions were 205 ft. by 38.j it.; she had diesel engines of 3,200 total b.h.p. and was capable of 1j knots.

For modern ocean liners, the use of tugboats in berthing and docking operations is normally considered indispensable; but it is on record that on Feb. 6, 19j3, the "Queen Mary," in exceptional circumstances. was able to berth at New York under her own power and without the help of tugs.

Even after the screw had been adopted for the propulsion of tugboats. the paddle wheel still continued to be used for this purpose. and in 19jj some paddle tugs with diesel-electric drive were built for the British admiralty.

2. Train Ferries. — The 417-ton steam train ferry "Leviathan," built in 1849 for the North British Railway company to run across the Firth of Forth from Granton to Burntisland, was the first of a type which later became quite general and was built to large size on several services. Almost at the same time another was built to cross the Tay at Dundee, but both these ferries were later replaced by bridges. In 1878 the Philadelphia and Reading railroad built its first ferry steamer to run across New York bay and in the early 1880s the Danes started a train ferry from Korsor to Nyborg. The idea of a similar service to run across the Straits of Dover was put forward in 1870, when the use of double-ended paddle steamers was proposed. Train ferries were introduced in 1936 between Dover and Dunkirk, in connection with the direct London-Paris service. Another train ferry on a large scale in Great Britain is that running from Harwich to Zeebrugge and employed largely for shipping French and Italian fruit to England.

3. Steam Trawlers. — In the early 1870s several attempts were made to introduce steam trawlers in the south of England. but they were not successful. Several years later a shipping slump caused numerous steam tugs to be laid up and the experiment of using some of these for trawling was tried. Most of these were paddlers, the first being the "Messenger" which made her first trip to the fishing grounds in 1877, but the experience gained in her and other converted ships showed that the paddle was unsuitable for the purpose. Experiments with screw boats were tried in the early 1880s and were an immediate success, the design developing rapidly and producing some of the finest sea boats afloat. Later, practically every maritime country acquired a big fleet of power trawlers and drifters. The internal-combustion engine made great strides in vessels of this type, and electric machinery was also tried on occasions.

4. **Icebreakers.**—"Eisbrecher I," launched in 1871, mas the first specially designed icebreaker to be built. She was planned on the experience gained a few years previously by a Russian shipowner named Britneff, who reconstructed the bow of the steamer "Pilot" in such a way that she could be driven onto the ice in the hope that she would break it by her own weight. In practice she was too small and light for this purpose, but the idea was appreciated and is embodied in all modern icebreakers, some of which run to a large size.

5. Tankers. — The increased consumption of oil for various purposes made it necessary to evolve some means of carrying it in bulk instead of in barrels as it had been carried from the earliest days of whaling. The first suggestion was in 1863, when the sailing vessel "Ramsey" had a few tanks built into her hold to carry oil in bulk in addition to stowing barrels in the ordinary way in her 'tween decks. From 1869 to 1872 the sailing vessel "Charles," of 794 tons, was carrying oil in 59 iron tanks which were built into her holds and which completely filled them. The problem of keeping ironwork oiltight was not then fully understood and these tanks were far too weak! with the result that in the working of the ship under sail constant leaks developed and eventually she was burned at sea. Several other ships were converted in similar fashion, mostly for the trade across the Atlantic to Le Havre and Antwerp, but they were all failures.

In 1872 the Red Star line of Philadelphia started a new system by having the steamship "Vaderland" of 2,748 tons built by Palmer Brothers and company on the Tyne with the idea of carrying a large cargo of oil in bulk in addition to her passengers. All the authorities were against this scheme on grounds of safety, and she was used for passenger and cargo only. as were also the "Nederland" of 1873 and "Switzerland" of 1874 which were designed on similar lines. This prohibition against shipping oil in passenger vessels still exists.

In 1879 Nobels, who were already noted for their work in building the pioneer motor and electrically driven ship. built a number of tank steamers to carry oil on the Volga river and attained considerable success with them. These steamers attracted some attention at the time. but the idea that oil would be safer in a sailing vessel than a steamer was still generally held and in 1886 the sailing ships "Andromeda" and "Crusader" were fitted with cylindrical tanks on an improved system for the purpose. Their designers attained a considerable measure of success in making their tanks oiltight, but in the same year the firm which later became Sir W. G. Armstrong Whitworth and Company. Ltd.. designed and built the first real tank steamer on modern lines.

The "Glückauf" had a dead-weight capacity of 3.000 tons and a speed of $10\frac{1}{2}$ knots, her engines being placed right aft for safety as is still almost invariably done in tankers. Her hull was subdivided into tanks and arrangements were made for pumping them on a principle which is still used.

After World War I a large number of tank steamers was built, although it is one of the most difficult trades to cater for and to maintain. In spite of numerous experiments oil remained almost invariably a one-way cargo. so that the ship had to be exceedingly economical because of the return journey in ballast. A large cargo is desirable for the ocean route and 13,000 tons dead weight and more became a usual size, while the speed seldom exceeded 11 knots.

After World War II, however, there has evolved a class of supertanker. One such notable vessel mas the "Spyros Niarchos." built at Barrow in 1955 for the Neptune Tanker corporation. Her dimensions were 757 ft. by 97.2 ft., with a dead-weight capacity of 47,750 tons. The hull was longitudinally framed and nearly all welded. The vessel was propelled by geared steam turbines of 18.000 s.h.p. at a normal service speed of 17 knots. The greatest shipbuilding activity of the 1950s was in tanker construction. Starting from the basic T-2 tanker of World War II, with a carrying capacity of 138,500 bbl., there was under construction a tanker with a carrying capacity over seven times that of the T-a. Tankers were constructed not only for transporting oil. but also for carrying liquid chemicals. gases, molasses and frozen fruit juices. Because of their tremendous length and unequal strain. the design of these tankers involves careful considerations of strength, and the majority of modern types are built on the longitudinal system, with great attention paid to fore-and-aft stresses.

6. Packet Steamers.—When the screw superseded the paddle for overseas work, the older fashion survived in the excursion steamers round the British coast, where shallow draft was generally necessary to get alongside the piers, and in the cross-channel services. The growing continental trade and the limitations in draft imposed by the French and Belgian harbours brought the paddle packet steamer to a high pitch of perfection in the last days of the 19th century, ships of considerably more than 2,000 tons gross with a speed of 22 knots and excellent seaworthiness being built in considerable numbers, mostly on the Clyde. No more of these big cross-channel paddlers were built after the turbine had proved its possibilities, but many other steamers propelled in this way, much smaller and rather slower, were built for the various excursion routes in the summer. Most of these again were excellent sea boats and were able to perform valuable mine-weeping service during World Wars I and II.

In the United States, however, where the huge inland waterways favour the side wheel, the paddle steamer was brought up to its highest state of development. Notable ships of this type were the "Greater Buffalo" and "Greater Detroit," built in 1923 for service on the Great Lakes, each having a gross tonnage of 7,739 and being driven by three-cylinder compound engines.

7. Standardized Ships.—In the early days of World War I mercantile construction was almost completely suspended in Great Britain, Germany and France in favour of warships, but it received a great impetus in the United States. When the German submarine campaign caused an acute shortage of tonnage it had to be resumed in an intensified form in Britain, while from 1917 the U.S. launched a shipbuilding campaign unprecedented in the history of the industry. In order to save time and money wherever possible, standardized shipbuilding came into vogue. It had existed within certain establishments for many years, the German yards, particularly. specializing in certain types and turning out large numbers of sister ships for various owners. During the war, however, it was carried right through the various countries and in some cases the inland steelworks, usually employed on bridge construction and the like, were utilized for fabricated ships with lines as straight as possible which were only put together and launched in the shipyards.

In the United States wood was largely used, both for full-powered ships and auxiliaries, but there was no time to permit the timber to season and they were built of green timber. Similarly a number of vessels of various types—lighters. tugs, tankers, etc.—were built of ferroconcrete, the rapidity with which they could be turned out compensating for their excessive weight in wartime, although only one or two of them survived more than a few months of peacetime trading.

In criticizing these standard ships built during World War I, there was a general tendency to forget the peculiar circumstances in which they were built and the necessity of getting something that would float into the water as quickly as possible. Their utility in competitive trading in peaceful circumstances was a secondary consideration. The United States shipping board, formed to run the tonnage so built in the U.S., was left with a large number of ships for which no purchasers or managers could be found, but many of them were later converted to diesel or electric power and their running expenses greatly reduced.

In the later years of World War II, quantities of standardized cargo vessels, called Liberty ships, were built in the United States. These were oil-burning ships; a fairly large number of such ships were built by Canada as coal burners. "Standardization and no changes" was an outstanding feature of World War II shipbuilding. The largest number of ships ever built in the world from one design was the Liberty ship. Another outstanding feature was the use of all welding in construction. Welding was not a new process but it was developed and used to a far greater extent than ever before, being applied not only to cargo but also to all classes of ships.

8. The Cabin Liner.—From the early days of regular services, the older and smaller units of the various companies were put on intermediate services at reduced prices, and these ships gradually came to be known as cabin-class ships. Few ships were specially built for the class until 1914, when Canadian Pacific Steamships, Ltd., commenced a long series with the "Metagama" and the "Missanabie," ships with a gross tonnage of about 12,500 and speed of 16 knots, having accommodation for 520 passengers in the cabin class, paying a fare approximating the second-class fare in the bigger ships, and 1,200 in the third class. Afterward the type was taken up enthusiastically by various companies, particularly on the North Atlantic, with such vessels as the "Duchess of Atholl" and her sisters, also owned by the Canadian Pacific line, having a gross tonnage of roughly 20,000, a sea speed of 17 knots and single reduction-geared turbines supplied by oil-fired high-pressure boilers which gave the remarkable economy of 0.64 lb. of oil fuel per shaft horsepower per hour for all purposes.

9. Fast Cargo Liners.—There was also a noteworthy tendency to build fast cargo liners after World War I, ships with a sea speed of 14, 15 and 16 knots, but carrying cargo only on regular schedule. Both steamers and motor ships were built for these services and found great favour with shippers. Great economy in running was obtained with the result that they secured a considerable proportion of the trade which was formerly carried by tramp steamers.

10. High-Pressure Steam.—In steamers this remarkable economy was made possible largely by the employment of high-pressure steam. The Clyde passenger steamer "King George V," built by William Denny and Brothers (Ltd.) in 1926 in conjunction with Yarrow, the boilermakers, and the Parsons Marine Steam Turbine company, had the first noteworthy installation apart from

unsuccessful experiments made about 1880. She was a steamer of 801 tons gross, burning coal under water-tube boilers working at a pressure of 550 lb. to the square inch with the steam temperature raised to a maximum of 750° F. This ship considerably exceeded her contract speed of 20 knots on trial and proved a success in many ways, particularly with regard to economy. But numerous adjustments and alterations had to be made after her launching.

In modified form high-pressure steam resulted in considerable economies, both in fuel consumption and weight. The general tendency was to increase the pressure both for naval and for mercantile work and 450 lb. became quite usual. While high-pressure steam saw its beginning in 1926, it developed rapidly in use, and in the 1930s very high-pressure and very high-temperature steam installations were made in U.S. navy destroyers and greatly increased their speed.

These principles were adopted in whole or in part by merchant vessels and became standard practice; *e.g.*, the tanker, "Atlantic Navigator," built in 1951, was equipped with boilers operating at a pressure of 650 lb. per square inch and a temperature of 1,020° F.

11. Gas-Turbine Propulsion. — The earliest recorded description of a gas turbine (in which the hot gases of internal combustion, instead of steam, act on the turbine blades) can be found in the patent obtained by John Barber, of Nuneaton, in 1791. The first vessel to be propelled at sea by a gas turbine was the 110-ft. triple-screw motor gunboat no. 2009 of the British admiralty, which in 1947 had a gas turbine of 2,500 s.h.p. fitted to the centre shaft. The first ship of the mercantile marine with gas-turbine propulsion was the motor tanker "Auris" of 12,250 tons dead weight, built in 1947 at Newcastle for the Anglo-Saxon Petroleum Co., Ltd. In 1951 one of her four main diesel engines was replaced by a gas-turbine installation of 1,200 b.h.p., constructed by the British Thomson-Houston Co., Ltd.

12. Express **Luxury Liners.**—The White Star liner "Oceanic" of 1871 was the first of the modern type of express luxury liner, which attracts more attention than any other type, but which can exist economically only on the direct service between Europe and the United States. The White Star line had then just been founded for the purpose of engaging in the Australian trade, and for that purpose had bought the name and house flag of one of the most famous of the clipper ship companies. Events caused the directors to change their intentions and the first ships were put on service between Liverpool and New York, the "Oceanic" being the pioneer. These ships differed materially from the accepted type of screw steamer, having more than ten beams to their length and being designed on the somewhat revolutionary lines advocated by Sir Edward Harland of Harland and Wolff, the Belfast shipbuilders. The tonnage of the "Oceanic" was 3,707 and while she was fully rigged as a four-masted barque her single-screw engines gave her a sea speed of 14.75 knots, and she proved herself an unqualified success after being generally condemned on theoretical grounds by the experts. Three years later the "Germanic" and "Britannic" were built, each with a gross tonnage of 5,000 and speed of 16 knots.

The Guion line, which until then had been engaged principally in the emigrant trade, then entered the race for the Atlantic blue riband with the "Arizona" of 1879, a ship of 5,147 tons with a sea speed of 16.25 knots. An improved edition of the same design was the same company's "Alaska" of 1881, her gross tonnage being 7,142 and her speed 17.75 knots. In the "Oregon," which was built just before the company got into serious financial difficulties and which eventually sank in collision with a small schooner, the gross tonnage went up to 7,375 and the speed to 19 knots.

The reply of the Cunard line was the construction of the "Umbria" and "Etruria" at the same establishment which had turned out the big Guion ships, Elder's Fairfield yard. They were ships of 8,120 tons with a speed of 19.5 knots and they marked the final development of the single-screw express liner on the Atlantic. Although they were specially designed to compete with the "Oregon," that ship had passed to the Cunard line before they were completed.

The next great improvement was the design of the "City of New York" and "City of Paris," when the twin-screw system was adopted for express ships. They were built for the Inman line in 1888 but were better known under the flag of the American line to which they were transferred in 1893. These ships secured the Atlantic blue riband and were the last big Atlantic liners to be built with the old-fashioned clipper stem. When it was desired to transfer them to the American line, congress permitted them to hoist the U.S. flag only on condition that two ships of at least equal tonnage were built in U.S. yards, which resulted in the "St. Louis" and "St. Paul," of 11,630 tons and 21 knots speed, being built in 1895, the first big Atlantic liners to be built in the United States since the 1860s.

The White Star line replied to these ships with the "Teutonic" and "Majestic" in 1889, ships which had a great struggle with the "City of New York" and "City of Paris" for the Atlantic record. In 1893 the Cunard line secured the blue riband without doubt with the "Campania" and "Lucania" of just under 13,000 tons with a sea speed of 22 knots.

In 1897 the German companies, which had built up a big business in comparative obscurity beside the companies racing for the blue riband, came out with the "Kaiser Wilhelm der Grosse" of the North German Lloyd, which lowered the record considerably. She had a gross tonnage of 14,350 and a speed of 23 knots. Their rivals, the Hamburg-American line, built the 14,500-ton "Deutschland" to compete for the record, but on their experience with her they decided to follow the policy of comfort and good cargo capacity on more moderate speed, a policy which was also followed by the White Star line after the "Teutonic." The North German Lloyd, on the other hand, steadily lowered its own record with the three ships which followed in the same series and to the same general design—the "Kronprinz Wilhelm" of 1901, the "Kaiser Wilhelm II" of 1902 and the "Kronprinzessin Cecilie" of 1906. Each of these ships marked a further advance in size and speed.

Before the last named could be tried at her best the Cunard line had built the "Lusitania" and "Mauretania" with the financial help of the British government. The dimensions of the latter were 762.2 ft. by 88 ft. by 57.1 ft. depth of hold, giving her a gross tonnage of 31,938, while her quadruple-screw direct-coupled turbines had a designed shaft horsepower of 68,000, intended for a speed of 25 knots. The "Lusitania" was sunk by a German submarine during World War I; the "Mauretania" had the unique distinction of holding the Atlantic blue riband for 22 years and when 20 years old proving herself capable of steaming at 29 knots to the rescue of a disabled cargo ship.

Maintaining their policy of avoiding excessive speed, the Hamburg-American line answered these Cunarders with the biggest steamers in the world. The first of the series was the "Imperator," later the Cunard "Berengaria." She was launched in 1912, her dimensions being 886.3 ft. by 98.3 ft. by 57.1 ft. depth of hold and her original gross tonnage 51,969. The second of the series was the "Vaterland," which became the "Leviathan" of the United States lines. Her dimensions were increased to 907.6 ft. by 100.3 ft. by 58.2 ft. depth of hold, and her gross tonnage was 54,282, later 59,957. The third ship was the "Bismarck," later the White Star "Majestic," similar to the "Vaterland" hut slightly longer.

Immediately after World War I nearly all the lines had to engage immediately in a shipbuilding program to replace casualties, although shipbuilding prices were at their highest level. The general tendency was to build a moderate-sized ship with good cargo capacity and comfortable passenger accommodation at reasonable rates. The Cunard line brought out the "Franconia" type of five ships of just over 20,000 tons gross with a speed of 17 knots, while the Hamburg-American line built four ships of the "Deutschland" type, having a sea speed of 16 knots and a tonnage of slightly more than 21,000.

This tendency was broken by the Compagnie Générale Transatlantique, which in 1926 built the "Ile de France," a ship of 43,450 tons gross with direct-acting turbines of 52,000 s.h.p. and a trial speed of 24 knots. The North German Lloyd responded by laying down the "Bremen" and "Europa," ships of about 50,000 tons each, with a speed of 28 knots on service. They had geared turbines and considerable weight was saved by a boiler pressure of 330 lb. to the square inch, while their design was revolutionary in many features, particularly in the bulb bow under the water line. The "Bremen," launched in 1328, beat all Atlantic records, but was outstripped by the "Europa," which later became the "Liberté" of the French line.

The first of the modern 1,000-ft. vessels was the "Normandie" of 83,423 tons, launched at St. Nazaire in 1932 for the Compagnie Générale Transatlantique. She had four-screw propellers with turboelectric drive of 160,000 total s.h.p., carried 2,170 passengers and crossed the Atlantic at a mean speed of 31.2 knots. At the outbreak of World War II the "Normandie" was in New York harbour, hut was not utilized by the French for war service. On Dec. 16, 1941, she was expropriated by the United States maritime commission for conversion into a troopship. In the course of conversion, however, fire broke out on Feb. 9, 1942, and the vessel capsized. This accident occurred just one day after the "Normandie" had been turned over to the U.S. navy by the U.S. maritime commission.

The first British vessel to exceed 1,000 ft. was the "Queen Mary" of 81,235 tons, built at Clydebank and launched in 1934 for the Cunard White Star line. She had four screw propellers 19.6 ft. in diameter, driven by turbines of 160,000 total s.h.p. In 1938 she recaptured the blue riband from the "Normandie" with a mean Atlantic speed of 31.7 knots. Another 1,000-ft. liner was the Cunard White Star "Queen Elizabeth" of 83,673 tons, built at Clydebank in 1438, carrying 2,288 passengers and propelled by turbines of 181,700 total s.h.p. supplied with steam at 450 lb. per square inch pressure.

In 1952 the 53,330-ton liner "United States," built at Newport News, Va., crossed from New York to Southampton at a mean speed of 35.59 knots (nearly 4 knots faster than the "Queen Mary") and thereby reclaimed for the U.S. the blue riband of the Atlantic. The "United States" was built to the specifications of the U.S. navy, to facilitate her rapid conversion into a troop carrier in the event of war. Wherever the choice lay between the demands of luxury or defense, the latter consideration is said to have prevailed.

14. New Design and Development. — In the 1950s impetus for new design and development came from the need for various special purpose ships, such as "roll-on, roll-off" ships for transporting automobiles, trailers, trucks and other vehicles. The prospect of the opening of the St. Lawrence waterway initiated the construction of a great many specially designed ships, in the U.S. and elsewhere, with automatic loading-on and loading-off features. Three types of offshore drilling rigs involved the art and science of ship construction. A whale factory ship, designed in Norway, was capable of utilizing in its self-contained structure everything in a captured whale except its spout. A modernizing process called "jumboizing" was being carried out on Liberty ships and tankers to increase capacity, the process consisting of cutting the ship in two, adding a new section, then welding together the new and old sections. Four new propulsion designs were in operation or under way: two types of gas turbine, a diesel and a modified turbine drive, to convert Liberty ships for greater speed and carrying capacity. The use of atomic energy for propulsion purposes was first made in the submarine "Nautilus," and was followed in other submarines, and designs were prepared for an atomic energy tanker, freighter, airplane carrier and cruiser. *See* also Index references under "Ship" in the Index volume.

(E. A.; F. C. Bo.; H. P. St.; E. S. L.)

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SHIPBUILDING (MERCHANT AND NAVAL).

Shipbuilding is one of the oldest of the engineering arts. For centuries, shipbuilding skills were passed on from generation to generation. The history of shipbuilding parallels that of ships, reaching from the primitive craft of ancient times through the age of sail to the modern era of huge steel vessels driven by steam, diesel engines or nuclear power. (See MARINE ENGINEERING; SHIP; SHIPPING, HISTORY OF.)

Only in comparatively modern times has it become more of a science than an art. An important manifestation of this change has been the increasing importance of the design stage of shipbuilding as compared with the actual construction work. It has become possible to plan all the features and predict generally the performance of a ship on paper before a single piece of structure is in place. Because of the natural division between ship design and ship construction, the former is treated in a separate article, NAVAL ARCHITECTURE.

SHIPYARDS

Ships and small craft are constructed and repaired in nearly all countries in industrial plants known as shipbuilding yards or shipyards. Most shipyards are privately owned and operated to make a profit, but some are government-owned and government-operated. Privately owned shipyards build merchant ships and some also build naval vessels. A few private yards do repair and maintenance work but do not build ships. To provide work during slack shipbuilding periods, many private shipyards also manufacture machinery or fabricate structural steel. Naval shipyards repair, alter and overhaul naval vessels; many also build naval vessels, and a few have large dry docks and repair facilities that are occasionally used for the maintenance of merchant ships. (See DOCKYARDS AND NAVAL BASES.)

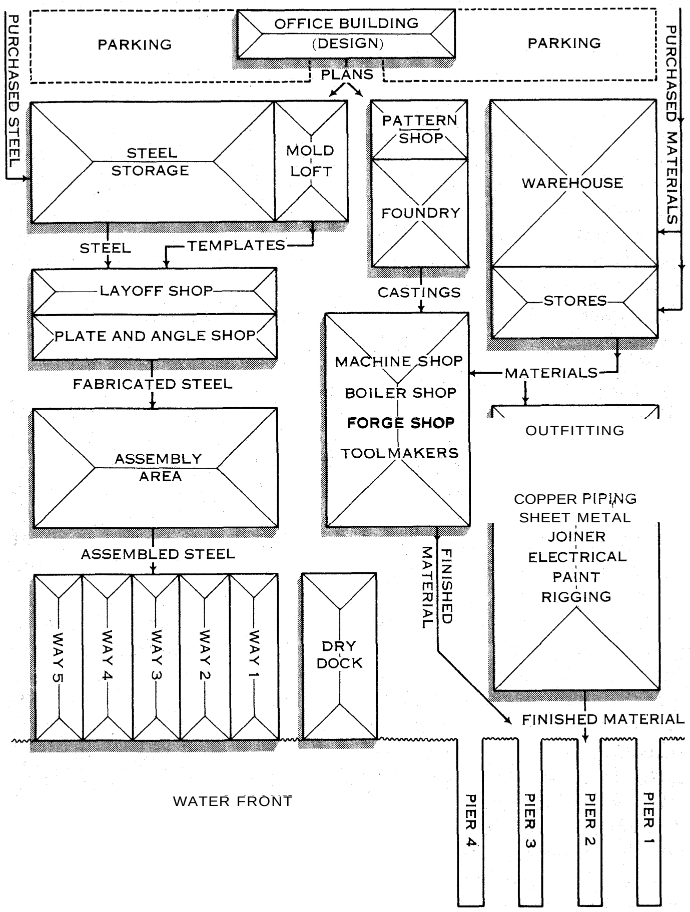
Over 90% of the world's merchant ships (including vessels of more than 1,000 gross tons) and all of the very large vessels are constructed in the following countries: Great Britain, West Germany, Japan, Sweden, the Netherlands. France, Italy, the United States, Norway and Denmark. The following countries or localities build comparatively few ships but have yards capable of constructing merchant vessels of over 1,000 gross tons: Spain, Belgium, Yugoslavia, Finland, Canada, East Germany, India, Australia, Portugal, Greece, Taiwan. Hong Kong. Bulgaria, Turkey, Argentina and Ireland. Figures for the U.S.S R. and China are not available.

The building ways on which new ships are constructed exceed 1,000 ft. in length in the larger shipyards. Most building ways are above the water level and the ships slide into the water stern first when launched. A few shipyards build large ships in a building dock, the equivalent of a graving dry dock. *(See* DOCKS.) Ships may be floated in or out of such docks by closing or opening a gate at one end and pumping water in or out. When a ship is built in such a dock its keel is horizontal and the framing and bulkheads are vertical instead of sloping. Men work more economically on a vessel if the keel is horizontal instead of on a slope such as is necessary for launching a vessel stern first. This reduces building costs and, when launched, the vessel is merely floated away instead of sliding down sloping ways. On the Great Lakes the usual practice is to launch vessels by sliding them sideways into the water. The keel and bottom plating are not sloped if the vessel is to be launched sideways.

Most of the larger private yards have either graving dry docks or floating dry docks. Small yards may have only relatively small marine railways. Graving docks capable of handling the largest merchant vessels are located in England, Scotland, France, Germany, Italy, South Africa, Japan, the United States and Canada. Some of the longer graving docks are so narrow that they cannot accommodate very large tankers having a beam of over 125 ft. Many graving docks in major shipbuilding countries are over 800 ft. in length.

The largest floating dry docks are in the United States. They have a lifting capacity of 90,000 long tons and can be towed at sea to new locations. They measure 927 ft. by 256 ft. and, when submerged to maximum draft, require over 78 ft. of water. They can accommodate vessels of more than 125-ft. over-all beam and more than 40-ft. draft. Very few floating dry docks have a lifting capacity of more than 50,000 tons, and most are of less than 10,000 tons' capacity.

Location.— Shipyards are located on bodies of water that are wide and deep enough to permit vessels to be launched from the building ways and delivered to the rivers. lakes or oceans on which they are to serve. As relatively deep water is necessary if a seagoing ship is to be operated at full power and attain maximum speed during the predelivery trial trip. it is desirable that the shipyard be within a few hours' steaming time of nater having a depth of at least five to ten times the vessel's draft. The location of a shipyard should permit the expeditious and economical delivery of the large quantity of heavy materials and equipment required for building Some items. such as boilers, may be too large to pass through railway tunnels or over bridges. A shipyard should also be close to a source of skilled workers,



SCHEMATIC DIAGRAM OF SHIPYARD ILLUSTRATING FLOW OF PLANS AND BUILDING MATERIAL

but not nithin a large city where taxes and the cost of land are high. There should be enough adjacent vacant land to permit expansion of the yard.

Layout.— With the exception of emergency shipyards built in wartime. most shipyards were of modest size when founded. The more successful ones gradually grew in both area and capacity into large yards nith many building ways, several dry docks. outfitting piers and the necessary design offices, shops and equipment to construct vessels of all sizes and types Most ships are launched nhen about tno-thirds complete and are then towed to outfitting piers where the rest of the nork is done. A few yards tow the vessel to another organization that does the outfitting work and prepares the vessel for the trial trip and delivery to the owners Many shipyards purchase such items as diesel engines, turbines and gears, boilers. propellers. joiner work, valves and castings. and merely install them in the vessel. Other yards produce such parts in their own shops.

In a typical large shipyard there are office departments devoted to administration, accounting, ship design. correspondence, cost estimating, employment. shipyard planning and maintenance, production control, blueprints and reproduction, purchasing and timekeeping. The principal yard departments may be subdivided into three basic groups. (1) the structural steel hull construction departments located near the building nays; (2) the outfitting departments convenient to the piers; and (3) the miscellaneous departments such as the pattern shop and foundry. warehouses and storerooms. shipyard maintenance shops. research and testing laboratories. heat-treating shop. fire department, clinic, apprentice training. yard transportation and inspection.

The usual hull steel construction departments and shops are the mold loft: steel storage department; steel layoff and fabrication shops; rolling, bending and galvanizing shops; and drilling, riveting. welding and shipwright erecting departments.

The major outfitting departments and shops include one or more machine shops, blacksmith forge shop, boiler shop, copper shop, joiner and furniture shops, electrical shop. piping shop. sheet metal shop and the painting. rigging. carpenter, machinery installation and toolmaking departments. In addition, there are many other operations or controls. including dry-docking, yard transportation of materials. tugboats, watchmen, steam plants, oxygen plants and a system for electric power distribution.

The figure diagrammatically illustrates a typical layout for a shipyard having five building ways, four outfitting piers and a dry dock. The materials purchased move only in the general direction of the vessel as they pass through the shops. In some shipyards the materials may crisscross back and forth as they are processed. This is wasteful of both time and manpower. Where vessels are launched sideways instead of stern first. a much longer water front is necessary and the layout of the yard is less compact.

Shipyard equipment includes the types of shops. tools and machines commonly found in other fields of industry— machine shops. furniture factories. sheet metal and plumbing shops, foundries, structural steel fabricators and electrical shops. In addition, well-equipped large shipyards may have several traveling cranes of 100-ton capacity, a huge 350-ton traveling gantry crane, a 1,200-ton forge press, vertical boring mills, lathes and long galvanizing kettles.

Organization and Personnel.— During normal times each large shipyard employs from 10 000 to 30,000 persons representing a nide variety of industrial trades. Many of the trades are used only in shipbuilding and require severa! years of training. If a skilled employee is laid off during slack times and takes another job, it may be difficult to replace him later.

Organization varies from yard to yard and from country to country. but basically the patterns are similar, since the fundamental problems are the same. The shipyard's principal activities may be classified as follows:

1. The cost-estimating and production control departments determine the bid that can be made on a proposal to build a ship; they also schedule the sequence of operations and required material deliveries after the contract has been signed.

2. The accounting department keeps abreast of the costs of current work. It also handles the payroll and timekeeping for the yard's labour force.

3. The personnel or employment department is responsible for personnel relations and the hiring and discharge of employees.

4. The plant engineering and maintenance department keeps the compressed air, water and steam pipes, electrical wiring, cranes, trucks and all other yard facilities up to date and in good operating condition.

5. The design departments produce the working plans needed for the construction of the ship and often prepare the basic design, contract plans and specifications. From requisitions prepared by the design departments, the materials department purchases the needed materials and provides for their storage.

6. The departments that fabricate or manufacture the materials. together with those that assemble, erect and complete them aboard the ship, employ about 75% of the yard's total personnel.

As ship design and construction involve many specialized trades used only in shipbuilding, apprentice training is customary. An apprentice is assigned to work as an experienced workman's helper for four or five years, after which he graduates and becomes a journeyman. In some of the larger shipyards apprentices also are paid while they take part-time classroom academic training, including calculus and advanced physics and chemistry. As college graduates in engineering need practical training, they may be given a special course through several departments for a year or so. Thereafter they are assigned to the departments that their talents seem best suited for.

Repair and Conversion.—Ship repair yards are located in major shipping ports. They specialize in repair and conversion work and seldom build new ships. Shipyards are primarily builders of new ships, but most also do repair and conversion nork.

In a typical large shipyard there is a ship repair department that arranges for new work, makes estimates of costs and oversees the work done on a vessel. Attached to the repair department is a materials procurement group. Production control and scheduling are under the supervision of the repair manager, who, together with his staff, co-ordinates the work of repairing ships in an effort to have the nork done on time and within the estimated cost. In shipyards engaged in building ships, the labour and direct supervision needed for ship maintenance, repair and conversion work is drawn from the personnel employed in new construction. The labour required fluctuates from day to day.

Routine maintenance work is done on seagoing ships at least annually. sometimes twice a year. It may consist merely of dry-docking the vessel to clean and paint the outside plating above and below the nater line while the ship's crew attends to topside and internal maintenance. In other cases it may involve replacement of propellers, tail shafts and boiler tubes and correction of a wide variety of defects.

Repair work is needed primarily because of damage due to accidents, abuse or carelessness. Accidents may include collision damage, bottom damage due to grounding, or damage to hatches as a result of careless cargo handling. Damage due to severe weather or fire may require extensive repair work. As ships represent a large investment and are manned by sizable crews, the depreciation, interest on the investment, stores, subsistence, crew wages, insurance and other costs may total a large sum for each day that a ship is under repair. This justifies the added cost of overtime to expedite completion of the work.

Conversion work may call for making major changes in a vessel, such as adding passenger quarters or converting from one type of vessel to another. A freighter or tanker, for example, may be converted to an ore carrier or collier. As the liquid cargo spaces of a tanker deteriorate more rapidly than does the remaining structure, it is sometimes necessary to remove the vessel's end sections, scrap the deteriorated amidship section which contains the bulk liquid cargo spaces, and replace it with new construction. Such a conversion requires the co-operation of nearly all the shipyard departments, including the design staff. *(See* also TANKERS.)

Production Control.—Production control in shipbuilding starts with the original proposal or contract for a new ship. The shipyard draws up a schedule of basic dates, including keel laying, launching and delivery. This schedule must be drawn up with proper regard for the availability of manpower, materials and shipways, for it would detract from the yard's reputation and be financially costly to be awarded a shipbuilding contract and then find that the delivery of steel, equipment components. boilers, engines. etc.. or the absence of an available shipway or manpower, mould prevent meeting the delivery date. If the shipbuilding contract contains a penalty clause, a delay could result in serious financial loss.

The time required for building large seagoing ships—from signing the contract to delivery—is about as follows: tankers. 15 to 18 months; freighters, 20 months; passenger vessels of moderate size, 30 months; and the largest, highest-powered passenger liners, about 40 months. To allow time for receiving from 40% to 50% of the steel, and time to fabricate enough structural steel to assure rapid progress on the building ways, from six to eight months usually elapse between the signing of the construction contract and the keel laying. This figure is for freighters and tankers; up to ten months or more may be required for large passenger vessels. The time on the building ways before launching varies, but under normal conditions it is approximately 60% of the time from keel laying to delivery for freighters, 50% to 60% for passenger vessels and 70% to 75% for tankers. If several sister ships are to be built, the keel of each being laid a few months after that of the one preceding it, the building time for the succeeding ships is usually less than that required for the first. To permit rapid and orderly erection. the hull structural steel drawings should be from 40% to 50% complete when the keel is laid. By the launching date nearly all design and material ordering should be completed for freighters and tankers and at least 75% completed for passenger vessels. The peacetime building period for a naval combat vessel. such as a large aircraft carrier, is a little longer than that for a passenger vessel of comparable size. The additional time is required between the keel-laying and launching dates.

Production control dates are prepared in elaborate detail. Large passenger liners and aircraft carriers, because of their greater complexity, warrant more detailed scheduling than do freighters or tankers. One of the primary purposes of the production control system is to provide design plans and the required material so that the ship may be completed economically and on schedule.

An inboard profile drawing is divided into sections along the natural boundaries of the ship's structure, such as between bulkheads and decks. The sections are numbered and scheduled in the sequence of erection on the shipway. Based on the time between keel laying and launching, a date for the completion of erection for each structural section is developed and assigned. Then suitable intervals for issuing drawings, material receipt, layoff, fabrication. subassembly and erection are determined and scheduled dates assigned. The hull structural design department compiles a list of the plans necessary to build the steel structure of the vessel and from the section or zone schedule assigns the schedule dates for starting and finishing each. Drawings needed as references for making associated drawings should be finished before the scheduled issue dates.

The next production control stage is scheduling of the piping, ventilation, electrical wire ways, joiner work, fixed furniture, portable furniture, carpets, decoration, etc., required to outfit the vessel, and the installation of boilers, main machinery and other components in the machinery spaces. The classes of work or operations involved in each zone are determined; and the scheduled dates for starting work on the vessel are decided for each class, based on the section or zone schedule. With each starting date assigned, schedules for shop work and materials are developed. All the outfitting work must progress in proper orderly sequence. In the machinery spaces, the boilers, condensers, turbines, reduction gears, pumps, generator sets, etc., should be installed in the sequence controlled by the corresponding structural steel erection schedules.

The stern frame, each size and type valve, each deck plate, even the ship's compass is identified by a piece mark or the equivalent on the working drawings and is scheduled for installation in the vessel. In a well-operated yard, every item needed for each installation phase should be delivered to the proper space in the ship in the sequence required by the schedules. The importance of doing so cannot be overemphasized; if proper sequence is not maintained, men may be forced to stand idle while waiting for some small part to be delivered to the ship, possibly only one valve that is needed to continue a pipeline installation.

Occasionally the receipt of materials is delayed by a strike in a vendor's plant, defective castings, the owner's changes in design, etc. If the delay involves only minor components or small areas of the vessel, it may be possible to absorb the delay without changing the basic dates. Accumulation of delays seriously affecting the sequence of structural erection or outfitting would require revision of the basic dates or costly overtime to meet the delivery date of the vessel. Most ship contracts contain *force majeure* clauses, absolving the contractor from a penalty for delays beyond his control. Supervisors meet frequently to decide upon schedule adjustments and overtime work that may be necessary.

In many shipyards, each design department has a small group that prepares the requisitions used by the purchasing department for ordering materials. The requisitions give all the information needed, including the date by which each item must be received In the shipyard. The distribution of blueprints to the many departments requiring them may be decided either by the design departments or by the production control department. As there are usually at least ten times as many yard employees doing the actual fabrication and erection as there are employees in the design departments. it often pays to work overtime in the design offices to provide the most efficient working period for the structural, outfitting and machinery installation personnel.

STEPS IN CONSTRUCTING A SHIP

Contract Plans and Specifications.—The basic design of a ship may be developed by an independent consulting naval architect or by a naval architect employed by the shipyard or the owner. (See NAVAL ARCHITECTURE.) The owner decides upon the vessel's general type, its cargo and passenger capacity, speed, cruising radius, maximum draft and other requirements. The contract plans and specifications are prepared to the owner's satisfaction and must meet governmental and classification society requirements. They are then usually issued to several shipyards for bids. The shipyard calculates the expected cost of construction, checks upon the availability of ways and equipment, decides upon the earliest possible delivery date for the finished vessel, and decides upon the bidding price and guaranteed time of delivery.

Working Plans.—The successful bidder promptly proceeds with the development of the detailed working plans. This is necessary because the contract plans show only the basic design features and are used only for the guidance of the design departments. Material ordering and detailed production control studies also are started. If the lines plan, nhich defines the shape of the hull, is not included with the contract plans, it is promptly drawn by the shipyard to permit model testing of the huil form and propellers in a towing tank. If the tests are satisfactory the small-scale ($\frac{1}{4}$ in. per foot) lines plan is sent to the mold loft where the lines are "faired" full size to eliminate minor irregularities in the curved parts of the hull shape. Accurate dimensions, to the nearest $\frac{1}{16}$ in., of the final shape of the hull, called offsets, are returned to the design division and used in the preparation of the detailed working drawings and in material ordering. For a very large merchant or naval vessel, over 5,000 working detail plans are made in the shipyard design departments. This does not include the subcontractors' plans used in the production of purchased materials. Usually, as the work progresses, the owner requests minor departures from the contract plans or specifications. They are treated as "changes under the contract." The bidding cost and, if necessary, the delivery date are adjusted for each such change.

The structural steel hull design work is expedited and steel requisitions are prepared as each drawing is completed. A few weeks of structural steel and arrangement plan progress is usually necessary before a large design staff can proceed effectively with the outfitting and engineering detail working plans. Orders are placed at an early date for major components that are to be subcontracted; these include turbines, boilers, diesel engines. reduction gears, electric generators and other parts requiring a long time to produce.

Construction.—The mold loft, in which the "lines" were faired full size. is a large unobstructed area nith a wooden floor more than 100 ft. wide and several hundred feet long. It may be the second floor over one of the larger shops. Using the hull design department structural steel plans, the loftsmen make full-size templates of nearly every piece of steel that is to be used in the vessel. Templates may be $\frac{3}{16}$-in. seasoned wood or thick paperlike material not affected by humidity. The templates outline the shape. which often involves curved edges; they contain full information on the welding to be done or show the centres and sizes of all rivets to be used in the structure.

Building Ways.—At about the time that the hull steel is being laid off preparatory to keel laying, the building ways are made ready. Oak keelblocks are spaced three or four feet apart along the vessel's centre line from the bow to near the stern. The topsides of these blocks slope at the angle from horizontal (usually about $\frac{5}{8}$ in. per ft.) specified by the design division. A temporary wood or metal structure is also installed to support all of the uncurved portion of the bottom shell plating of the vessel and in some yards even the curved portions of the bottom shell plating. Later, in addition to the keelblocks, wood shores 12 in. to 15 in. in diameter are wedged into place to support the vessel. If the ship is to be built in a building dock there is no slope, as the vessel mill be floated instead of sliding sternward into the water when launched. Similar arrangements are made for a sideways launch, except that the vessel and her supporting members are horizontal before the launching.

Laying Off Steel.—When the steel is available and the mold loft work has sufficiently advanced. the templates made in the mold loft are sent to the layoff area. Workmen centre punch and mark up each plate and shape delivered from the steel storage space, using the mold loft templates. The steel is then ready for fabrication.

If several duplicate ships are to be built, but not simultaneously, the full-size templates from which the steel is to be laid off and fabricated must be stored temporarily. This requires considerable space and handling and there may be occasional damage. An optical system is in use to replace full-size templates for plates that do not have to be rolled or pressed into curved shapes. Developed from the design shown on the small-scale hull design department drawings, new larger and very accurate pencil 'drawings are made. usually to about one-tenth of the full size of the steel that is to be marked up or laid off preparatory to fabrication. The small pencil drawings are traced in ink on special tracing film nhich is then photographically reduced in size on a small glass negative. The steel plate that is to be laid off is placed horizontally below a special optical projector, just as printing paper is placed below the photographer's enlarger. Full-size light lines from the projector are visible on the steel plate. and these lines are used for laying off. The negatives involve no storage problem as they are only about 4 in. by 5 in. instead of full size.

Fabrication and Assembly.—The plate and angle shop shears, acetylene torch equipment, planers, bending rolls, presses, furnaces, drill and countersink machines and other equipment prepare the finished steel plates and shapes ready for subassembly or for erection in the ship. After fabrication. the plates and shapes, if riveted, are usually moved directly to the ship by cranes; shipwrights then adjust them in final positions and secure them by a few bolts passed through the rivet holes. When aligned into final position in relation to the adjoining structure, the plates are riveted.

Much of the steel that is to be welded instead of riveted is subassembled after fabrication. A number of adjoining pieces of steel are placed together, each accurately located in the position it is to occupy permanently in relation to the associated pieces. The pieces are then welded together to form a large unit that will fit into place in the ship. This is done in the assembly area near the building ways. The size of subassemblies is limited by the capacity of the cranes that transfer them to the ship.

Securing heavy steelnork in place overhead and then welding it together may be slow, difficult work. In many cases, much of this work can be avoided by erecting and welding the subassembly upside down. When completed. the subassembly is inverted and transferred to the ship where it is welded to the adjoining structure or to other subassemblies. Although many modern ships have some riveting, welding has largely superseded the riveting used throughout most ships built before World War II.

Keel Laying.—The first keel plate or corresponding subassembly of bottom shell plates is lowered by a crane and accurately positioned on the keelblocks. Adjoining plating promptly follows. A prominent person is often selected by the owner to drive the first rivet or start the welding that joins the plating. Speeches and newspaper publicity follow. Immediately after the ceremonies, erection work proceeds and continues until the vessel is launched. The erection sequence depends upon the type of vessel, but normally the amidship portions of the vessel are advanced more rapidly than the structure near the bow and stern. Piping within the double bottom is installed as it is erected.

When the double bottom and inner bottom plating is well advanced, the side framing and bulkheads are erected. Machinery space foundations are installed. Pillars and girders, deck plating and side shell follow. Some yards delay installing the boilers, propulsion machinery and other large, heavy equipment until after the launching. This requires large engine and boiler room casings or other openings through which to lower or move them into place on their foundations. If such equipment is available in time, it can often be installed, even though not accurately aligned into exact final position, before structures are erected in the zones through which it must pass.

Many spaces, such as the double-bottom tanks used for fuel oil, fresh water and sea-water ballast. must be tested for tightness before the vessel is launched. Any leaks or defects are then corrected. Bulkheads and tank spaces above the double bottom are also tested and corrected if necessary. Lastly, the superstructure, or deckhouses, is installed. Outfitting work such as joiner work, piping above the inner bottom, ventilation ducts and electric wiring may be started before launching, but most of the outfitting work is done later. Shortly before launching, when the hull structural steelwork is nearly completed, the propeller shafting and machinery are accurately aligned and secured. This is done at the last moment as the main hull steelwork warps and changes slightly in shape as erection progresses.

Launching. — If the harbour or river is wide, building ways are at right angles to the water; in restricted waters the ways may be at an angle of 45° or so from the mater front. As noted above, the ship usually slides stern first into the water, though a few shipyards, particularly those on the Great Lakes, have the building way parallel to the water front and launch the vessel by sliding it sideways into the water. Whether the ship is launched stern first or sideways, a launching is an impressive spectacle usually witnessed by hundreds of workmen, townspeople and guests. The sponsor christens the vessel by breaking a bottle of champagne on the bow at the instant the vessel begins to slide toward the water. To see a large liner or naval vessel, perhaps 1,000 ft. long and weighing 30,000 tons, slide down the launching ways at considerable speed is a thrill even to shipbuilders who have launched dozens of ships.

Ships constructed in a building dock are usually fully afloat when the sponsor arrives; after the christening, tugboats slowly tow the vessel to the outfitting pier.

Most building ways are inclined toward the mater with a slope of from $\frac{1}{2}$ in. to $\frac{3}{4}$ in. to the foot. Up to the time of launching the ship has been supported by keelblocks and shoring. Just before launching, the neight of the ship is transferred from the keelblocks to the launching ways down which the ship will slide to the water. The launching ways consist of two parts: ground ways and sliding ways. There are usually two ground ways placed symmetrically on either side of the keel about one-third of the breadth of the ship apart. The ground ways are large timbers extending longitudinally beneath the vessel and beyond it into the water until the ends are submerged sufficiently to provide a satisfactory buoyancy and weight balance for the ship during the launch. On the ground ways there are sliding ways that carry the weight of the ship during launching. A timber cradle transmits the weight to the sliding ways. Between the sliding and ground ways is a thick, greaselike lubricant. The launching ways are erected well before the launch, but the weight of the ship is carried on the keelblocks and shoring until the day of the launching.

During the last few hours before launching time the hull is wedged up on its cradle, releasing the pressure from the keelblocks, which are then removed. The ship is kept from sliding down the ways by various methods; one of the commonest is that of joining each of the sliding ways to the ground ways by a piece of timber or metal. At the scheduled moment these membdrs are cut away, thus freeing the vessel to slide toward the water.

When launched in a narrow river or harbour the vessel must be stopped quickly before the stern strikes the opposite bank. Commonly the vessel drags heavy weights, usually chains, along the ground until they gradually bring it to rest. The vessel is then tow-ed to the outfitting pier where divers release the launching cradle and it is pulled clear of the ship.

Outfitting. — During the outfitting period all work necessary to complete the ship is done. This includes completing the installation of the propulsion and auxiliary machinery, electric generators and the electric system and equipment, and the air-conditioning, heating and ventilating systems. Outfitting also includes joiner work, painting and plumbing, and the installation of galley equipment, furnishings, lifeboats and navigating and radio equipment. Thorough tests are conducted for such parts as the steering gear, windlass, elevators, cargo-handling gear, davits and many other items so that during the trial trip the only tests made are those that cannot be done at the pier. Shortly before the trial trip the ship is "inclined" (see NAVAL ARCHITECTURE) to check her centre of gravity and weight.

Trials. — As soon as the propulsion machinery is in operating condition it is run at low power for a few hours while the vessel is secured to the pier. This dock trial permits testing and making minor adjustments before the trial trip. Shortly before the trial trip the vessel is put in dry dock and her outside plating is painted. If the ship was outfitted while afloat in salt water, barnacles and other marine growths that have accumulated on the hull must be removed.

A few days before delivery to the owners, shipyard personnel take the ship under its own power to deep water for a trial trip. During the trial trip the ship and her equipment are thoroughly tested and inspected. The ship is operated at varying speeds, and the speed at maximum power is checked. Fuel consumption is measured, steering and backing tests are conducted, even the anchors are lowered and then raised. Trial trips may last from a few hours to a week, depending upon the type of ship. Finally, when all the unsatisfactory items noted during the trial trip have been corrected, the completed vessel is delivered to the owners.

Shortly after delivery, a large passenger liner begins her maiden voyage. She is complete with electricity, running water, telephones and a sewerage system. The luxurious air-conditioned staterooms and suites, lounge rooms, ballroom, smoking room, theatre, cocktail room, dining room, bars, shopping centre, library, children's playroom, game deck, gymnasium, swimming pool, barber shop, beauty parlor, doctor's office, printing shop and many other features justify calling such a ship a mobile city afloat.

SUBSIDIES

The wage rates that prevail in each country affect the wages paid to shipyard employees and to ship crews. Prevailing wage rates are also reflected in the cost of the locally made materials used in shipbuilding. It follows that in a country having relatively high wage rates the cost of building, maintaining and operating ships is higher than it is in a country having low wage rates. If the ships of a country uith a low wage scale earn only a normal profit, then the ships of a country with a high wage scale in the same service would operate at a loss, unless subsidized.

The amount of the subsidy varies widely and changes from time to time. In a high-wage country such as the United States the subsidy for ship construction may approach half the cost of the vessel; the operating subsidy is also high. Although not truly a subsidy, the added cost to provide for national defense features, such as abnormally high speed, may be paid for by the government.

See SHIPPING INDUSTRY.

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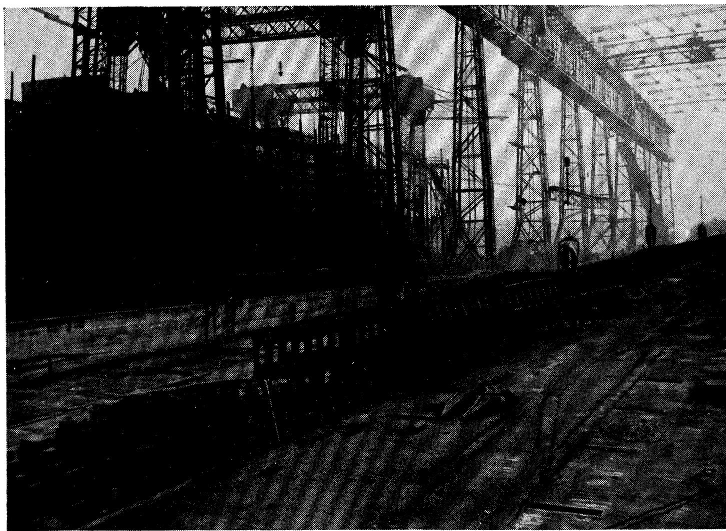
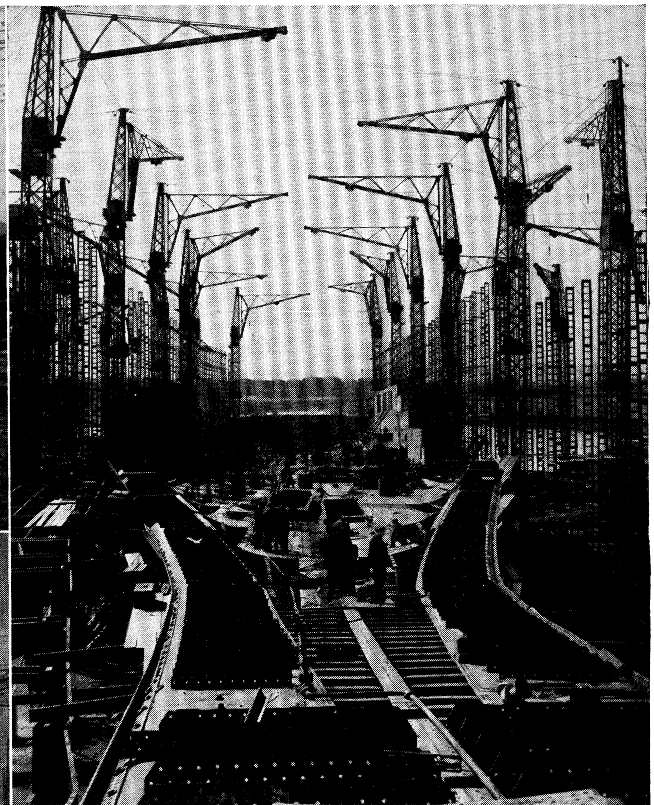
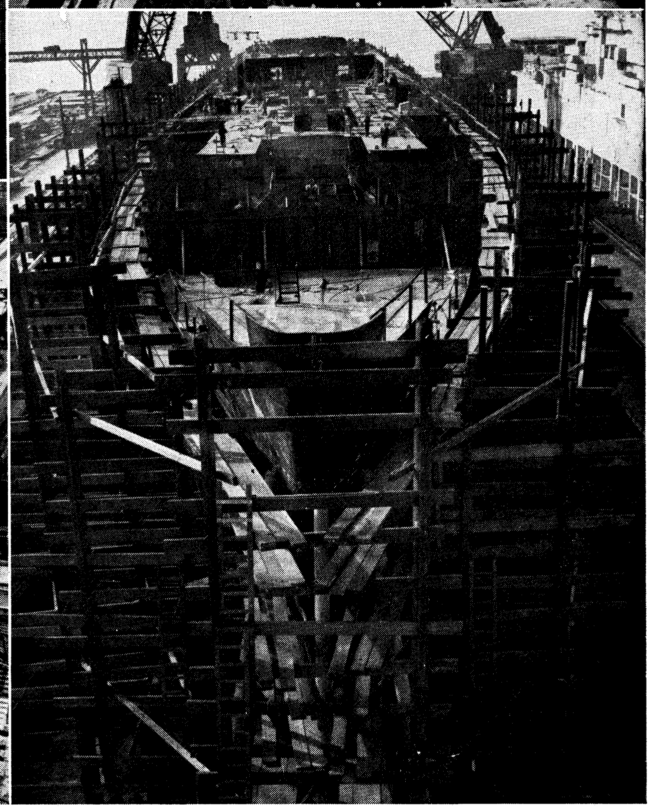
(S. A. V.)







BY COURTESY OF (TOP LEFT) THE INTERNATIONAL MERCANTILE MARINE COMPANY (TOP RIGHT, CENTRE LEFT) THE CUNARD STEAM-SHIP COMPANY LIMITED, (BOTTOM LEFT, BOTTOM RIGHT) NEUPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY: PHOTOGRAPHS, (TOP RIGHT, CENTRE LEFT) STEWART BALE, LIVERPOOL, (BOTTOM LEFT, BOTTOM RIGHT) NIXON

SOME LARGE VESSELS UNDER CONSTRUCTION

Top left: Laying the keel of the S.S. "Olympic," first step in actual construction of a ship. The "Olympic" was launched in 1910

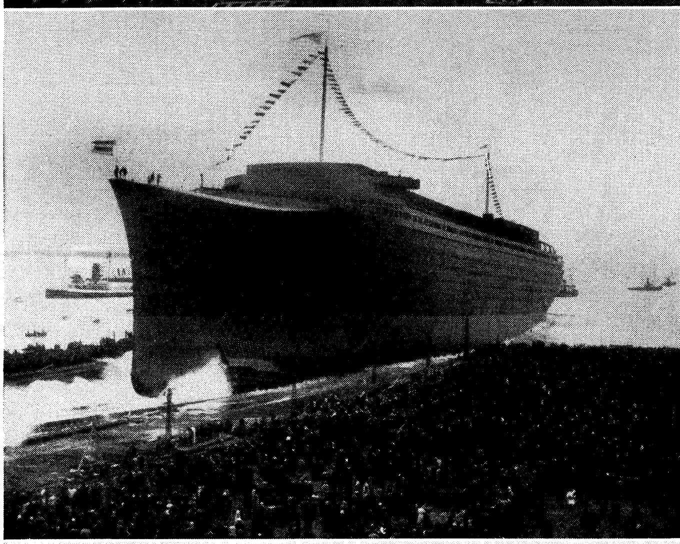
Top right: Work in progress on the interior structure of the double bottom of the liner "Queen Elizabeth"

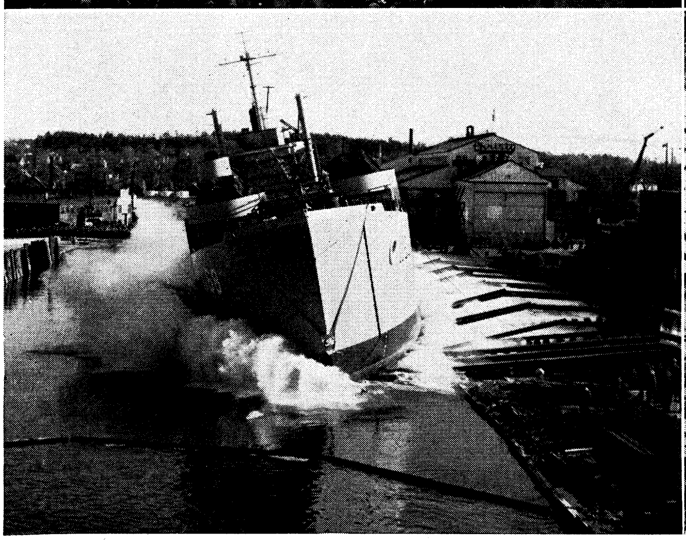
Centre left: View of the hull of the "Queen Elizabeth" as the framing neared completion toward the stern and plating was in progress

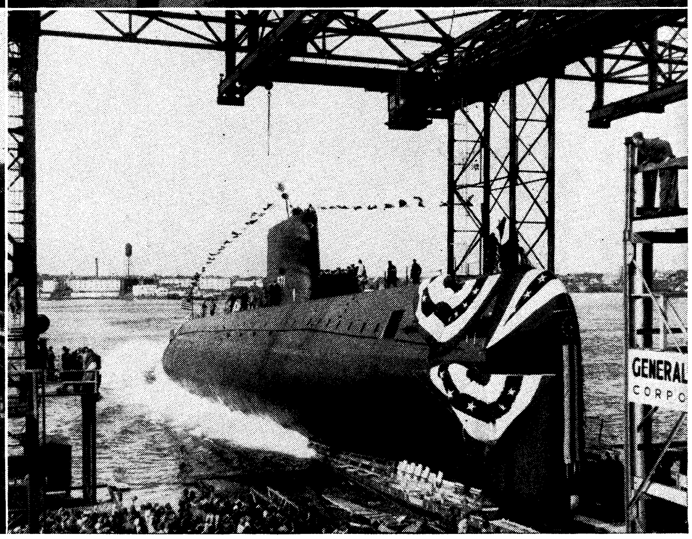
Bottom left: General view of the U.S.S. "Forrestal" under construction. The flight deck is nearing completion, and work has begun on the superstructure (to the right, rear)

Bottom *right:* Progress picture from the S.S. "United States"

SHIPBUILDING







BY COURTESY OF (TOP. CENTRE RIGHT) THE CUNARD STEAM-SHIP COMPANY LIMITED. (CENTRE LEFT) THE FRENCH LINE. (BOTTOM LEFT) CHRISTY CORPORATION, STURGEON BAY, WIS.; PHOTOGRAPHS, (TOP) STEWART BALE, LIVERPOOL, (BOTTOM RIGHT) WIDE WORLD

LAUNCHING

Top: The "Queen Elizabeth" ready for launching at Clydebank, Scot., Sept. 27, 1938

Centre left: Launching of the "Normandie" at St. Nazaire, Fr., in 1932. The vessel was eventually scrapped after a series of disasters beginning with a fire on Feb. 9, 1942, in New York harbour

Centre right: The "Queen Mary" entering the water, Sept. 26, 1934

Bottom left: Side launching, a technique used by shipyards of the Great Lakes region

Bottom right: Submarine launching; the "Nautilus," the world's first atomic-powered vessel, at Groton, Conn., Jan. 21, 1954

SHIPHERD, JOHN JAY (1802–1844), U.S. home missionary, who with Philo P. Stewart founded Oberlin college, was born near Granville. N.Y., on Mar. 28, 1802. While a student at Pawlet academy (Pawlet, Vt.). young Shipherd decided to become a minister. He went to Cambridge academy (Cambridge, N.Y.) in preparation for Middlebury (Vt.) college, but he was accidentally poisoned and his health so affected that he had to leave school. After failures in the marble and whetstone industries at Vergennes, Vt., he went to live with the Rev. Josiah Hopkins at New Haven, Vt., to study with him, and after a year and a half he was ordained an evangelist by a Congregational council at Blanton, Vt., in 182;. He preached a year at Shelburn. Vt., and in 1828 became general agent for the Vermont Sabbath School union with headquarters in Middlebury. In 1830 he decided to become a home missionary and went to Cleveland, O., without an appointment.

He was appointed pastor at Elyria, O., of a congregation that had agreed to the "Plan of Union" between the Congregationalists and the Presbyterians. His ministry was not very successful. In 1832 with a former classmate from Pawlet academy, Philo P. Stewart, who had been in charge of manual labour at a Choctaw Indian mission in Mississippi until his health broke. Shipherd planned a community of pious settlers and a school combining general education and manual labour, which would be open to women as well as men. They named the community for Jean Frédéric Oberlin (1740–1826), the Alsatian philanthropist, and Shipherd'set out for New York and New England to recruit settlers and teachers and to raise money and clear title to land 9 mi. from Elyria.

On Shipherd's return in Sept. 1833, preparatory and infant departments were opened, in December the Oberlin Collegiate institute was announced, and Shipherd returned east the following spring to raise more funds. In the following autumn the first college students were enrolled, but the financial status of the school was still poor. When students at Lane seminary in Cincinnati. O., rebelled against their trustees' refusal to allow discussion of abolition. Shipherd won them over to Oberlin on the conditions that financial backing be secured from Arthur and Lewis Tappan of New York city, who had established Lane seminary, and that Charles G. Finney (1792–187j), the evangelist. whom the brothers had established in a church in the Chadwick Street theatre in New Tork city, would be brought to Oberlin to teach theology. Shipherd again went east, fulfilled the conditions, and the Lane "rebels" came to Oberlin in 1835. After two vain efforts to found similar communities and schools elsewhere, Shipherd led a group to Michigan and founded Olivet college in 1844.

Shipherd died there on Sept. 16, 1844.

SHIPKA PASS, in Bulgaria, a pass in the Balkans, celebrated as the scene of fierce fighting in the Russo-Turkish War of 1877–78. The main road from Rumelia to Bulgaria. leading from Sistova by Tirnova and Eski Zagra to Adrianople. crosses the Balkans near the village of Shipka, and this passage was of necessity an important point in the Russian plan of operations. The road does not pass between high peaks, but crosses the main ridge at the highest point; it is therefore not a pass in the ordinary sense of the word.

Near the summit, running parallel, and close to the road is a series of three ridges, about zoo ft. high, and about 2 mi. from north to south, which formed the position for a force holding the pass. It was originally held by a Turkish force of about 4.000 men with 12 guns, prepared to resist the Russian advance. On July 17 they repelled a feeble attack from the north, and the following day faced round and drove back an attack by Gourko from the south. These attacks were to have been simultaneous, but Gourko, having met with unexpected resistance, was a day late. Though so far successful, the Turks evacuated their strong position, and it was occupied by the Russians on July 19.

Suleiman Pasha, having concentrated with Reouf Pasha and driven Gourko across the Balkans at the end of July, moved to the Shipka on Aug. 21 and attacked. The Russian force there, including five battalions of Bulgarians, then numbered 5,000, but that day a regiment from Selvi brought their numbers to 7,500, and this force held the position against 30,000 Turks for three days, when heavy reinforcements arrived. The fighting continued till the morning of the 26th. when Suleiman. his troops being exhausted, and having lost 10,000 men, entrenched himself in the position he then occupied in a semicircle round the southern end of the Russian position. Having called up more battalions from Yeni Zagra. after a four days' artillery bombardment. he attacked on Sept. 17 and was repelled with a loss of approximately 3,000 men.

There was no more fighting on the Shipka till the general advance of the Russians after the fall of Plevna. Radetzky's command of about 60,000 men advanced from Gabrova on Jan. j. in three columns. Radetzky. with the central column, moved by the main road and attacked the Turks. who still faced the position on the summit, while Skobelev and Mirski. crossing by trails about 3 mi. to the west and east of the Turkish position. attacked their reserves on the far side. about Shipka and Shenova, where Vessil Pasha (who had succeeded Suleiman in command) had formed an entrenched camp.

These flank columns made their way over the mountains. deep in snow, Mirski attacked alone on Jan. 8, as Skobelev's advance had been delayed. but the following day both columns attacked, and after fierce fighting the Turks surrendered. The force on the summit had that day repulsed, with heavy loss, a frontal attack by Radetzky, but they were included in the surrender. Their numbers were 36,000, including 6.000 sick and wounded, and 93 guns. The Russian losses were j.500.

Not only were the Turkish attacks on the Shipka unsuccessful, but they were made without object. At the end of July. when Suleiman forced Gourko back over the Balkans. the moral equilibrium and the plan of operations of the Russians had been upset by the second battle of Plevna, and the Shipka ceased to have any strategical importance for the time being. Had Suleiman at that time followed up Gourko and joined Mohammed Ali, or moving round acted with Osman against the Russian flank, the evacuation of the Shipka would have been compulsory. Suleiman. knowing nothing of strategy. preferred to act independently, and his action was supported by the still more ignorant ministers at Constantinople.

The Shipka was merely a geographical point until the Russians were prepared to advance, but, fortunately for them. the Turks chose to waste an army in fighting for it throughout the critical period of the operations. Suleiman divided his forces and used up his troops in costly frontal attacks on Mt. St. Nicholas, the southern and strongest point of the position, whereas a well-supported flank attack would probably have met with success. The manner in which he sacrificed his men earned for him the name of the "Shipka butcher." (J. H. V. C.)

SHIP LANES: see SHIPPING ROUTES.

SHIPLEY, an urban district in the Shipley parliamentary division of the West Riding of Yorkshire, Eng.. 3 mi. N.N.W. of Bradford. Pop. (1951) 32,680. Area 3.4 sq.mi. Shipley is in Airedale south of the hire river and on the Leeds-Liverpool canal.

Mentioned in Domesday Book as Scipeleia, it was developed when Sir Titus Salt started his vast woolen mills (1853) and built the model village of Saltaire with its Italian-style Congregational church (1859) and the Saltaire institute (1870).

Engineering is important. but Shipley is also a residential area. The urban district (created 1894) includes Shipley, Windhill. Wrose. part of Frizinghall and Saltaire parishes.

SHIP MONEY, a tax, the levy of which by Charles I of England without the consent of parliament was one of the causes of the Great Rebellion. The Plantagenet kings of England had exercised the right of requiring the maritime towns and counties to furnish ships in time of war; and the liability was sometimes commuted for money.

Notwithstanding that several statutes had made it illegal for the crown to exact any taxes without the consent of parliament, the levying of ship money in time of war had never fallen wholly into abeyance, and in 1619 James I aroused no popular opposition by levying £40,000 of ship money on London and £8,550 on other seaport towns.

On Feb. 11, 1628. Charles I issued writs requiring £173,000 for the provision of a fleet to secure the country against French invasion and for the protection of commerce, and every county in England was assessed for payment.

This was the first occasion when the demand for ship money aroused serious opposition and Charles withdrew the writs. His determination to rule without parliament. however, led him to re-employ this financial device.

The first of six writs issued annually 1634–39 appeared in Oct. 1634 and was directed to the justices of London and other seaports, requiring them to provide a certain number of ships of war of a prescribed tonnage and equipment, or their equivalent in money, and empowering them to assess the inhabitants for payment of the tax according to their substance. The distinctive feature of the writ of 1634 mas that it was issued to provide against not a present danger but one to be apprehended. The citizens of London immediately claimed exemption under their charter, while other towns demurred to the amount of their assessment; but no resistance on constitutional grounds appears to have been offered, and a sum of £80.000 was collected, all of which, as on future occasions, was spent on the fleet.

On Aug. 4, 1635, a second writ of ship money was issued, directed on this occasion, as in the revoked writ of 1628, to the sheriffs and justices of inland as well as of maritime counties and towns, demanding the sum of £200,000, which was to be obtained by assessment on personal as well as real property, payment to be enforced by distress. This demand excited growing popular discontent, so Charles obtained a written opinion, signed by 10 out of 12 judges consulted, to the effect that in time of national danger, of which the crown was the sole judge, ship money might legally be levied on all parts of the country by writ under the great seal. Had this ruling gone unchallenged the king's prerogative would have become the sovereign power in the realm. The issue of a third writ of ship money on Oct. 9, 1636, made it evident that the ancient restrictions, which limited the levying of the impost to the maritime parts of the kingdom and to times of war or imminent national danger, had been finally swept away, and that the king intended to convert it into a permanent and general form of taxation without parliamentary sanction.

Payment was refused by Lord Saye and by John Hampden (*q.v.*), a wealthy Buckinghamshire landowner. The case against the latter (*Rex* v. *Hampden,* 3 *State Trials,* 82;) was heard before all the judges in the exchequer chamber, Hampden being defended by Oliver St. John (*q.v.*) and Robert Holborne, and lasted for six months. Seven of the 12 judges, headed by Finch: chief justice of the common pleas, gave judgment for the crown, and 5 for Hampden. In 1639 Charles issued for the last time a writ of ship money, but of £217,000 demanded, only about £50,000 was collected. In 1641, by an act of the Long Parliament, introduced by Selden, the illegality of ship money was expressly declared.

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SHIPPARD, SIR SIDNEY GODOLPHIN ALEXANDER (1838–1902), British colonial administrator, was educated at King's college school and Oxford, and was called to the bar in 1867. He was attorney general of Griqualand West from 1873–7, when he was made acting recorder of the high court of Griqualand. From 1880–5 he sat as a judge of the supreme court of Cape Colony; and he was British commissioner on the Anglo-German commission in 1884–5 for settling the claims of British subjects at Angra Pequena and other parts of the southwest coast.

Shippard, while at Oxford in 1878, had discussed with Cecil Rhodes the plan of the projected British advance in south central Africa. He saw in the German annexation of Damaraland and Namaqualand the first step in a design to secure for Germany territory stretching from ocean to ocean. Consequently when after the Warren expedition of 1885 he was chosen to organize the newly acquired British possessions in Bechuanaland he saw in his appointment an opportunity for forestalling the Germans, and also the Boer adventurers who likewise sought to be beforehand with Great Britain in the countries north of the Limpopo.

At the end of 1887 he went to Grahamstown to induce the high commissioner (Sir Hercules Robinson — afterward Lord Rosmead) to sanction the conclusion of a treaty with the Matabele King Lobengula binding that ruler not to cede any territory to any other power than Great Britain. He failed, and then telegraphed to Cecil Rhodes at Kimberley to come and try the effect of his eloquence. Rhodes came. and by taking upon himself all pecuniary responsibility succeeded in obtaining the requisite sanction. The treaty was signed and British interests secured. Shippard thenceforth governed Bechuanaland with conspicuous success. He was administrator, chief magistrate and president of the Land Commission for British Bechuanaland, and resident commissioner for the Bechuanaland Protectorate and the Kalahari. He was created knight commander of the Bath in 1887. In 1896 he played an unofficial part in the negotiations between Robinson and the Johannesburg reformers after the Jameson Raid.

Shippard then returned to England, where he died on March 29, 1902.

SHIPPING, HISTORY OF. The history of shipping is much more than an aspect of economics. It is an integral part of the history of civilization. When the ship, that is, a vessel propelled by sail or oars, equipped with steering gear and capable of seagoing voyages, emerged in the remote past, the sea, hitherto a barrier to intercourse between societies, became a highway across which men traveled for the exchange of goods and ideas. The peoples which have contributed most to the development of shipping throughout history have been the island races and the inhabitants of the coastal areas of land masses. Their environment does not of itself explain this fact. The urge to maritime activity has usually arisen from the need to wrest a living from the sea, from the desire to increase material prosperity or from the quest for geographical knowledge. In the absence of these factors, peoples favourably situated for it have failed to create a thriving maritime tradition, or have done so only during certain periods of their history.

Through the ages the greatest sea powers have been those societies whose livelihood, and indeed existence, have been dependent upon the security of their sea communications, since their natural policy has been to devote the major part of the state's resources to the maintenance of strong fleets for the protection of these vital interests.

This article is divided into the following sections:

1. Ancient Shipping
2. Rome and the Trade With the East
3. The Rise of Venice
4. Northern Shipping
5. Developments in Ship Design and Navigation
6. Oceanic Exploration
7. The Rise of the Northern Maritime Powers
8. Anglo-Dutch Rivalry
9. The Establishment of British Predominance
10. The Last Days of Sail
11. The Great Transition (to Steam)
12. The Organization of Shipping
13. International Rivalry
14. Maritime Disasters

For a general discussion of modern sea-borne trade, ship operation, maritime lan and related topics, *see* SHIPPING INDUSTRY. The history of various types of vessels is covered in detail under SHIP.

1. Ancient Shipping. — The scenes of the greatest maritime activity in antiquity were the Mediterranean and the northern part of the Indian ocean. Shipping in the Mediterranean dates from very early times. The first organized shipping there belonged to Crete, an island excellently situated on the natural sea routes of the eastern Mediterranean. By 3500 B.C., the Cretans had built up an extensive commerce, including trade with Egypt, Syria and Greece. The decline after 1400 B.C. of Cretan power, probably following an earthquake, was accompanied by the decay of its maritime importance. The principal beneficiaries of this event were the

Phoenicians.

The Phoenicians inhabited the coastal regions of Lebanon, and they were invited by their geographical position to engage in the trade of the Mediterranean. Situated as they were at the termini of the chief routes from Asia, the Phoenician merchants were able to exploit the transit of oriental luxury goods to Greece and the west. The period of Phoenician greatness, the age of the supremacy of Tyre and Sidon, lasted approximately from 1100 to 800 B.C. Their ships were to be found all over the Mediterranean, and to protect and extend this commerce the Phoenicians established a chain of trading posts and colonies from the Levant to the Straits of Gibraltar. One of these settlements was Carthage in North Africa. As the predominance of Tyre and Sidon declined under the pressure of external foes, Carthage gradually took over the leadership of the empire and became the strongest maritime power in the Mediterranean. Carthaginian enterprise was worthy of the great traditions which it inherited. Besides controlling the Mediterranean trade, the Carthaginians attempted the circumnavigation of Africa in the 5th century B.C., and from their outpost at Cadiz they sailed to Britain and established commercial contacts with Cornwall. The extent of its interests brought Carthage into conflict with the rising power of Rome, and the era of its supremacy ended with the destruction of the city by the Roman armies in 146 B.C.

Navigation in the Red sea, the Persian gulf and the Indian ocean originated. according to some authorities, before 3000 B.C. A coasting trade between the Malabar coast of India and the Persian gulf, whence eastern products were transported by land to Tyre and Sidon and exchanged for western goods, was operating on an organized basis by 1000 B.C. Sea communication between India and the Red sea came later, and was not very frequent until the end of the 4th century B.C. when the efficient rule of the Ptolemies began in Egypt. They encouraged the trade with the east in every possible way, restoring the ancient and disused canal across the Isthmus of Suez between the Red sea and the easternmost branch of the Sile delta, with the intention of making Egypt the entrepôt between east and west and a focal point for trade between three continents.

The systematic development of traffic between the Red sea and India continued from this time onward. but it was mostly indirect. Indian ships brought the cargoes to Aden and other ports near the mouth of the Red sea, whence they mere transported by local shipping. The Indians were active at sea during this period. In addition to the trade from the west coast. there was considerable shipping between Ceylon and the Ganges and regular sailings between India and the Malay archipelago where cargoes for Europe were obtained.

2. Rome and the Trade **With** the East.—The failure of the Ptolemies to establish direct shipping between Egypt and India was not remedied by their inefficient successors. The canals and roads which had been constructed fell into disuse (see TRADE ROUTES), and not until the Mediterranean world and the near east were welded together under the authority of the Roman empire did favourable conditions exist for further development of trade with the east. The emperor Augustus supported the expansion of this commerce, and during his reign Roman subjects, usually Greeks, began to make the direct voyage between the ports of the Red sea and India, coasting all the way. The Greeks had seafaring traditions dating back to the era of Phoenician greatness and beyond. They had taken second place to the Phoenicians, but their long experience as shipowners and merchants enabled them to benefit from the stimulus to trade provided by the Pax Romana. A great impetus to the direct trade was the discovery early in the 1st century A.D. by the sea captain Hippalus of the secret of the seasonal winds of the Indian ocean. This knowledge made possible the regularization and expansion of the trade. The passage time between Egypt and India was reduced. Sailing on the southwest wind which blows from July to September, seamen no longer had to follow the coast line but could steer directly across the sea, confident that the wind would bring them to their destination. In November the northeast wind sets in and a speedy return voyage could be made on it. The significance of the discovery is underlined when it is recalled that the ancient navigator possessed no instruments apart from the lead and line and that, although the ships carried sail, they could only run before a following wind. Without information of the sort obtained by Hippalus accurate navigation out of sight of land for days was impossible. The use of the prevailing winds as a navigational aid was not in itself novel. The Cretans, Phoenicians and Greeks had employed similar methods in the Mediterranean. They were also familiar with the polestar as a guide to direction. But in the Indian ocean Europeans, at least, were until the time of Hippalus ignorant of the monsoon winds and the discovery brought their ships in increasing numbers direct to ilialabar, to the east coast of India and beyond. The result, as attested about A.D. 80–89 by the author of the *Periplus* of *the Erythraean Sea*, was a remarkable expansion in traffic between east and west.

Westbound cargoes of precious stones, silks and other luxuries were shipped from India to the headwaters of the Red sea, transported to Alexandria and there reloaded for the voyage to Italy. Exports from the west included base metals and coral! and a large balance was settled in gold and silver. This trade continued to thrive in the 2nd and 3rd centuries and began to dwindle only with the decline of Rome. As it did so, commerce tended to return to its old channels, the goods being shipped to the mouths of the Red sea and Persian gulf for transport to the Mediterranean by the Arabs.

With the expansion of Islam, the Arabs came to control the shipping of the western part of the Indian ocean, and when the Portuguese reached the eastern seas in 1498 they found the trade there monopolized by the Moslems and similar in pattern to that which had been established in the centuries following the fall of Rome.

Under the Roman empire, trade flourished in the Indian ocean, the Mediterranean and in northern waters. Its growth was accompanied by the development of legal and commercial institutions in which the Roman instinct for law and order found expression. The Roman maritime code was based upon the ancient laws and customs of the sea first formulated, according to tradition, by the inhabitants of the island of Rhodes. It regulated among other things seamen's wages, the rights of merchants, the responsibilities of shipowners relative to passengers and cargo and punishments for offenses ranging from piracy to negligence. The code also governed matters affecting contracts, charter parties and bills of lading and bears witness to the existence of a highly organized shipping industry. Its main features survived the fall of Rome. They were incorporated in the laws of Oléron, n·hich provided the foundations of English maritime law, the sea laws of Visby (Wisby) and the Hanseatic ordinances of 1614 and 1681, and constituted the basis of modern maritime law.

3. The Rise of Venice.—After the collapse of the Roman empire in the west, the Mediterranean continued to be a great artery of commerce. The Byzantine empire, the capital of which was Constantinople. maintained the commercial traditions of Rome. Constantinople became the centre for the redistribution of eastern luxuries which arrived there by the Black sea and the land routes; and Byzantine merchantmen traded with the barbarian states of the west. The continuity with classical times was broken by the Islamic conquests of the 7th and 8th centuries. Commerce in the western Mediterranean was completely disrupted. Only in the Adriatic and Aegean seas did trade survive. Out of this wreckage emerged the maritime preponderance of Venice.

The Venetians, who lived on the islets of the lagoon at the head of the Adriatic, were dependent upon fishing and maritime trade for their existence since they possessed no land fit for cultivation. Content at first with the primitive exchange of necessities with their mainland neighbours, their interests and their shipping expanded without interruption. Profiting from their political connections with Constantinople, they obtained a share in the carrying trade upon which the supply of the flourishing cities of Byzantium depended, and by the 10th century they possessed trading posts from the Adriatic to the Bosporus. Their interests were further increased by the crusades, as a result of which the Venetians gained admission to the cities of the Levant where east and west met.

They excluded the Byzantines from the trade and won a monopoly (disputed only by the shipowners of Genoa and Pisa) over the shipment of spices to Italy for distribution throughout western Europe.

The Mediterranean was once more a great centre of shipping, over which Venice predominated. The Venetians practised the most highly developed commercial techniques, including marine insurance, and the organization of their merchant fleets which were partly state-owned was carefully regulated in the interests of safety and efficiency. By the possession of the strategic points they controlled the trade routes between the Levant and Italy and their predominance in the eastern Mediterranean was not effectively challenged until the late 15th century by the onslaught of the Ottoman Turks. The reduced importance of the Mediterranean trade in consequence of the discovery of the ocean routes also contributed to the decline of Venice; but the disappearance of its greatness was nevertheless a slow process.

4. Northern Shipping. — Information about. northern shipping in ancient times is slight. The exchange of commodities between the British Isles and the continent was common by 2000 B.C. The Frisians participated from an early date in a coasting trade along the shores of the North sea which persisted until the 9th century. The first great seafarers of the north were the Scandinavians. Their maritime activity originated in the 7th century in the search ior loot. and the destructive aspect of their expansion carried them to the British Isles and to the coastal regions of northwest Europe. Pillage may have been their initial inspiration, but they were also traders and explorers. In the 9th and 10th centuries their trade acquired considerable proportions. Goods from Russia, which had been opened up by the expansion southeastward from Sweden, were shipped across the Baltic to Gotland. From this island they were transported in the long open ships of the Norse to southern Denmark and to the harbours of the North sea. This same period saw the establishment of the Scandinavian settlements in the Faeroes, Iceland and Greenland. Their great knowledge of the North Atlantic enabled them to make regular voyages in the ocean and even to reach America, where a short-lived colony was established.

From about 1100 the Scandinavian mastery over the Baltic and the commerce between Russia and the west was disputed and eventually ended by the penetration to the Baltic region of the Germans. During the 12th and 13th centuries the Germans colonized the area east of the Elbe and founded the great ports on the Baltic coast from Liibeck to Riga, In 1160 they seized Gotland. Led by Liibeck. the new towns formed a maritime confederation known as the Hanseatic league (*q.v.*). The Low Country ports joined it. The Scandinavians could not compete with the superior wealth and organization of the Germans. The Hanseatic sailing ships with their greater tonnage capacity supplanted those of the northmen. Laden with timber, hemp, honey and wax from Russia and with corn from the Baltic provinces they navigated the Baltic and sailed through the Sound to discharge their cargoes in the Low Countries. France and England. The Hanseatic merchants also controlled the distribution of the commercially important Baltic herring throughout northern Europe. The return cargoes included Biscay salt, wine and cloth. Wherever they traded. they established agencies for the conduct of business, extending from Novgorod to London. Their operations anticipated the monopoly later exercised by the Dutch over the carrying trade of the north; indeed competition from the Hollanders contributed to the decline of the Hansa in the 1jth century and led. together with other factors. to its eventual eclipse.

5. Developments in Ship Design and Navigation.——Between the 13th and 1jth centuries ships became more seaworthy and there were important developments in the science of navigation. From ancient times there had been two types of ship: the galley and the sailing ship. The galley was in the main a warship. It was a swift and maneuverable vessel driven by oars. This made it independent of the wind. but its radius of action was limited by the endurance of the oarsmen, and, though employed in the merchant fleets of Venice, it was not very suitable as a merchantship because of lack of stowage for cargo and supplies. Moreover, it was not built for voyages in a rough sea. Traditionally the merchant vessel was a sailing ship. For centuries there had been little improvement in its design. It usually carried only one mast and sail, was dependent upon a following wind and was slow and clumsy. During the period in question the sailing qualities and sea-keeping capacities of ships were improved by the perfection of the stern post rudder which gave much greater control over the ship than did the traditional steering oar or oars, and by improvements and additions to the sail, masts and rigging. By the 14th century the three-masted sailing ship had been developed in the Mediterranean and was soon taken up all over Europe. Over the same period the chart and compass came into general use. Crude charts probably existed in the 9th century, but the art of chart making was the great skill of the cartographers of Venice and Genoa whose portolano charts with their accurately delineated coast lines were regularly used by the Mediterranean navigators. The use of the compass by Europeans also originated in the Mediterranean. The compass was transmitted to the Italians from the Chinese, who were active at sea between the 10th and 12th centuries: through the medium of the Arabs. The mathematical knowledge indispensable for the development of astronavigation was liken-ise obtained from the Arabs by the Italian maritime experts. The invention of the cross-staff in 1342, though it did not come into general use until much later: enabled the navigator to measure the altitude of the polestar and thus determine his latitude. There were still great deficiencies.

No method existed for the calculation of longitude; it was not known how to assess compass variation; and there was no means of estimating accurately the speed of the ship. Deep-sea navigation was therefore subject to great errors. but the progress registered was significant. All these improvements taken together were a great stimulus to shipping. Before their introduction European seamen. the Norse excepted, made only coastal voyages and short sea passages. Maritime activity centred around the landlocked Mediterranean and Baltic, and the Atlantic coasts. The Italians rarely passed beyond the.Straits of Gibraltar and northern mariners seldom went farther south than the Bay of Biscay. Soon a more enterprising spirit was evident. Sailing ships and even galleys began to make the direct voyage to England and the Low Countries from the Mediterranean. Nevertheless the essential patterns of European trade tended to remain static. Maritime predominance was transferred from one possessor to another. Venice had won the monopoly over trade in the eastern Mediterranean from Byzantium; the Hansa had eliminated the Scandinavians and was in the 15th century being undermined itself by the Hollanders. Longer voyages were being made. but the traditional trade routes were unchanged. The revolutionary happening was the conquest of the ocean by the Iberian seamen.

6. Oceanic Exploration. — Thepioneers of oceanic exploration were the Portuguese. The Portuguese were influenced by two maritime traditions. Their commercial connections with Italy introduced them to the scientific knowledge of the Italians. Their geographical position brought them face to face with the mystery of the Xtlantic and familiarized them with the problems of sailing there. The fusion of these elements produced a school of navigators equipped with Mediterranean geographical and navigational knowledge and schooled in the traditions of Atlantic seamanship. Under the guidance of Prince Henry the Navigator the systematic exploration of the African coast and of the Xtlantic islands began in 1418. Progress was slow. The adverse winds and currents encountered in African coastal waters drove the pioneers out to sea to obtain knowledge of the Atlantic wind systems. The problem of ascertaining latitude in regions where the polestar was no longer visible had to be solved. The design of ships had to be adapted to the needs of the explorers, hence the evolution of the swift and maneuverable caravel.

In 1488 the Cape of Good Hope was rounded. The climax of the Portuguese effort came in 1498 when Vasco da Gama reached India. The superiority of European ships and weapons over those of the Moslems in the Indian ocean soon became apparent. Portuguese predominance was established between the western boundary of the ocean and Malabar, and naval bases were set up at the strategic points. The next step was to wrest from the Moslems the control of the routes across the Bay of Bengal leading to the far east. To this end Malacca was seized in 1511. Within a short time, a direct trade with China was begun and a foothold was obtained in the Moluccas, the Spice Islands'. The rapid expansion in the eastern seas resulted in the establishment of a Portuguese monopoly over the shipment of spices and other oriental goods to Europe by the ocean route.

During the 1jth century there was much speculation among nautical experts as to the possibility of reaching Asia by sailing due west from Europe. All were agreed that the world was a sphere. What was disputed was the claim that the distance to be covered was nithin the limits of the endurance of ships and crews In 1492 the rulers of Spain authorized Christopher Columbus to attempt such a voyage. The result of this enterprise was the discovery of the West Indies and then of the American mainland. In 1j13 the Spaniards crossed the Isthmus of Panamá and reached the Pacific.

The relationship of the new continent to Asia was unknown until 1522, when Magellan's ship returned from the first voyage of circumnavigation The conquest of the Atlantic was followed by the establishment of a regular trade between Spain and its dependencies in the new world. This trade was carefully regulated by the cronn. From the middle of the 16th century, two fleets sailed annually from Seville, one for the Spanish blain and one for the Gulf of Mexico, to supply the colonists with European manufactures and African slaves. They loaded their return cargo of tropical produce and bullion during the winter and recrossed the Atlantic accompanied by an escort of narships in the spring. There was no direct trade between Spain and the far east. Spain tapped Asia through its settlement at Manila in the Philippines. whence the cargoes were shipped across the North Pacific to Mexico and transported by land to the Atlantic seaboard for shipment in the annual fleet.

The two Iberian powers claimed an exclusive monopoly over the trades opened up by their explorers. The enforcement of this monopoly depended upon their ability to control the sea communications in the face of attempts by interlopers to enter the trades. The ocean thus became a source of international rivalry.

7. The Rise of the Northern Maritime Powers.—Before the mid-16th century. English maritime enterprise was limited by the Venetian and Hanseatic monopolies. by the poor sailing qualities of the ships and by the ignorance of scientific methods of navigation. English trade was considerable. but most of it was conducted in foreign vessels. The medieval kings, though not indifferent to economic affairs. did little to encourage native shipping. their principal interest in commerce being to obtain a fiscal revenue from the duties paid by foreign merchants. The first navigation law for the increase of English shipping was enacted in the reign of Richard II. but foreign competition mas not thereby effectively checked. In any case, English merchants were primarily interested in the export of cloth and as long as the European markets provided a sufficient outlet for the industry, there was little incentive for oceanic exploration. The exception to the general indifference was the attitude of the west country merchants, whose commercial links with Spain and interest in the fisheries gave them an Atlantic outlook. The men of Bristol sponsored the voyages of John and Sebastian Cabot between 1497 and 1509 in search of an oceanic route to Asia across the northern latitudes of the Atlantic. The chief results of these voyages were the development of the Newfoundland fishery, a matter of some consequence since it gave English mariners experience in oceanic seamanship, and the emergence of the idea that it was possible to sail directly from the Atlantic to the Pacific by a passage situated to the north of America.

After 1576 a series of voyages was undertaken in search of this northwest passage. But the voyages of the Cabots aroused little immediate enthusiasm on a national scale Henry VII and Henry VIII, however. encouraged maritime expansion, provided that Englishmen did not enter those areas over which the Spaniards and Portuguese claimed jurisdiction. They also curbed the privileges of the Hansa and favoured the growth of English shipping. By 1550 a new outlook existed. Merchants and politicians recognized that the cloth industry needed new markets and they wanted direct access to the sources of luxury goods and precious metals. The intellectual background had also been prepared Geographical knowledge was more nidely diffused and the study of scientific methods of navigation was gaining ground. English ships began to appear regularly for the first time in the Mediterranean and off the Barbary and Guinea coasts John Hawkins attempted to trade directly with the Spanish colonists. offering for sale slaves which he had obtained in West Africa. The route to Archangel around the North cape was discovered and an important trade with Russia inaugurated.

Drake's voyage of circumnavigation (1577–80) opened the Indian ocean to the English by demonstrating the weakness by European standards of Portuguese seapouer there. This gronth of overseas trade the bulk of which was carried on by the chartered companies—the Muscovy, Levant. East India companies and others—was the first stage in the expansion of English shipping. It was accompanied by the rise of a naval tradition associated with the victory over the Spanish Armada in 1588, and was followed by the first successful plantation of settlements in North America and the West Indies in the early years of the 17th century. It remained to be seen, however, whether these modest beginnings could be consolidated

The English were not alone in developing an interest in overseas trade. The French Atlantic coast mas also a gateway to the ocean. The hardy seafarers of Brittany and Normandy were fishing in the north Atlantic in the early 16th century; by 1520 they were privateering in the Caribbean. The French crown encouraged maritime enterprise, but the promising developments under Francis I were arrested by the outbreak of religious civil war in 1559 French traders and fishermen continued their activity in the Mediterranean and Atlantic, but France was put out of the race for colonial and maritime predominance for 50 years.

It was otherwise with the Dutch. The shipping of the Netherlands like that of England had been restricted by the Hanseatic monopoly The development of the North sea herring fisher? in the 15th century stimulated native shipping in the ports of the northern Netherlands particularly at Amsterdam The shipping interest there soon sought other employment for its ships and crews. During the 1jth century ships from the Netherlands entered the Baltic and successfully challenged the Hansa The Dutch owed this success to the greater tonnage capacity of their ships and to their geographical position. The Netherlands were situated at the point where the north-south trade routes converged and at the mouths of important inland waterways which gave an outlet to the trade of the continent. The nar of independence from Spain during the 16th century fostered an aggressive economic nationalism in the nascent Dutch republic. Territorially the republic was small, but from its maritime resources it derived a power and influence which enabled it to resist Spain and to pursue a policy of commercial expansion

Increasingly self-confident. the Dutch rounded the Cape of Good Hope in 1595, entered the East Indies, succeeded by 1658 in expelling the Portuguese from the Spice Islands. Malacca and Ceylon and supplanted them as the carriers of spices to Europe, in addition to deriving vast profits from the control they exercised over trade between Asiatic ports. They crossed the Atlantic ,and founded colonies in the Caribbean and North and South America. These territorial acquisitions were made mith an eye to commerce. Dutch shipping soon predominated in an extensive carrying trade between Europe and the Spanish. French and English settlements across the Atlantic. In Europe they made thernselves indispensable as the principal carrier to states such as Russia and Sweden which did not possess sufficient ships for their commerce, and the Dutch flag was evident from the Baltic to the Levant. This supremacy m s based upon the technical superiority of their merchantmen. Dutch ships combined maximum cargo capacity and exceptional sailing qualities with low freight costs; owing to the incorporation in their design of devices which made possible small crews and reduced time on voyage. It also owed much to careful organization.

Amsterdam, the chief port of the republic and the supplanter of Antwerp as the depot for the distribution of spices in northern Europe, was a great financial centre and the home of the most efficient commercial methods. In the first half of the 17th century, Dutch merchantmen and fishing vessels numbered over 6.000. This period was the golden age of the Dutch shipping industry.

8. Anglo-Dutch Rivalry. — In comparison with the Dutch, English shipping made little progress between 1600 and 1650. Because of Dutch competition the English East India company failed to establish itself in the Spice Islands and had instead developed a trade with India. The Baltic trade upon which depended the supply of shipbuilding materials was largely in the hands of the Dutch. Trade to and from the plantations in America was often carried by Dutch instead of English ships. After 1650 a rapid expansion of the English mercantile marine took place, and possibilities inherent in the Elizabethan enterprises were realized. The merchant fleet is reckoned to have doubled itself. between 1660 and 1658 and at the end of the century numbered 3.381 seagoing ships with a total estimated tonnage of 293,703. The size of vessels remained small. Probably more than a quarter were of less than 200 tons; few were more than 400. Those employed in the American and West Indies trades, including those which called at West Africa to collect slaves, probably ranged from 200 to 300 tons. The big East Indiamen of 600 tons and more were the exception. The governments of the day promoted the increase of commerce and shipping by a protectionist policy which was given concrete expression in the navigation laws of 1651 and 1660, and by the construction of powerful fleets to secure the trade routes.

Anglo-Dutch rivalry came to a head in three hard-fought and indecisive maritime wars beween 1652 and 1674. After 1674, however, the Dutch were involved in a series of continental wars with France which overtaxed the resources of the state, with a consequent decline in its naval strength. Although they retained most of their colonies and an extensive overseas trade: they lost the initiative in maritime affairs and were no longer counted as a great seapower.

9. The Establishment of British Predominance. — The 18th century was a period of uninterrupted expansion for British shipping. In 1699 its tonnage was 293,703; in 1750, 609,798; in 1792, 1,540,000; in 1814, 2.616.000. It was also a period of endemic maritime war with France and Spain. For over a century the French had been striving to recover the ground lost during the civil wars. Richelieu. Colbert and their successors nurtured a colonial empire in Canada and the West Indies, and founded companies for the development of West Indian, Mediterranean and eastern commerce. But a large French merchant fleet did not materialize. Trade with the Levant, which employed about 800 ships annually, flourished. The West Indian trade at its peak employed about 500; but the French East India company never really flourished. Moreover, the carriage of a large part of French overseas trade remained in the hands of foreign shipowners. The inadequacy of French maritime resources and the country's extensive continental commitments handicapped French statesmen in their efforts to create a navy sufficiently powerful to win the dominion of the seas and secure the colonies. Canada was lost in 1759. The French merchant marine suffered heavy losses in wartime. and the colonial trade survived only under cover of the neutral flag. Dutch and Scandinavian shipping interests built up an extensive carrying trade in the mid-18th century between Europe and the French and Spanish colonies; but neutral shipping was severely curtailed during the Napoleonic Wars when Britain exercised an almost absolute dominion over the sea and strictly limited the employment by France of neutral bottoms. The failure of the French challenge left Britain predominant at sea.

When considering the employment of British shipping. the great transoceanic trades spring first to mind. The East India company's fleet numbered about 100. including some ships of 1,200 tons. the largest contemporary British merchantmen. They sailed to and from London. Those bound for India cleared the Thames one year and returned the next. The round voyage to China and back, an increasingly important aspect of the company's commercial activities as tea drinking increased, might occupy three years. The East Indiamen used the Cape of Good Hope route and their outward and homeward sailings were timed so that they could cross the Indian ocean on the monsoons. There was also the flourishing West Indies trade which supplied Great Britain with coffee. sugar and rum. much of it for re-export to Europe. and provided a market for British manufactured goods. The ships employed in this branch of overseas trade were of 200 to 500 tons, and they made one round trip a year, clearing from London, Bristol or Liverpool in the autumn and returning in the following spring. Before 1808, when the slavery act of 1807 came into force and slavery under the British flag was prohibited, many ships engaged in this trade visited the Guinea coast of Africa on the outward voyage to collect a cargo of Negro slaves.

Traffic with North America also gave employment to British ships. After the establishment of the independence of the United States in 1783, the British shipowners met with competition from the Americans in this trade and, in time of war especially. American vessels tended to predominate. Transatlantic traffic also included progressively expanding trades with Newfoundland and Canada, in both of which, as in trade with the United States: Liverpool was prominent. These long-distance trades, important though they were to the national economy, by no means account for the total employment of British tonnage. The Baltic and Mediterranean trades, even a-hen allowance has been made for the fact that foreign ships were permitted to share in them, probably employed as many British ships as did the long-distance trades, including vessels of 300 tons and more. Finally there were the coastal trades. Among these the coal trade between the Tyne and London in which some 500 vessels with an average size of 220 tons were engaged was rated high in the national interests, not only for its economic importance but as a nursery for seamen and as a pool of recruits for the Royal Navy. To complete the picture, and to prevent over-simplification, reference must be made to the numerous cross trades, including those between North America and the West Indies, Newfoundland and the Iberian peninsula, and to the existence of a considerable carrying trade between foreign ports.

The growth of British shipping coincided with changes in the structural organization of commerce. One such change in the 18th century was the decline of the old chartered companies. By 1800 the monopolization of a trade by one of these companies was exceptional; in fact, the East India company's monopoly over trade with the east which lasted until 1813 survived longer than any of the others. The chartered companies had been of great service in the establishment of overseas commerce when corporate trading had provided some degree of security for merchants. The regularization of the channels of trade and the support provided by British diplomatic representatives abroad reduced the need for the companies and they gradually fell into disuse. Commerce was conducted by small firms and partnerships. Another change which took place over the same period was a growing differentiation between merchants and shipowners.

In the early years of the 18th century merchants were often the owners or part owners of the ships in which their goods were carried; in its closing years shipowning was a business distinct from trading, a fact which the General Shipowners' society, founded in 1788, was at pains to emphasize. The interest of the shipowners was the carriage of other people's goods. In this increasingly complex and expanding world of shipping, subject as it was to the dangers produced by mar quite apart from those inherent in the normal navigational hazards, a stable marine insurance market was an essential element. This was provided in the 18th century by the underwriters who operated at Lloyd's and other London coffeehouses and, to a lesser degree, by provincial underwriters. The contribution made by the growth of sound insurance to the development of British shipping can hardly be exaggerated. A comparison between the dislocation and loss of confidence which resulted from an enemy swoop upon the Smyrna convoy in 1693 and the ability of shipping and commerce to withstand the strain of the Napoleonic Wars, and even to increase in spite of the heightened risks, is a measure of the significance of reliable marine insurance.

The regularity of ocean voyages also reflected the progress made in navigation since the 15th century. In 1731 the cross-staff and its successor the astrolabe were superseded by the sextant, the invention of John Hadley. which reduced the errors in astronomical readings resulting from the motion of the ship. The problem of assessing variation had also been overcome. The determination of longitude at sea was not practicable until the 18th century. The lunar method was known, but its application was prevented by the inaccuracy of instruments and it could not be employed until after the invention of the sextant. A simpler method depended upon the possession of an accurate clock. In 1735 John Harrison made a chronometer of great reliability and its successful employment by Capt. James Cook on his second voyage of discovery (1772–75) demonstrated finally the conquest of this problem. Over the centuries a great body of information relative to winds, currents and coast lines had also been built up. This information was incorporated in reliable charts and sailing directions which were more generally available than hitherto. The extent to which these more certain methods of navigation were employed by merchant marine skippers is difficult to measure. No provision as yet existed for examining the competence of the masters and officers, and it is probable that many of them were dependent upon rule of thumb methods and experience. The incidence of shipwreck was high. The government took some steps to supervise shipping, establishing, for instance, in 1787, a compulsory register; but not until 1850 did it accept any responsibility for the competence and discipline of the merchant service.

10. The Last Days of Sail.—The history of shipping in the 19th century is dominated by the transition from sail to steam and from wood to iron. Yet it was in some respects the age of the sailing ship's greatest achievements. There was little advance in ship design during the 18th century, but in the 19th century British and American ship designers were driven to experiment boldly when faced by the stimulus of Anglo-American rivalry and the challenge of steam. The American shipping industry had been nurtured in the New England states during colonial days! and it grew to maturity in the 18th century when the trade with the West Indies had flourished. The establishment of independence denied American ships legal entrance to the British West Indies under the terms of the navigation acts; but American shipping was sufficiently virile to flourish in other branches of commerce and an extensive trade with Europe was built up. It suffered as did all neutral shipping after 1793, and was further damaged by the War of 1812. By 1815, the total United States tonnage was half that of Britain. In ship design the Americans were ahead. British merchantmen were constructed with an eye to cargo capacity. Their beam was excessive in proportion to their length, and speed was sacrificed. As long as British supremacy was assured, there was little stimulus to change.

But during the war. the Americans developed fast sailing brigs and schooners, and after 1815 enterprising companies like the Black Ball line instituted regular packet services between American ports and Britain. They established a monopoly over the transatlantic passenger and mail services which was not seriously disputed by the British until 1838. The emigrant traffic also fell in great measure under the control of American shipowners. American tonnage increased rapidly in the first half of the 19th century. By 1850 it was, if lake and river craft are included, about 750,000 tons less than the British; by 1861, 250,000 tons less. The United States challenge must not be judged solely in terms of figures.

With vast quantities of softwood at their disposal American shipbuilders turned out cheaper and faster vessels than the British. and their designers continued to experiment. Their greatest achievement was the design of the Californian clipper. The discovery of gold in California in 1848 was followed by a great demand for passages from the Atlantic to the Pacific coast around Cape Horn. The clippers were built to meet this demand. They combined strength with speed and in all-round performance were superior to all contemporary sailing ships. The creation of these vessels occurred when a strong body of British political opinion favoured, for a variety of reasons, the repeal of the navigation acts. Despite opposition from sections of the shipping interests, repeal came in 1849. British shipping was thus exposed to foreign competition in the previously protected trades. Among those now thrown open was the China tea trade. The American clippers invaded it. In 1850 the "Oriental" was chartered at Hong Kong to carry tea to London. The passage was completed in the record time of 97 days. The spur of competition such as this stimulated the design in Great Britain of ships which could match the Americans. The result was the construction of the Blackwall frigates and the China clippers. In 1856 the "Lord of the Isles" beat two American clippers in the race from China to London. This ship was built of iron. Iron had still to win general acceptance as a shipbuilding material. Most of the British tea clippers in the 1850s and 1860s were wooden ships or else were of composite build. Composite ships were iron-framed and planked with wood. They could stow more cargo than wood-built ships and were fast sailers. The timber used was hardwood. This preserved the tea cargoes better than did softwood, thus giving the British clippers a distinct advantage over the Americans.

In 1861 the American Civil War began. American shipping was disrupted. After the war, American capital and energies were poured out into the westward expansion across the continent. The tonnage of the United States declined as a result. Another contributory factor to this decline was the general transition in the same period to iron-built ships. The American iron industry was not yet sufficiently developed to enable a major building program to be undertaken. Meanwhile, for two decades British clippers such as the "Thermopylae" and the "Cutty Sark" continued to demonstrate their sailing qualities in the China and Australia trades; but the era of the sailing ship was approaching its end. Already the steamship could undertake long voyages at an economic rate. Its employment in the tea trade was postponed by the belief that tea transported in a steamship would be tainted. In 1863 the steamer "Robert Lowe" delivered a cargo of tea in good condition at London. After 1880 most of the China clippers were transferred to other trades. The sailing ship held its own on'the Australian and New Zealand runs until the last decade of the century; it still engaged in some trades until the early years of the 20th century.

11. The Great Transition.—The construction of the steam engine was the starting point of the transition from sail to steam. Before the end of the 18th century the use of the steam engine to drive ships was recognized as possible in Britain. France and the United States. The experiments of William Symington led to the building of the "Charlotte Dundas." a steam paddle tug which was in service on the Clyde in 1802. Another British pioneer, Henry Bell, produced in 1812 the first successful passenger steamer built in Europe, the "Comet." The American Robert Fulton constructed the "Clermont" which began a regular service between New York and Albany in 1807. The next step was a transatlantic voyage. In 1819 the "Savannah" crossed from west to east in 29 days. This voyage can hardly be rated as a steamship crossing, since the "Savannah" was a sailing ship equipped with auxiliary engines for use when the wind failed. She was only under steam for about 85 hours. Four British steamships crossed in 1838, the most famous, the "Great Western," taking only 15 days between Bristol and New York. This achievement was followed next year by the foundation of the British and North American Royal Mail Steam Packet company (now the Cunard line) which began a regular mail and passenger service between Liverpool and North America in 1840. The paddle steamers of the Royal Mail company broke the monopoly of the American packet service in the Atlantic. The ensuing rivalry between Samuel Cunard and E. K. Collins of New York for the mail contract ended in victory for Cunard by 1855. The success of steamships in the Atlantic led to the establishment of other companies for the carriage of mail and passengers. In these specialized services. the sailing ship was steadily eclipsed. As a carrier of cargo in the long-distance trades, the steamship had yet to prove itself. Its heavy consumption of coal entailed expensive running costs. The shortage of coaling stations excluded it from certain routes. The success of the steamship was assured by three technical developments: the use of iron as the chief shipbuilding material; the invention of the

TABLE I.—*Number and Tonnage of Merchant and Fishing Vessels Sunk by Naval Action 1914–18*

Country	Number				Tonnage			
	Periods			Total (51 months)	Periods			Total (51 months)
	24 months from Aug. 1, 1914	6 months from Aug. 1, 1916	21 months from Feb. 1, 1917		24 months from Aug. 1, 1914	6 months from Aug. 1, 1916	21 months from Feb. 1, 1917	
					000 tons			tons
United Kingdom:								
Merchant	517	270	1,692	2,479	1,659	829	5,271	7,759,090
Fishing	297	97	281	675	35	12	25	71,765
France	91	171	435	697	184	144	571	899,358
Italy	88	119	414	621	136	182	528	846,388
United States	..		134	134			341	341,394
Other Allies	59	51	262	372*	101	74	438	612,781*
Neutrals	207	374	955	1,626†	419	541	1,360	2,320,038†
Totals (all countries other than enemy countries)	1,349	1,082	4,173	6,604	2,534	1,782	8,534	12,850,814

*Excludes and † includes 118 ships of 298,343 tons which when sunk belonged to countries which were neutral but subsequently became allies.

screw propellor; and the perfection of the compound engine. The tonnage capacity of iron ships was much greater than that of the largest wooden ship which could be built. I. K. Brunel's "Great Eastern" of 18.914 tons launched in 1858 may have been a commercial failure, but the construction by the great engineer of this vessel justified the claims of iron to be considered the best shipbuilding material. While the "Great Eastern" was on the stocks. the compound engine was perfected. This cut the consumption of coal. In 1866 the Holt brothers of Liverpool experimented with an iron-built vessel fitted with compound engines and a screw propellor on a voyage to China. The voyage, a technical and commercial success, ensured the ultimate triumph of the steamship as an ocean cargo carrier.

The opening of the Suez canal in 1869 clinched the issue. The canal and the Red sea were unsuitable for sailing vessels. The use of this route by steamships gave them an immense advantape over the clippers. With the establishment of coaling stations along the route, the steamship had no rival. From this time onward. a series of rapid developments—the transition from iron to steel, the adoption of twin screws. the introduction of the triple expansion engine. the replacement of coal by oil and other technical advances—combined to make maritime transport quicker. safer and cheaper than at any other period in history. The triumph of steam coincided with a remarkable growth of British tonnage. In 1880 the mercantile marine of the British empire exceeded the total tonnage of all foreign merchant fleets. Its steam tonnage of 2,949,282 tons was more than double that of the rest of the world. This pre-eminence was due directly to the technical revolution. Great Britain's coal resources and the highly developed state of the iron industry enabled it to take immediate advantage of the changes and to outstrip all other countries. World trade generally was expanding, and the British tonnage found full employment in an extensive carrying trade. British ships predominated the world over.

12. The Organization of Shipping. — The transition to steam and the building of larger ships caused changes in the structure of the shipping industry. Tramp steamers, that is. vessels which have no regular itinerary but which can be chartered for a definite period for a voyage or series of voyages. continued to be owned by small partnerships or by individuals. Modern tramps may be owned by a large company: however. since no costly organization is required, the small shipowning business still has a place where tramp steamers are concerned. The most important international centre for the transaction of business relative to the chartering of tramps is the Baltic Mercantile and Shipping Exchange. Ltd. (the Baltic) in London, founded in 1883. It derived its name from the Baltic coffeehouse where such business had been previously transacted, though in a much simpler form. The agreements between owners and charterers are arranged by shiphrokers.

The steamship led to the introduction of liner services. Liners differ from tramps in that they provide a regular service between fixed ports in accordance with an advertised timetahle, a thing that was impossible during the days of sail. To maintain this regularity, a complex and expensive organization is necessary. Many of the famous modern liner companies originated in the 19th century as small concerns which specialized in the carriage of mail. They have tended to increase in size, to unite with one another, and to pool their financial interests by the exchange of shares. Their interests too are much wider. Intense competition between rival liner companies resulted in the development of the conference system. In effect. this was an agreement between lines operating the same services. whether for passengers or cargoes. to standardize their tariffs for an agreed period and to offer deferred rebates to regular shippers on condition that they did not use vessels belonging to companies outside the conference lines. This system has been frequently attacked by shippers, and has been investigated by the governments of Great Britain and the United States. It was. and is. defended on the grounds that the provision of regular services involves costly overheads and that the lines are therefore entitled to a measure of protection from casual interlopers.

One of the best-known conferences is the North Atlantic Passenger conference which regulates the fares and services on the transatlantic routes. Modern competition from air travel gives a new significance to this method for the protection of common interests of the passenger liner companies. A specialized type of vessel. neither liner nor tramp, is the tanker which is designed to carry liquid cargoes. generally oil. in bulk. Between 1914 and 1939. tanker tonnage rose from 1,500,000 tons to 16.000.000 tons. because of the increased demand for oil as a ship fuel and for industrial purposes. Many tankers are owned by the oil companies themselves. Others are of the tramp type. They offer their services for the carriage of liquids wherever required, and are usually owned by Norwegians. During the war tanker tonnage rose again. In view of the importance of fuel oil. the part played by the tanker in world economy is likely to increase further in the future.

13. International Rivalry. — During the first decade of the 20th century, the British shipping industry began to feel the effects of competition from foreign liners and tramps. The Scandinavians, particularly the Norwegians, became keen competitors for the general carrying trade German. French. Italian. Dutch and American liners. many of them subsidized by their governments,

TABLE II.—*Losses of Merchant Ships, World War II, Sept. 1939–July 31, 1946**
(1,000 gross tons and over)

Flag	No.†	Gross†
British	2,121	11,677,475
French	189	914,804
German	694	3,241,503
Greek	225	920,098
Italian	491	2,145,491
Japanese	1,175	5,261,663
Netherlands	252	1,287,005
Norwegian	486	2,035,078
Panaman	115	607,642
Swedish	162	485,790
United States	605	3,932,626
Other	395	1,376,220
Total	6,910	33,885,395

*From war causes alone. Only those vessels are included whose identity was definitely established Vessels are charged to the flag under which they operated, regardless of actual ownership. Data, especially for axis losses. are not necessarily complete. Includes vessels on charter to the military services. †Includes 9 ships totaling 29,427 tons sunk by

TABLE 111.—*Allied and Neutral Shipping Sunk by Axis, World War II, Sept. 1939–Aug. 1945**
(Gross tons in 000)

Year	Submarines		Aircraft		Mines		Surface craft		Unknown and other		Total	
	No	Gross	No	Gross	No	Gross	No	Gmss	No	Gross	No	Gross
1939	103	421	10	3	83	257	15	61	4	4	215	746
1940	440	2,125	177	568	201	512	96	519	78	188	992	3,912
1941	429	2,162	323	970	108	230	102	493	167	332	1,129	4,187
1942	1,155	6,250	143	705	48	103	85	400	139	248	1,570	7,706
1943	462	2,579	76	424	37	109	10	48	10	43	595	3,203
1944	132	773	19	121	25	95	13	27	8	28	197	1,044
1945	54	263	5	37	19	79	5	10	6	14	89	403
Total	2,775	14,573	753	2,828	521	1,385	326	1,558	412	857	4,787	21,201

"Includes merchant and fishing vessels of all tonnages, but excludes merchant vessels employed in military services.
Source: Dept. of Deiense, *Aircraft and Merchant Shipping in World War II* (Oct. 7, 1949).

started to compete with British liner companies on all the chief routes. Nevertheless, by 1914 the British flag covered nearly half the world's total tonnage; and more than half the world's maritime trade, including a third of that between foreign countries. was carried by the British merchant fleet. its greatest rival in terms of tonnage was the German marine. The United States came next; the Japanese merchant fleet mas rising rapidly. Shipbuilding was not the only form of competition. Many nations excluded foreign ships from their coasting trades, and extended the prohibition to trades between one possession and another, even those separated by miles of ocean. The United States, for instance, reserved the trade between New York and San Francisco, ,Calif., which after 1914 passed through the Panama canal, to its own ships. and applied the same rule to trade between New Tork and Honolulu, T.H.

The diversion of large numbers of British merchantmen to war duties and the losses sustained by belligerent and neutral merchant fleets caused a general scarcity of tonnage during World War I. This situation created a favourable opportunity for neutral states to expand their merchant navies with the intention of making themselves self-sufficient in the matter of sea-borne trade. The British and U.S. need for tonnage between 1914 and 1918 resulted in a great program of shipbuilding by them. After the war. it was found, especially as international trade tended to contract, that world tonnage was in excess of world needs. Shipping everywhere suffered a serious depression. By 1922 about 11,000,000 tons were idle for want of employment. The depression hit both liners and tramps. In Great Britain. the tendency toward the amalgamation of different liner companies was accelerated; other countries subsidized their lines heavily to keep them in operation. Tramp shipping suffered heavily. State subsidies to enable merchantships to compete economically in the struggle for freights became the fashion. The British government had to fall into line. In 1935, after many small firms had been compelled to close, the British Shipping act was passed. This authorized the payment of a subsidy to tramp steamers for every voyage undertaken below a standardized freight rate. Shortly afterward, world trade began to expand. and the subsidy was no longer necessary. The situation was changed by the outbreak of World War II in 1939. The demands which it made upon shipping were enormous. British shipping was requisitioned in 1940, and charter agreements were made with Allied governments.

The entrance of the United States into World War II was followed by a colossal building program there. At the end of hostilities, the American marine was the largest in the world. During the war, the employment of Allied shipping was controlled successively by the Combined Shipping Adjustment board and the United Maritime authority. The United Maritime Consultative council was established in March 1946 for the voluntary pooling of shipping for relief work over a limited period. Meanwhile those maritime nations whose shipping had been depleted between 1939 and 1945 began. by building and purchase, the restoration of their merchant fleets. Shipping losses in World Wars I and II are shown in Tables I. II and III.

14. Maritime Disasters. — In the last 100 years maritime travel has become much safer. Improvements in ship design and the introduction of radio and radar navigational aids have contributed to this fact. With the support of marine insurance companies. persistent efforts have been made to enforce certain regulations. such as Plimsoll's compulsory load line. The international adoption of safety devices and of minimum standards of seaworthiness for vessels has been the subject of discussion between the principal maritime nations at conferences such as that held in London in 1948. At both the national and international level, safety at sea has become the business of the governments of the maritime powers. Disasters which occur are investigated carefully and recommendations are made on the basis of the lessons learned therefrom. Collision, fire and grounding have been, and continue to be, responsible for the majority of steamship losses (see Table IV).

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TABLE IV.—*Some Major Steamship Disasters*

Date	Name	Flag	Circumstances of loss
1854	"Arctic"	U.S.	Sunk after collision with French steamer in Atlantic. As a result side lights, *i.e.*, red on port bow, grcen'on starboard, were made compulsory.
1873	"Atlantic"	British	Sunk on the breakers off Meagher's Island on between Great Britain and United States. This accident reflected the need for more careiul navigation.
1912	"Titanic"	British	This White Star passenger liner oi 46,000 tons, the largest ship afloat, vas lost on her maiden voyage after striking an iceberg in the North Atlantic. Lifeboat accommodation, ior 1,178 persons, was inadequate; passengers and crew numbered 2,224 of whom 1,513 were lost.
1914	"Empress of Ireland"	British	The most serious collision oi the first hali of the 20th century was that between this Canadian Pacific ship and a Norwegian collier in the St. Lawrence, in a fog. The "Empress': sank with the loss of over 1,000 lives.
1941	"Normandie"	French	The largest oi the inter-war Atlantic liners, of 86,000 tons, was put under restraint in New York harbour in 1940 by the U.S. authorities when France fell. She was destroyed there by fire.
1947	"Ramdas"	Indian	A qoo-ton ferry steamer sank in a storm in Bombay harbour, India; about 626 lives were lost.
1949	—	—	More than 600 Chinese were missing and assumed dead after a collier, a freighter and a liner carrying war refugees collided and sank.
1949	"Magdalena"	British	This Royal Mail liner of 17,500 tons ran aground near Tijucas Islands, 20 mi. S. of Rio de Janeiro. All the passengers were saved, but the ship was a total loss.
1952	"Champolion"	French	This 12,546-ton liner was wrecked off Beirut, Lebanon; 17 lives were lost.
1953	"Empress of Canada"	British	A Canadian Pacific liner which capsized in Gladstone dock, Liverpool, after having caught fire. Refloated in June 1954, she was sold to a firm oi Italian ship breakers.
1953	"Princess,, Victoria	British	This cross-channel motor ship of British railways foundered in the Irish sea on passage from Stranracr to Larne during a severe northerly gale, with loss of 128 lives. It was the most serious peacetime disaster to a British merchant vessel in terms of casualties for nearly 40 years.
1956	"Andrea Doria"	Italian	Had been on the North Atlantic service of the Società Italia di Navigazione since making her maiden voyage in 1953. She collided with the "Stockholm" of the Svenska Amerika linien, and sank off Nantucket Island, with loss of 52 persons.

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SHIPPING, WAR CONTROL OF: *see* WAR CONTROL OF SHIPPING.

SHIPPING BOARD: *see* UNITED STATES SHIPPING BOARD.

SHIPPING INDUSTRY. The function of the shipping industry is to transport goods and persons across water, that is, across the world's oceans or along its coast lines, or through its inland waterways. The chief work of the shipping industry is to provide, man and manage the vessels that carry most of the goods entering into world trade; and also to provide and maintain the ancillary services necessary for the receiving of cargoes and for their onward dispatch at ports of destination. As a transport industry it differs from most other industries in that it does not manufacture products to sell but exists to provide a service; and it performs this function almost entirely in an international field —the high seas—for the most part outside the territories of the shipowner's country of domicile. Shipping is an essential element in world commerce and is highly competitive on an international scale. It is also an important factor in the economy of the major trading nations; and, especially since the beginning of the 20th century. the possession of a merchant fleet has become important as a strategic necessity.

The shipping industry had its origin in the Industrial Revolution and its consequences—the invention of the marine steam engine screw propulsion and the use of iron and later steel, for shipbuilding. Although the transition from sail to steam was gradual, the early steam navigation companies were the real founders of the shipping industry. The great expansion of world commerce that followed the Industrial Revolution called for a new system of ship management and shipping services, by which the ship became an instrument of world trade and an essential service to commerce, rather than a private venture on the part of a merchant trader or shipmaster or shipowner-merchant. After the opening of the Suez canal in 1869. which sounded the death knell of the sailing ship, the expansion of the volume of world sea-borne trade became enormous. and the development of the mechanically propelled merchant ship, and its continual increase in size, efficiency and numbers made this possible.

Table I demonstrates the expansion of the world fleet of mechanically propelled merchant ships, and the decline of the sailing ship in the period between 1886 and 1935; Table II illustrates the subsequent development of the world merchant fleet (see *World Merchant Fleets* below). Though it is not possible to provide comparable statistics of the increase in the volume of world sea-borne trade over the same period. particularly for the 19th century, League of Nations statistics estimated that by 1929 the amount of world sea-borne trade had reached a level 35% higher than that in 1913. In the depression of the early 1930s the figure dropped at one time almost to the 1913 level, but by 1937 it had fully recovered to the 1929 level. According to United Nations statistics, the volume of sea-borne trade reached in 1937 (490,000,000 metric tons) had again been recovered by 1948. By 1953 the tonnage involved in sea-borne trade had further increased by over 40%.

For the early history of maritime commerce, *see* SHIPPING, HISTORY OF, and TRADE ROUTES. (The history of various types of vessels is covered under SHIP.)

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I. MAIN ELEMENTS OF SEA-BORNE TRADE

While the volume of sea-borne trade has been steadily increasing after the introduction of steam navigation, its nature and direction have been subject to changes The main elements of seaborne trade are food and raw materials exported by primary producing countries and manufactured goods and capital plant exported by industrial countries in exchange The shipping industry exists to enable these goods to be interchanged. but the greater part of the cargoes carried by merchant ships consists of basic raw materials (such as coal. oil, mineral ores and fertilizers) and foodstuffs (particularly grain. sugar, rice, vegetable oils, fruit, meat and dairy produce).

The growth of the world's population and the expansion of industrial development continues to make additional demands on the shipping industry. The process is best illustrated by taking the development of British trade and shipping. The invention of the steam engine led to a world-wide demand for British coal exports, which increased from about 11,000,000 tons in 1870 to as much as 73,000,000 tons in 1913, not taking into account an additional 21,000,000 tons shipped overseas for use as ships' bunkers. After World War I the growth of motor transport and the development of diesel engines for industry and transport caused a decline in the demand for exports of United Kingdom coal, which amounted to about 36,000,000 tons in 1938, in addition to 10,000,000 tons for bunkers. Meanwhile, of course. the importation of petroleum products had already assumed large-scale proportions. By 1935 the United Kingdom was importing oil at the rate of 65,000,000 tons from the middle east alone.

Yet the demand for industrial energy was so great that Great Britain had also become a net importer of coal, and the continent of Europe as a whole was importing coal from the United States at the rate of about 30,000,000 tons a year. Another long-term development which can be traced is the increase of the requirements of the steel industry. For many decades British steelworks were able to rely on domestic supplies of native iron ore, but in the first half of the 20th century they had to draw more and more on supplies from sources such as Sweden, France, North Africa and Newfoundland. Demand for iron ore increased so rapidly after World War II that United Kingdom imports of iron ore rose from 11,500,000 tons in 1954 to about 15,000,000 tons in 1956, some of which had to be drawn from much more distant parts of the world. such as Venezuela, Brazil and Liberia, so that there was an additional load to be accepted by the shipping industry.

Parallel developments took place in the United States economy. Before R7orld War II the Cnited States was a prominent exporter of petroleum products to the rest of the world, but shortly after the war it became a net importer of oil. At the same time its coal export trade soared to new heights as a result of a deficiency of fuel in western Europe. The steel industry expanded so rapidly that it, too, could no longer rely on supplies of domestic ore, and a vast expansion of imports from Labrador, South America and Liberia began.

Technical and economic changes affect demands on the shipping industry, and basic trade routes are laid down according to the pattern of economic geography. It is the geographical position of sources of the principal commodities shipped and that of their main centres of consumption that chiefly shape the pattern of world shipping movements, although these are. of course, influenced by political and physical factors as well.

The chief grain-producing areas of the uorld, for example, are the United States and Canada, Australia, Argentina. the U.S.S.R. and France. India at one time was an exporter of wheat. but the growing population and rising standard of living of that part of the world have made India and Pakistan substantial importers of grain; much the same noa applies to the countries under Soviet influence, and the exportable surplus of France as often as not becomes a deficit. There is a steady flow of grain from the three principal exporting areas—North America, Australia and Argentina—to the continent of Europe and to Japan, as well as to most other countries in the world, but the largest importer of grain is the United Kingdom, as it is of most other foodstuffs. Britain's need for imported foodstuffs is indeed a staple element in seaborne trade, for it must rely on meat from Australia. New Zealand, Argentina and Uruguay; on fruit from South Africa, Australia, New Zealand, the Mediterranean countries, the West Indies and Central and North America; on dairy produce from Australia, New Zealand and Denmark; and on perishables from the near continent, particularly from France, Belgium and the Netherlands. Sugar comes mainly from Cuba, Mauritius and Queensland (Australia), which are the main exporters of this commodity to the rest of the world.

Of the sources of energy, oil is steadily surpassing coal in volume, but after World War II coal was a staple export from the United States to western Europe, mainly to Italy, France and the German Federal Republic, to Japan and to South America. The main oil-exporting centres after World War II were the middle east (Iraq. Iran. Kuwait, Saudi Arabia, Bahrein and other neighbouring oil fields) and Venezuela and the Caribbean area. The Soviet Union and the United States are prolific producers, but mainly for domestic consumption. Thus oil from the middle east flons to all parts of the uorld. the principal consumers being the United Kingdom and western Europe, with increasing consumption in India, Africa and the far east, the United States, South America and Australia.

Of industrial ran materials, mineral ores became predominant after World War II. The steel industries of the United States, the United Kingdom, the German Federal Republic and Japan are the greatest consumers of iron ore, which is imported from Labrador. West and h'orth Africa, India, Sweden (as a rule through Norwegian ports). Venezuela and other parts of South America Copper is imported by the major industrial countries chiefly from Rhodesia and Chile; tin from Malaya and Bolivia; lead and zinc from Australia. Bauxite, or alumina, the raw material for the production of aluminum. flons mainly from the Caribbean to the United States and Canada, and from West Africa and the south of France to the United Kingdom, Norway and other European producers. The produced metal is exported by Canada and the Gnited States in ingot form to other manufacturing countries particularly Great Britain, from which the finished manufactured products may be exported to all parts of the world.

Besides the principal commodities in the sea-borne trade mentioned above. many others are handled by the shipping industry in quantities exceeding 1,000,000 tons a year, and they include phosphates, iron and steel scrap, potash, nitrates and other fertilizers, pyrites, sulfur and sulfur compounds, basic slag, cement, rubber, aool, cotton, oilseeds and vegetable oils of various kinds, rice. coffee and so on. Other commodities, such as tea. jute, timber, tobacco. copra. salt, china clay, chemicals and other products are shipped by sea in large quantities; and a great variety of shipments of manufactures. machinery and processed goods are made possible by these imports.

II. SPECIALIZATION IN SHIPPING

It would be an oversimplification to suppose that international trade is mostly a two-way traffic between industrial manufacturing and primary producing countries, or even an interchange of manufactured goods between one country and another. Much of the world's trade is triangular in character, involving the shipment of raw materials from one country to another, where they are converted or processed for export to a third country. The rate and direction of flow of trade in various commodities, whether raw materials. foodstuffs or manufactured goods, is subject to continual change, which calls for considerable flexibility in the employment of ships.

The different types of goods carried by sea require, moreover, a wide variety of types of ships, and it is the business of the shipping industry to provide such vessels. The growth of international trade has thus encouraged the development of some specialization in shipping, nhich has taken various forms, such as the provision of ships designed to carry certain cargoes or to participate in certain trades along well-established routes.

1. The Liner and the Tramp.—The two main branches of the shipping industry are the liner business, and tramping. The essential difference between the liner and the tramp is that the former operates regular scheduled services on a predetermined trade route, whereas the tramp is prepared to carry any suitable cargo which offers from any part of the world to any other part of the world. The liner services are the railways of the oceans, running regular services at stated times between scheduled ports. and charging previously advertised tariff rates. The tramps are more like taxicabs or road transport operators. which may ply for hire or will contract to transport goods between any required ports, the terms being arranged by negotiation betu-een the parties on each occasion, or on a contract basis. The tramp system had its origin in the days when it was customary for the master to be o ner, or at least part owner, of his own ship. He would load it with a cargo of goods which he hoped to sell in some foreign country, and use the proceeds to buy a cargo which he could sell in another country or for which he could find a ready market at home.

As more regular trade developed between two overseas countries, such as that between the United States and the United Kingdom across the Atlantic, particularly with the advent of steam navigation, which gave greater assurance of regularity of communications. the steam navigation companies began to operate liner services. The liner services were. and still are, of particular value for passengers and mails, and for small traders not dealing in commodities normally consigned in shiploads. The shipper of commodities in bulk. such as grain or coal, naturally found it more economical to hire ships on the open market, offering his business of transportation to the lowest bidder, or buying and selling his commodity in the market where sea transport costs were for the time being cheapest. Thus the tendency is for tramp ships to be the carriers of homogeneous cargoes of commodities in bulk, while liners are principally carriers of heterogeneous cargoes, made up of hundreds of small consignments of goods of many kinds, as well as mail and passengers.

There thus grew up what is now a world-wide network of liner services between the principal ports of the world. The services link the metropolitan countries of the world with their overseas associates; they link the countries of Europe with the other continents. directly across the Atlantic to the eastern shores of North and South America. through the Panama canal to the western shores of America. the Pacific ocean, Australia and New Zealand; directly to North. West and South Africa and on to other parts of the world; or through the Suez canal to East Africa. the Indian ocean, the East Indies and the far east. They link the Cnited States in addition directly, or through the Suez and Panama canals, with Europe. South America, Africa and the countries of the Indian and Pacific oceans. They link Japan with Africa and America, India with Africa. China with India and. finally, by transshipment to coastal liner services they provide sea communications between practically all the seaports of the world.

The bulk cargoes carried by tramp ships also tend to flow in volume along regular routes from time to time, and where these coincide with regular liner services the liners will periodically pick up "parcels" of these commodities. particularly grain, but usually only in order to fill up holds that otherwise mould be empty.

2. Various Types of Cargoes. — The principal bulk cargoes have varying characteristics (liquid cargoes are in a category apart requiring specially designed ships and must be considered as a separate branch of the shipping industry). The normal dry-cargo tramp ship is adaptable in design. so that it is capable of carrying. as occasion arises, cargoes as different as iron ore, coal, grain. sugar. cotton or copra. Each of these cargoes has different characteristics. Owing to the difference in stowage factors (cubic capacity per ton) for example. a ship large enough to carry 10,000 tons of coal might be loaded down to its maximum draft with less thsn 5.000 tons of ore, and if it were to carry grain "shifting boards" would be necessary in the holds to prevent the cargo upsetting the stability of the ship by pouring over to one side when the ship rolled.

Different methods are used for loading and discharging different types of cargo. Cargoes shipped in cases, bales or bags must be handled by the ship's derricks or by shore cranes. and the same applies to cargoes of commodities like timber, steel or scrap. Iron ore and coal are discharged by grab, and grain by elevators or suction pipes.

3. Specialized Carriers. — Where any one commodity is carried in large quantities over regular routes. it becomes an economic advantage to build ships specially suited to the cargo concerned. and because of the vast expansion of world trade in bulk commodities the tendency is for specialized bulk-cargo carriers to be built. The specialized ore carrier is a typical example. Large numbers of these have been built since World War II. although they were in operation on the Great Lakes at the end of the 19th century. They rely entirely on shore appliances for cargo handling, not being provided with derricks. although some ore carriers designed for service to ports where shore-handling facilities do not exist are equipped with self-unloading gear. These, of course, are ultra-specialized.

Specialized ships such as ore carriers may still be divided into the two categories of liner and tramp. in that some of them are built by tramp ship-owning companies with the object of their being hired out. or chartered. to the shippers or importers of ore, usually on a long-term basis, while others are built and operated by the shippers or consumers of ore themselves. mainly the large steelworks. The latter vessels are liners in the sense that they are designed for and operate on regular routes between predetermined terminals, but they do not operate as common carriers and accordingly are better called industrial carriers. Several other industrial consumers of raw materials in bulk, such as major importers of sugar, newsprint, molasses, gypsum and chemicals, operate their own fleets of bulk carriers in a similar fashion. as well as hiring ships from tramp shipowners on the open market.

4. Tankers. — The transport of petroleum products by sea is a special branch of the shipping industry which has witnessed a vast expansion in the 20th century, particularly after World War II. Some indication of the rate of expansion is given by comparison of world tanker tonnage in 1939 and 1956. In 1939 the world tanker fleet totaled 11,586,000 tons gross, comprising 16.9% of the total tonnage of all merchant ships. By June 1956 the tanker fleet had reached a total of 28,211,000 tons gross, representing as much as 26.8% of the total world fleet then in existence, Measured in terms of dead-weight tonnage the world tanker fleet rose from 16,000,000 tons in 1939, to more than 23,000,000 tons in 1946; yet the 1946 figure had been doubled by 1957.

Liquid cargoes such as crude oil or gasoline 'need ships heavily subdivided into compartments in order to restrict the movement of the free surface derived from the motion of the ship at sea which would otherwise upset the stability of the vessel. No ship-borne cargo-handling facilities in the way of derricks or cranes are required, since the oil is pumped on board through pipelines at the oil terminals and discharged through pipelines by means of the ship's own pumping system at ports of destination. Owing to the inflammable nature of the cargo. special precautions have to be taken against the risk of fire. Before World War II the greater part of the world tanker fleet was owned and operated by the major oil companies, operating as industrial carriers, but they depended for their marginal requirements on the chartering of tramp tankers.

After World War II, despite the expansion of their own fleets, the oil companies had to rely to a much greater extent for their ocean transport on tankers operated by tramp companies. generally on a long-term time-charter contract basis. A particular feature of the tanker trade is that it is almost entirely a one-way traffic, and since tankers are not suitable for carrying any other type of cargo without structural alteration, the outward journey has to be made in ballast. An ekception is made for iron ore, which has a low stowage factor. Sweden. an ore-exporting and oil-importing country, evolved a ship capable of carrying an inward cargo of oil and an outward cargo of ore. As a result of the exploitation of the Labrador ore fields. this combined oil and ore carrier mas increasingly built after World War II. In the winter season the ore-loading ports of Labrador are closed by ice, so that these specially designed ships can find alternative employment as oil carriers in the off season. Other liquid cargoes besides oil products may be carried in considerable bulk. and there are tankers used only for goods such as molasses. caustic soda and other chemicals, wine (and sometimes water), or for semiliquid cargoes like asphalt and bitumen, and even gas in liquid form.

5. Coastal and Short-Sea Shipping. — Most of the ocean-going types of ship have their counterparr on a smaller scale in the coastal shipping industry. whose function and extent naturally varies in different parts of the world according to geographical conditions. Coastal shipping (sometimes referred to as cabotage) is another branch of the shipping industry, since its services are generally confined to the coastal waters of a particular country. In countries with continental coast lines. such as the Cnited States, Australia and India, for example, coastal shipping may not differ operationally from ocean-going shipping, and in the United States

the term is extended to include the intercoastal trades between the Pacific and Atlantic coasts via the Panama canal. and the noncontiguous trades between continental America and outlying areas such as Hawaii. In Europe. where national coast lines are comparatively short, and the restriction of coastal trades to ships of the national flag is not practised, coastal shipping has a more international character.

In the United Kingdom. for example, there can be distinguished the purely coasting trade, plying solely among the islands and along the coast of Great Britain; the home trades. which ply between the United Kingdom and the continent of Europe within the limits of Brest, in France, and the Elbe. in Germany; and the short-sea trades, between the United Kingdom and Scandinavia, the Baltic sea and the Mediterranean. Some shipping companies, of liners. tramps or tankers, may operate in all of these trades. while others may specialize in any one.

In the coasting and short-sea trades there are also many specialized vessels such as cross-channel passenger ships, train ferries, ramp-loading or roll-on roll-off motor vehicle transports, ships specially designed for container traffic and the like, as well as colliers and tankers. These tend to be operated by companies specializing in particular routes over which traffic is heavy but localized. As these services often form sea links between or extensions of railway systems, the railway companies often operate them. In fact, the coastal shipping industry may be regarded as complementary to the inland system of transport communications. as well as a link with neighbouring countries; and a most useful characteristic of the coastal ship is its ability to load cargo directly from the ocean-going vessel for transshipment along the coast and distribution to smaller ports whose depth of water or lack of facilities precludes the direct approach of the larger ship.

6. Inland Waterways. — The shipping industry also includes transport services along rivers and inland waterways. Vast quantities of materials are shipped along waterway systems such as those of the Mississippi, the Amazon. the Niger and the Rhine, sometimes penetrating thousands of miles into the heart of a continent.

(See also WATERWAYS, INLAND; INLAND WATER TRANSPORT.)

7. Ancillary **Services.**—At the port. where the sea transport and inland transport systems meet, many ancillary services must be provided for ships. such as towage, stevedoring. warehousing, replenishment of stores. repair and maintenance and the like. At this point industrial practice varies widely between different ports. the various services being provided by independent contractors, by the port authority or by the shipping companies themselves. In many ports, particularly where large liner companies operate, the companies have their own subsidiary organizations which provide such services. not only for their own ships but also for others. Some of the larger shipping groups operate or control fleets of tugs, loading and discharging facilities and labour, warehouses and refrigerated stores. lighterage and land transport, and even provide for the building. repairing. equipment and maintenance of ships for themselves and for other shipowners.

Inland waterways and seaports must be kept clear by dredgers, and in northern waters which freeze in winter icebreakers must be used to clear shipping lanes; salvage services must be provided for clearing wrecks and other obstructions to navigation and for rescuing ships which have broken down; and cable ships must be provided to maintain telegraphic communications between all parts of the world. All these maritime services. essential to the operation of international sea-borne trade. are part of the shipping industry. However. the fishing industry, including whaling. may be regarded as a separate maritime activity unconnected with the commercial operation of merchant ships. (See FISHERIES; WHALE FISHERIES.)

III. SHIP OPERATION

The essential differences between the liner and tramp sections of the shipping industry. namely in the kind of transport service they perform, have been described above. As the carrying performance of liners and tramps differ, so do the operational organization and methods of the companies that run them.

1. Liner Operation. — The growth of liner services resulted from the introduction of steam navigation, which enabled ships to maintain regular services at predictable intervals, mechanically propelled ships being much less dependent than sailing ships on the vagaries of wind and tide. A sailing ship, wherever bound, did not ordinarily sail. either with general merchandise or a bulk cargo, until its holds were full. Sailing dates were therefore uncertain. and arrival dates even more so. The merchant was obliged to ship his goods in speculative anticipation of the state of the market at the time of their arrival at destination, and shippers of small consignments or parcels of cargo were even more uncertain of being able to deliver at a specified time. Fast sailing ships (such as those of the American Black ,Ball line) were actually the first to attempt regular liner services across the North Atlantic early in the 19th century, but it was not until the coming of the steamship that such services became firmly established.

The possibility. with liner steamships, of regular sailings from a wider range of loading and discharging ports. with a guarantee that ships would sail whether full or not. and the development of more reliable postal and, later. telegraphic communications, allowed much more international business to be done. particularly by traders wishing to send small consignments of goods to various destinations at frequent intervals or even only occasionally. Thus liner cargoes are usually composed of a wide variety of general merchandise, of differing values. nature and quantity, including material that does not customarily move in shipload lots along the trade route concerned. The first modern liner services naturally followed the direction of the greatest demand. The Cunard line started the first regular steamship liner services to the United States in 1840, and in the same year the Peninsular and Oriental Steam Navigation company began a liner service to the Mediterranean area. In 1842 the Royal Mail Steam Packet company (now Royal Mail lines) started a regular steam packet service to the West Indies. with the aid of a government mail subsidy.

The operator of a liner service has special interests in the particular trade route that he caters for. The design and performance of his ships will be directed toward fulfilling in the most economical way possible the requirements of shippers using his services. Some liner routes, for example, like those between the United Kingdom and Australia and New Zealand. have to cater for a large proportion of refrigerated cargoes such as meat and dairy produce, as well as wool and parcels of grain or base metals, in the direction of Great Britain. and for machinery and motor vehicles and other manufactured goods in the opposite direction. The requirements of liner trades on any particular route range widely in character and fluctuate in quantity. They are apt to be shipped by numerous individual exporters and consigned to no less numerous individual consignees. The collection of such consignments and their assembly into the ship at the loading port, or ports, and their distribution at the ports of discharge obviously require an extensive. permanent organization at either end of the liner route; and the liner company must have staff and offices at the ports that it serves. although in some of the less active ports these functions may be carried out by agents acting for one or more liner companies. Besides this, the services of forwarding agents or travel agents must be employed for soliciting cargo or passengers from inland centres sometimes far removed from the ports of shipment. and it must always be possible to arrange for the transshipment or onward movement of cargo and passengers from terminal ports to eventual destination.

2. The Conference **System.**—Not only do the liner companies provide regular and frequent services between different parts of the world for the carriage of every conceivable kind of cargo in consignments large and small, but they are prepared to do so at previously advertised fixed charges. They are enabled to do this by means of the liner conference system, which first began to be practised in the United Kingdom-Calcutta trade in 1875. The object of the conference system is to regulate uneconomic competition. The shipping companies of different ownership and nationality that operate services between the same range of ports form a conference agreement to regulate the freight rates that they will charge for each type of goods carried; and in some cases the agreement also allocates a specified number of sailings to each company. Coupled with this agreement there is generally a deferred rebate system by which regular shippers of goods by conference vessels receive a rebate of a percentage of the tariff freight rate. payable after a period of proved loyalty, provided they use conference vessels exclusively.

The shipping conference system has sometimes come under attack as tending to create monopolies and to restrict competition against the public interest. After investigations, however, the evidence has weighed in favour of the conference system (which in the United States is subject to regulation and approval by the maritime administration). It has been felt that no combination of shipping companies can force unreasonable freight rates on shippers, since under those circumstances an outside company will step in to provide a genuine service at reasonable rates; and. on the other hand, shipping companies that provide regular sailings with good ships and maintain staffs and organizations in ports to handle and dispatch cargoes, irrespective of whether trade is good or bad, are entitled to some protection against the casual ship that picks up an occasional cargo at cut rates. It is to the advantage of the shipper that through this system he can rely on a well-managed service, running ships that will carry any desired quantities of his goods at predetermined rates, and that these rates are not usually changed without at least three months' notice.

3. Tramp Operation.--Unlike liners, tramp ships do not provide scheduled sailings between predetermined ports. and they are generally used solely for the carriage of bulk commodities, or homogeneous cargoes, in whole shiploads. There is no fixed tariff of freight rates and no conference system. Every voyage of a tramp ship is the subject of a separate negotiation between the owner of the ship and the owner of the cargo, and its terms are generally arranged through a shipbroker in one of the shipping exchanges located in various parts of the world, but mainly in London and New York.

4. Brokerage and Chartering. — Most of the world's tramp ship chartering business is carried out in the Baltic Mercantile and Shipping Exchange. Ltd., in London, commonly known as the Baltic. This exchange had its origins in the early 18th century, when merchants and ships' captains were accustomed to meet in coffeehouses (the most famous of which was Lloyd's) to arrange cargoes for ships. The Virginia and Baltic, and the Jerusalem were the two coffeehouses chiefly patronized by merchants and captains until the business was moved to the Baltic tavern in 1810. In 1823 the first rules and regulations of a "Baltic club" were drawn up, limiting membership to 300 and providing for accommodation and refreshments. At that time tallow mas the principal commodity in the Baltic trades, but with the repeal of the corn laws in 1846 the buying and selling of grain cargoes became one of the chief activities and called for larger premises. In 18j6 larger premises were taken in South Sea house and two years later membership had doubled.

The opening of the Suez canal and the growth of steam navigation caused a further expansion of trade and in 1903 the Baltic exchange in its present form was opened in an entirely new building. After World War II air chartering was added to the exchange's activities. and in 1956 a new building was opened as an extension to the 1903 structure, doubling its size.

On the floor of the Baltic exchange brokers circulate daily, some of them representing the shippers of cargoes such as grain. coal or ores who require shipping space for their movement, and others representing the owners of tramp ships wanting further employment. When seeking a ship for the carriage of a cargo, the broker naturally looks out for a ship of the right size and specifications, ready at the right time and in the right port, and prepared to carry the cargo at the cheapest possible rate. Conversely, the owner's broker must attempt to anticipate the charterers' requirements by having his ship at the right place at the right time, but he must also try to obtain the highest freight rate possible without running the risk of losing the contract to a competitor. This constant interplay of supply and demand, of ships as well as of cargoes, has the effect of reducing sea transport costs to a minimum, although tramp freight rates fluctuate frequently and widely, at times.

These conditions of fluctuating rates also offer opportunities for specuiation, as on a stock exchange. The shipper of grain, for example. may decide to charter a ship at what he considers to be a cheap rate even before he has sold the cargo, which he will attempt to dispose of in the best market while it is still afloat. In this case the ship will be chartered for a voyage from, say, the Plate river to the English channel "for orders," freight rates having been previously arranged to cover a variety of alternative eventual destinations. Again a shipper or an owner may agree to charter a ship for a period of time at a certain rate, in the hope that he will later be able to "re-let" it to another owner or shipper at a higher rate, if the market improves. A good deal of "forward" chartering may also occur, in which a contract is entered into for performance at some specified time at a predetermined rate that both owner and hirer hope will prove favourable, according to their view of future market conditions.

5. Methods of Chartering. — There are four principal methods of chartering a tramp ship—on voyage charter, on time charter, on bareboat charter, or on a contract or "lump sum" basis. The voyage charter is the commonest. Under this a ship is chartered for a single voyage between specified ports with a specified cargo at a negotiated rate of freight. The charterer agrees to provide the cargo for loading at the port or ports and the owner to present the ship for loading within an agreed range of dates. As soon as the cargo has been delivered at the port or ports of destination, the ship is free for further employment at the owner's discretion. Sometimes, however, the arrangement is for a series of consecutive voyages, generally for similar cargoes over the same route. The freight rate is expressed in terms of so much per ton of cargo delivered.

On time charter, the charterer undertakes to hire the ship ior a stated period of time, or for a specified round voyage or occasionally for a stated single voyage, the rate of hire being expressed in terms of so much per ton deadweight per month (see below for meaning of tonnage measurement). Whereas on a voyage charter the owner bears all the expenses of the voyage (subject to agreement about costs of loading and discharging), on time charter the charterer bears the cost of bunkers and stores consumed.

On bareboat charter, which is less frequently used in ordinary commercial practice, the owner of the ship delivers it up to the charterer for the agreed period without crew, stores, insurance or any other provision, and the charterer is responsible for running the ship as if it were his own for the period of the contract.

Contracts can also be arranged on a lump-sum basis, when an owner agrees to ship a given quantity of a stated cargo from one port to another for a stated over-all sum of money. Sometimes large quantities of cargoes such as coal are arranged for on a contract basis. The shipowner agrees to undertake the shipment of a given quantity over a given period at a fixed price per ton of cargo, but not necessarily in any specified ship, although he will generally use his own ships if they are available, unless he can subsequently charter other ships at a cheaper rate. The question of substituted ships, however, often leads to disputes and the terms of the contract may make special provisions for this eventuality.

6. Legal Aspects of Chartering. — Once the owner's broker and the charterer's broker have agreed on the terms of contract, the ship is "fixed,'! although by word of mouth alone. The proud motto of the Baltic exchange is "our word is our bond," and that code of ethics is observed by shipbrokers throughout the world, whether they are members of the Baltic or not, for the simple reason that any shipbroker who did not abide by it would be unable to transact further business. Legally, however, the final contract is the written "charter party," which for most transactions is accepted as a standard document and is agreed to by all parties normally concerned in a tramp ship "fixture" for a particular trade. The standard form of charter party covers all the main points which experience has shown might later lead to misunderstanding or disputes about the liabilities of each party. while the variable details; such as the particulars of the voyage, cargo, ship, loading and discharging conditions and ports, rate of freight, etc., can be inserted in accordance with the prior verbal agreement. The charter party is the document that is subject to scrutiny and interpretation by a court of law in the event of dispute, but in practice most disputes are by agreement submitted to arbitrators (generally independent shipbrokers appointed by each participant) for settlement, unless an important legal precedent is involved.

Among the most important clauses in any charter party are generally those nhich lay down the number of days allowed for loading or unloading, and those which determine who is to hear the expenses involved. As a rule, a certain number of days are allowed for loading, and if the charterer fails to finish loading in the time specified the shipowner is entitled to compensation for demurrage, while the charterer on the other hand is entitled to dispatch money if the cargo is loaded in less than the time agreed in the charter party. Similar conditions usually apply in the port of discharge.

Tankers, ore carriers and other industrial carriers operate either like dry-cargo liners or like tramps, except that on scheduled services they do not normally act as common carriers. In other words the tanker or the ore carrier is operated by an oil company or a steel company or an ore exporter exclusively on company business, whether on a regular schedule or not; or it is owned by an independent tramp shipowner and taken on charter by an oil or steel company to fulfill its marginal transport requirements on terms similar to those employed in the dry-cargo tramp shipping market. That is, perhaps, a simplification of the procedure, since in fact the oil company may, for example. find it convenient to charter its own ship to another oil company for a voyage or for a period of time, just as a tramp shiponner might do. Most of the major oil companies (and permanent large shippers of bulk commodities) build and operate for themselves fleets of ocean carriers—and their operation is a matter of company convenience. requiring no contractual obligations or other arrangements except suitable shore staffs and organizations or agencies at the terminals. The great expansion of oil transport requirements after World War II led to a rapid growth of the world tanker fleet, and capital commitments made it more than ever necessary for oil companies to rely on the tankers built and operated by the growing number of independent tank shipowners.

IV. INTERNATIONAL MARITIME LAW

1. The International Conventions.—Ships operate in an international field, the high seas, and are subject not only to the laws of the country in which they are registered and to the laws of the country in whose territorial waters they may be, but also to a series of internationally agreed conventions, the principles of which are incorporated into the domestic legislation of most maritime countries. There has gronn up, particularly in the years since the expansion of steam navigation, a body of international maritime law—"the common law of the sea"—nhich has been developed through international agreement. For example, nearly all the world's maritime nations have adopted the International Rules for the Prevention of Collision at Sea, which were originally based on British rules formulated in 1862 and made internationally effective after a series of international meetings culminating in a conference at Washington, D.C., in 1889. These rules lay down in great detail how ships must navigate in respect of each other, what lights must be shown and what signals must be given in accordance with circumstances; and any infringement of this international code of conduct is accepted in all maritime courts of law as prima-facie evidence of liability in case of collision.

Similarly, the internationally accepted requirements for the protection and safety of life at sea, as far as the ship and its equipment are concerned. are embodied in the International Convention for the Safety of Life at Sea. The sinking of the "Titanic" in 1912 gave rise to a general desire to raise the standards of safety of life at sea and a convention nas drawn up in 1914, requiring certain minimum standards for passenger ships, but this did not become fully operative owing to World War I. A second Safety of Life at Sea convention was drawn up in 1929; this decided minimum standards for the construction of passenger ships engaged in international voyages and for the provision of lifesaving appliances, and extended its rules for the safety of navigation to all ships on all voyages. The provisions regarding radio equipment mere extended to cover cargo ships of more than 1,600 tons gross.

Improved techniques led to the convening of a third Safety of Life at Sea conference in London in 1948, after which a third International Convention on the Safety of Life at Sea was adopted. This came into force on Nov. 19, 1952, having been ratified one year previously by the following countries in order of acceptance: United Kingdom, New Zealand, the United States, France, the Netherlands. Sweden, Norway, South Africa. Iceland. Portugal, Canada, Pakistan. Denmark, Yugoslavia, Italy. Belgium, Israel, Japan and the Philippines. The scope of the 1949 convention was again extended to include, in several matters, cargo ships of 500 tons gross and above. Minimum requirements were laid down for the construction of ships, for the provision of watertight bulkheads. for the closing of openings in hulls for lifesaving appliances, for fire appliances, for radio equipment and direction finders for grain divisions in ships carrying grain cargoes, for the carriage of dangerous goods and for emergency musters and drills. The 1952 convention also embodied the recommendations of governments associated with the World Meteorological organization. and provided for the continuance of the International Ice patrol maintained by the United States coast guard in the North Atlantic.

Whereas the Safety of Life at Sea convention deals with the construction of ships from the safety point of view, particularly in respect of passengers and crews, the International Load Line convention deals with the strength and seaworthiness of ships in normal operating conditions. This convention emerged from the efforts of Samuel Plimsoll, who succeeded in securing the passage of the British Merchant Shipping act, 1875, which provided for the marking of a load line, thereafter popularly known as a Plimsoll mark, on the ship's side, indicating the maximum depth to which a ship could legally be loaded.

In order to protect the competitive position of British ships, the Merchant Shipping act of 1890 required all foreign ships leaving British ports to comply with the load line regulations. This led to the adoption of the load line rules by most maritime countries, and the International Load Line convention of 1930 was ratified by 54 nations. The 1930 rules followed the British proposals closely, but provided for the deeper loading of tankers, of ships of special construction and of vessels carrying deck loads of timber. Provision was also made for the adjustment of load lines to suit seasonal and geographical variations in conditions.

2. Commercial Legislation.—International agreements and international law are also concerned with the business dealings between maritime countries. In this connection the International Maritime committee (Comité international maritime) and the International Law association did invaluable work. Delegates to the International Conference on Maritime Law held at Brussels in 1922 recommended to their respective governments the adoption of a set of rules. known as The Hague rules, which establish the responsibilities, rights and immunities of carriers under bills of lading (documents acknonledging receipt of cargo for shipment and proving entitlement to the goods). The Hague rules. which are generally also incorporated into the terms of a charter party, were given widespread legislative sanction by maritime countries, in Britain by the Carriage of Goods by Sea act. 1924, and in the United States by the Carriage of Goods by Sea act, 1936, which is also taken in conjunction with the Harter act, 1893. Legislative sanction is not necessary to secure international agreement or observance in every case.

The York-Antaerp Rules of General Average, for example, differ in some respects from English law relating to marine insurance and contracts of affreightment. They were formulated by delegates from various maritime countries meeting at York, Eng., in 1864 and at Antwerp in 1877. and nere revised at Stockholm in 1924 and at Amsterdam in 1950. They were so widely adopted by the maritime nations that for all practical purposes they have the force of law. (See MARINE INSURANCE.)

V. SHIPOWNERS' AND SEAMEN'S ASSOCIATIONS

Shipo-cvners themselves are generally organized on a national, and sometimes on a regional. basis. The most highly organized associations of this kind grew up in the United Kingdom. where all but a negligible minority of shipowners are members either of the Chamber of Shipping of the United Kingdom, based in London, or the Liverpool Steam Ship Owners' association. These two associations have sections which look after the special interests of subgroups in the industry. such as tankers, tramps, liners, coasters: etc. In order to speak with one voice in negotiations with the government on matters of highest policy, the two associations created a joint organization known as the General Council of British Shipping. These organizations speak for shipowners as a whole in respect of a great many industrial matters. such as pilotage and towage agreements and contracts? port organization, dock labour and national legislation, and to settle countless points at which external matters touch the maritime industries. Foreign associations often also undertake wage negotiations with seafarers; the British associations. however. do not. Wage negotiations are handled by a separate organization known as the Shipping federation. which was formed early in the 20th century in order to combat the activities of the newly created National Union of Seamen. Wage negotiations in the British mercantile marine since World War I have been conducted entirely through the medium of the National Maritime board, which consists of representatives of the Shipping federation on the one side and representatives of the seafarers' and officers' unions on the other. The work of the National Maritime board extends. in addition. to the associated subjects of manning scales, hours and conditions of work and standards of accommodation. etc.. as well as to such matters as sickness benefits. pensions and contracts of employment. Since 1947 it has been possible for British officers and seamen to enter either into individual service contracts with shipping companies, or into a general service agreement with the industry as a whole which guarantees a minimum wage for a minimum period of two years, whether or not the seafarer is in employment, provided that he undertakes to serve in any British ship to which he may be posted. (See also LAWS RELATING TO SEAMEN.)

On the international level. the national shipowners' associations are members of the International Chamber of Shipping, provided that the national industries concerned are not state controlled. This organization, whose offices and secretariat are housed at the London headquarters of the Chamber of Shipping of the United Kingdom, was formed before World War II. and excluded state shipping organizations of any kind. The ownership of the national fleet. or of a substantial part of it, had to be vested in private individuals or companies. The International Chamber of Shipping was suspended during World War II but in 1946 shipowners representing 14 nations (Australia, Belgium, Canada. Denmark, Finland, Greece, India, the Netherlands. New Zealand. Norway, Spain, Sweden, the United States and the United Kingdomj met in London to reconstitute it. The assembly wished to avoid the overlap of its functions with those of other organizations and, "bearing in mind the vital need for preserving the principles of private enterprise in a complex industry which must essentially operate in an international sphere," drew up a broad definition of its own purposes as follows:

(a) To promote internationally the interests of the shipping industry on all matters of general interest not already dealt with by other specialized organizations within the industry.

(b) To co-ordinate expert advice within the industry in regard to technical questions affecting it and, in particular, with a view to securing improvements in standards of safety and the fullest advantage of technical and scientific progress. In this connection it will be necessary at the outset to consider the procedure which should be followed in the light of postwar circumstances and in relation to government activities in this field.

(c) To provide a medium for the exchange of views and information on questions affecting the industry internationally.

To deal with matters of a more routine nature other international shipping organizations exist. Prominent among these is the Baltic and International Maritime conference, which was started in 1905 as the Baltic and White Sea conference, in Copenhagen, with the object of putting a stop to the cut-throat competition which then existed between tramp shipowners engaged in the Baltic and White sea trades. The conference mas organized primarily with the object of securing minimum freight rates and arranging uniform chartering terms among shipowners of different flags. By 1955 the Baltic and International Maritime conference consisted of shipowner and shipbroker members from 3j different countries representing some 17,000,000 tons gross of tramp shipping. The conference now embraces many kinds of trades in all parts of the world, and one of its principal functions is to inform members of changes in port expenses, in costs of loading and discharging cargoes and in labour conditions in ports; but perhaps the most valuable part of its work consists of the drawing up of standard forms of charter party for use in a wide variety of tramp shipping trades. and of securing acceptance for them. Most of this work is carried out in co-operation with the documentary committee of the Chamber of Shipping of the United Kingdom.

VI. CLASSIFICATION AND TONNAGE MEASUREMENT

1. Classification. — To ensure compliance with the various international safety and load line and other maritime conventions. as well as with the requirements of national legislation concerning the registry and constructibn of merchant ships, most maritime nations require ships to be built under the supervision of government surveyors or of surveyors belonging to recognized classification societies and in accordance with their standards.

Lloyd's *Register*.—The leading classification society. operating in almost every country in the world. is Lloyd's Register of Shipping. which began its work long before any national legislation existed for the performance of its purposes. The history of Lloyd's Register of Shipping can be traced back to 1760, when the first printed "register of ships" appeared. Particulars of ships were listed. with various classification symbols affixed, each denoting the condition of various parts of the ship's structure or equipment. This was for the guidance of marine underwriters and insurers, and it is generally agreed that Lloyd's took its name from Edward Lloyd's coffeehouse in London, the home of the modern marine insurance market. The society was reconstituted in 1834. and again in 1914. The shipping community maintains it voluntarily and its management committee is composed of shipowners, shipbuilders. marine engineers and marine underwriters. with naval architects. master mariners and others with specialized knowledge and qualificatioris serving on the various technical committees. Its principal work is the supervision of the survey and classification of merchant ships of all nationalities according to rigid standards. Through a world-wide organization of surveyors initial classifications are made when ships are built, and maintenance surveys of hull, machinery, boilers, refrigerating plant. etc.. are carried out periodically or whenever the ship has suffered damage from collision or from any other cause. Lloyd's Register surveyors test and approve. during its manufacture, the steel intended for use in the ship's structure or for its engines and boilers; they survey refrigerating machinery at sea or on land: they supervise the testing of chains. anchors and pressure vessels; and are competent authorities for the assignment of freeboard to all classes of ship in accordance with the provisions of merchant shipping acts or the load line regulations.

The society publishes annually a register book which contains in several volumes full details of all merchant ships in the world of more than 100 tons gross; this is kept up-to-date by means of fortnightly supplements. Separate registers are kept of British and American yachts. The society also publishes annual and quarterly statistical summaries of shipping registered or under construction in the world. In 1949 Lloyd's Register of Shipping took into amalgamation the British Corporation for the Survey and Registry of Shipping, a similar organization founded by shipowners in Glasgow in 1890 as a rival classification society.

Lloyd's Register of Shipping operates in most maritime countries. often in co-operation with classification societies established by other nations. These include the American Bureau of Shipping, originally established in 1867, and resuscitated as a result of the large volume of merchant ships built in the United States during World Wars I and II; the Bureau Veritas, which was founded in Antwerp in 1828 but moved its headquarters to Paris in 1832; the Norske Veritas, established in Norway in 1894; Germanischer Lloyd, founded in Germany in 1867; and Kegistro Italiano Navale, originally founded in Italy in 1861. Most of these and other national classification societies work in close conjunction with Lloyd's Register of Shipping.

2. Tonnage Measurement.—Classification societies are largely agreed as to the strength requirements of different types of ship; and the technical. legal or commercial enactments of the conventions are almost universally accepted; but complete international agreement on methods of tonnage measurement was slow to develop. The two chief reasons for this were, first the possibility of interpreting the term tonnage in several senses, and secondly the fact that a ship's tonnage is calculated by one of several methods according to the standard of measurement required. In speaking of shipping, the term ton may be used not only to name a unit of weight, in the usually accepted sense: but also to name a unit of volumetric capacity.

Displacement Tonnage and Deadweight Tonnage.—As far as weight is concerned. the ton is the long ton of 2,240 Ib. avoirdupois, and this is used to measure the weight of the ship and its contents. According to the law of Archimedes, the weight of a floating vessel and its contents is equal to the weight of water that it displaces. This weight is known as the displacement tonnage, and the term is used ,most commonly in comparing the size of warships. In a cargo-carrying ship it is obvious that the displacement varies according to the amount of cargo, bunkers and stores that are in the ship, and as it is important to determine the amount of cargo that can be carried, the ship's displacement must be calculated both when it is in light condition and when it is loaded, to find the difference which represents the weight of cargo that can be carried. The lightweight displacement tonnage is equivalent to the weight of water displaced by the ship's hull. machinery and equipment, plus the weight of the crew and their effects, when no cargo or bunkers are carried. When the maximum permissible weight of bunkers and cargo is added, the ship has reached its full displacement tonnage. The difference between the full displacement tonnage and the lightweight displacement tonnage is called the deadweight tonnage, and this corresponds to the weight of cargo and bunkers the ship can carry. Deadweight tonnage is the measurement ordinarily used to describe and compare the sizes of dry-cargo ships and tankers.

Many procedures, for example the assessment of harbour dues and canal transit dues, require the use of a different system of tonnage measurement, based on the volumetric ton. The volumetric ton is a measure of the capacity of the enclosed space in a ship. one ton equalling 100 cu.ft. of enclosed space. The volume of the ship up to the tonnage deck (which is generally the uppermost continuous deck) excluding certain exempted spaces such as the double-bottom tanks: the steering-gear compartments, the galley and other spaces not used for the carriage of cargo, is described as the underdeck tonnage. and is expressed in terms of 100 cu.ft. per ton. The internal volume of 'tween decks and deck erections used for the carriage of cargo is added to the underdeck tonnage to give what is called the gross tonnage, again in terms of 100 cu.ft. of enclosed space per ton gross. In merchant shipping statistics the gross registered tonnage is usually given. It is also given for passenger ships. whose deadweight tonnage is relatively unimportant as a means of comparing them in size. For the purpose of assessing dues payable for port, canal. pilotage. lighthouse and other services, the freight-earning capacity of the ship is usually accepted as the criterion of measurement, and this is commonly arrived at by deducting from the gross tonnage the space devoted exclusively to such items as machinery. bunkers, crew accommodation and navigating quarters in order to calculate the net registered tonnage. It is apparent that the final tonnage measurement of a ship according to the volumetric reckoning depends much on the definition of the spaces exempted from computation for various reasons.

The British system of tonnage measurement is the one most used by maritime nations. but in certain areas, notably the Suez and Panama canals: there are different systems of measurement for the assessment of tonnage on which dues are payable, and all ships have to be specially measured for the assessment of their dues when passing through these areas.

For the purpose of assessing freight rates on cargo, yet another form of volumetric tonnage is employed, known as the measurement ton, which is equivalent to 40 cu.ft. of capacity. This term has no connection with the tonnage measurements used for registration and for the assessment of dues. It derives from the fact that the charge made for carrying cargo is normally based either on the weight of the cargo or on the amount of space it occupies. Freight rates cannot all be fairly assessed by weight alone. It is obvious that a ton of feathers would occupy a far greater amount of the ship's hold than a ton of coal; for example. Likewise a heavy item of machinery, although occupying much less space than a ton of coal, would prevent the extra space being used for the carriage of more cargo, for such a deadweight cargo would bring a ship down to its load line limits with much of the cubic capacity of its holds still unfilled. Hence liner freight-rate tariffs are generally expressed in terms of so much per ton weight or measurement? the measurement ton being the equivalent of 40 cu.ft. of capacity, and the rate paid being the higher of the two.

VII. INTERNATIONAL PROBLEMS

Despite the large measure of international agreement and co-operation which has been achieved in the shipping industry, particularly in the 20th century, there is still much competition betn-een merchant fleets. Those of one nation compete among themselves, and international rivalries are also strong. The situation is complicated by the fact that merchant shipping has an economic and strategic as well as a commercial value for most maritime nations. They depend on merchant fleets for the survival of their military power—troops and supplies must be carried by sea. and so must food and industrial raw materials. Many maritime nations too. particularly island nations such as Great Britain and Japan. depend for their economic existence on imports of food and of raw materials for industry, as well as on a flow of exports sufficient to pay for these. All this depends on merchant shipping. Moreover, Great Britain. Japan, Norway and many

TABLE I.—Tonnage of the Vessels of 100 Tons and Upward Prior to World War II, Belonging to Each of the Several Countries of the World

Countries where owned	1886		1914		1920		1935		
	Steam and motor ships	Sailing vessels	Steam and motor ships	Sailing vessels	Steam and motor ships	Sailing vessels	Steam and motor ships	Sailing vessels	Total
	Gross tons (000)	Net tons (000)	Gross tons (000)	Net tons (000)	Gross tons (000)	Gross tons (000)	Gross tons (000)	Gross tons (000)	Gross tons (000)
Great Britain and Ireland	6,162	3,249	18,892	365	18,111	220	17,298	102	17,400
British Commonwealth	378	1,377	1,632	157	2,032	220	2,986	125	3,111
Total British empire	6,540	4,625	20,524	521	20,143	440	20,284	227	20,511
United States including Gt. Lakes	496	1,587	4,330	1,038	14,574	1,475	12,223	629	12,852
Japan	78	32	1,708	...	2,996	...	4,086	...	4,086
Italy	195	705	1,430	238	2,118	124	2,838	46	2,884
France	738	319	1,922	397	2,963	282	2,989	36	3,025
Germany	604	806	5,135	325	419	253	3,693	10	3,704
Norway	140	1,352	1,957	547	1,980	240	3,967	1	3,968
Netherlands	190	229	1,472	25	1,773	20	2,554	5	2,559
Sweden	150	331	1,015	103	996	77	1,541	10	1,551
Spain	362	159	884	15	937	60	1,164	13	1,178
Denmark	143	128	770	50	719	84	1,099	2	1,101
[illegible]	54	289	821	16	497	33	1,711	...	1,711
Other countries	601	655	3,436	411	3,790	321	. .	...	
Total	10,291	11,217	45,404	3,686	53,905	3,409	63,727	1,159	64,886

Source: *Lloyd's* Register *of Shipping.*

TABLE 11.—Number and Tonnage of Steam and Motor Vessels Registered in Various Countries, 1939–54
(100 gross tons and over)

Country	1939		1949		1954	
	No.	Tons gross	No.	Tons gross	No.	Tons gross
United Kingdom	6,722	17,891,134	6,077	18,093,159	5,740	19,014,220
Other British Commonwealth	2,255	3,110,791	2,585	3,956,581	2,622	3,790,319
Total	8,977	21,001,925	8,662	22,049,740	8,362	22,804,539
Denmark	705	1,174,944	698	1,170,373	704	1,613,903
France	1,231	2,933,933	1,236	3,070,398	1,257	3,840,888
Germany	2,459	4,482,662	889	300,234	1,797	2,226,407
Greece	607	1,790,666	377	1,329,257	351	1,176,373
Italy	1,227	1,424,804	1,013	2,442,659	1,143	3,798,385
Japan	2,337	5,629,845	1,121	1,563,936	1,727	3,577,826
Liberia	..	..	..	..	245	2,381,066
Netherlands	1,523	2,969,578	1,492	2,990,195	1,683	3,442,537
Norway	1,987	4,883,813	2,069	4,916,396	2,286	6,805,157
Panamá	159	717,525	535	3,016,227	595	4,091,013
Sweden	1,231	1,577,120	1,278	2,047,664	1,252	2,701,110
United States:						
Ocean-going	2,345	8,909,892	4,606	25,558,133	4,323	24,880,381
Great Lakes	508	2 451 641	420	2,255,633	433	2,463,637
Other countries	4,467	6 6 8	5,852	9,860,070	6,200	11,618,304
World total	29,763	66,509,432	30,248	82,570,915	32,358	97,421,526

Source: Lloyd's Register of *Shipping*

other maritime nations, depend to a great extent for their economic well-being on the ability to balance their international trading accounts with the invisible exports represented by the earnings of their shipping industry.

Politics and strategy interfere with the ordinary business activities of the shipping industry in several ways. For internal political reasons, some states decide that the provision of shipping services shall be a state monopoly. but in practice this is difficult to achieve since a state's jurisdiction does not extend beyond territorial waters. Various practices observed from time to time, however, are designed to protect the domestic shipping industry and to discriminate against shipping of other flags. These discriminatory measures may be used to protect the shipping of the national flag, even if the ships are not state owned. Higher port dues may be charged to foreign ships, for example, or national-flag ships may be favoured. In bilateral trade agreements it is sometimes stipulated that a fixed proportion of the cargoes must be carried in ships of the national flag. A common method of assisting the domestic shipping industry is to reserve coastal shipping to ships of the national flag, a policy abandoned by Great Britain with the repeal of the Navigation acts in 1850. This decision greatly assisted the expansion of the British mercantile marine, but several other nations, notably the United States, adopted the opposite attitude and strictly reserved coastal trade.

Another means of assisting the national shipping industry and of protecting it against economic competition is the payment to it of direct or indirect subsidies from the national exchequer. These subsidies may take many forms, varying from tax exemptions or preferential credit terms to direct subsidy of shipbuilding or of operating costs. In the United States, where shipbuilding costs and manning costs are much higher than in most maritime countries, the Merchant Marine act of 1936 and its successors attempted to promote the use of U.S.-flag merchant ships by means of direct subsidies to liners on specified essential trade routes. In France, Italy, India and Argentina, the state participates directly in the ownership of the larger liner organizations. Ships engaged in international trade, whatever their flag, all have similar expenses. They pay much the same for bunkers. for repairs and maintenance. for cargo-handling, and for port dues, except insofar as flag discrimination may be practised. Crews' wages, however. do differ among ships of different flags. Shipbuilding costs tend to vary widely from one country to another, but in general shipowners may build where they please. The payment of direct shipbuilding or operating subsidies, therefore, is not as objectionable to unsubsidized shipowners as is the reservation of cargoes to ships of a particular national flag, whether this rule is incorporated in trade agreements or written into legislation. In the United States, for example, after World War II, the shipment of gift cargoes under the Mutual Security act and the cheap sale of surplus farm products were allowed only on condition that at least half the ships used were of the U.S. flag.

Although operating costs are much the same for ships of all flags. profits are subject to the rates of taxation in different countries. If all ships paid the same taxes, the margin of profit for each company would depend largely on its efficiency. After World War II, heavy taxes combined with a sharp rise in shipbuilding prices to cause the registration of more and more shipping companies in countries such as Panamá and Liberia. where taxation was low. Greek and American shipowners resorted in large numbers to registry under these so-called flags of convenience, with the result that by 1957 the merchant fleets of Liberia and Panamá combined were the largest in the world, after those of the United Kingdom and the United States.

VIII. WORLD MERCHANT FLEETS

Statistics of world merchant shipping tonnage are little more than estimates until the later years of the 19th century, when steamships began to oust sailing ships from predominance in world trade. The statistics given in Table I illustrate the decline of the sailing ship between 1886 and 1935, and the increase in the total tonnage of merchant shipping in the world, which rose from 10,291,000 tons gross (steam only) in 1886 to 64,886,000 tons gross (including sail and barges) in 1935. By 1939, before the outbreak of World War II, the world total had reached 69,440,000 tons gross including sail (see Table II, which, however, excludes sail), and despite the enormous losses suffered during the war (Table III) the world fleet had reached 80,292,000 tons by 1948. The growth continued so that by 1955 the total tonnage exceeded 100,000,000 tons gross for the first time.

A significant feature of the development of the world merchant fleet after 1920 was the growth of the number of ships propelled by diesel engines, and Table IV illustrates the increase in the proportion of motorships. A simultaneous development was the replacement of coal by oil as fuel for steamships, a movement which reached its peak just after World War II. By 1956 the coal-burning ships still in existence accounted for less than 10%

TABLE *111.—Losses of Merchant Ships, World War 11, Sept. 1939–July 31, 1946**
(1,000 gross tons and over)

Flag	1939		1940		1941		1942		1943		1944		1945		1946†		Total	
	No.	Gross	No.	Gross	No.	Gross	No.	Gross	No.	Gross	No.	Gross	No.	Gross	No.	Gross	No.	Gross
British	86	434,677	460	2,589,984	567	2,800,161	589	3,484,070	253	1,496,835	120	640,558	44	227,391	2	3,799	2,121	11,677,475
French	10	62,258	45	243,705	10	36,629	24	114,524	38	143,006	60	310,971	2	3,711	..	..	189	914,804
German	22	140,738	67	335,847	103	508,964	83	332,733	108	483,018	193	841,878	118	598,325	..	..	694	3,241,503
Greek	9	42,686	55	237,490	82	294,131	47	211,758	20	87,554	10	37,826	2	8,653	..	..	225	920,098
Italian	2	9,339	44	212,935	129	625,565	104	400,487	154	581,159	51	289,309	7	26,697	..	..	491	2,145,491
Japanese	1	11,930	2	4,274	10	67,226	175	877,278	301	1,419,054	492	2,303,421	194	578,480	..	..	1,175	5,261,663
Netherlands	6	38,845	43	206,367	43	246,979	112	519,909	27	157,089	15	90,534	6	27,282	..	..	252	1,287,005
Norwegian	16	55,681	100	360,334	89	334,072	152	741,981	67	345,169	36	120,439	24	73,757	2	3,645		2,035,078
Panaman	..	..	11	54,255	12	39,104	71	397,987	11	70,558	9	44 389	1	1,049	..	..	115	607,642
Swedish	18	33,913	52	149,277	25	79,520	36	139,273	20	66,769	10	11		1,226	..	..	162	485,790
United States	..	..	1	5,883	15	82,245	314	1,937,855	139	955,221	93	652,486		279,964	3	18,972	605	3,932,626
Other	22	68,572	85	292,572	75	234,759	125	480,029	52	195,750	26	78,334	48	23,193	2	3,011	395	1,376,220
Total	192	898,639	965	4,692,923	1,160	5,349,355	1,832	9,637,884	1,190	6,001,182	1,115	5,425,957	447	1,850,028	9	29,427	6,910	33,885,395

*From war causes alone. Only those vessels are included whose identity was definitely established. Vessels are charged to the Aag under which they operated, regardless of actual ownership. Data, especially for axis losses, are not necessarily complete. Includes vessels on charter to the military services. †Losses caused by striking mines.
Source: U.S. Maritime Commission.

TABLE IV.—*Fuel Analysis* of World Tonnage
(Tons gross)

Source: Lloyd's Register of *Shipping.*

of the total tonnage! and the number of coal-burning ships still being built mas negligible.

After World War II a vast increase in world tonnage took place. This was partly due to the existence of many ships in the United States defense emergency reserve fleet, but chiefly to the rapid increase in the demand for oil tankers (see Table V). The United States became a net importer of oil, while the United Kingdom and the continent of Europe also required sea transport for oil, The middle 1950s saw a rapid expansion of world industry, especially of the steel industry in the German Federal Republic, in the United Kingdom and in Japan. The United States, though its domestic supplies of iron ore were inadequate, likewise expanded its steel industry. These circumstances caused an even greater demand for merchant shipping.

Although the total gross tonnage of the world merchant fleets constantly increased, the actual number of ships remained more or less steady (see Table II) because the average new merchant ship was larger. especially after World War II. The average speed of ships also increased, although to what precise extent it is impossible to measure. Large ships tend to have higher speeds than small ones, however, and there can be no doubt that the ton-mile capacity of the world fleet after the end of World War II increased proportionately even more than the total gross tonnage.

1. British Commonwealth. — As a result of British war losses and of the U.S. emergency shipbuilding programs of World Wars I and **11,** the mechanically propelled tonnage registered in the United States on two occasions exceeded that registered under the British flag. Great Britain nevertheless retained the largest active merchant fleet in the world, although its proportion of the world total declined in the 20th century. The British commonwealth owned 63.6% of the mechanically propelled merchant shipping in the world in 1886, 35.2% in 1914, 37.4% in 1920 and 34.6% in 1927. By 1935 the proportion was 31.9%, and in 1939 it was 30.4%. The tonnage in 1939 was 21,215,000 tons gross, and despite heavy war losses amounting to nearly 12,000,000 tons gross, the 1939 tonnage total was exceeded by 1948. Great Britain's proportion of the world total, however, including the U.S. inactive fleet: had been reduced to 27.4%. By 1955 British tonnage had increased to 23,231,000 tons gross, but its percentage had dropped to about 23.4%.

Most of the British-registered tonnage is owned and operated by the United Kingdom. In 1939, 7,009 ships of 17,984,158 tons gross were registered in the Gnited Kingdom and 2,479 ships of 3,231,103 tons gross in the British commonwealth outside the United Kingdom, mainly in Australia, Canada, Hong Kong, India, Malaya, New Zealand, South Xfrica and the West Indies. Canada acquired a substantial fleet of vessels built during World War I, but after a few years most of the ocean-going ships were re-registered in the United Kingdom, although the beneficial ownership remained in Canada. The general movement toward flags of convenience. referred to above, however, started a tendency from 1956 onward for United Kingdom shipowners to register new tonnage in such commonwealth countries as Bermuda and the Bahamas, so that profits used for the purpose of replacing obsolescent tonnage would not be subject to United Kingdom taxation.

The privately owned United Kingdom merchant fleet at Jan. 1, 1957. excluding fishing vessels, tugs and other nontrading vessels, as well as ships of less than 500 tons gross in size, exceeded 18,000,000 tons gross. Oil tankers and whaling factory ships accounted for more than 5,000,000 tons gross of the total gross tonnage. Passenger and cargo liners totaled nearly 8,500,000 tons gross and tramps just over 2,800,000 tons gross. The remainder consisted of ships engaged in the coastal and short-sea trades. The United Kingdom continued to maintain the largest fleet of purely passenger ships in the world. They are engaged principally in the following trades: (1) Great Britain, France and Ireland to Canada and the Gnited States; (2) Great Britain to South Africa, Australia, New Zealand, India and the far east; (3) Great Britain to Spain, Portugal and Central and South America; (4) cross-voyages, for example Australia to the far east and New York to Bermuda; (5) cross-channel services between Great Britain and Ireland and the continent of Europe; and (6) pleasure cruising in off-seasons from Great Britain, Australia. the United States and elsewhere. Specially designed refrigerated cargo liners, often carrying up to 100 passengers, sail between Great Britain and Australia, New Zealand, South America and South Africa, carrying homeward cargoes consisting mainly of meat and dairy produce. Cargo liners, many of them able to accommodate not more than 12 passengers, operate regular services from Great Britain and the continent of Europe to all parts of the world. They also sail between overseas countries, for example from the United States to India, from Canada to West and South Africa: from the United States to the far east; and they may go around the world without touching Great Britain. British shipping services make a substantial contribution to the nation's balance of international payments through earnings of foreign currency. An inquiry carried out into the earnings of the British shipping industry for the year 1952 showed that receipts of foreign currency for freight, passenger fares and charter hire totaled £509,700,000, while disbursements abroad totaled £288,300,000, making a net contribution of £221,400,000 to the nation's balance of payments.

Many of the well-known British shipping companies were founded in the earliest days of steam navigation, and some of them have even longer continuous histories. One of the biggest shipping groups in the world is centred on the Peninsular and Oriental Steam Navigation company, which operates passenger and cargo-liner services between Great Britain and the continent of Europe to India, Pakistan, Ceylon, Malaya. Australia and the far east. The group also includes the Orient line passenger services to Australia, New Zealand and the Pacific coast of North America and the refrigerated cargo-liner services to Australia and New Zealand operated by ships of the New Zealand Shipping company and the Federal Steam Navigation company. It includes the Nourse line, trading between the West Indies and India, the British India Steam Navigation company, trading between Britain and India and East Africa, as well as in the Indian ocean, the Hain Steamship company, engaged in world-wide dry-cargo tramping, the General Steam Navigation company, with a network of liner services between the Mediterranean and the Baltic seas, and the Union Steamship company of New Zealand. In 1956 the P. and O. group broke new ground by ordering a fleet of 25 tankers.

The Cunard line is famous for its transatlantic liners, but it also operates cargo services to the Mediterranean. The Port line, affiliated to the Cunard line! sends refrigerated liners to Australia and New Zealand. The Brocklebank line, another Cunard affiliate, runs to the Indian ocean from Great Britain and the United States. The Union-Castle line, which operates mail, passenger and cargo services to South Africa, merged in 1956 with the Clan line, a company running a world-wide network of cargo-liner services, to form the British Cominonwealth Shipping company. Royal Mail lines operate passenger and refrigerated cargo-liner services to South America, and cargo-liner services to the Caribbean and the Pacific coast of North America, while their subsidiary, the Pacific Steam Navigation company, operates passenger and cargo services to the west coast of South America.

Another large group is the Furness Withy group, operating passenger and cargo-liner services in many parts of the world. Most of the companies referred to above are public companies, but there are also some private companies or partnerships in which there is no public participation by means of shareholdings. Some of these, for example Alfred Holt and Company (the Blue Funnel line) and Ellerman lines, operate substantial fleets. The P. and O. group and several other shipping companies have substantial interests in independent air transport undertakings. Tramp shipping companies tend to be larger in number and smaller in size. Large tanker fleets are operated by the British Petroleum and Shell oil companies, but there is also a large number of independently owned and operated tramp tanker companies.

2. Denmark. — The Danish merchant fleet, which totaled 705 vessels of 1,122,608 tons gross in 1939, suffered heavy losses during World War II. hut by 1950 the strength of the fleet had more than recovered, and it reached 718 vessels of 1,269.011 tons gross. By 1956, although the number of vessels had declined to 687, the gross tonnage had advanced to 1,695,221 tons gross, of which about 30% consisted of tankers. Most Danish ships are propelled by diesel engines, the Danish firm of Burmeister and \Vain having built the motorship "Selandia," the first ocean-going motorship in the world. There is a substantial ferry traffic between Denmark and Sweden and Denmark and Germany, as well as plenty of trade between Denmark and the United Kingdom?in which Danish ships participate; but only about one-third of the foreign trade passing through Danish ports is carried in Danish ships. Danish shipowners, however, find much employment in overseas trading and in 1953 carried more than 9,400,000 tons of cargo between foreign ports. In 1953 gross earnings of Danish shipping in foreign currency totaled 976,000,000 Kr., excluding 119,000,000 Rr. in time-charter earnings. More than four-fifths was earned in purely foreign trade. By far the largest shipowning company in Denmark is the A. P. Moller concern, which operates around-the-world services as well as tramps and tankers, with a fleet totaling more than 400,000 tons gross. Next largest is the East Asiatic company, running regular liner services to India. Australia, the far east and North America, with a fleet of nearly 300,000 tons gross. The United Steamship company operates cargo liners to all parts of Europe, as well as to North and South America, while the J. Lauritzen concern operates refrigerated cargo-liner services to North and South America and to the Mediterranean, and also provides ships specially built for service in polar waters.

3. France. — The principal activity of the French mercantile marine is the carrying of trade from metropolitan France to other parts of the French union, notably to those in North Africa. \Vest Africa and the West Indies. and to former French-controlled territories in southeast Asia. A world-wide network of liner services. however, is operated by the state-controlled Compagnie Générale Transatlantique (French line) and other lines such as Messageries Maritimes. A good deal of coasting trade is carried in French vessels, and traffic between French territories in Africa and metropolitan France is largely reserved to vessels of French registry. The French liner fleet includes a substantial number of large passenger liners, like those of the French line which operate in the North Atlantic trade, and a high proportion of specially designed banana carriers and fruit ships. France runs fewer dry-cargo tramp ships than do many other European nations.

In 1939 the French merchant fleet numbered 1,282 vessels totaling 2,952,975 tons gross. About half of this fleet was lost during World War II, but by 1949 its previous strength was restored, partly in consequence of a prompt rebuilding program and partly through the purchase of surplus U.S. ships and the acquisition of ex-enemy vessels as war reparations. Regular planned and subsidized shipbuilding programs enlarged the French-flag fleet until by 1956 it had reached the total of 3,943,201 tons gross. of which 32% consisted of tankers. Much of the postwar expansion was due to the building up of a tanker fleet much larger than that considered necessary before the war.

4. Germany.---German merchant shipping reached its peak in 1914 after a decade of highly successful competition on the high seas. In that year the German merchant fleet totaled nearly 5,500,000 tons gross, and the flags of such liner companies as Norddeutscher Lloyd, the Hamburg-America line and the Hamburg South America line. were well known throughout the world. The defeat sustained in World War I. however, caused the disruption of this fleet. By 1920 less than 700,000 tons gross remained under the German flag. But by persistent effort. the merchant fleet was rebuilt. and although it had not quite reached 4,500,000 tons gross by 1939, its quality and efficiency were above average. A world-wide network of liner services had been re-established, as well as a tramp fleet which flourished particularly in the Baltic and short-sea trades.

World War II resulted in a second eclipse of the German merchant fleet, and postwar restrictions on the size and speed of the ships that the Allies permitted to be built deferred the rebuilding of the fleet for several years. By 1949 the German-flag fleet had been reduced to 300,000 tons gross. A rapid expansion began in 19j0. however, the bulk of the building program being confined to fast modern cargo liners of moderate size. By 1956 the fleet of the German Federal Republic had grown to 2.08; vessels of 3,206,381 tons gross, nearly all of them being of post-1950 construction. The nucleus of a Federal Republic tanker fleet emerged, and plans were made for the resumption of the passenger trade.

5. Greece. — The Greek-flag merchant fleet expanded steadily between World Wars I and II. from 496,996 tons gross in 1920 to 1,780.666 tons gross in 1939, but this was due not so much to new construction as to the purchase of second-hand ships from other flags. As a result the average age of the ships of the Greek fleet was high. and in 1939 some three-quarters of the total tonnage was more than 20 years of age. For the most part this fleet was engaged in international dry-cargo tramping. Severe losses were suffered during World War II, but after the war large numbers of n-ar-built Liberty ships were purchased from the United States and by 1950 the Greek-flag fleet totaled 1,348,874 tons gross. Thereafter a decline set in, for many Greek owners preferred to register their ships under foreign flags, especially under flags of convenience such as those of Panamá and Liberia. Indeed, even before World War II, many Greek shipowners felt their gift for shipping commerce restricted by successive Greek legislatures. and transferred their operations to other flags. Owners of Greek nationality achieved a predominant position in world dry-cargo tramping in the years following World War II. They operated mainly from London and New Tork.

6. Italy. — Between World Wars I and II the principal Italian liner companies were liquidated and reconstituted as a state-owned organization known as the Finmare group, comprising four major lines. the Italia line, the Lloyd Triestino line. the Adriatica line and the Tirrenia line. Capital was provided by the state. which in 1937 also assumed control of the major shipbuilding yards, and in 1939 the Italian merchant fleet consisted of 1,335 vessels, totaling 3,448.453 tons gross. Only about 12% of this tonnage remained at the end of World War II. but by purchase. salvage and new construction the prewar total was passed by 1953. The state-owned liner group continued in existence and was responsible for the building of several large passenger liners, fast cargo liners and specialized ships. The privately owned section of the industry, engaged in liner: tramping and tanker operations, also succeeded in rebuilding and expanding, and by 1956 the Italian-flag fleet had reached the record total of 4,196,762 tons gross, of which 31% were tankers.

7. Japan. — The maritime expansion of Japan was extremely rapid between World Wars I and II, tonnage having almost doubled between 1920 and 1939, when the peak figure of 5,629,845 tons gross was reached. The geographical situation of Japan is favourable to the natural development of a large shipping industry, which was fostered between the wars by comparatively low-wage rates and a measure of state support. A great deal of the tramp and liner trades between Japan. China and other Pacific countries fell to Japan during this period, and in addition such large liner groups as Nippon Yusen Kaisha and Osaka Shosen Kaisha built up a world-wide network of passenger and cargo-liner services. Defeat in World War II left Japan with a largely obsolescent fleet totaling little more than 1,000.000 tons gross, but by 1950 postwar restrictions had been for the most part removed and the Japanese fleet again began to increase. largely as a result of government-sponsored shipbuilding programs. By 19j6 the Japanese merchant fleet had reached a total of 4,075,781 tons gross. consisting mainly of postwar dry-cargo liners and tramps. A start had been made on building tankers and ore carriers, and plans were being made to resume passenger services.

8. Liberia. — The rise of a merchant fleet registered under the flag of Liberia is entirely a development of the decade following 1 War I Whereas in 1939 the tonnage registered in Liberia was too negligible to be noted separately, by 1956 it totaled 5 584,-378 tons gross, and the Liberian fleet was the fourth largest merchant fleet in the world. This phenomenal increase was due entirely to the postwar tendency of shipowners of other nationalities, eiperially Greeks and Americans, to register their new ships under flags of convenience, thereby evading onerous taxation burdens or other restrictive measures imposed by their national legislatures. Most of the ships registered in Liberia are vessels of postwar build, and in 1955, 69% of the total consisted of tankers, almost all the remainder being dry-cargo ships engaged in international tramping.

9. Netherlands. — There are three principal branches of the Netherlands shipping industry, which consists mainly of ocean-going passenger and cargo liners, tankers owned by the major oil companies. particularly the Royal Dutch/Shell group, and coasting and short-sea vessels engaged mainly in trade with the United Kingdom and neighbouring and Baltic sea countries. The chief mainstay of the ocean liner companies before World War II was the trade with the Dutch East and West Indies. Despite the granting of political independence to Indonesia after the war, the principal Dutch liner companies were able to retain a great part of their network of services. The Netherlands merchant fleet in 1939 totaled nearly 3,000,000 tons gross, a figure which was again achieved, despite war losses, by 1949. By 1956 the fleet had grown to 4,006,077 tons gross. much of the increase being due to the growth of the tanker fleet.

10. Norway. — The Norwegian merchant fleet expanded to a marked extent during the 20th century, owing to the traditional skill and seafaring bent of the Norwegian race and the dependence of Norway's economy on its income from international shipping services. Although the overseas trade of Norway itself is not sufficient to maintain a large merchant fleet, the iatter grew to comparatively large proportions mainly through the enterprise of Norwegian shipowners in the world-wide tramping trades. From mainly tramp origins, a number of liner groups developed, operating world-wide services. but the expansion of the fleet since the end of World War 11 has been largely due to the enterprise of tramp tanker owners. The Norwegian merchant feet grew from 2,219,388 tons gross in 1920 to 4,834,902 tons in 1939, but about 40% of this tonnage was lost during World War II in the service of the Allied powers. Substantial purchases of U.S. war-built tonnage, together with an intensive postwar reconstruction program. helped to restore the prewar strength by 1949; but the potentialities of the international tanker market were such rhat Norwegian shipowners made even greater efforts to build. As a result, by 1956 the fleet had reached the figure of 8,035,340 tons gross, of which 57% consisted of tankers.

The net foreign currency earnings of the Norwegian shipping industry contribute a substantial amount to the nation's international balance of payments. In the period covered by the years 1930 to 1939, both inclusive, the net foreign-currency earnings of the shipping industry, the cost of importing ships built abroad being deducted. paid for 23.3% of the nation's total import bill. Between 1946 and 1949. because of the high cost of replacing war losses with new ships built abroad, the net shipping contribution accounted for only 5.5% of the balance, but between 1950 and 1953 the prenar percentage nas restored.

11. Panam&. — Statisticsof ships registered under the flag of Panamá were not kept separately by Lloyd's Register of Shipping until 1924, when 1j vessels totaling 85,593 tons gross were listed. From 1931 onward there was a gradual increase in the merchant shipping registered in Panamá, although the beneficial ownership was vested almost entirely in the United States, until the total of 717,525 tons was reached in 1939. After World War II the practice grew for U.S. oil companies and Greek and other independent tramp shipowners to register their ships under the flag of Panamá, and by 1949 the merchant fleet registered in Panamá exceeded 3,000,000 tons gross. By 1954 the figure of 4,000,000 tons gross had been exceeded. but then a slight decline began, owing to the preference for Liberia as a flag of convenience. The fleet in 1956 totaled 3,925,751 tons gross, of which 2,066,562 tons gross (52.5%) consisted of tankers.

12. Sweden. — The Swedish merchant fleet reached 1,000,000 tons gross in 1913 and gradually increased its tonnage until by 1939 it reached 1.581,919 tons gross. This expansion continued after World War II and by 1949 the total exceeded 2,000,000 tons gross. In 1956 the total reached 2,922,092 tons gross, of which about 30% consisted of tankers. In addition to a substantial coasting and short-sea traffic, and a fair-sized ocean-going tramp fleet, Sweden has a number of well-established liner groups, such as the Brostrom concern! which includes the passenger liners of the Swedish American line, the Transrederierna group, operating world-wide cargo-liner services, and the Johnson line, which specializes in high-speed cargo-liner services. Iron ore is one of Sweden's major exports, and the Grangesberg-Oxelosund concern built up a large fleet of ore carriers to cope with this trade, many of the larger units being able to carry iron ore exports on the outward voyage and cargoes of imported oil products on the return voyage.

13. United States. — In 1913 the United States ocean-going merchant fleet, including the coastwise fleet, totaled nearly 3,000,-000 tons gross. As a result of an emergency shipbuilding program toward the end of World War I, the U.S. ocean-going fleet reached a total of 14,738,506 tons gross by 1922. but a gradual decline then set in until by 1939 the total ocean-going fleet amounted to 9,336,15j tons gross, of which only about two-thirds was then active. High-wage costs and high shipbuilding costs made it impossible for the U.S. privately owned merchant fleet to compete effectively with foreign flags. In an endeavour to stem the decline of the U.S. foreign-going fleet. the Merchant Marine act of 1936 introduced a system of differential subsidies for the building and operating of liner services on specified "essential trade routes." These helped to sustain the cargo-liner companies. although they failed to provide any incentive for private investment in shipping. They did not apply to the tramp companies. which almost disappeared, or to the tanker companies. which found the obligations of the shipbuilding subsidy provisions irksome and sought refuge in registration in Panamá and other countries abroad, or to the intercoastal and coastwise shipping companies which, despite the protection afforded them by the reservation of their trades to U.S. flag ships. were unable to cope with the competition of inland transport systems.

TABLE VI.— U.S. Water-Borne Foreign Commerce Carried in U.S. Flag Vessels
(cargoes in 000,000 lb.)

Sear	Exports				Imports			
	Dry cargo		Tanker		Dry cargo		Tanker	
1946 . . .	143,474	60.9%	30,360	39.9%	50,703	56.3%	47,679	75.8%
1950 . . .	107,618	30.6%	18,270	43.5%	93,777	31.1%	100,162	54.9%
1956 . . .	258,403	18.7%	33,153	19.5%	159,843	26.4%	162,707	23.2%

Source: U.S. Bureau of the Census.

World War II saw another intensive shipbuilding effort in the United States, which agreed with Great Britain to build chiefly cargo ships of emergency type, while Britain for the most part built warships. As a result the United States merchant fleet in 1946 totaled 36,000,000 tons gross. This was more than half the world total tonnage at the end of World War II. because ships of other flags were often lost. and few losses were replaced during the war years. Disposal of the U.S. surplus tonnage to the other Allied powers began in 1936 and many ships were sold at favourable prices. By 1950 the United States-flag merchant fleet had been reduced to 25,000,000 tons gross, but of these 14,000,000 tons gross had been permanently laid up in the emergency defense reserve fleet. The Merchant Marine act of 1936 continued in force and various other legislative measures were taken in an attempt to maintain the volume of U.S.-flag shipping in commercial service. At least half the ships carrying government-sponsored cargoes had to be of the U.S. flag. United States-controlled tanker tonnage under foreign flags continued to increase, and the subsidized passenger and cargo liners maintained their tonnage, but the decline of coastwise and intercoastal shipping continued.

By 1956 the total United States seagoing merchant fleet, including inactive ships but excluding Great Lakes vessels. comprised 3.989 ships totaling 23,643,154 tons gross. Of the ocean-going fleet 496 vessels, totaling 4,210,162 tons gross, were tankers, practically all of which were active.

United States shipping on the Great Lakes continued busy. Tonnage reached a peak of 2,611,040 tons in 1934. By 19j6 the total was still just over 2,500,000 tons gross, but prospects began to decline with the decrease of iron ore deposits in the area.

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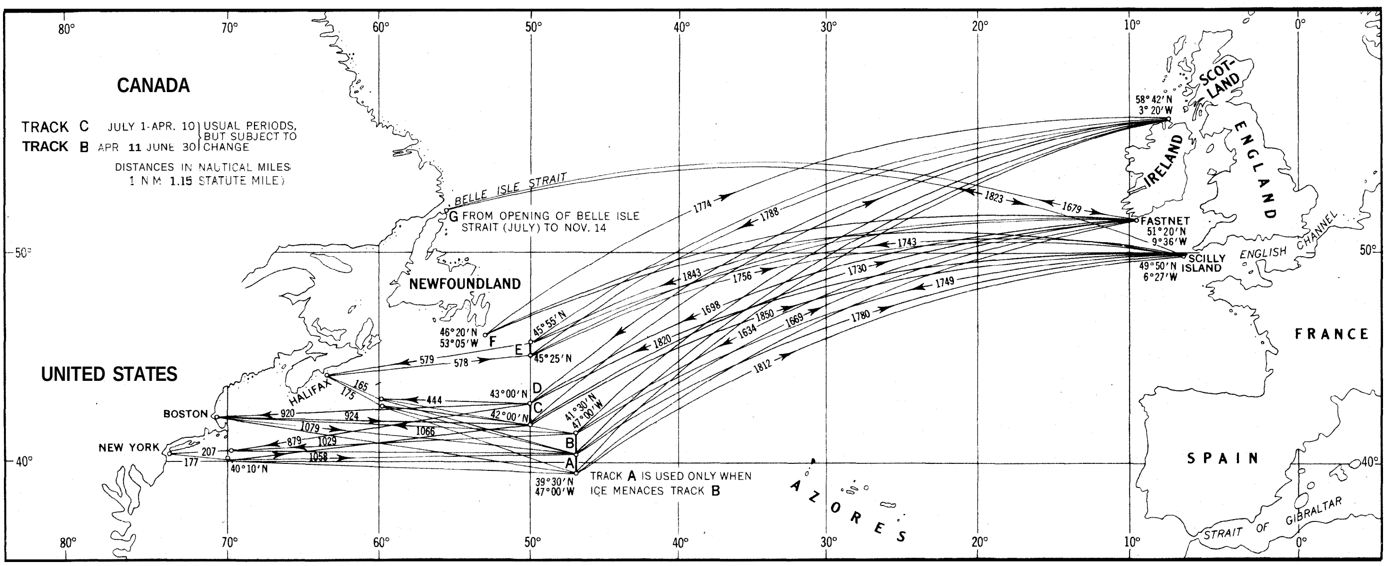
SHIPPING ROUTES. When man first began to venture on the sea, his route was determined by the landmarks along the shore. As the science of navigation developed and he could determine his latitude by the heavenly bodies. he was no longer bound to the coast. It was not, however, until the perfection of the chronometer by John Harrison in 1762 that a shipmaster could accurately plot both his latitude and longitude. Then with exact positions he became more aware of the effects of winds and currents on his ship and began shaping his course to take advantage of them. The shortest route was not always the quickest one: for example, the westbound clipper ships from Europe to America made much faster passages by following a southerly route to avoid the influence of the Gulf stream and the prevailing westerly winds.

No systematic effort was made to study regular ship routes until the decade preceding the American Civil War when Lieut. Matthew Fontaine Maury, then superintendent of the depot of charts and instruments, the forerunner of the present U.S. navy hydrographic office, enlisted the aid of shipmasters generally to furnish him with copies of their log books. From these he produced his Pilot *Charts* with recommended routes that by estimate saved the merchants and shipmasters of the United States more than $2,000,000 annually, and those of Great Britain about $10,000,000 each year. His contributions to the maritime world earned him the title of "Pathfinder of the Seas."

The development of steam navigation ended the shipmaster's dependence on wind as the sole means of propulsion and led to the gradual adoption of the ship lanes of today. The shortest distance between two ports is a great circle on the earth's surface and the modern high-powered steamer follows such routes whenever practicable. However, deviations are made to avoid intervening land masses: ice infested waters and regions of continuous adverse meteorological conditions. Low-powered steamers travel routes taking advantage of favourable winds and currents. The leading hydrographic offices of the world have made studies of the various routes and publish in their volumes of sailing directions advice on the routes to follow. While the high speed of planes has led to international agreements on air lanes and a rigid control on plane flights, there are at present no mandatory international rules governing the ocean lanes, and the selection of the routes to be followed is left to the discretion of the steamship owners and shipmasters.

North Atlantic. — The combination of frequent fog, high density of travel and the annual incursion of ice has led to the establishment of definite ship lanes that are recognized internationally in the North Atlantic between the United States and Europe; these are traveled by the largest and fastest liners. The danger of collision in the North Atlantic was first recognized by Maury, following the sinking of the U.S. mail steamer "Arctic" in Oct. 1854 by the French steamer "Vesta" in a thick fog about 50 mi. east of Cape Race. Nfd., which resulted in the loss of about 300 lives. This disaster inspired him to include in his *Sailing Directions* (185j) a section "Steamer Lanes Across the Atlantic." wherein were graphically depicted and recommended for the first time separate lanes for steamers eastbound and westbound that would not only lessen the danger of collision between ships, but would also provide nearby help in case of disaster. The lane to Europe crossed the 50th meridian of west longitude in latitude 42" and was from 15 to 20 mi. wide; the lane from Europe crossed the 50th meridian of west longitude 200 mi. to the northward and was from 20 to 25 mi. wide, the latter being made wider on account of the greater percentage of fog, the greatest width in both lanes being given where most fog was to be expected.

The pioneer work of Maury was continued by the U.S. navy hydrographic office which emphasized the necessity of lanes across the Atlantic, not only to obviate collisions, but also to avoid the danger from ice. In 1875 the Cunard Steamship company ordered its shipmasters to follow ship lanes that were laid south of the zone into which icebergs normally drifted. Several of the other large



NORTH ATLANTIC LANE ROUTES

and more progressive passenger lines followed this policy, and as a result the number of accidents due to ice showed an encouraging decline. In the meantime. through the medium of the monthly *Pzlot Chart of the North Atlantic Ocean,* the hydrographic office pointed out to the maritime world in general the need to adopt steamer lanes.

The International Marine conference, held at Washington. D.C., in 1889, and attended by delegates from 26 maritime countries, decided: "Steamer lanes for trans-Atlantic navigation are not adopted, although the various steamship companies are urged to adopt regular routes for vessels of their own line." At the urging of the hydrographic office, a conference nas held in 1891 between representatives of five principal trans-Atlantic steamship companies, the Cunard, White Star. Inman, Sational and Guion lines, to consider the lanes as recommended on the *Pzlot Chart* These routes were formally adopted to be followed by all ships of the lines concerned and in 1898 the North Atlantic Track agreement came into being with the adherence of all the major passenger lines of that day. The agreement. although purely voluntary in nature, has remained in effect into the second half of the 20th century with seasonal shifts of the lanes being made as recommended by the commandant of the U.S. coast guard and the U.S. hydrographer. This adoption of recognized steamer lanes contributed greatly to the safety of navigation in the Sorth Atlantic and aas especially gratifying to the hydrographic office, which had so long advocated the lanes as shown on the *Pzlot Charts.*

As a result of the sinking of the British steamer "Titanic" on April 1j, 1912, with a loss of over 1,500 lives. the first International Convention for Safety of Life at Sea was convened at London in 1913. The steamer lanes were considered and the following resolution adopted: "The selection of the routes across the North Atlantic in both directions is left to the responsibility of the steamship companies, nevertheless the High Contracting Parties undertake to impose on these companies the obligation to give public notice of the regular routes which they propose their vessels should follow. and of any changes which they make in them. The High Contracting Parties undertake, further, to use their influence to induce owners of all vessels crossing the Atlantic to folloa, as far as possible. the routes adopted by the principal companies." Similar resolutions were adopted at the subsequent conventions of 1929 and 1948.

With but minor changes. the lanes of the North Atlantic Track agreement, used by the principal steamship companies prior to the London conference, remained unchanged until 1924 when the tracks A, B, C. D, E, F and G were adopted. These. with slight modifications, are the tracks in use today and are shown on the accompanying chart. The routes are seasonal and provide, as far as possible, for safety from the danger of ice, fog and collision with fishing vessels on the Grand Banks. Tracks A. B and C are the United States-European lanes, while D. E, F and G relate to vessels bound to and from Canada. The seasonal United States track empioyed is the one that is ice-free.

An additional safeguard to the North Atlantic lanes resulting from the conference of 1913 was the establishment of the International ice patrol. which, during the ice season, guards the region in the vicinity of the Grand Banks of Newfoundland. warns ships of dangerous ice, recommends safe tracks and makes studies of ice conditions. The cost of the patrol is borne by those nations whose vessels traverse the area. The management of the ice patroi is entrusted to the United States government and is carried out by the U.S. coast guard.

Originally conducted with surface craft, the ice patrol today is maintained principally by reconnaissance aircraft based at the headquarters of the commander of the international ice patrol in Argentia, Nfd. Only in serious ice years is it necessary to dispatch a cutter to stand by ice known to be drifting into the steamer lanes. Since the inauguration of the International ice patrol services, not a single life has been lost or a vessel sunk on the United States-European lanes as the result of collision with icebergs. *See* also TRADE ROUTES. (W. G. WT.)

SHIP'S BELLS, in use as early as the 15th century, make possible the distinctive method of sounding the time on board ship. The mariner's 24-hour day is divided into six watches, each four hours long. except that the 1600 to 2000 watch (4 P.M. to 8 P.M.) may be "dogged" or shortened into the first and second dogwatches, each two hours long, in order to rotate the watches and to allow the men on duty to have their evening meal. Through the 18th century, time was ordinarily measured on board ship by using a sandglass which approximated 30 min. The quartermaster or ship's boy turned the glass when the sand ran through, and it became customary for him to strike the bell as he did this. Eight times in each watch the glass was turned and the number of strokes on the bell indicated the number of half hours elapsed after the men came on deck. These strokes are sounded in pairs, with an interval following each pair.

The time and place of origin of this seagoing custom is unknown but it was nearly universal among Europeans and sailors of the Mediterranean area by the 18th century. After the mutiny at the Nore (1797), British ships followed a special numbering in the dogwatch. From 1600 to 1800 the usual bells are struck, but at 1830 (6:30 P.M.) only one bell is struck instead of five; two at 1900 (7 P.M.); three at 1930 (7:30 P.M.); and eight bells at 2000 (8 P.M.). Thus, the signal for the mutiny, five bells in the second dogwatch, has never been given.

International law required that a ship at anchor sound a series of rapid successive strokes on the bell as a fog signal, while at other times this is a fire signal. (J. B. HN.)

SHIPS' FIGUREHEADS: *see* FIGUREHEADS. SHIPS'.

SHIPTON, MOTHER, a reputed witch and prophetess who is supposed to have lived in early Tudor times. There is no really trustworthy evidence of her existence! but tradition has it that her maiden name was Ursula Southill. Sowthiel or Southiel. that her parents were peasants, living near the Dropping Well. Knaresborough. Yorkshire and that she was born about 1486–1488. Her mother, Agatha Southill. was a reputed witch, and Crsula. who was phenomenally ugly, was regarded by the neighbours as "the Devil's child."

When about 24 she married a builder of York, Tobias Shipton. Her most sensational prophecies had to do with Cardinal Wolsey, the duke of Suffolk, Lord Percy and other men prominent at the court of Henry VIII. She is said to have died at Cliiton, Yorkshire, in 1561, and mas buried there or at Shipton. Her whole history rests on the flimsiest authority, but her alleged prophecies had an extraordinary hold on the popular imagination. The suggestion that Mother Shipton had foretold the end of the world in 1881 caused most poignant alarm in rural England in that year, the people deserting their houses and spending the night in prayer in the fields, churches and chapels.

SHIRAKAWA (1053–1129), Japanese emperor who succeeded his father Gosanjō II on the throne in 1072. The times were troubled. The encroachment of private estates (*shōen*) on the public domain seriously undermined the economic foundations of the imperial government. The warrior monks of the nearby temples threatened the capital city of Kyoto, and the weakening of the Fujiwara family. which had dominated the emperors for over two centuries. made for bitter factionalism within the court. Shirakawa left the throne in 1086 and as retired emperor (*jōkō*) succeeded in retaining power in opposition to the Fujiwara regent (*kampaku*). Drawing around him a group of courtiers, many of whom were from the Minamoto and other non-Fujiwara families, he established an administrative centre replete with judicial functions and a military guard. This was the cloister government (*in-no-chō*) through which former emperors exercised power until 1183. Shirakawa himself held the reins of government until 1129. Although at first Shirakawa sought to reduce private estates. he soon gave up the effort and became instrumental in converting large tracts of public domain into imperial *shōen.* With these sources of wealth he lavishly patronized Buddhism. He failed to strengthen the imperial government and prevent the rise of the provincial warrior gentry. *See* also JAPAN : *History.* (J. W. H.)

SHIRAZ, the capital of the province of Fars in Iran. 180 mi. N.E. by E. of Bushire. Pop. (1956) 169.088.

According to Moslem authors the town arose after the Mohammedan conquest. Shiraz owes some of its architectural distinction to Karim Khan Zand (1751–79), who governed it as regent (declining the title of shah)?made it his capital and greatly beautified it by many handsome monuments; but much of this work was destroyed by the eunuch ruler Agha Mohammed Khan. Of its numerous mosques, the ruined Jami Atiq is'the most noted and ancient, parts of it dating from the 9th century. The largest mosque in Shiraz is the Masjid i Nau, or New Mosque.

North of the city, is the Sa'diyyeh, an enclosure planted with cyprus and orange trees, which holds the tomb of the celebrated mystic poet Sa'di, and in a cemetery nearby is the Hafiziyyeh with the tomb of the poet Hafiz. Shiraz was also the birthplace of the religious reformer called the Bab.

Shiraz is an important trade centre. The area produces sugar beets, barley, oats and gum tragacanth. The most noted product is wine of the Khullar vineyards. The town is noted for its silverwork, inlaywork made of *Khatam-Kari,* cloths, brocades and silk floss, and is the centre of a rug industry. (P. Z. C.)

SHIRÉ, a river of east central Africa, the only tributary of the Zambezi navigable from the sea. The Shirk (length about *300* mi.) issues from Lake Nyasa and almost immediately enters a shallow sheet of water called Malombe or Pa-Malombe, *18* mi. broad and *12* or 13 mi. long. A shifting bar of sand obstructs the end of Malombe nearest Nyasa, but does not prevent navigation. Below hlalombe the bed of the Shirk deepens. The river flows through a mountainous country and in its descent to the Zambezi valley forms rapids and cataracts, rendering its middle course unnavigable for a distance of *60* mi. A little before the Zambezi is reached the country becomes flat. The Shirk joins the main river in about *35° 25'* E., 17° *50'* S.

The lower part of the Shirk is in Portuguese territory; the upper part is in the Nyasaland. Below Port Herald the Shirk is navigable all year. *(See* NYASALAND PROTECTORATE; ZAMBEZI.)

SHIRE, one of the larger administrative divisions in Great Britain, now generally synonymous with "county" (*q.v.*), but the word is still used of smaller districts. The Anglo-Saxon shire was an administrative division next above the hundred (*q.v.*) and was presided over by the ealderman and the sheriff (*q.v.*).

SHIRE MOOT, an assembly of the free men of a shire for judicial, fiscal and other administrative business. It is first mentioned in the reign of Edgar (958–975), and then probably consisted of all the free landholders of the shire. In course of time the burden of suit to this court became attached to particular estates, and by the 13th century the number of persons present at a shire court was small. Each shire moot met at a specified place, and in the 10th century twice a year only, though more frequent sessions were held in later centuries. The shire court received fresh importance in the 12th century from the occasional presence of royal justices itinerant, and at a later time it came to play an important part in the machinery by which members were elected to parliament from the counties.

SHIRLEY or SHERLEY, **JAMES** *(1596–1666),* English dramatist, was the most successful writer for the stage when the playhouses were closed in *1642.* He was probably born in London in Sept. 1596. He was educated at Merchant Taylors' school and Catharine hall, Cambridge, where he took his B.A. degree in or before *1618.* Before going to Cambridge he seems also to have spent a short time at St. John's college, Oxford. He took orders and went to a living near St. Albans, which he left on his conversion to Roman Catholicism. He was then (1623–25) master of St. Albans grammar school, but failing to settle to the work he eventually went to live at Gray's Inn, London, and became a playwright.

From *1625* till the Puritans closed the theatres in *1642* he was most successful. There survive 31 plays of his sole authorship, and six masques and entertainments. Ftom *1636* to *1640* Shirley was in Ireland and had several plays produced in Dublin, presumably at the Werburgh street theatre, the first in Ireland, which opened in *1637.* In the Civil War, he served with the Cavaliers, but on their defeat returned to teaching and writing educational textbooks. Throughout his career he wrote and published poems.

Driven from their London house by the Great Fire of *1666,* Shirley and his wife died from the experience within a day of each other. They were buried at St. Giles's-in-the-Fields on Oct. *29,* 1666.

Shirley's plays are packed with situations and types such as had been used more and more recklessly by Jacobean dramatists. His tragedies deserve regard mainly for their consummate stagecraft and their astonishing but rare bursts of poetry and psychological insight. The romantic plays and realistic comedies that form the bulk of his work use old conventions delightfully to create fantasy and mild satire. Shirley's reputation as an individual artist may rest on such plays as *The Opportunity, The Gratefail Servant* and *The Imposture,* as well as on one of the finest lyrics in English, "The Glories of our Blood and State."

Shirley wrote the magnificent entertainment presented by the members of the Inns of Court to the king and queen in *1633.* entitled *The Triumph oj Peace,* scenery devised by Inigo Jones and music by W. Lawes and S. Ives; and *Cupid and Death (1653). The Contention of Ajax and Ulysses (1659)* closes with "The Glories of our Blood and State."

The standard edition of Shirley's works is *The Dramatic Works and Poems of James Shirley, with Notes by William Gifford,and Additional Notes, etc.,* by Alexander Dyce, *6* vol. *(1833).* Edmund Gosse edited *(1888)* six plays for the Mermaid series.

See also R. S. Forsythe, *The Relation oj Shirley's Plays to the Elizabethan Drama* (1914); *A. H.* Nason, *James Shirley, Dramatist (1915).* (P. GN.)

SHIRLEY, WILLIAM (1694–1771), colonial governor of Massachusetts, was born at Preston in Sussex, Eng., Dec. *2, 1694.* He studied at Cambridge and was later admitted to the bar. In 1731 after *11* years of law practice in England, he migrated to Boston. Mass. Shirley was a constant but not always successful office seeker. His loyalty to the imperial prerogatives, his ability and his friendship with the duke of Newcastle resulted in his being appointed admiralty judge in *1733* and the king's advocate general in *1734.* In 1741 he was appointed to the governorship of Massachusetts and proved to be a popular and successful governor in a rather difficult period. He handled such problems as that of the proposed land bank adroitly enough to win the respect of the advocates of that ill-fated scheme, and he managed to give Massachusetts a relatively sound currency. His most important achievements as governor were in the realm of colonial and imperial defense. He was quite successful in building up the Massachusetts fortifications and unusually astute in his analysis of the nature and importance of the struggle between England and France for control of North America. During King George's War (1740–48) he organized and planned Britain's one great victory, the capture in *1745* of Louisbourg on Cape Breton Island. In *1753* Shirley renewed his recommendations for united action against the French and drew up a plan for offensive warfare. After the defeat and death of Gen. Edward Braddock in western Pennsylvania in *1755.* Shirley became commander in chief of the English forces in America but neither in America nor in England could he command the respect and co-operation necessary to carry out his well-conceived plans. After the failure of his expedition against Ft. Niagara he was replaced as commander and governor and was recalled to England where he was charged with treason. After being vindicated he was appointed governor of the Bahamas in 1761. In *1770* he returned to Roxbury. Mass., and died there on March *24,* 1771.

See G A Wood, *William Shirley, Governor of Massachusetts, 1741–1756 (1920)*; C. H. Lincoln, *Correspondence of Wnz. Shirley (1912).* (RI. MU)

SHIZUOKA, prefecture *(Ken)* on the Pacific coast in central Japan. Area *3,000* sq.mi.; pop. *(1960)* 2,756,271. Served by the Tōkaidō central trunk railway line. Favoured by a warm climate, Shizuoka has developed a varied agriculture. Oranges and tea are the chief products, and fishing is highly developed at Shimizu, the principal port. The processing of food and other industries are important. Hamamatsu (*q.v.*) is famous for the manufacture of musical instruments. Topographically and geographically the eastern and western sections differ. Volcanoes and hot springs dominate the east, while large river valleys occur in the west.

SHIZUOKA-SHI, the prefectural capital *11960* pop. 328,819) is situated on the delta of the Abegawa river. The climate is mild, Shunpei, as Shizuoka was called until 1869, was a castle town as well as one of the 53 stage towns on the Tōkaidō highway. About 70% of Japan's tea is raised in its environs and the city is famous as a trading and processing centre for green tea. Shizuoka is the site of Shizuoka university, a women's pharmaceutical college and several industrial and agricultural experimental stations.

(R. B. H.)

SHMIDT, OTTO YULIEVICH (1891–1956), Russian scientist and polar explorer, was born on Sept. 30 (new style; Sept. 18, old style), 1891, at Mogilev. He was a university teacher of mathematics before and immediately after the Revolution of 1917. His support for the new regime and his administrative ability caused him to be appointed to various senior civil service jobs: he was manager of the state publishing house, deputy head of the central statistical administration and a member of the state planning commission. After taking part in the Soviet-German Pamir expedition of 1928, he became interested in the arctic and went on an expedition to Franz Josef Land in 1929. Next year he was made director of the Arctic institute and in 1932 first head of the chief administration of the northern sea route (Glavsevmorputj. the newly formed government department responsible for arctic development. During his six years in this job he directed the extensive Soviet program of exploration and exploitation of arctic resources: and generally spent the whole of each summer season aboard an icebreaker off the north Siberian coast. He led the expeditions in the "Sibiryakov" (1932) and "Chelyuskin" (1933–34), the establishment of the north pole drifting station (1937) and its relief (1938). In 1939 he left arctic work and devoted himself to science for the rest of his life. He had been elected an academician in 1935 and vice-president of the Academy of Sciences in 1939. On his initiative the academy created the Institute of Theoretical Geophysics in 1938. He was its director until 1918. advancing at this time a new theory of the origin of the earth. He was chief editor of the *Great Soviet Encyclopaedia* from 1921 to 1931 and of the journal of popular science, *Priroda.* To this remarkable record of activity he added a professorship of mathematics at Moscow University from 1926 until his death, becoming in this capacity the founder and leader of the Moscow school of algebra. His publications were mainly mathematical papers and articles on polar work. His influence on Soviet life and thought was both considerable and remarkably diverse. He died in Moscow on Sept. 7, 1956. (T. E. A.)

SHOA, a former province of the Abyssinian empire. From about the middle of the 10th century until nearly the close of the 13th century. Shoa was the residence of the Abyssinian sovereigns, who had been driven out of Axum. About 1j28 Shoa was overrun by Moslem invaders and was for over a century afterward a prey to Galla raiders. It remained independent of northern Abyssinia until 185j, when the emperor Theodore reduced it to submission. In 1889 Menelek II, king of Shoa, made himself master of the whole of Abyssinia. *See* ETHIOPIA.

SHOCK. The usual signs of the syndrome called shock are weakness, profound depression and pallor. The skin becomes moist, cold and grayish. The pulse is rapid and weak. The blood pressure usually is below normal. Respirations are shallow. If the patient has sufficient strength, he may be restless, but frequently he can be aroused only with great difficulty. The metabolism is low and there is suppression of all vital functions, so that the patient is obviously gravely ill.

The term shock was first used in the 19th century to characterize the alarming symptoms known to result from a wide variety of causes, both physical and psychic. Such an uncritical use of the term robbed it of significance, and many workers who were attempting to clarify the problem of shock advocated discontinuance of the term altogether and substitution of a more descriptive word; but nevertheless it persisted. Qualifying words or phrases indicative of the probable cause of the condition are usually employed with the word shock, as, for example, traumatic, postoperative, anaphylactic, histamine, transfusion, etc. In the last analysis, death from almost any cause might be preceded by a number of symptoms that are characteristic of shock; therefore, consideration of the condition usually has been limited to collapse resulting from hemorrhage and from various forms of physical trauma.

Traumatic shock was classified by W. B. Cannon into two types, primary and secondary. The primary type was defined as the collapse occurring immediately after severe injury and was considered as indistinguishable from syncope and collapse. Secondary shock was defined as collapse occurring after a variable period of time following severe injury.

Medical authors at mid-20th century made little distinction between shock and collapse or syncope, except to recognize that if collapse or syncope persists for a sufficient time, shock will result. According to V. H. Moon, the attempt to distinguish between shock and collapse is like distinguishing between breeze and wind. N. E. Freeman defined shock as "the clinical condition characterized by progressive reduction in circulating blood volume due to increased capillary permeability." (Norman E. Freeman, "The Mechanism of Shock," *Military Surgical Manuals,* vol. v, 1943.) Moon defined it as "a disturbance of fluid balance resulting in a peripheral circulatory deficiency which is manifested by decreased volume of blood, reduced volume flow, hemoconcentration and by renal functional deficiency." (Virgil H. Moon, *Shock: Its Dynamics, Occurrence and Management,* 1942.)

H. N. Harkins defined shock as "An oligemia [decreased volume of blood] *initiated by* traumatic local fluid loss, either whole blood, plasma or both; *accompanied by* decreased cardiac output, diminished volume flow, lowered venous pressure, decreased oxygen consumption, arteriolar vasconstriction, progressive hemoconcentration, capillary congestion, acapnia [diminished carbon dioxide in the blood], and secondary blood pressure fall; and *perpetuated by* a summation of these factors and possible hyperpotassemia [increased blood potassium], increased generalized capillary permeability, anoxia [lack of oxygen], action of tissue metabolites, and deficiency of adrenal cortical hormone." Harkins also pointed out that "other changes. both chemical and pathologic, may occur in shock, including increased blood nonprotein nitrogen, decreased coagulability of the blood, and in some instances increase in plasma magnesium." (Henry N. Harkins, "Recent Advances in the Study and Management of Traumatic Shock," *Surgery,* 9:231–294, Feb. 1941; *ibid.,* 9:607–655, April 1941.)

Knowledge of the cause of shock has been obtained from the obserVztion and treatment of patients and from experimentation with animals. One of the most attractive theories of the cause of traumatic shock, the so-called traumatic toxemia theory of Cannon and W. M. Bayliss, afforded a satisfactory concept of the initiating factor of shock. According to this theory, a toxic substance is absorbed from the injured tissues and distributed to all parts of the body. where it injures the capillaries which in turn allow fluid to leak through them to such an extent that the volume of circulating blood becomes inadequate. In view of the fact that histamine or histaminelike substances had been demonstrated in animal tissues and that shock had been produced experimentally by injections of this drug, the toxemia theory was readily accepted. It was called into question, however, by A. Blalock and by E. Parsons and D. B. Phemister; though weakened, it was not abandoned. There is substantial agreement among authorities that loss of blood, blood plasma or body fluids by whatever means is the most important initiating factor in shock of most types.

Hemorrhage, excessive sweating, vomiting, dehydration, diarrhea, extensive bruises of the flesh, severe injury to the body or limbs, low blood pressure, cold, pain, burns and psychic stimuli such as fear and grief predispose the individual to shock, since any one of these. if severe and prolonged enough, may result in reduction of the volume of circulating blood. Some of the results of this are known, such as increased capillary permeability after anoxia. but others have been only surmised. Clearly, reduction of the circulating blood volume causes anoxia of the tissues. in turn causing injury to the capillaries which permits further loss of plasma volume. This cycle, if uninterrupted, becomes irreversible. and death is certain.

Treatment. — With more knowledge of the cause, prevention and treatment can be better carried out. Treatment of shock depends to some extent on the nature of the injury or disease responsible for its development. Attention is first directed to the loss of blood or other body fluids, and steps are taken to prevent further loss. Hemorrhage, vomiting, sweating and diarrhea are controlled as soon as possible, and pain is relieved. In case of severe injury of the extremities, the part is immobilized. Rest and quiet are recommended as soon as the patient has been made reasonably comfortable. Prevention of further loss of body heat is accomplished by use of covers, hot-water bottles and heating pads, but caution against overtreatment is frequently suggested. Elevation of the foot of the bed or placing of the patient in the "shock position" may be of benefit. Vasoconstrictor drugs are not indicated as a routine treatment but may be of benefit in exceptional cases such as so-called spinal shock. In cases in which pulmonary ventilation is inadequate for saturation of the blood, oxygen is administered. Operations in the presence of shock are done when possible with local-acting or short-acting drugs such as pentothal sodium or evipal.

Finally. since the fundamental factor in the production of shock is a decreased volume of circulating blood, the best treatment of the condition is the transfusion of whole blood or blood plasma, but if these are not available appropriate doses of solution of acacia, pectin, dextran or any of the other recommended blood substitutes should be injected. Isotonic solutions of sodium chloride and glucose are recommended for temporary use until more adequate measures can be instituted.

Prevention. — In civilian and army hospitals prevention of shock is of paramount importance. Patients who have lost large amounts of blood are prepared for operation by adequate transfusion. Those who have become dehydrated receive fluids by infusion or are given proper quantities of fluid by mouth. Every effort is made to avoid the onset of shock by taking proper preventive measures in preparation of the patient for operation.

Preparation for intravenous administration of fluids is routinely made before the operation begins. At the first sign of a deficient circulation, fluids are supplied to the patient. In case of severe hemorrhage during the operation, blood is administered in sufficient quantities to prevent the occurrence of shock. *See* also references under "Shock" in the Index volume.

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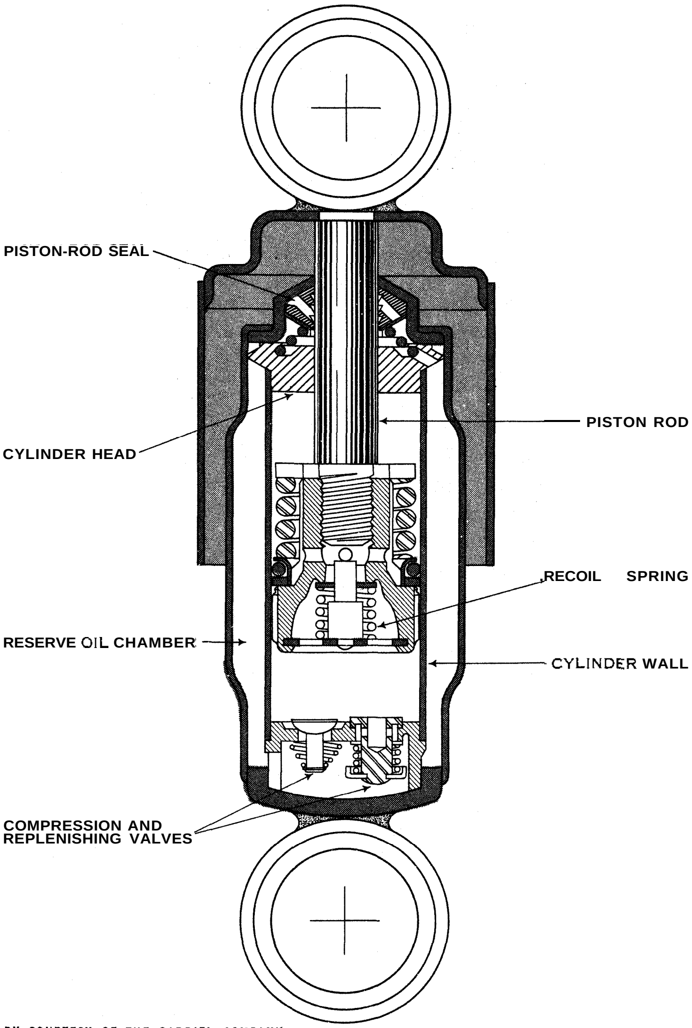
SMOCK ABSORBER, a device for controlling the motion of an elastic suspension system such as that of a vehicle. The spring elements of such a suspension system are deformed by an impulse applied to the wheels and tend to react after the force of the impact is spent. Shock absorbers slow down the vibratory motion of the suspended portion and quickly restore equilibrium.

Modern shock absorbers are hydraulic devices and are double acting in that they oppose both the compression of the springs and the rebound. The direct-acting or strut type (*see* figure) is attached to the vehicle frame and axle by two eyes. The central tubular cylinder is fitted with a piston that is attached by a piston rod to the upper eye. The cylinder moves with the lower eye and an annular fluid reservoir surrounds it. A spring-loaded one-way seal prevents fluid flow downward past the piston, but permits controlled flow upward. A valve in the under side of the piston controls the rate at which fluid can flow from the chamber during rebound. The fluid reservoir communicates with the compression chamber through two spring-loaded valves in the base of the cylinder. The discharge valve at the right controls the rate at which fluid can escape from the cylinder during a compression stroke and the valve at the left later refilis the cylinder. Relative motion of the sprung and unsprung portions of the vehicle can be only as rapid as the reciprocation of the piston in the shock absorber, which can be no faster than the fluid flow from one compartment to another permits. Controlled resistance to fluid flow limits the rate at which the suspension can vibrate.

Shock absorbing mountings are used to isolate the vibration of machines, such as diesel engines. These mountings usually employ some resilient member, such as blocks of cork or rubber, interposed between the engine and the floor on which it rests.



BY COURTESY OF THE GABRIEL COMPANY

CROSS SECTION OF HYDRAULIC SHOCK ABSORBER

Large calibre guns are fitted with recoil mechanisms that permit the gun barrel or the breech to move back under the reaction to the acceleration of the missile. This movement is gradually stopped by a hydraulically damped spring that returns the parts to their operating position.

See VIBRATION CONTROL. (O. C. C.)

SHOCKLEY, WILLIAM BRADFORD (1910–), U.S. physicist, received the Nobel prize for physics in 1956 jointly with John Bardeen and Walter Houser Brattain (*qq.v.*) for their work on the transistor (*q.v.*). Shockley was born in London of American parents Feb. 13, 1910. Reared in California, he was educated at California Institute of Technology (Pasadena) and Massachusetts Institute of Technology (Ph.D., 1936).

He joined the technical staff at the Bell Telephone laboratories in 1936, and there he began experiments which led to the invention and development of different forms of the transistor. During World War II he served as director of research for the antisubmarine warfare operations group of the U.S. navy and as an expert consultant for the office of the secretary of war. After the war he served as director of transistor physics research at the Bell laboratory. He was visiting professor of physics at the California Institute of Technology in 1954, deputy director of the weapons system evaluation group of the defense department in 1954–55, and joined Beckman Instruments, Inc., to establish the Shockley Semiconductor laboratory in 1955. In 1958 he became president of the Shockley Transistor corporation in California, a subsidiary of Beckman Instruments, Inc.

SHODDY, a special type of fabric made from materials which have already been spun into yarn and woven into cloth but have been torn up into a fibrous mass, respun and rewoven. The re-manufactured materials are very short in fibre. so it is usually necessary to mix some better material with them to carry the bulk through the machines into the yarn Good wool or noils (the short from combing). but more often cotton, is employed. The yarns thus spun are in the majority of cases woven into pieces as weft yarns, the warps usually being cotton. See also YARN.

SHOE-BILL (*Balaeniceps* rex), a giant bird from the White Nile, related to the herons. In singularity of aspect few birds surpass Balaeniceps, with its gaunt gray figure, about 5 ft. in height. its large head surmounted by a little curled tuft. its scowling eyes and its huge bill. in form not unlike a whale's head but tipped nith a formidable hook. It forms large flocks and frequents dense swamps. The flight is heronlike, and the birds settle on trees. The food consists of any small animals or carrion. The nest is a hole in dry ground, roughly lined with herbage, and from 2 to 12 chalky white eggs are laid.

SHOEBURYNESS, a promontory on the Essex coast of England, 4 mi E. of Southend-on-Sea, and the point at which the coast line trends northeast from the estuary of the Thames. It has a gunnery testing establishment On the seaward side of the Ness is an earthwork attributed to the Norsemen.

SHOES and boots are very ancient items of dress, their value as protective covering in severe climates or rough terrain being obvious. In all early civilizations shoemaking skills were developed by hand craftsmen to a high degree; styles and variety were produced by the artisan but the process was slow and expensive. Modern mass production depended upon the development of shoe machinery. which began about the middle of the 19th century, and the industry developed most extensively in the more highly industrialized nations. In the early 1960s the United States alone, for example, produced and consumed more than 25% of the world's leather footwear—an average of 3½ pairs per capita annually. It is estimated that purchase of about half of these was for replacement or utility, that of the other half was motivated by the appeal of fashion Women's dress shoes are influenced by fashion' to a greater extent than are other types, and in the United States in the 1960s about 47% of all shoes manufactured were women's shoes (The remainder consisted of men's shoes, 17%; children's shoes, 23%; slippers, 12%; athletic and other specialized types, 1%) Somewhat similar figures apply in Great Britain, another leading producer of leather footwear, although the consumption rate was slightly lower—just over three pairs a person. Per capita consumption and spending for footwear is also directly related to personal or family income (except that high-income families spend proportionately less on all clothing, including footwear, than middle- and low-income families). Thus in the United States low family income states such as Mississippi and Arkansas averaged less than 2.5 pairs per capita a year, while high family income states such as Connecticut and New Jersey averaged 4.7 pairs.

CONSTRUCTION AND DESIGN

History.—The first type of footwear was a simple wrap-around of leather (the basic construction of a moccasin). held together on the foot with raw-hide lacings. Gradually this design was improved upon and assumed many variations. Another early design was the simple sandal, consisting of a sole held on the foot by a leather thong. The oldest shoe now known is a sandal made of woven papyrus, found in Egypt and dating from about 2000 B.C.

Moccasins, sandals and simple boots were the prevailing types of footwear almost up until the middle ages. Wooden clogs or shoes, commonly used by the poorer classes, were also important, though distinctly different from the more desirable leather types. Until modern times footwear was largely homemade, though a considerable share was produced by artisans and craftsmen; large guilds of these shoemaking specialists date back to ancient Rome. While there were small shoemaking shops consisting of a few craftsmen, the first signs of the "mass-production" factory did not appear until the 18th century. The first shoe factory in the United States is credited to John Adams Dagyr, a Welshman who opened a shop in Lynn. Mass., in 1760. He employed a number of shoemakers. each performing only one operation, who produced a supply of shoes from mhich customers could purchase directly from stock. Previously. most purchased shoes mere custom-made.

In 1818 lasts (wooden forms) for shaping shoes were first made in rights and lefts. Another milestone was reached in 1846 when Elias Howe invented the sewing machine. Previously, the majority of shoes mere made by attaching sole to upper with tacks or nails or wooden pegs; if they were sened the work was done by hand. The sewing machine not only greatly speeded production but made a better shoe. Shortly after, and over the next 60 or 70 years, a steady flow of new and improved shoe machinery was introduced, and by the beginning of the 20th century the shoemaking industry was on a full mass-production basis.

Materials.—Since time immemorial the universal basic material for shoes and boots has been leather, used for uppers, linings, counters, inner soles, outer soles. welting and other parts. It is still dominant but in modern times is being replaced by other materials to an increasing extent, particularly in the component parts of shoes. For example. at one time the great majority of inner soles and outer soles were of leather but most are now made of nonleather materials, such as rubber or synthetic fibres or composition materials. Other parts of the shoe are also being made of nonleather materials. There are, for example, plastic melting and plastic heels; coated fabrics for linings; natural and coated fabrics for uppers; plastic counters or back-part stiffeners and chemically compounded box toes. Most of these materials, the products of modern chemistry, are priced lower than leather and at the same time meet all required performance standards.

Leathers commonly used in shoe uppers and linings include side leather (cowhide), calf, kid, sheep, reptile (alligator, snake and lizard), horsehide (cordovan). and certain specialty types such as kangaroo, deer and ostrich. Each leather has its distinctive characteristics and each tends to find its own specialized applications in footnear. Calf is the "luxury" leather, used in the finest grade men's and women's shoes. Side leather (made from cattle hide, and called "side" because the large hide is cut down the middle, lengthwise, into two sides for easier handling) is the most versatile of all shoe leathers. It comes in several grades and is used for a great variety of footwear—women's lightweight casual footwear, children's school shoes and other kinds. An estimated 70% of all leather used in shoe uppers is side leather.

Kid leather, made from goatskin, also has wide use, ranging from women's high-grade dress shoes to men's comfort shoes. Sheepskin is used largely in slippers and linings Reptile leathers (alligator, lizard and snake) are used in some women's and a few men's shoes. Cordovan (from horsehide—a small "muscle" layer in the hide) is a heavy leather popular in men's shoes. Certain specialized leathers such as kangaroo (used in comfort and athletic shoes), ostrich (used in a few women's shoes) and pigskin also find application.

Patent leather is usually made from cattle hide and given a special surface finish. Suede is made from any of several leathers (calf, kid, cattle hide) by a process consisting of buffing the inner surface to create a napped finish.

Certain fabrics, among which are linen. satin and silk, have found increasing use in footwear. Another modern development has been coated fabrics, consisting of a fabric base coated nith a chemical surface finish to give a vast variety of textures and designs, many of them simulating leather grains to a remarkable degree. These find wide use in less expensive shoes, especially in women's and girls' footwear. Synthetic fibres are producing new families of materials. such as nylon mesh and nylon velvet. Much synthetic patent and suede is also produced for shoes.

Some of these leathers and other materials are used for linings as well as for outside uppers of shoes.

Styling and Design.—Many kinds of footuear—men's work shoes, oxfords and riding boots, for example—remain essentially unchanged from year to year, but in other types fashion plays a considerable role. Each year new styles are prepared to conform with the seasonal turnover and the general trends of fashion In the U.S. it is estimated that more than 100.000 new sample styles are prepared annually by the manufacturers. After the retailers have made their selections, about 20% to 25% of the original samples will go into production.

Most manufacturers design their lines twice yearly, for spring-summer and fall-winter. Some designing is done for one brief season, such as summer, or for resort-cruise wear. The greatest demand for variety of style is in women's shoes, followed by men's and girls' shoes. Seasonal turnover in women's styles is quite pronounced. while in men's shoes it usually requires several seasons before distinct changes take place.

Determining the styling features to be incorporated in a new season's line is a highly complicated procedure. In women's shoes, for example, consideration must be given to colours, materials, lasts. patterns. ornamentation, silhouettes, heel shapes and heights, textures and surface finishes. All these must be welded into a "line" of scores of different styles for the new season. And all these must be attuned to general fashion trends in women's apparel, for shoes are regarded as the most important accessory in a woman's ensemble.

Styling a new line involves an expert team of specialists: the designer, fashion co-ordinator, style man. sales manager, sales staff and pattern man. New lines are usually prepared from 4 to 12 months ahead of season. New styles or style trends in footwear are usually initiated by the makers of higher-grade, higher-priced shoes. Once a new shoe is launched and receives the first signs of consumer interest, it is immediately adopted by the volume or medium- and lower-priced shoe lines.

After about 1945 in the U.S., juvenile footwear, particularly in girls' shoes. moved toward "fashion." While the conventional school oxford remained a basic shoe. a wide variety of new types and styles of shoes uon increasing favour among the young.

Methods of Construction. — There are said to be more than 800 ways in which to make a shoe, but only a few of these are actually used. Fundamentally, shoe construction consists of attaching the sole to the upper in such a way as to create a bond sufficiently durable to withstand the wearing conditions for nhich that shoe was designed. There are four basic construction methods:

1. Sening, which includes such types as the Goodyear welt process. in which the sole is sewed to a welt strip that has previously been sewed to the upper and insole; and the stitchdown, in which the upper is turned out and stitched down to the sole.
2. Cementing, in which the outer sole is attached to the insole and upper by adhesives.
3. Molding. in which the sole is vulcanized or "molded" to the upper.
4. The use of fasteners, as in nailed or stapled shoes.

There are numerous variations nithin each classification, and special features of one process may be combined with special features of another to provide a sort of "crossbreed" construction.

Each kind of shoemaking has certain distinctive features uhich make it particularly adaptable to certain kinds of wear. For example. the Goodyear welt process is known for its sturdiness and hence is commonly used in men's and boys' dress shoes as well as in better-grade children's shoes of certain types. Cement construction enables shoes to be built on lighter, sleeker lines and is therefore used for most women's and many girls' shoes. as well as for some lighter types of men's shoes. Molding. as in the vulcanized process, combines economy of construction with rugged durability and is used in men's work shoes as well as in some juvenile footwear. It is also used in all rubber-canvas shoes.

About 80% of all shoes manufactured in the United States in the 1960s were made by three of these processes: cement (54%), Goodyear melt (19%) and stitchdown (7%). Trends or shifts in the use of certain shoe constructions are motivated by technological changes. economics and fashion. The cement process was launched commercially in the early 1930s and by the 1960s was used in over half of all shoes made in the C.S. The Goodyear welt was still regarded as one of the best of shoemaking methods but had steadily declined from its once dominant position. Market demand for lighter shoes and the proportionately higher number of women's shoes manufactured partially account for this Differences in manufacture are also significant. In most basic constructions about 150 different operations are required to make the shoe, and as many as 200 may be required. Certain modern methods of construction, such as the vulcanized and injection-molding methods. have been well received because they reduce the number of operations required as well as the number of component parts. In Great Britain, for example, one-fifth of all the footwear made at the beginning of the 1960s was produced by these methods, and the proportion was increasing.

Steps in Production. — Shoe manufacturing is essentially an assembly process of fusing together a number of components: heel. sole, counter. upper (vamp and quarter). lining. toe box, welting, insole, ornamentation and the like. Proper assembly on a high-speed production line requires the most meticulous planning and precision of prefabricated parts so that the shoe fits well, looks well, wears well, performs well and feels well. The assembly line is actually a series of departments, each specializing in a group of operations, from the cutting of the leather to the packing of the finished shoes in boxes. A great variety of machines and devices, each for a specialized operation, is utilized. Work proceeds on a pretimed schedule. Each style or type of shoe has its own preplanned schedule in moving through the production line. Operations and machines must be adjusted differently for different styles or types of shoes: or even when different materials are used.

Because the shoe industry is so largely mechanized (the day of the hand craftsman is virtually gone). it is highly dependent upon machines and the shoe machinery industry. Several large shoe machinery companies provide these many different machines.

The individual components of a shoe are usually purchased by the shoe manufacturer from outside suppliers who specialize in such components. The manufacturer purchases these components (linings, soles, insoles, counters, heels, etc.) according to his specifications for size, weight, grade, colour, finish: etc., all to be assigned to a particular style or type of shoe in his line.

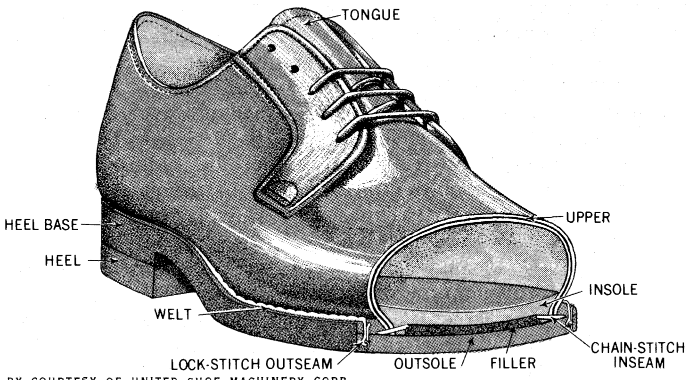
Each specialized construction has its distinctive procedures but there are certain essential features common to all constructions. The major steps in shoe construction may be briefly outlined as follows:

The cutting room is the launching point in the shoemaking process. Here the upper materials and linings are cut out with dies that have been designed especially for that particular shoe, but in the case of short production runs the older method of hand cutting around templates is still retained. The cutter must be an experienced craftsman; upper materials are costly, and a high degree of precision is required so that the parts will assemble according to plan. The dies are used with clicking or cutting machines, and the weight and cutting edge of the die must be accommodated to the particular type of material being cut. Special machines are also used to perforate the upper material or emboss it with a particular design. Splitting machines (for reducing the thickness of a material) or crimping machines (for preforming leather parts) may also be used in the cutting room.

The shoe then moves to the fitting (or closing) room where the precut parts of the upper are fitted together, usually by sewing or stitching, although some cementing is done. This assembly includes the upper portions of the shoe, linings, stays, facings. eyelets, etc. Many types of sewing machines are used, some of them attaining speeds of more than 4.000 r.p.m. and able to sew from one to eight rows of stitching at one time. In the U.S. and Great Britain almost all the operators in the fitting room are women (who constitute about half of all shoe production employees).

As the shoe moves out of the fitting room in preparation for the important lasting operations, it begins to take shape. The assembled upper, in loose form, is ready to be fitted over the wood last for which the patterns were precisely designed. First. however, the insole is placed on the bottom of the last. This insole, of a shape and size to conform exactly to the bottom of the last, is a sort of "security layer" between upper and outer sole to fuse the shoe parts into a firm unit. The counter or stiffener at the back part of the shoe is placed between the lining and outside of the upper. These parts — insole. counter and upper — are now on the last and the entire unit is presented to the assembling machine. The shoe is thus made ready for lasting.

The lasting machines are ingenious mechanisms that grip the



BY COURTESY OF UNITED SHOE MACHINERY CORP.

CONSTRUCTION OF MEN'S WELT SHOE

upper at the toe and sides with pincers. pulling the leather tightly over the wood last so that the material conforms in minute detail to the whole fore part of the last. The heel or back part is also lasted.

The shoe is now ready to have the outer sole applied. After lasting. however, a number of operations are required to prepare the shoe for bottoming. It is at this point that some of the essential differences between the various types of shoe constructions are evidenced. The Goodyear welt. cement, stitchdown and vulcanized constructions enter the sole-laying stage under different sets of prepared conditions. Also. of course. the method by which the sole itself is attached is distinctly different. Once the sole is attached it must still receive finishing touches such as trimming and staining and burnishing the edges. The bottom of the sole must be cleaned or buffed and polished.

Applying the heel is an equally meticulous operation, done with special heeling machines. These attach the heel with nails driven securely into the heel; in the case of high heels, a long screw goes down into the heel for added security. Once the heel is attached, it also undergoes trimming and finishing operations.

The final series of operations consists of such details as applying heel or sock linings, inserting laces, attaching buckles to a strap, and brushing or polishing. Finally there is a thorough inspection, and the shoes are then ready for packing and shipping.

Boots are made in much the same way, the major differences being in the lasts. which generally have a bootlike shape. and in the patterns for the uppers. The type of construction depends upon the type of boot; for example. a work shoe or boot might be made on a vulcanized construction while a riding boot would be made on a Goodyear welt process.

THE FOOTWEAR INDUSTRY

United States: *Industry Structure.*—In the 1960s there were about 850 shoe manufacturing firms in the U.S. The leading 10 firms accounted for 30% of the total production: the leading 30 firms for 42%; and the top 80 for more than 54%. Though shoe production has shown a steady gain (averaging out to about 10,000.000 pairs a year increase). the number of shoe manufacturing firms continues to decline. marginal firms being eliminated under the duress of competition and capital requirements.

New England accounted for about one-third of the nation's shoe production, with Massachusetts the leading state, representing 17% of all shoe output in the 1960s. Other major shoe-producing states were New York and Pennsylvania, each with 14%; Missouri. 10%; and Ohio, Tennessee. Wisconsin and Illinois. each averaging between 3% and 5% of the total.

Unlike shoe factories in most other countries. American plants are highly specialized, making only men's or women's or children's shoes or slippers. with further specialization in grades or price lines produced. The American shoe worker averages an output of about 2.900 pairs a year, the highest productivity level in the world. Factories tend to be medium sized. The best efficiency level is found to be at a production rate of between 4.000 and 10.000 pairs a day. The largest shoe-manufacturing firm produces over 200.000 pairs a day, but this is distributed over some 50 different plants. Most shoe factories are located in smaller communities rather than in large cities or heavily industrialized areas.

Retailing and Marketing.—Approximately 850,000,000 or more pairs of footwear (including rubber footwear and imports) are sold in retail stores annually in the United States. Slightly over half of these are sold through shoe stores. The rest are distributed through various types of retail establishments— department stores, mail-order and variety store chains, clothing stores, general merchandise stores, discount houses and even drugstores. About 71% of all shoes is sold in only 13 states. and 44% is sold in only 5 states (New York, California, Ohio, Illinois and Pennsylvania). New York alone accounts for 14% of all shoe sales.

The annual dollar volume for the average shoe store is below $75.000. Shoe retailing is a relatively complex function, involving not only the basic inventory and operating requirements of any retail establishment but also consideration of fashion, foot health, fitting and other specialized requirements. For this reason, it is a higher-risk business than comparable retail stores in other fields. The seasonal turnover of styles, for instance, necessitates astute judgment to hold losses on wrong selections to a minimum. In women's shoes, careful selections must be made in terms of colours, heel heights, patterns, etc.

Shoe fitting is an extremely important function in the shoe store and requires experience and judgment combined with highly specialized knowledge and training; badly fitted shoes do not wear well, feel uncomfortable and in addition constitute a health hazard (see FOOT, DISEASES AND DISABILITIES OF). In addition to size (length and width) fitting involves the proper adaptation of shoe to foot in terms of leathers (some have more "yield" than others), lasts, heel heights, gait characteristics, etc. The store must carry a large and costly inventory to fit the vast variety of feet it must service, to say nothing of the customer's desires in style. A shoe factory may produce as many as 140 different sizes on a single style of shoe. A shoe store may carry as many as 65 sizes on a single style and have only one pair in each size. It would require duplication cf sizes in the more popular ranges. A store may carry 50 to 100 different types and styles of shoes, and it can readily be seen that the problem of inventory and risk is extremely complex.

After 1945 there were some important changes in shoe retailing trends in the U.S. One change was in the locations of shoe stores, many of which are now situated in suburbs and shopping centres and even as "free-standing" stores on highways. A considerable amount of shoe business is done outside the downtown districts. Certain types of outlets formerly not associated with shoes have gone increasingly into the business. Among these are supermarkets, discount stores. variety stores, some drugstores, and various general merchandise stores. Another trend has been toward "self-service" shoe stores with interior layouts where customers can browse and shop. These are called self-selection layouts but are accompanied by fitting services.

Another change. particularly after the mid-1950s. was in the amount of footwear imported into the U.S. In 1954 leather shoe imports amounted to about 7,700,000 but by 1962 reached over 55.000.000 pairs. Rubber footwear imports showed an even more spectacular gain—from less than 1,000,000 pairs in 1954 to 100,000.000 pairs in 1961. These gains in footwear imports were expected to continue through the 1960s, though perhaps at a slower rate. Principal sources were the Cnited Kingdom, Italy, Japan and Hong Kong; except for rubber footwear, most of the imports were men's and women's shoes, and chiefly in the lower price lines.

U.S. manufacturers have given only token effort to the exporting of shoes. For many years before and after World War II shoe exports remained around 4.000.000 pairs a year and by the early 1960s had dropped to around 3.000.000 pairs.

The U.S. shoe industry as a whole continues to show steady though rarely spectacular growth. It is known as a "stabilized" industry, not subject to sharp' increases in times of prosperity, nor sharp declines in times of recession or slump. Its production and sales growth pattern is closely related to population growth and to a lesser extent to income growth, with some proportionate increase in consumer spending for shoes. (WI A R)

Great Britain.— In the early 1960s there were some 1.200 shoe manufacturing firms in the United Kingdom. but a third of these mere very small employing under 20 workers As in the United States. there was a tendency for manufacturing units to become fewer and larger but shoemaking, as compared nith other industries. nas still one of small-size factories. only five employing more thdn 1.000 workers. Almost equal numbers of men and women were employed, and piecework was common.

After the United States. Great Britain is one of the world's largest footwear producers. The main centres of production are Leicestershire and Northamptonshire, traditional shoemaking areas where originally cattle and sheep were plentiful (for hides and skins) and the country was well wooded with oak (for bark-tanning), Northampton is world renowned ior its high grade of men's footwear, and Leicester has developed into a centre for medium-grade \\-omen's shoes. High-grade fashion shoes are made in Norwich and London. and these two centres also manufacture children's shoes. Southwest England. once the centre for heavy boots for miners and agricultural workers, has developed as the main centre for molded footwear and good-quality women's and children's shoes. The Rossendale valley in Lancashire is noted for its slipper production. The tendency for larger manufacturing units accentuated the trend toward greater specialization as regards type and price of shoe produced in different firms and areas.

Although the labour force in the industry steadily decreased (in the early 1960s it was about 100.000 compared with 115.000 a decade earlier), improved techniques and machinery raised productivity. and after World War II total output rose steadily by an average of 3.000.000 pairs a year. In 1960 the industry produced nearly 160.000.000 pairs of leather footwear (*i.e.*, excluding rubber), of which some 40% was women's shoes while men's and children's shoes and slippers each accounted for about 20%.

With financial support from the government, the industry maintains an efficient research station (British Boot. Shoe and Allied Trades Research association). In addition to laboratory research. it offers to its members consultancy services on practicai problems and acts as independent arbiter on matters concerning consumer complaints.

Retailing *and Marketing.*—The end of the 1950s saw a spectacular rise in consumption of footwear in Great Britain, largely because of the growing "teen-age" market and a general increase in consumer expenditure on clothing and footwear. Speedier changes in fashion, particularly in women's shoes, also caused the buying public to spend more on shoes. but these changes brought new problems for manufacturers and retailers alike. Total consumption of leather footwear in 1960 amounted to more than 160,000,-000 pairs (or more than 3 pairs a person) and rubber footwear purchases made up a further 40,000,000 pairs, the over-all value being 1290.000.000.

Multiple retail organizations (covering 7,700 outlets) sold 45% of this footwear, and independent retailers (comprising 5.900 outlets). 26%. Co-operatives, department stores, mail-order and credit trading concerns accounted for 5%–6% each. Some 20%–25% of British footwear was retailed under manufacturers' brand names. but the great majority of shoemaking firms produced anonymously to orders irom wholesalers and retailers.

Domestic production only partially satisfied the increased consumption. and imports of leather footwear rose from 2.500.000 pairs in 1955 to 14.500.000 in 1960. when one in every 11 pairs sold came from abroad. Most of these came from Europe. with Italy and France predominating. and were mainly women's shoes and slippers. Imports of rubber footwear also rose. with Hong Kong traditionally the largest supplier.

British footwear was exported to more than 100 overseas markets. and in 1960 some 9.000.000 pairs of leather footwear worth F12.000.000 were sent abroad, nearly half of them being men's shoes. The biggest single market was the United States. taking practically one-third of Britain's footwear exports; one-half went to the commonwealth and one-sixth to Europe. The commonwealth countries. however. were a diminishing market for British shoes, as quantitative restrictions were imposed to protect the growth of the young. local footwear manufacturing industries. As old markets contracted. new ones opened up, and 1959 saw the start of a flow of British footwear exports to the U.S.S.R.

Western Europe.— Besides Great Britain. the main footwear producing countries in Europe are Germany. France and Italy. Italy's output rose conspicuously during the 1950s. trebling itself between 1951 and 1559. Italy also became the leading European exporter of footwear, accounting for 40% of the continenr's exports of leather footwear. This success was due to the development in Italy of an elongated. light-weight styling of shoes which proved extremely popular. All the European countries experienced a rise in consumption of footwear in the 1950s and all. except Norway, increased their output. The emergence of the European Common Market and the European Free Trade area led to greater trading in footwear between the countries concerned. On the retail side the main outlets were independent shops and department stores: multiple organizations were not developed to the degree they had in Great Britain, but buying groups began to be established by retailers. Both the Common Market and the Free Trade area had their own liaison committees of manufacturers' organizations, and the Organization for Economic Cooperation and Development hides and skins committee compiled production and trading statistics on footwear in their member countries to encourage greater co-ordination of footwear production and marketing in this area.

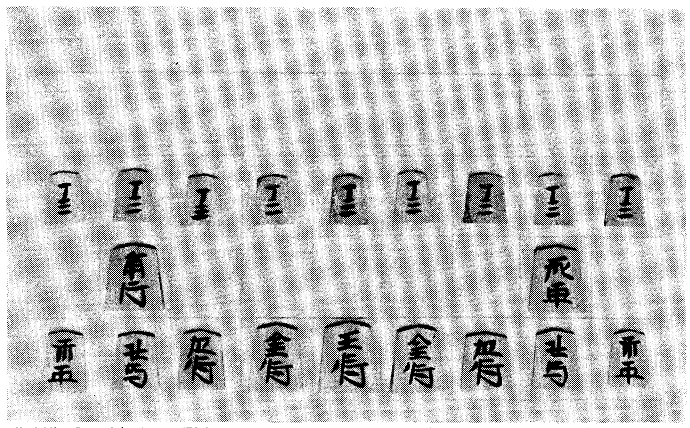
See also references under "Shoes" in the Index volume.

(P. G.-SM.)

SHOFAR, SCHOFAR or SHOFER, the ancient ram's horn trumpet of the Hebrews. It consisted of a natural horn turned up at the bell end. and. having a short conical bore of very large calibre, it would be capable of producing at most the fundamental octave and twelfth.

SHŌGI is a Japanese form of chess (*q.v.*), the history of which is obscure. Traditionally it is thought to have originated in India and to have been transmitted to Japan via China and Korea.

Shōgi, like chess, is played on a squared board with pieces of varying powers, and the ultimate object is the checkmate of the king. Two distinctive features, however, differentiate shōgi sharply from European chess: (1) captured men are not "dead" but may be replayed as part of the captor's forces; (2) there is no pawn chain or blocked pawn position. Each player has 20



BY COURTESY OF THE METROPOLITAN MUSEUM OF ART, GIFT OF GUSTAVUS A. PFEIFFER, 1948

WOODEN SHOGI CHESSMEN: JAPANESE. 20TH CENTURY

men. which oppose each other on a board composed of nine horizontal and nine vertical rows. There are nine pawns (*fu*), a rook (*hisha*) and a bishop (*kaku*), one king (*ōshō*), two gold generals (*kinshō*), two silver generals (*ginshō*), two knights (*keima*) and two spearmen (*kyōsha*). From the standpoint of mobility. *hisha* and kuku roughly correspond in chess to the queen, *kyōsha* to the rook. *kinshō* and *ginshō* to the bishop: the others are the same in both games. Rook and bishop oppose each other diagonally. the rest on the same file. The pieces are flat, blunt and slightly tapering toward the front. Each bears identifying characters. Captive men are held at reserve bases until they are needed on the field again, hence the number of pieces in play remains approximately the same from the beginning to the end of the game.

All men except the king and gold generals are promoted on entering the last three rows of enemy territory.

See E. Ohara, Japanese Chess: the Game of *Shogi* (1958); Stewart Culin, Games *of* the Orient (1958). (E. D S)

SHOGUN, abbreviation of sei-i-tai-shogzcn (barbarian-subduing generalissimo), was one of several titles under which early Japanese emperors commissioned supreme military commanders for campaigns against the Ainu of northern Japan. The title first appeared in A.D. 720 but lost its original meaning with the pacification of the north country in the 9th century. Minamoto Yoritomo (1148–99) first used the title as a basis for asserting military and political authority over the country. Yoritomo won military hegemony of Japan in 1185 and acquired imperial appointment as shogun in 1192. Together with other inheritable high court ranks and titles it provided the legal foundation from which his military headquarters (*bakufu*) exercised control over all military families in Japan. As the military class acquired increased powers over national and local affairs, the shogun became de facto ruler of Japan, though the emperor continued to retain formal sovereignty. Yoritomo's successors as shogun ruled from Kamakura (1192–1333). The second line of shogunal succession, begun by the Ashikaga family, ruled from Kyōto (1338–1573). The third line, established by the Tokugawa house, used Edo as its capital (1603–1867). With the intrusion of western powers into Japanese affairs in the 19th century, the question of definition of powers between the shogun (called "tycoon") and emperor (mikado) became an issue. In 1867 the Tokugawa shogun resigned his title and "returned" his prerogatives of civil and military administration to the emperor. See also JAPAN: History. (J. W. H.)

SHOLAPUR, city and district in Maharashtra state, India. The city is 140 mi. S.E. of Poona. Pop. (1961) 337,544. Two colleges connected with Poona university are there.

SHOLAPUR DISTRICT (5,811 sq.mi.) is watered by the Bhima and its tributaries, feeders of the Kistna river system. The district's liability to drought is partly offset by canals and tanks. Pop. (1961) 1,858,512. The chief trade centre (for cotton, oilseeds and oil) is Barsi (pop. 41.849). 37 mi. N. of Sholapur. Pandharpur (40,514), 33 mi. W. of Sholapur, is the popular centre for the worship of an aspect of Vishnu, Vithoba, whose image is the object of an elaborate bathing rite.

SHOLEM ALEICHEM, pseudonym of SOLOMON RABINOWITZ (1859–1916), popular Yiddish classical author. Born in Pereyaslav, in the Poltava district of the Ukraine, on Feb. 18. 1859, he was educated for the rabbinate at nearby Varonkov. Drawn to writing as a youth, he became a private tutor of Russian at the age of 17, and at 18 went to the estate of Elimelech Loeff near Kiev to tutor his 12-year-old daughter Olga. He fell in love with her, an event that cost him his position. He served as a government rabbi in Lubin and when he was 21 married Olga. Her father's death in 1885 brought him a considerable fortune. His first writing had been in Russian and Hebrew, but between 1883, when his first story in Yiddish appeared, and his death he published over 40 volumes of novels, stories and plays in Yiddish. He used part of his fortune to encourage Yiddish writers and edited the annual, Die Yiddishe *Folksbibliotek* (1888–89); he lost the rest of it in business. His works were widely translated. and he became known in the United States as the "Jewish Mark Twain." He left Russia in 1905, established his family in Switzerland, and lectured in Europe and the United States.

At the outbreak of World War I he went to New York city where he died on May 13, 1916.

English translations from his Verk, 14 vol. (1908–14), include Jewish Children, trans. by Hannah Berman, 3rd ed. (1937); *The* Old Country, trans. by Julius and Frances Butwin, 3rd ed. (1954); and Adventures of Mottel, the Cantor's Son, trans. by Tamara Kahana (1953). He was the first to write in Yiddish for children. Adaptations of his work nere important in the founding of the Yiddish Art theatre in New York.

See Maurice Samuel, The World of Sholom Aleichem (1943).

SHOOTING: see HUNTING.

SHOOTING STAR (Dodecatheon), the common name for a genus of beautiful plants of the primrose family (Primulaceae), comprising some 30 species native to North America and northeastern Asia. They are stemless, perennial herbs, with basal leaves and a naked flower stalk which bears at its summit a cluster (umbel) of singularly shaped flowers similar to those of the garden cyclamen. The shooting star, commonly grown in gardens (D. meadia), with pink or white flowers, is native to open grounds from Pennsylvania to Manitoba south to Georgia and Texas. Numerous species occur in the western states, seven being found in California, among which are the Sierra shooting star (D. *jeffreyi*), the lowland shooting star (D. *patulum*) and the upland shooting star (D. *hendersonii*).

SHOP FRONT DESIGN. The shop front, since the earliest days of barter, has been a pertinent problem in design for the obvious reason that, apart from the requirement of presenting merchandise attractively, the interest of the prospective customer has had to be maintained.

History. — The stores of the Roman forum, and in particular the light thrown upon the habits of the populace by the resurrections of Pompeii, show that the shops of earlier generations had much in common with ours. Chifflot completed a remarkable work showing a restoration of the house of the Centenaire which showed the palatial home of the owner with its interior courts away from the street, and facing the street the small shops which were rented to merchants whose interests were quite separate from the house at the back. The stores were open to the street, inasmuch as the use of glass, for enclosure, was unknown. The design of the stores themselves, however, indicate an attempt at design which would attract the passer-by. The stores always clustered around the main buildings of the city throughout the East, and later throughout Europe.

Throughout the East, the bazaar has been, and still is, the source of barter of goods of any type. The arrangement of goods consists primarily in displaying the complete stock.

Throughout the middle ages, the cathedral was the focal point of public interest. and around it would be found the stores of popular appeal, The bridges of the great cities long held the stores that still divert the tourist on the Rialto in Venice or the traveller crossing the Arno in Florence. Pont Neuf, in Paris, lost its stores in the final rebuilding during the 19th century.

Throughout France, many examples are still in evidence at Caen, Bourges, Rouen, Compiegne and as well in Paris, itself, of historic buildings of excellent design, where the store was planned as the important feature of the building. It is of course equally clear that during the middle ages, and even up to the French Revolution, the shopkeeper under the guild system maintained a certain dignity quite distinct from the aristocratic classes, and inasmuch as the store was often the outlet for goods manufactured above by the family, or the outlet for merchandise assembled by the owner, it was possible to beautify the store in proportion to the artistic intelligence of the proprietor.

The inns, such as the 16th-century Hostellerie du Grand Cerf, at Les Andelys, are quite definite instances of unusually good design developed under trade requirements. The inns, like the modern restaurants, had similar requirements of attraction and were successful in proportion to the charm and interest they maintained An exhibit of the Metropolitan Museum of Art in New York city, emphasizing a quite different social phase, is an 18th-century store front of painted and carved wood.

Holland. in the days of its great commercial glory. built homes for the great houses that maintained business contacts throughout the world and in particular during the 16th, 17th and 18th centuries erected many buildings that are standing to this day as examples of industrial production of high order. The home of the merchant was, and usually still is, part of the business structure and this has tended to produce a particular feeling of intimacy in detail that is lost when the typical store building of the modern scheme is projected. The Dutch houses along any of the great canals in Amsterdam, for instance, are built of brick and are extremely simple in their decoration. The more recent Dutch store design has completely emancipated itself from the domestic store policy and has broken every restriction either of form or of use of material. These façades are interesting experiments though it is more than likely that another generation will choose certain elements of strength from which to evolve a simpler and less bizarre form of building.

On the whole, the variation between the store preceding the 19th century and our own type is essentially that of a change in business policy; the larger store developing from a bazaar into a great organization has required monumental buildings. At the same time, a parallel development of the specialized store has resulted in the construction of special settings for the display and sale of merchandise requiring environment, as, for example, small shops, candy stores and the particularly American development of the drug store which is quite in sharp contrast to the dignity of the apothecary of Europe. With the development of the modern store and the distinctly modern use of large sheets of glass, the frame of the store, in many instances, has become the band enclosing the expanse of display within. The only reasonable explanation of this boldness is the demand for sudden changes of display — hardware in the morning to clothes or food in the afternoon. Under such circumstances the less striking the setting the simpler the problem of the window designer. (E. J. K.)

Technique. — The great development in recent years in the design of shop fronts has been caused by the growing expanse of display space, the use of new materials and the intensification of sales technique. The modern shop front is designed as a picture frame for the contents of the window and also as a means of attracting customers at long range. Intelligent merchants have discovered that mere expanse of plate glass is not enough. In other words, the picture needs a frame, but at the same time, the frame must not be so important that it overpowers the picture. The attraction of customers from a distance offers a more difficult problem — the reconciliation of the desire of the shopkeeper to have his shop as conspicuous as possible with the desire to preserve the beauty of the street as a whole. It is obtained by richness of material, interesting form, prominent signs, bright colours, strong lighting.

The extent of display space has been increased by new types of glass joints, metal mouldings and deep vestibules with elaborate convolutions of plan, so that even on a short frontage a large display is possible — more powerful lights and greater control by colour screens and spotlights, together with a great advance in the art of window dressing have added to the effectiveness of the display itself. Show window interiors should be designed as a background for the display, not so dark as to absorb light or so light as to make prominent shadows, or of a colour or treatment so strong as to overpower the display. The display itself is treated as a composition of sculpture or painting, arranged in mass with stands and drapery and accented by lighting. (R. H. S.)

Modern Tendencies. — In the modern store, wood and plaster have practically disappeared and the use of marble, stone, bronze and the less expensive materials, such as cast iron, copper and quite recently polished rustless steel, is usual.

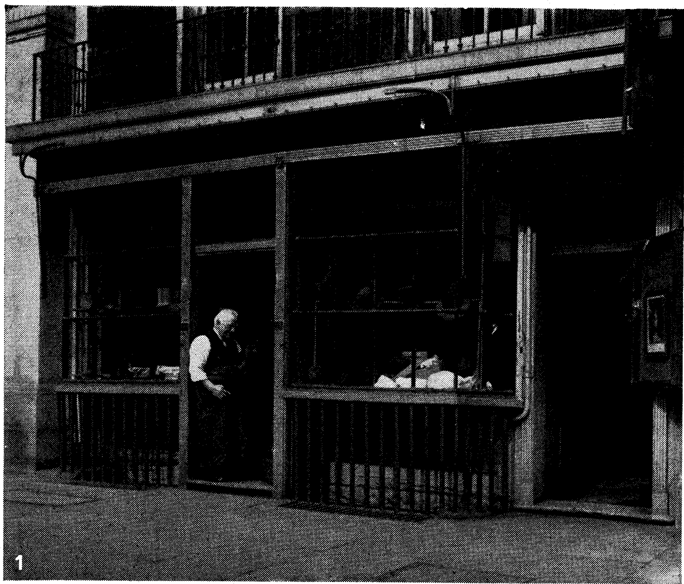
As a matter of solution of design, the stores in America have not shown great brilliancy in spite of the tremendous opportunities that have been presented. This, in large measure, is due to extreme conservatism Two influences appear in recent years: one, an attempt to introduce into store design the principles of the Colonial or English Georgian architecture, and many excellent examples of store fronts are now in evidence throughout New England. The very close derivation of detail from historic sources has produced charm of design and intimate scale that is in thorough sympathy with the buildings surrounding the shop. The other tendency has been to copy the specialty store, as was particularly developed in Paris during the 19th century, and up to this particular day, the theory being largely that of creating a striking frame for a very special display of goods. In quite a number of these stores, however, where the designer has proceeded with a free hand in the solution of a problem, unusually excellent results have been obtained, and on a number of the streets in Paris examples of these stores may be seen. The Rue St. Honoré, the Rue de la Paix, Avenue de L'Opéra and the Rue Royale, in Paris, as well as Unter den Linden and the Kurfiirstendam, in Berlin, are especially to be noticed and there the variety of design is almost as extensive as the quality of merchandise which the stores contain. In these various stores the proportion and size of the show window are in direct relation to the scale of the merchandise in the store. The back of the window is very often made an interesting part of the composition, but it is not clear that this element of design is of sufficient importance to warrant comparison with the well developed façade and the illumination within.

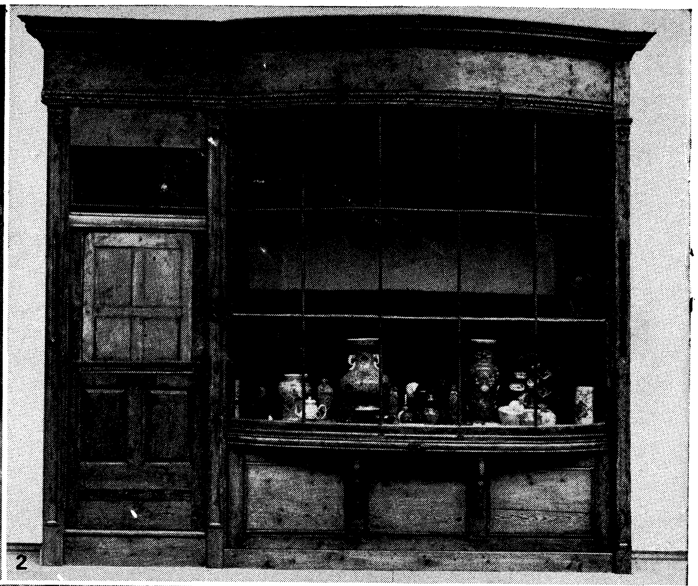
Fifth avenue, in New York, has a character thoroughly at variance with the streets noted. Although the original theory of the shopkeeper had quite simply been a willingness to adapt European forms, the rapid development of the Avenue has forced serious changes in style in so breathless a form that the description is difficult. At one period, particularly at the beginning of the 20th century, the classic revival produced excellent varieties of Italian palaces transformed into stores that are slowly feeling the pressure of business changes. The uneven sky-line which the daily rebuilding further exaggerates tends to complicate the problem by presenting difficult questions of scale. The struggle seems to lie between the policy of the large show window of the Altman, Bonwit Teller and Franklin Simon store type as against the smaller window and larger wall surface as exemplified in the Cammeyer, Dobbs and Bergdorf-Goodman stores. The tendency on Fifth avenue has been thoroughly conservative and its appearance, in spite of the restraint, is dignified and well worthy of the most important shopping district in the country.

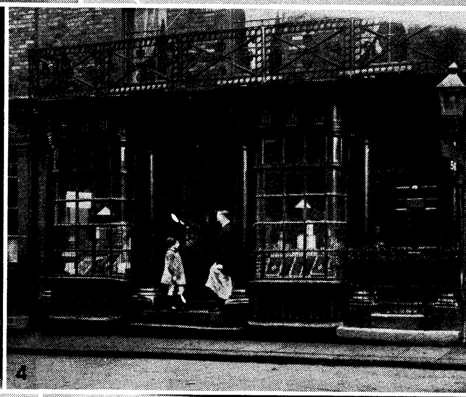
In Germany, the illumination of the exterior and the interior of the window has been greatly exploited by the use of tubular lamps which, on occasion, frame the store opening, or where the same lamps are used to develop a store name and appear during the day as letters against a proper background, at night presenting a brilliant design against the dark surface of the building. These tubular lamps do not throw a large amount of illumination but show themselves as brilliant units of glowing colour. In Germany, likewise, the use of sheets of glass is to be noted, wherein varying possibilities of effect are produced. In some cases a white glass is used to form surface patterns through which, at night, light is thrown, thereby presenting a very brilliant impression to the street. This is particularly noticeable in restaurants or stores where the major requirement is a sensational effect. Another use of the glass is in the application of sheets of opaque material; blue, black and white glass acting as a veneer, either framed in metal or bolted to the wall as purely decorative material. Throughout France and Germany, mosaic has been extensively used, and the possibilities of colour effect which this material permits appear to be unlimited.

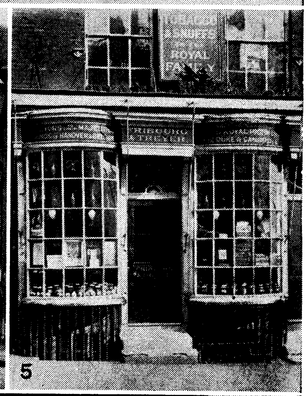
In Paris, the large stores, as contrasted with the specialty shops of the streets before mentioned, have developed a design extremely characteristic of Paris. The Printemps, Bon Marché and the Galleries Lafayette have, during the past few years, redesigned their façades, not only to keep abreast of the modern note in design, but to maintain the public's interest, apparently in their own evolution. It is quite likely that Paris, being a cosmopolitan city, requires more active development than similar cities in the United States or England might find advisable, and it is likewise obvious that according to American and English standards French stores are somewhat over-elaborate. There must be a nice balance between the interesting frame and the merchandise within, quite in the same proportion that a painting or a piece of sculpture requires careful handling to be enhanced by its background. In spite of this criticism, however, the French stores unquestionably are of great interest and apparently hold the popular enthusiasm through their present policies.

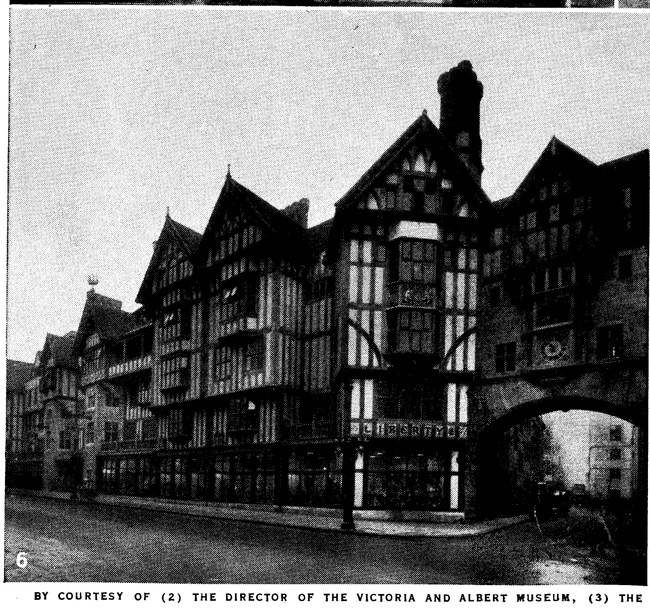
The German stores, in particular the Wertheim building, designed by A. Messel in 1905, and which is still the prototype for big store design in Germany, resemble the French stores in their elaboration, with profuseness of carving and decoration, explaining a period when money was available for such use. It would seem to be a happy misfortune that the requirement for economy











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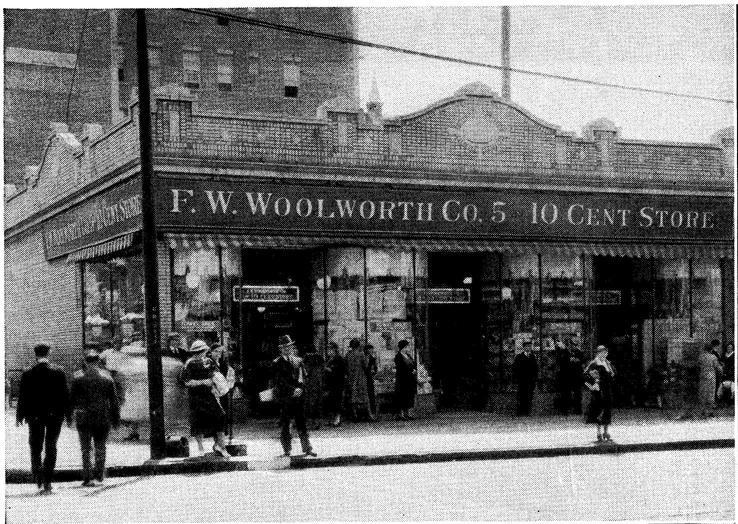
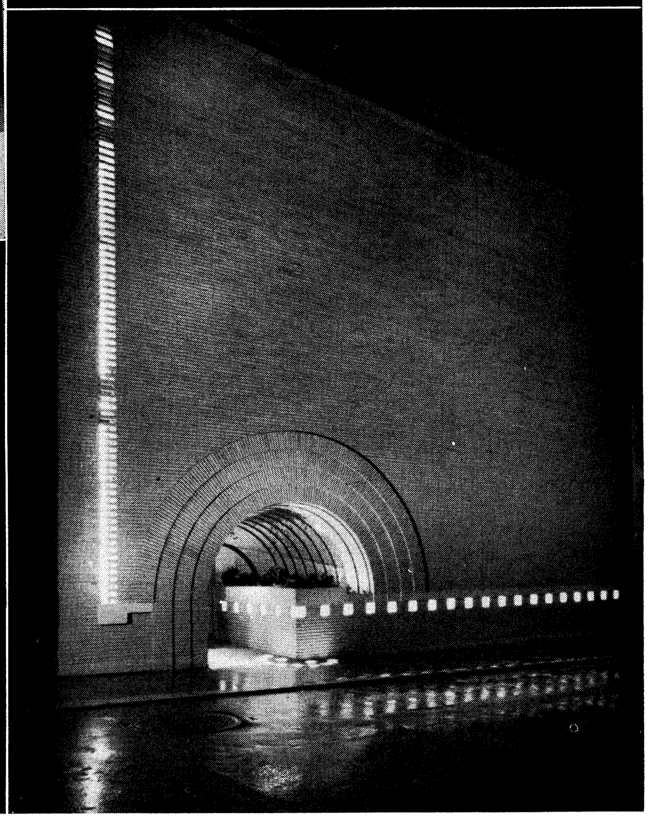
EXAMPLES OF SHOP FRONT DESIGN

1. An 18th century hatter's shop in London
2. A late 18th century shop front from Petty France, Westminster
3. An 18th century Louis Seize shop front, similar to English examples of the same century
4. Early Georgian shop front
5. The Old Snuff House of Fribourg and Treyer. Business probably established there about 1720. Front preserves its original state
6. Liberty's Tudor Building, London. Quaintness of Tudor architectural style attracts attention
7. Favil Press shop front designed by H. J. Birnstingl, London





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20TH-CENTURY SHOP FRONTS

Top left: Typical U.S. shop front of the 1930s. Standard sign and lettering easily identified merchandise for sale

Top right: Fur store in Milan, It. An example of the mid-1940s, the entire store front was treated as a large window

Centre left: Cigar store familiar in many U.S. cities

Bottom left: Shoe store, Washington, D.C. An example of open-front design popular in the 1950s

Bottom right: Design by Frank Lloyd Wright in which shop front is a wall of yellow brick in Germany today is causing the designers to simplify the forms to a point where effects are obtained with a great reduction in decoration and more emphasis on proportion, colour and purity of form.

Among American examples might be noted the work of Louis Sullivan, in New York and Chicago, in particular the Carson Pirie Scott and Co. store which, although most exuberant in detail, shows an interesting variance in pattern from the work of its day.

In more recent days through 1935, the tendency has veered more and more toward simplicity—note the stores in the new Rockefeller group in New York. Materials are given most careful consideration for the simple reason that ornamentation being secondary, proportion and substance are of primary importance. Lettering is often the only enrichment and has, therefore, been studied in relation to the scale and character of the establishment. Lighting of the store windows has progressed far beyond the requirements of a decade ago. New reflectors are available and the amount of light has increased materially. Show window backs have changed from elaborate wooden structures to far simpler elements that permit rapid change of displays and settings.

See ARCHITECTURE; LIGHTING. (E. J. K.)

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SHOPPING CENTRE (SHOPPING PLAZA), a shopping district or area in which is located a group of shops offering a balanced variety of goods and services. In the United States, such centres or plazas may be classified (1) as controlled or uncontrolled, depending on sponsorship or ownership, planning and organization, or (2) as neighbourhood, district or regional, depending on the size of the operation and the trading area served. The first shopping centres developed without formal planning in neighbourhoods of large cities not far distant from the central shopping district. Later, many centres were established in suburban areas, where they were planned to provide adequate parking space and harmonious architectural treatment.

The shopping centre or plaza is primarily a post-World War II development and constitutes a response to such changing environmental factors as movement of population to suburbs, changes in consumer buying habits, increased use of the automobile, increased traffic congestion in cities (particularly in the central districts), and scarcity and high cost of parking facilities. Designed to serve the needs of their surrounding areas, shopping centres vary widely in regard to size, number and kinds of shops, location and over-all design.

The controlled type, for example, may be subdivided into two groups. One is the centre built by a real-estate organization that expects to profit from its investment by leasing all the units of the centre to others. The second is the centre developed by a large retailer whose own branch shop constitutes the focal point of the centre; ownership of the facilities enables the retailer to control selection of tenants, extent of competition, types of sales promotion and similar factors.

On the basis of size and trading area served. three different kinds of shopping centres may be distinguished: (1j the convenience or neighbourhood centre, usually serving from 5.000 to 10,000 families, arranged in a strip pattern and with a supermarket as the chief tenant; (2j the community or district centre. serving 20,000 to 40,000 families: often arranged in an L-shaped pattern, with a department store as the chief tenant; and (3) the regional centre, serving as many as 500,000 people or more and laid out around a central mall or with shops clustered around the chief tenant, commonly a branch of a large department store.

Among these three kinds of centres, the regional, because of its size and large variety of merchandise, is most important. Regional centres provide an environment conducive to regular patronage through attractive facilities, including arcades, benches and well-designed store interiors and fixtures; in addition, evenng hours, nhich encourage family shopping, aid them in attracting customers. Increasingly, chain-store companies in such fields as food. variety goods and apparel are recognizing that shopping centres, since they constitute strongholds of established brand names, provide the most promising locations for new units.

The growth of shopping centres and plazas has had significant effects on downtown areas or the central shopping districts of the cities near which the centres are located. Sufficient business has been deflected from the central shopping districts to induce downtown merchants to adopt various measures to regain this lost volume or at least to prevent further losses. Such measures include increasing expenditures for store and equipment modernization, promoting improved transportation facilities for easier access to downtown areas. providing enlarged and improved parking areas, holding special sales promotional events and, surprisingly. encouraging the renovation of the downtown sections of many cities to resemble shopping plazas by converting some streets to pedestrian malls and building peripheral roadways.

These measures probably will slow but not stop the growth of shopping centres; the share of retail money spent in the downtown section of the metropolitan area probably will continue to decline. No shopping centres exactly comparable to those in the United States exist in Great Britain or Europe. The nearest approach to this type of planned shopping centre is to be found in the English New Towns, the new centres of blitzed cities such as Coventry, and in postwar development in Denmark and Sweden. None of these, however, has been designed to serve a motorized society. (D. J. D.)

SHOP STEWARDS. Prior to 1914, shop stewards in Great Britain were confined to certain of the skilled trade unions. The duties of the shop steward were to inspect trade union contribution cards at regular intervals. to recruit new members for the union, to keep a watch on possible encroachments in the trade of other sections of labour. and to report regularly to the trade union branch or district organization which he represented on matters arising in the ivorkshop demanding official attention. In some cases he was also responsible for representing grievances of members of his union in the workshop to the management. His powers were, therefore restricted.

The conditions of wartime led to the assumption of new functions by shop stewards. The official trade union organizations were parties to the industrial truce agreed upon at the beginning of the war, and in any event, their machinery was too cumbrous to deal with the questions which arose from day to day in almost every munitions factory.

During the war, therefore, shop stewards became negotiators and superseded in a large degree in factories and TI-orkshops engaged on war production, the ordinary official machinery of trade union negotiation. At the end of the war, the restoration of more normal conditions broke the power of the shop stewards. They have, however: in many unions now become a normal part of trade union organization. Shop stewards have been appointed in factories and workshops in a variety of industries where they did not exist prior to the war. In addition to carrying out their well-established duties. they are in some industries empowered to negotiate on minor matters, but their negotiating powers are derived from the unions and are not exercised independently of the unions as was so frequently the case during the war. See TRADE UNIONS.

SHORE, JANE (d. 1527), mistress of the English king Edward IV, is said to have been the daughter of Thomas Wainstead, a prosperous London mercer. She was well brought up, and married young to William Shore, a goldsmith. She attracted the notice of Edward IV, and soon after 1470, leaving her husband, she became the king's mistress, Edward called her the merriest of his concubines. and she exercised great influence; but, says More, "never abused it to any man's hurt, but to many a man's comfort and relief." After Edward's death she was mistress to Thomas Grey, marquess of Dorset. She also had relations with William Hastings, and may perhaps have been the intermediary between him and the Woodvilles. At all events she had political importance enough to incur the hostility of Richard of Gloucester, afterward King Richard III, who accused her of having practised sorcery against him in collusion with the queen and Hastings. Richard had her put to public penance, but the people pitied her for her loveliness and womanly patience; her husband was dead, and now in poverty and disgrace she became a prisoner in London. Thomas Lynom, the king's solicitor wished to marry her, but was apparently dissuaded.

Jane Shore survived till 1527; in her last days she had to "beg a living of many that had begged if she had not been." She figured much in 16th-century literature, notably in the *Mirrour for Magistrates,* and in Thomas Heywood's *Edward* IV. The legend which connected Jane Shore with Shoreditch is quite baseless; the place name is very much older.

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SHOREDITCH, a northeastern metropolitan borough of London, Eng., adjoining the city. Pop. (1951) 44.871. Area 1 sq.mi. It has large housing estates and is a centre of the furniture-making industry. Furniture and woodwork are the theme of the Geffrye museum (1914) in Kingsland road. In 1576 James Burbage (*see* BURBAGE, RICHARD) built in Shoreditch London's first theatre. In City road stood the Eagle tavern and there too is the Royal Chest hospital. The Grand Union canal runs through the borough.

SHOREHAM-BY-SEA, a seaside resort and urban district in the Arundel and Shoreham parliamentary division of West Sussex, Eng., 6 mi. W. of Brighton. Pop. (1951) 13.057. Area 4.8 sq.mi. It lies at the mouth of the Adur river and 1 mi. upstream is the village of Old Shoreham, the original port, whose importance declined with the eastward shift of the river mouth, now 1 mi. from New Shoreham. The modern harbour embraces this lower reach of the river and also a semiartificial waterway that extends eastward from the river mouth for 2 mi. to Portslade and where ships can lie afloat at all states of the tide.

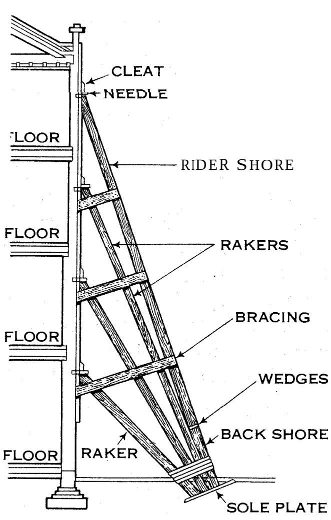
Shoreham was called a borough in 1236 and from 1272 to 1883 returned two members to parliament. Weekly markets and an annual fair dating from the time of Edward I were held for centuries. Shipbuilding has been carried on since the 13th century, and there is trade in coal, grain, timber and cement.

On the west side of the Adur opposite Shoreham is the Brighton-Worthing municipal airport; to the northwest of it is Lancing college, a public school for boys. At Shoreham Gap, 2 mi. N.E., 596 ac. of downland were presented to the National trust in 1946.

SHOREY, PAUL (1857–1934), outstanding U.S. classical scholar and humanist, was born at Davenport, Ia., on Aug. 3, 1857. Having graduated from Harvard in 1878 he mas admitted to the Chicago bar in 1880. Later he studied at Leipzig, Ger. (1881–82), Bonn, Ger. (1882), the American School of Classical Studies at Athens (1882–83) and the University of Munich, from which he received the Ph.D. in 1884. He was professor of Greek at Bryn Mawr college (1885–92), then went to The University of Chicago as professor of Greek and chairman of the department of Greek. He was Roosevelt professor in the University of Berlin, 1913–14. A man of vast erudition, Shorey was a brilliant teacher and lecturer, especially in the fields of Greek poetry and philosophy.

Shorey's writings include *The Idea of Good in Plato's Republic* (1895); *The Odes and Epodes of Horace* (1898); *The Unity of Plato's Thought* (1903), his most significant work in that it summed up his whole concept of Plato; *The Assault on Humanism* (1917); *What Plato Said* (1933); and his edition (with English translation) of Plato's *Republic* (Loeb Classical Library, 1930–35). He was a constant contributor to *Classical Philology,* of which he was managing editor from 1908 until his death in Chicago on April 24, 1934. (G. SM.)

SHORING, a form of prop or support, generally temporary in nature, used during repair or original construction of buildings, and in excavations. Temporary support may be required, for example, to relieve the load on a masonry wall while it is repaired or reinforced. The support may be supplied by shoring the wall with heavy timbers sloping upward at about 60°–75°. The top of the timber is so arranged that part of the wall load will be transferred to the shore. The lower end of the shore will frame onto a base in order to transfer the load to the ground with a minimum of deformation. Wedges may be used to bring the shore snuggly into contact aith the wall. If the wall is several stories high, as in the figure, more than one shore is required. The spacing betaeen the shores depends upon the condition of the wall, magnitude of the load. structural quality of the shores, and the character of supporting base and ground.



SYSTEM OF RAKING SHORES

Shores are used to support the forms for cast-in-place concrete slabs, beams and girders in reinforced concrete frames. Such supports may be 4 × 4's or larger timbers cut to appropriate length and placed to true grade by wedges. The size of the timber depends upon the load and length of the shore. Lateral bracing is needed in both directions t~ prevent the buckling of the shore. In some cases timbers may be framed into towerlike arrangements to provide capacity for greater loads. There are several patented shores that may be used in place of timber shores for concrete forms. These have the great advantage of easier placement and easier adjustment for length. The adjustment may be made by means of a threaded member or by a gripping device.

One method of constructing a pier in water is to use a cofferdam, which may be a rectangular enclosure made by driving sheet piling. usually steel, around a horizontal frame system. The outside members of the frame against nhich the sheet piles bear are called wales. The transverse and longitudinal members between the wales are shores. The wales and shores may be constructed of heavy timbers, structural steel, or a combination of the two materials.

The shores must be sturdy and well braced to withstand the shock of being hit by a heavy dredging bucket; they must also be able to withstand the horizontal forces resulting when the water is pumped from the cofferdam. The number of horizontal frames required may vary from one to five. (F. W. ST.)

SHORNCLIFFE, a military camp in Kent, England, on high ground immediately north of Sandgate and 3 mi. W. of Folkestone.

It was first established in 1803, when Sir John Moore used it to train the troops which afterward formed the Light Division during the Peninsular War.

Its location was chosen to be a strategic position, on the flank of Napoleon Bonaparte. who was expected at that time to cross the channel and invade England. During World Wars I and II, it was used as a training camp for British soldiers.

SHORT, SIR FRANK (**FRANCIS** JOB) (1857–1945), English topographical engraver and water-colourist, was born at Wollaston, Worcestershire. on June 19, 1857. He was educated to be a civil engineer, and in 1881 came to London. In 1883 he studied at the Royal College of Art, the Westminster School of Art and the Royal Institute of Painters in Water-Colours. Short's style was at first closely modeled on that of Seymour Hayden's, and earlier successes included mezzotints after J. M. W. Turner's *Liber Studiorum* (1885 *seq.*) and his best original works are mezzotints and aquatints such as "The Night Picket at Hammersmith" (1916) and "Morning Flare in Chichester Harbour" (1922). Elected A.R A. in 1906. he was knighted and made a royal academician in 1911. As director of engraving at the Royal College of Art from 1391 to 1924, he greatly influenced younger engravers. He published *On The Making of Etchings* (1888) He was president of the Royal Society of Painter-Etchers and Engravers from 1910 to 1938.

Short died on April 22, 1945, at Ditcliiing. Sussex. (D. L. Fr.)

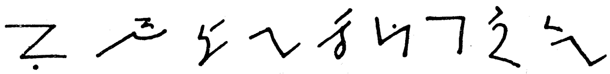
SHORTER, CLEMENT KING (1857–1926), English journalist and author. was born in London on July 19, 1857. He was editor of the *Illustrated London News* from 1891 to 1900, and founded and edited the weekly *Sketch* (1893), the *Sphere* (1900) and the *Tatler* (1903). In 1896 he published *Charlotte Bronte and her Circle,* and later edited the Haworth edition of the Brontes nith Mrs. Humphrey Ward. In 1924 he issued a private edition of Patrick Branwell Bronte's *And the Weary are at Rest.* He died Nov. 19, 1926.

SHORTHAND is the art of writing legibly, by means of brief signs, at a rate sufficiently rapid to record speech. It has been variously known as stenography (close, little or narrow writing), tachygraphy (snift writing), brachygraphy (short writing). But the term "shorthand" is now almost universally applied to it. Shorthand is now employed widely in reporting the proceedings of parliament and legislative bodies, the trial of cases in courts of law and especially for taking dictated business correspondence.

The Shorthand of the Ancients. — The earliest record we have of an organized system of shorthand dates from the year 63 B.C., the age of eloquence in Rome. At that time a freedman and friend of Cicero, Marcus Tullius Tiro, invented a system of *notae* that was used in recording the speeches of Cicero, Seneca and others of the Roman senate. The system invented by Tiro mas taught in the Roman schools, uas learned by emperors, and remained in use for several centuries. We are informed by Plutarch, in his life of Cato the younger, that the speeches of Caesar and Cato in connection with the conspiracy of Catiline were taken down verbatim by *notarii* who had been placed by Cicero in various parts of the Senate.

An inscription on a marble slab from the Acropolis at Athens. attributed to the 4th century B.C., indicates that a system of brief writing was practiced among the Greeks. Tiro's system was based on the orthographical principle; it abounded in the use of initials, following in this respect the abbreviating formulae in common use with the Romans; and, principal distinction of all, it was marked by this peculiar excellence which renders it superior to every other system known till to-day — namely, that by it, one and the same consonant letter, without the addition of points or any other signs whatsoever, expressed. by the inclination of such letter in three different directions, the exact vowel, *a, e,* or *i,* ahich followed. In the case of some of the consonants the whole five vowels, and even the diphthongs, were capable of like indication.

Example of Tironian Notae:



Nemo fideliter diligit quem fastidit nam et calamitas querula

Shorthand in the Middle Ages. — After the fall of the Roman empire, the use of the Tironian system survived for several centuries. In A.D. 625, Tironian notes were used in the royal diploma of the Merovingian King Clotaire II. In subsequent years we find on public documents brief notations as to the composition of deeds, names of officials concerned, etc. It is the opinion of some authorities that such notations were a protection against forgery. Examples of Greek shorthand are confined to a few fragmentary papyri and waxen tablets ranging from the 4th to the 8th century, chiefly among the Rainer collection at Vienna to which Prof. Wessely has devoted much labour. A manuscript (Add. ms. 18231) in the British hluseum contains marginal notes in shorthand of the date A.D. 972 (Wattenb., *Script. Graec. specim.,* tab. 19). Dating from the 10th century, we find the Paris ms. of Hermogenes, with some tachygraphic writing of that period which Bernard de Montfaucon deciphered with incredible labour *(Pal. Gr.,* p. 351). But the largest amount of material is found in the Vatican ms. 1809, a volume in which as many as 47 pages are covered with tachygraphic nriting of the 11th century. Cardinal Angelo Mai first published a specimen of it in his *Scriptorum veterum noca collectio* (1832); and in his *Novae patrum bibliothecae tom. secundus* (1844) he gave a second, which, in the form of a marginal note, contained a fragment of the book of Enoch.

Shorthand and the Early Christian Church. — With the rise of the Christian Church and a demand for the exact utterances of the religious ieaders of the day, the teaching and practice of the Tironian *Notae* received a new impetus. Many of the trials of the early Christians were reported by shorthand writers who were employed by the church for that purpose.

Revival of Shorthand in England. — England was the birthplace of modern shorthand. The publication by Dr. Timothy Eright in 1588 of his *Characterie: an Arte of Shorte, Swifte, and Secrete Writing by Character* marked the beginning of this development in England. Bright's system was invented during the reign of Queen Elizabeth and dedicated to her. It provided that each sign could be given four different slopes, and that the base of each could be modified by 12 varying terminations.

With the publication of the *Arte of Stenographie* in 1602 by John Willis began the introduction of the systems based on the alphabet. These systems are sometimes referred to as orthographic, because they followed the spelling of the words, omitting silent letters and in many cases the vowels in a word. One of the best known of these orthographic systems is that of Thomas Shelton, published about 1630, in which the famous diary of Samuel Pepys was kept. In 1767, Dr. John Byrom published his *Universal English Shorthand.* His principal contribution to the art was greater lineality in writing, and representation of the five vowels by writing a dot in five different positions with respect to the consonant outline. His system was popularized by Thomas Molyneux, who published seven cheap editions between 1793 and 1825. In 1786, Samuel Taylor published in London an *Essay Intended to Establish a Standard for a Universal System of Stenography.* He siniplified his system considerably by limiting each letter to one sign, except w, and by the elimination of a great many of the arbitrary signs that had characterized previous systems. His system was eventually adapted for use in France, Italy, Holland, Sweden, Germany and other Continental countries.

Development of Phonetic Shorthand. — Most of the early systems of shorthand in England were orthographic or alphabetic, but the idea of writing according to sound continued to gain in favour. The first published system using a phonetic base was that of William Tiffin (1750). Others were Lyle (1762), Holdsworth and Aldridge (1766), Roe (1802), Phineas Bailey (1819), Towndrow (1831) and De Stains (1839).

PITMAN SYSTEM

The publication by Isaac Pitman, in 1837, of *Stenographic Sound Hand* marked *a* new era in the development of phonetic systems. Not only did he classify the sounds of the language scientifically and arrange his material for writing accordingly, but he introduced simple expedients of abbreviation that made for rapidity. A short summary of the principles underlying the system is given.

Since the system is phonetic, all words are written according to their sounds. The words *lain, deal, may, knife* would therefore be written as if they were spelled *lān, dēl, mā, nīf.*

Consonants.—The consonants in the system are drawn from simple geometrical forms, straight lines and shallow curves. It is a curious fact that, while the tendency in longhand writing, beginning about A.D. 600 with the development of the Uncial letters, was anay from the Roman capital letters and toward a cursive style, this tendency did not affect shorthand writing, although several systems appearing before Pitman's were cursive in form. In Pitman's system there are 26 signs for 24 consonant sounds in the language, two of the signs being provided nith duplicates for convenience in joining with other signs. The first 16 signs occur in pairs, a light sign for a light sound, and a heavier sign for a heavy sound.

Vowels.—The 12 vowels in the language, *ah, a, e, aw, o, oo,* as heard in the words, "Pa, may we all go too'" and their corresponding light sounds, a, *e, i, o, u, oo,* as in the words, "That pen

PITMAN'S SHORTHAND **ALPHABET**

CONSONANTS

Names	Sign	Names	Sign	Names	Sign	Names	Sign
pee	P	chay	CH	ef	F	es	S
bee	B	jay	J	vee	V	zee	Z
tee	T	kay	K	ith	TH	ish	SH
dee	D	gay	G	thee	TH	zhee	ZH

em M ... en N ... ing NG ... el L ... ar R ...
way W ... yay Y ... hay (aspirate) H ...

VOWELS

LONG		SHORT	
1. AH	1. AW	ă	ŏ
2. EH	2. OH	ĕ	
3. EE	3. OO	ĭ	ŏŏ

DIPHTHONGS

I OI OW U

is not much good," are represented by a dot and a dash, disjoined. A heavy dot placed opposite the beginning of a consonant represents the long vowel ah; opposite the middle of the stroke it represents *ā;* and opposite the end of a stroke it represents *ē*. A short, heavy dash placed similarly represents the sounds *aw*, 6, *ōō*. The dot or the dash is made very light to represent the corresponding light or short vowel sounds. To illustrate: pa ... a y ... tea ... sigh ... ode ... bug ...

The sound *s* when preceding or following another consonant is expressed by a small circle: pays ... tease ... spy ... spouse ... When the sound ses occurs other than at the beginning of a word, it is represented by a large circle: paces ... teases ... spices ... excessive ... When the large circle is the beginning of a consonant it represents sw: swoop ... Swede ... swim ...

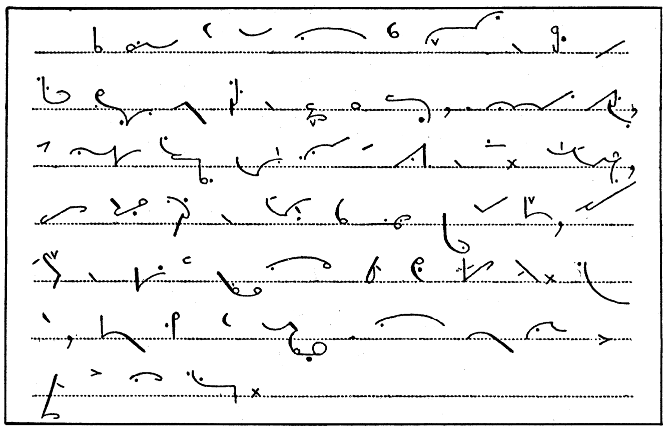
The small circle for *s* is turned into a small loop to represent *st*, and into a larger loop to represent *str:* past ... pastor ... b o a s t boaster ... must ... muster ... state ... steam ...

Use of Hooks.—The hooks used as abbreviating devices are obtained from segments of the circle s, or of the large circle for *ses*. A small hook written at the beginning of a consonant on the left of straight downstrokes and under horizontal strokes adds r: a small hock written at the end of a consonant under the same conditions represents n: pray ... brain ... tray ... train ... grow ... grown ... A small initial hook written on the right side of downstrokes or above horizontals represents 1; at the end of these strokes, it expresses *f* or *v*: play ... pave ... brave ... blow ... bluff ... glow ... glove ... The common sound of shun, no matter how it is spelled, is expressed by a large hook: passion ... petition ... occasion ... When used with curved letters, the hooks are always written inside the curve. The small hook represents r at the beginning of a stroke and *n* at the end of a stroke: frayed ... fan ... fans ... loan ... A large hook at the beginning of a curve adds *l* and at the end of a curve it adds shun: flow ... flung ... evil ... notion ... motion ... The halving of a stroke indicates the addition of *t* or d. This principle is of great value in writing the past-tense forms of verbs: float ... floated ... plate ... plated ... pain ... pained or paint ... grade ... graded ... label ... labelled ... Doubling the length of a consonant adds *ter*, *der* or ther: track ... tractor ... laugh ... laughter ... bill ... builder ... mole ... moulder ... pore ... porter ...

Vowel Indication.—In rapid writing it is not possible to insert all vowels, nor is it necessary. Three methods are employed to indicate the presence or absence of a vowel. Letters having alternate forms are used for this purpose; the downward *r* usually indicates that a vowel precedes it, whereas the upward form is usually used when a vowel follows. By writing a word in position with relation to the line, it is possible to indicate a vowel. Words may be written above the line to indicate a first-place vowel, on the line for a second-place vowel and through the line for a third-place vowel. The first up or down stroke in the word generally takes the position, and the rest of the outline follows in regular order. The position of the word is determined by the first vowel. The third method of vowel indication is by the use of some of the consonant outlines instead of their abbreviated form, as the use of the *s* stroke in place of the circle at the beginning of a word, or the writing of the *n* stroke in place of the *n* hook in such a word as *funny*.

Grammalogues.—A large number of the most commonly occurring words have been condensed in outline form so that they can be written with one stroke of the pen without vocalization. These words are memorized and learned thoroughly so that they can be written with great facility. Illustrations: that ... is ... as, has ... are ... our ... it ... should ... cannot ... you ... this ... Just as the early authors discovered that joining words increased the speed of writing, so Pitman's system affords an extensive use of this principle of phrasing: you cannot ... you cannot be ... Besides the list of grammalogues, there

Illustration of Pitman Shorthand



It is certain that any matter that is likely to strain our attention severely should be attended to when the mind is clear, the memory retentive and the mental faculties fully alert and ready to act. Unfortunately, we cannot always arrange to follow this excellent division of our time, and we are obliged to deal with business matters just as they turn up. After all, it may be said that in all these cases the matter may be left to the judgment of the man affected.

is a list of contractions which it is necessary for the writer to memorize before he can develop much speed. These contractions are usually long or awkward outlines that have been reduced in form by dropping parts of the word but at the same time keeping them significant enough to establish their identity. Examples of these are: indispensable dangerous.

The Pitman system was introduced into America a few years after its publication. Alfred Baker tells us in the *Life of Sir Isaac Pitman* that the first instruction book in Pitman shorthand was brought out by Mr. Stephen Pearl Andrews (Boston, 1844). In 1852, Mr. Benn Pitman, brother of the author of the system, came to America to continue the work he had been doing for several years. After the publication of the 10th ed., in which the vowel scale was changed, Benn Pitman refused to adopt the change and adhered to the old forms. Many others who had learned and practised the system began to modify it and publish it in altered form. Among these were A. J. Graham, J. E. Munson, E. Longley and Eliza B. Burns.

Script Systems.—Just as Pitman and his predecessors rejected the orthographic principle in shorthand and adopted the phonetic basis, so another group of authors discarded the use of geometrical signs. As early as 1787, S. G. Bordley had presented his cursive shorthand. This was followed by R. Roe (1802), T. Oxley (1816), J. and J. Aitchison (1832) and D. Cadman (1835). In France and Germany script systems had been introduced successfully and are in nide use to-day. Fayet's French system and Gabelsberger's German system are illustrations.

GREGG SYSTEM

In 1888, John Robert Gregg published his Light-Line Phonography, in which he incorporated what he considered this fundamental idea of employing shorthand characters that were in harmony with the slant and movement of longhand as well as many other principles, the lack of which had given rise to many criticisms of existing systems. Gregg adopted the phonetic principle and added a scientific analysis of *handwriting.* The title of the first book of his system was The Phonetic *Handwriting.* Gregg brought his system to America and offered it to the public soon after its publication in England. At present it is taught in more schools in the United States, and practised by more stenographers, than any other. A summary of the system is presented. The basic principles given below are taken from a copy of the original Light-Line Phonography, published in 1888: (1) Total absence of shading or thickening. (2) The characters being based on the elements of the ordinary longhand, the strokes are familiar and the motion uniform. (3) The insertion of the vowels in their natural order without lifting the pen. (4) The absence of positions, or the placing of words on, above, or through the line of writing to imply the omission of certain vowels or consonants. (5) The preponderance of curve motion.

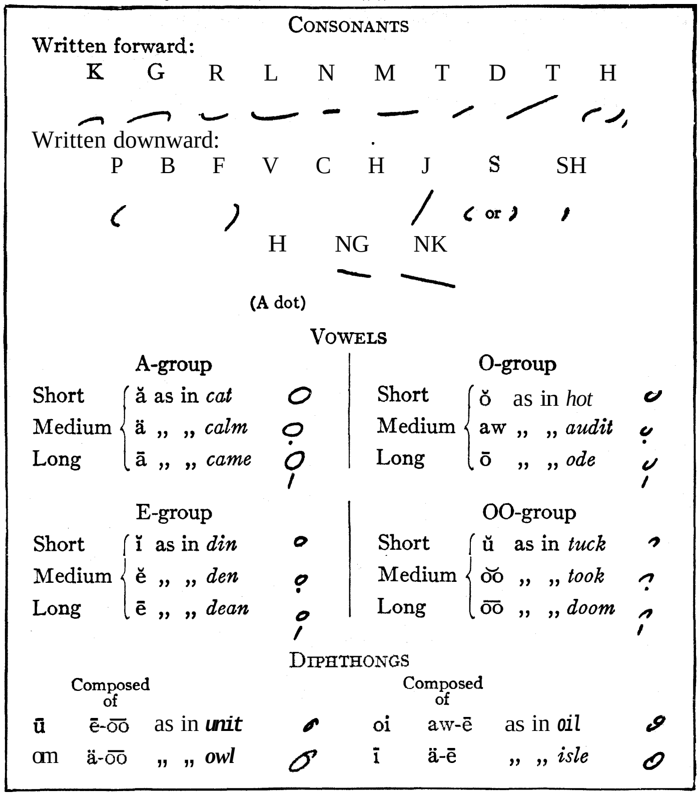
Although some changes have been made in the system since 1888, these principles have remained the same.

Consonants.—The consonants generally are paired according to affinity of sound and are distinguished by length. Consonant signs were selected which would permit the joining of many frequently recurring consonantal combinations nithout modifying the primitive form and to make possible the writing of these forms with but one movement of the pen, thus: pr br pl bl kr kl gr gl

The Signs *for S and Th.*—To facilitate joining in various combinations alternative signs are provided for the frequently recurring sound of *s*, written downward, and for th, written upward. In the use of these forms two principles serve as guides: uniformity of rotation and forward movement when joined to curves; sharp angles when joined to straight strokes.

***Vowel** Signs.*—The vowels are expressed by circles, small and

GREGG SHORTHAND ALPHABET



large, and by hooks. A small circle expresses the E-group of vowels, *ĭ, ĕ, ē;* a large circle, the A-group, *ă, ä,* a. The circle is written on the inside of curves and on the outside of angles; before and after straight strokes, or between straight strokes in the same direction, the circle is written clockwise; between reverse curves the circle is turned back on the first curve. A system of diacritics is provided for showing the exact shade of sound, as for example *ă, ä,* a, but since the large circle expresses an a-sound in any case, the need for these diacritics arises rarely. To illustrate the application of the rules for joining circles: key air meet gain make aim me mean wreck lake The hook vowels are derived from a small elliptical figure, thus: the lower part expressing the O-group of vowels, *ŏ, aw, ō;* the upper part expressing the OO-group, *ŭ, ŏŏ, ōō.* These hooks join naturally in most combinations but they are modified in two instances to avoid unnecessary angles, thus: the O-hook is turned on its side before n, m, *r*, l; the OO-hook is turned on its side after n, *m,* and after k, g, if followed by r or *l.* Illustrations: ought wrote know shop ,obey to foot mode mood cull coal on nor

Signs for W and Y.—*W* has the sound of *ōō*, as *ōō-ā-t* in **wait,** and is expressed by the sign for *ōō. W* within a word is expressed by a short dash struck under the vowel sign. The sound for y is equivalent to long e, as *ē-ōō-th* in youth, and is so expressed, except *ye* is expressed by a small loop, and *ya* by a large loop. Illustrations: wait weave youth yacht yellow Yale queen

Diphthongs.—The signs for the four pure diphthongs, ***ū, ow, oi,*** i, are written by simply joining the signs for the sounds composing them. Concurrent vowels are written in the same way. **Illustrations:** feud now toil try price science enjoy radio

Blended Consonants.—When two straight lines form an obtuse or blunt angle the natural tendency of the hand is to slur the angle and allow the lines to form a curve, thus

This principle is applied in securing a number of frequently recurring syllable signs:

TEN, DEN		as in tenor	denote	
TEM, DEM		as in temper	demolish	
ENT, END		as in paint	bond	
EMT, EMD		as in prompt	deemed	
DEF-V, TIVE		*as in* defeat	native	
JENT-D, PENT-D		as in gentle	happened	
MEN, MEM		*as* in mention	memory	
TED, DED, DET		**as** in heated	seated	
SES		*as* in passes	faces	
XES		as in boxes	mixes	

Expressing R.—By writing the circle with a reverse movement before or after straight lines; between a horizontal and an upward character; between a downward character and t, *d*, *n*, *m*, the sound *r* following the circle is expressed. Illustrations:

art share **yard** tardy
barn chart earn cart

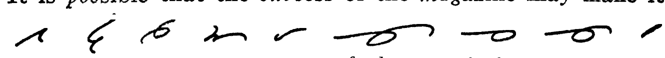
Wordsigns and Phrases.—The Gregg system includes a list of forms, called wordsigns, for the commonest words of the language which are reduced to the simplest outlines. Examples: the **of** **and** a-an in-not that at-it is-his I

These words, through repetition, comprise more than one-quarter of all written and spoken English.

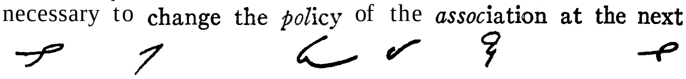
Phrasing.—Phrasing forms a very important function in the Gregg system. Since the words do not depend on position for vowel indication, phrasing is limited only by whether or not outlines can be joined easily. The following phrases will show how the principle is applied to wordsigns: of the that the **it** is in the in that and in

General Abbreviating Principle.—The rule for abbreviation given in the first edition of Light-Line *Phonography* remains the same to-day. It reads, "Drop the termination of words, *i.e.*, write so much of the outline as will, with the aid of the subject matter and vocalized context, suggest the whole word, as *unan* for unanimous, etc." This principle is already familiar in longhand, as Rev. for Reverend, *Ans.* for answer, Jan. for January, *Phila.* for *Philadelphia*, etc. Illustration:

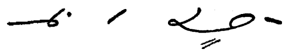
It is ***pos*****sible that the** ***suc*****cess of the** ***mag*****azine may make it**



necessary to **change the** ***pol*****icy** of the ***asso*****ciation at the next**



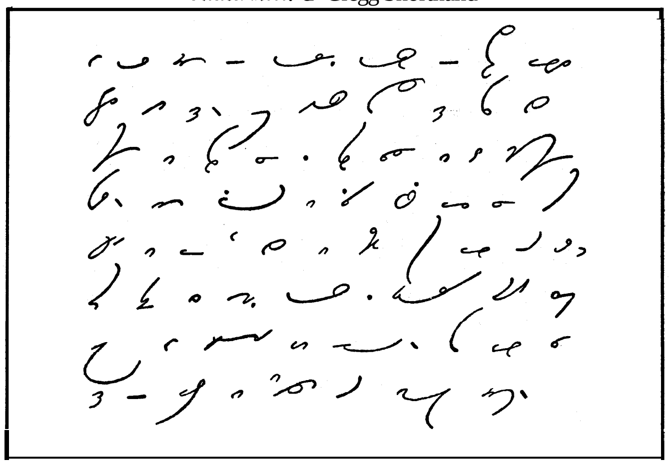
meeting at Philadelphia.



The principle is applied generally to long words not taking regular suffix endings. Its application gives brief and legible word-forms for a large number of words.

Prefixes and *Suffixes*.—The system is provided with joined and disjoined prefixes and suffixes, built up on the principle of analogy, for the most part, thus: forgive submit parallel overthrow going fairly nation common **envy** **impress** express proper

Illustration of Gregg Shorthand



The real success in learning lies in absolute honesty particularly to yourself. Never try to make yourself believe that you have done your best when a voice within you says you should have done better. You can hold your head high only when you have satisfied your own self that your efforts have been honest and thorough. Having chosen your calling, lay a solid foundation on which to build the structure of your knowledge. Be honest with yourself in whatever you undertake, and you will be successful.

Conclusion.—Expert writing of shorthand has been recognized in some States as a profession; the Department of Education of the State of New York conducts an annual examination and awards to those successful in passing the test the degree of C. S. R. (certified shorthand reporter). From 1909 to 1927, the National Shorthand Reporters' Association conducted an annual speed contest consisting of three five-minute dictations on different classes of matter. Records have been established of 280.4 words a minute on court testimony (Charles L. Swem); 2j9.6 words a minute on judge's charge to the jury (Martin J. Dupraw); and 220 words a minute on straight literary matter (Martin J. Dupraw, Nathan Behrin, Solomon Powsner), the degree of accuracy attained in all cases being greater than 99%.

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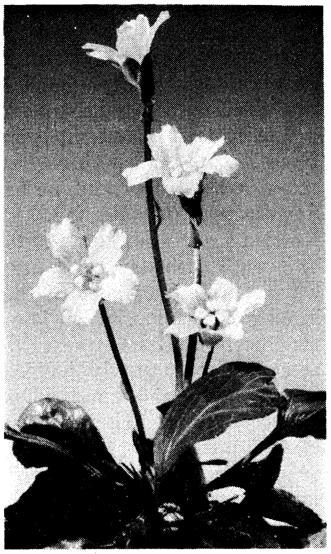
SHORTHOUSE, JOSEPH HENRY (1834–1903), English novelist, was born in Great Charles street, Birmingham, on Sept. 9, 1834, of Quaker parents. He was the eldest son of Joseph Shorthouse, a chemical manufacturer, and Mary Ann, daughter of John Hanker, of the same town. He was educated at Grove house, Tottenham, where he proved a promising and industrious pupil, and upon leaving school entered his father's business, in which he was all his life actively engaged. His literary interest was fostered by a local essay club, to which he contributed many papers.

Shorthouse wrote his most famous story. *John Inglesant,* when he was 40; he finished it in 1876 and after keeping it for three years in manuscript printed 100 copies (1880), one of which came into the hands of Mrs. Humphry Ward, who recommended it to Macmillan, but Gladstone was at once struck by its quality, and made its reputation by his praise. It became the most discussed book of the day, and its author was suddenly famous. Besides *John Inglesant* (1881). Shorthouse published other novels, none of which had the same success. Shorthouse died March 4. 1903.

SHORTIA. a rare herb *(Shortia galacifolia)* of the family Diapensiaceae, called also colts-foot, found only locally in the mountains of North and South Carolina. It is an early-blooming stemless perennial, with round, shining, slightly toothed leaves borne on stalks rising from the base, and beautiful white. some-what bell-shaped flowers, each solitary on a stalk, three to six inches long, which rises above the leaves. It is cultivated in the wild garden. One other species is found in Japan.



ROCHE

LEAVES AND BLOSSOMS OF SHORTIA (S. GALACIFOLIA)

SHORT STORY, a kind of prose fiction, distinguished from the novel *(roman)* and the nov-elette *(nouvelle* or *novella)* by its compression and intensity of effect. More prescriptive def-initions than this have been ad anced, some of them so ar-bitrary as to place unattractive and unnecessary limitations upon a developing art form. For the short stdry,-like the novel, is still in a process of development and perhaps ultimate definition. The serious short story of the 20th century might be visualized as occupying a square. the four corners of which are marked by the narrative essay or sketch, the lyric poem, the prose drama and the unit of local social his-tory. Some short stories would be located in the centre of the square: others although within the square, would be closer to one corner than to the others Washington Irving's 19th-century "The Legend of Sleepy Hollow," with its slight uncomplicated action, its embellishments of time and place and the immediate presence of the voice and personality of the author, can only with difficulty be distinguished from a narrative essay or sketch. James Joyce's "The Dead," with its luxuriant evocation of sen-suous images and its intensity of mood, differs from a lyric poem only in its expansiveness and its failure fully to utilize rhythm and sound.

Ernest Hemingway's "The Killers." stripped as it is of overt comment or analysis, and making its effect primarily by the im-plications of dialogue and a few simple actions aithin a limited scene, could easily be produced as a one-act play. Finally. Theo-dore Dreiser's "Old Rogaum and His Theresa," concentrating as it does upon a conflict within an immigrant family in special eco-nomic and social surroundings, is akin to a chapter in a social history of New York city.

Early Forms of Short Fiction.—If it has been largely in the 20th century that the lyric and dramatic possibilities of the short story have been explored. the similarities of the short story to particularized history and to the expanded anecdote are tradi-tional. These likenesses may be suggested by the origins of the words used to denote a short prose fiction: "story." with its roots in the Latin historia, suggests the relation of fictional accounts to the presentation of historical events; the English tale and the French conte suggest something told or recounted, and by impli-cation the felt presence of the teller or narrator. Short stories, in the sense of short tales told by an oral teller, of course antedate the records of human history. The most primitive man undoubt-edly could arrange a series of remembered events in a time se-quence and thus have the rudiments of a story. Among the earliest writings of man are *Tales of the Magicians,* a collection of stories from ancient Egypt which probably date from about 4000 B.C., and similar collections may be found in the ancient writings of Arabian, Hindu, Greek and Hebrew cultures. It has often been pointed out that the Bible contains tales that would fit the present conception of the short story: the books of Ruth and Jonah, for example, or such parables in the Gospels as that of the Prodigal Son. The literature of the middle ages and the Renais-sance abounds in short narratives in both prose and verse, of which the *Decameron* of Giovanni Boccaccio is the foremost ex-ample.

Western European literature after the Renaissance has produced numerous fables, romances, tales and sketches, which kept a tra-dition of short prose narration alive.

Emergence of the Short Story.—It was not until the be-ginning of the 19th century, however, that the short story as a distinct literary form began to attract the attention of serious writers in large numbers. Almost simultaneously in Germany, the United States. Russia and France collections of short fiction be-gan to appear. In Germany, E. T. W. Hoffmann published his exotic tales between 1814 and 1821; Jacob and Wilhelm Grimm collected popular legends and fairy tales; and Johann Ludwig Tieck wrote his fantastic stories during the same decade. In the United States the publication of Irving's *The Sketch Book* in 1819 and 1820 marked the beginning of a long tradition in the American short story. One of the three taies in that collection, "Rip Van Winkle," has generally been regarded as the first Ameri-can short story. In 1832 the first stories of Edgar Allan Poe and Nathaniel Hawthorne began to appear. With Irving, these two authors were to become the best American writers of the short story in the first half of the century. At almost exactlv the same time, two Russians, Alexander Pushkin and Nikolai Gogol, turned from the writing of novels and the drama to the short story. where their attention to the details of ordinary life Lon-trasted sharply with that of the fantastic and the legendary which had been exploited by the earliest German and American story writers.

Finally by 1830, three writers in France—Prosper Mérimée, Honoré de Balzac and Théophile Gautier—had begun a distin-guished tradition of the conte nhich was to continue throughout the century. What is remarkable about this sudden flourishing of a literary form in several countries at approximately the same time is that all of these writers, in spite of their varying tech-niques and subjects, were united in their conception of the short prose narrative as a potentially important form of literary art and in their consequent exploration of the possibilities and limits of the short story as a genre. Indeed the term short story was not to appear very frequently until much later in the century. Even story was quite infrequent. although as early as 1824 Irving used "Strange Stories by a Nervous Gentleman" as a subtitle for an installment of his *Tales of a Traveller.* Tieck called his first collection of stories *Die Gemalde* (pictures); Irving called his stories sketches or tales; Poe called his tales or articles; Haw-thorne used tales. sketches, even parables.

Why the conception of the short story as a new form should have come at just this time, relatively so late in the development of western literature, is somewhat difficult to explain. Possibly the short story could not be developed until the novel itself had reached the status of serious art and some degree of maturity in the latter half of the 18th century The widespread experimenta-tion with new forms as part of the romantic movement at the beginning of the 19th century may also be suggested as a con-tributing factor. In the United States the form found special favour, not only as a literary medium in the refinement of which the U.S writer could participate from the very beginning, but also as a type of writing admirably suited to publishing conditions in the new republic. There the flood of annuals or "gift books." which followed the first number of *The Atlantic Souvenir* in 1826 provided a ready market for short works which the U.S. writer, handicapped in the publication of novels by the international copyright situation, could supply on equal terms with British writers. From the annual gift books, which provided a first publishing outlet for Hawthorne, evolved the popular magazines, in which Poe's work most often appeared. Because magazines editors competed with each other for short fiction to fill the pages of their monthly issues, a whole new market was created. These editors probably adopted the sentiment expressed facetiously by Irving in a preface to his *Tales of a Traveller:* "If the tales I have furnished should prove to be bad, they will at least be found short; so that no one will be wearied long on the same theme."

Later Poe expressed the importance of these economic circumstances when he argued that the short story was the child of the American magazine. Certainly the popular magazine, both in the United States and in Europe, has continued to be by far the largest outlet for short stories, consuming hundreds of thousands of them during a century and a half and creating various formulas for "the popular story," which provides ephemeral entertainment for readers without disturbing them unnecessarily, and conceats old plots and hackneyed ideas in ingeniously invented novelties of detail.

The importance of Poe in the history of the short story is that he used the magazine to insist that a short story was potentially a superb art form. It is true that such writers as Hoffmann, Irving and Gogol had recognized the rewards of attention to the artistry of the tale; but Poe in his famous review of Hawthorne's *Twice-Told Tales* in *Graham's Magazine* for May 1842, claimed that "the tale proper, in our opinion, affords unquestionably the fairest field for the exercise of the loftiest talent, which can be afforded by the wide domains of mere prose," reserving the highest order of excellence for the lyric poem. Furthermore, he formulated the first set of principles for the art of the short story in a famous paragraph:

> A skillful literary artist has constructed a tale. If wise, he has not fashioned his thoughts to accommodate his incidents, but having conceived, with deliberate care, a certain unique or single *effect* to be wrought out, he then invents such incidents—he then combines such events as may best aid him in establishing this preconceived effect. If his very initial sentence tend not to the outbringing of this effect, then he has failed in his first step. In the whole composition there should be no word written, of which the tendency, direct or indirect, is not to the one pre-established design.

Some of Poe's principles—coherence and design, for example—were hardly new, being those assumed for literary art from the time of Aristotle onward; yet their application to the short story indicated that it had grown by 1842 into a significant literary form. Moreover, if it is true that Poe's somewhat mechanical conception of composition and his emphasis on a "single effect" could in the hands of critics like Brander Matthews 60 years later lead to a falsely rigid reduction of the short story to certain "essential ingredients" which could be concocted for the popular magazines, it must be remembered that Poe achieved a notable variety of works within his definition: the classic horror tale "The Cask of Amontillado"; the detective tale "The Purloined Letter"; and the tales of psychological exploration "Ligeia," "William Wilson" and "The Fall of the House of Usher."

The two other U.S. writers of this period whose work deserves mention, Hawthorne and Herman Melville, were more important as novelists than as writers of shorter works. Hawthorne in his *Twice-Told Tales* (1837) and Melville in *The Piazza Tales* (1856) added a moral ingredient to the short story which Poe's tales of effect lacked. Rich in symbol, proceeding from the depths of human experience, and appealing to the intellect as well as to the emotions, their work has an integrity and complexity which for many modern readers Poe's and Irving's have seemed to lack. Each of Hawthorne's stories, like the black cloth in his "The Minister's Black Veil," holds a "mystery which it obscurely typifies," and it examines the ambiguities of human life in a manner which Poe's "single effect" does not comprehend.

The Short Story in Europe.—While U.S. writers were taking advantage of their special circumstances to build a strong tradition of the short story, writers in France and Russia were no less active. In contrast to the romantic fantasy and eccentric distortions of Tieck, Hoffmann and the Grimms in Germany, or the U.S. variations of the tale of romance and terror in the comic Gothic of Irving, the psychological interest of Poe and the moral concern of Hawthorne, such French writers as Mérimée and Balzac were grounding their work in realism and emphasizing such clarity of observation, vividness of detail and precision of statement that the stories "stand and speak before the reader." the writer remaining impersonal and objective. This tradition of objectivity, which led the short story away from its similarities to the narrative essay or sketch, where the presence of the author's personality continuously is felt, toward the direct representation of the drama, uhere the incidents must reveal the meaning of the work implicitly rather than explicitly, has been the major contribution of the French story writers, not the early masters. but also those who continued this tradition much later in the century—Gustave Flaubert and Guy de Maupassant.

The Russian tradition, beginning with the stories of Gogol in *Dead Souls*, reached an early maturity in the nork of Ivan Turgenev, whose first and perhaps finest collection of stories, *A Sportsman's Sketches* (1852), indicated the direction which the Russian story was mainly to take. These stories. grounded in the ordinary circumstances of peasant life as Gogol's had been, have little of the appearance of the striking combination of incidents leading to a climax which Poe had recommended in his review of Hawthorne's tales ten years before. Each story catches a character in a particularly revealing incident one which illuminates the whole life of the individual in an impression which seems deceptively casual. In one of his best stories, "The Country Doctor," Turgenev seems to express wonder at the very method which he invented: "It's strange how things happen in life: you live with someone for a long time, you are on the best of terms, yet you never once speak to them frankly and from the heart; with someone else, you've hardly even got acquainted—and there you are: as if at confession, one or other of you is blurting out all his intimate secrets." The overheard revelation of the "intimate secrets" of a character or characters is the primary intention of Turgenev's stories, and the representation of character rather than the combination of striking incidents is his primary method.

Thus in the contrasting emphases of Poe and Turgenev two different approaches to the short story appeared, the one assuming that the proper method of the story was to invent incidents which when plotted to a suspenseful climax offered a sweeping total effect, and the other assuming that the proper method was to begin with the representation of characters who themselves seemed to suggest incidents that would reveal the quality of their lives.

This basic division can be seen again in the contrasting methods of the two most influential short story writers of the beginning of the 20th century—one French and the other Russian. Guy de Maupassant mastered the method of Poe, bringing to it the compression. the economy of detail and the vivid precision of style which were typical of the French story almost from the beginning. His ingeniously constructed plots and striking climaxes were imitated by writers on both sides of the Atlantic, to whom such a story as "The Necklace" seemed a perfect model. That the mannerisms and tricks of the Maupassant story should have been adopted by great numbers of writers of the popular magazine story and converted into a sterile formula does not deny the achievement of Maupassant himself, whose ironic pessimism and realistic examination of life set him apart from the writers who packaged his wares for mass consumption. The influence of Anton Chekhov, on the other hand, was not so much to be found among the writers of the popular story as among the large number of young writers of the 1920s in England and the United States, to whom the plotted story of Poe and Maupassant, as brought to a superficial polish in the tales of O. Henry. Jack London and Rudyard Kipling, seemed to eliminate the possibilities of individual experiment.

Chekhov's stories, like those of Turgenev's, focused on revealing moments in the lives of his characters, and their climax comes not so much in a striking incident as in a growing understanding of the nature of a character and his situation. A story, he argued, should have neither beginning or end, for it was at these points that the author was tempted to impose an artificial neatness and certainty on the complexity of life. The unity for which he strove was not an external resolution of a complicated action, but rather an internal unity of revelation of character.

Each tradition, the Poe-Maupassant story emphasizing plotted action or the Turgenev-Chekhov story emphasizing revelation of character, could of course provide successful stories, for plot and characters are inextricably intertwined in a significant story. The best stories of the 20th century proceed from an organic theory of the form, for which Henry James became not only a tireless explicator but also a distinguished practitioner. In his important essay "The Art of Fiction" (1884) James argued that a piece of fiction "is a living thing, all one and continuous, like any other organism. and in proportion as it lives will it be found . . . that in each of the parts there is something of each of the other parts . . . What is character but the determination of incident? What is incident but the illustration of character? . . . It is an incident for a woman to stand up with her hand resting on a table and look at you in a certain way; or if it be not an incident I think it will be hard to say what it is. At the same time it is an expression of character." James's preoccupation with discovering the proper form for each work. in which each of its elements contributes fully to its effect and in which the total structure embodies its meaning, is reflected less in his immediate influence on his contemporaries than in the influence which his fiction and his criticism had on English and American writers after World War I.

The Short Story in English.—James's own contemporaries in the U.S. were developing two other schools of the short story. both of which seemed more promising at that time than they did several decades later. Near the beginning of James's career, the "local colour" movement produced hundreds of stories aimed at exploiting the regional peculiarities of the different sections of the United States. Among the best of the local colourists were Bret Harte and Mark Twain in the west. Hamlin Garland in the mid-west. George R'ashington Cable and Joel Chandler Harris in the south, and Sarah Orne Jewett and Mary E. Wilkins Freeman in New England.

At best. the movement provided its readers with genuinely imagined representations of the regional life of a nation only recently torn by civil war, and it extended the range of short fiction into localities not before explored by the short story writer. At worst, the local colourists merely dwelt upon the quaintness of local characters and dialect. and marketed an "atmosphere" applied with a broad brush. Near the end of James's career "the O. Henry manner" was in vogue. The stories of O. Henry, with their rush of incident, crackling style and startling trick endings, achieved for their author an immense popularity and a host of imitators who filled the popular magazines with stories written to his formula. Later critics have found his work to be lacking in intellectual depth and his central theme—the effect of coincidence on character—scarcely worthy of the endless variations he played upon it; yet for many ordinary readers in the United States and England. O. Henry is pleasantly remembered as "a man who could tell a story."

.Although storytelling has been a folk pastime in England for centuries and short fiction has been written in England from the time of "The Green Knight" of Arthurian romance on to the present, the English short story was quite undistinguished until late in the 19th century. The masters of the English novel—Sir Walter Scott, Charles Dickens, George Meredith and Thomas Hardy—occasionally attempted short works. but they gave little evidence of comprehending the potentialities of the form which was maturing in Russia. France and the United States. Short fiction filled the English magazines. but most of the stories were merely amusing anecdotes or sentimental and pious recountings of minor domestic crises.

During the 1880s, however, the influence of such American writers as Irving, Poe, Bret Harte and Ambrose Bierce began to be felt in the romances and fantasies of Robert Louis Stevenson, Oscar Wilde and the contributors to *The Yellow Book*. It was in Rudyard Kipling, however, that the short story in England found a talent comparable to Maupassant in France. Kipling's stories abounded in flamboyant effects and striking incidents of British colonial life; well plotted and colourful, they provided the models for many English writers during the first two decades of the 20th century. Yet it was not until after World War I that the short story in Great Britain really flourished. The major novelists—Joseph Conrad, James Joyce. E. M. Forster. Virginia Woolf and D. H. Lawrence—showed an awareness of the short story form that their 19th-century counterparts had lacked. Ironically, the two writers whose influence has been strongest on the 20th-century story were Joyce of Ireland and Katherine Mansfield of New Zealand. Joyce's *Dubliners* (1914) showed a remarkable ability to transmute the incidents of ordinary life into classic art through richness of imagery, objectivity and restraint. Mansfield's delicate stories, rendered in poetic prose and focusing upon internal, psychological conflicts. have an obliqueness of narration and subtlety of observation which reveal plainly the influence of Chekhov.

Though probably not so influential in determining new courses for the short story as Joyce and Mansfield. W. Somerset Maugham undoubtedly had the widest public of any English short story writer throughout almost half of the 20th century. A sleek objectivity and an incisive dissection of human frailties are the marks of his stories; their sardonic comedy is an acid variation on the wry humour which characterizes many English stories. A later generation of writers—V. S. Pritchett, Graham Greene, H. E. Bates, Elizabeth Bowen and William Sansom—have demonstrated that the short story in England reached maturity by the middle of the 20th century, after scarcely 50 years of distinguished achievement.

The Short Story in the **U.S.**—The 20th-century short story in the United States has been equally rich. justifying Poe's prediction in 1842 that the form could encompass "a vast variety of modes or inflections of thought and expression." As in England, the major novelists—Willa Cather. F. Scott Fitzgerald, Hemingway, William Faulkner. John Steinbeck and Robert Penn Warren—were likely to be equally at home in the short story and the novel.

From Stephen Crane to Eudora Welty, the U.S. writer! whose only tradition sometimes seems to be to break with tradition! was constantly evolving new individual forms for his vision of life. His work has been marked by an intense devotion to craft, a thorough grounding in actuality without false sentiment or moralizing and an ability to discover the universal in the regional. His American "voice," a robust colloquial speech, has gone through successive stages of refinement in the style of Mark Twain. Sherwood Anderson and Hemingway. His preoccupation with the regional qualities of U.S. life, particularly the south (as in Faulkner, Warren. Katherine Anne Porter and Welty) and the mid-west and west (as in Anderson, Steinbeck and Walter Van Tilburg Clark). has come not merely from the attraction of local colour but rather from the hope that the human spirit could best he caught at close range. His concern for his native scene has not prevented influences from Europe from being absorbed into the American short story, particularly the work of Thomas Mann, Franz Kafka. Mansfield. Joyce, Chekhov, Riaupassant and Flaubert. and in turn the impact of the U.S. story has been widely felt in Europe. By mid-20th century the short story had reached full stature, an essential literary medium for writers throughout the western world.

See also NOVEL and the biographies of the major short story writers.

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SHOSHONE, a North American Indian group which occupied, in the early 19th century, a large continuous territory extending from the present Inyo county in southeast California across parts of Nevada and Utah into southern Idaho and western Wyoming. In addition. one tribe of Shoshone, the Comanche, occupied much of western Texas. Among all the Shoshone there were at least 50 bands or territorial subdivisions which were never united politically. All these people spoke dialects of the same language which differed so little that persons from Death Valley, Calif., could understand those from west Texas. The Shoshone may be divided into four major groups: western, centring in Nevada; northern, in northern Utah and southern Idaho; Wind River, in the western half of Wyoming; Comanche, in west Texas.

The western group did not acquire the horse until the Mormons arrived in the area about 1847, and then only in very small numbers because the desert environment would not support many horses. When first discovered the Shoshone were living principally on wild plant foods, especially seeds. Houses were small, domed structures of brush, called *wickiups*. There was no political organization; the largest unit was a family group or a small fluid band. Hostilities were confined to feuds and small raids.

The northern group possessed horses by the time the expedition of Meriwether Lewis and William Clark visited them in the early 19th century, and probably much earlier. They also had some measure of band organization. They traveled into Wyoming and Montana to hunt buffalo in season. lived in hide tepees and wore hide clothing like the Plains Indians. They were more warlike than the western Shoshone.

The Wind River Shoshone and Comanche acquired horses as early as 1joo; and the Comanche, who were living in Wyoming at that time, traveled south to Texas on horses during the next few decades. All the Wind River bands stayed together under one chief for about half the year, but the Comanche bands probably never all assembled at any one place. The Comanche were unusually aggressive, even for Plains tribes.

The population of the Wind River Shoshone is estimated to have been 2.500 in the early 19th century, and that of the Comanche 7,000. The northern and western Shoshone combined did not exceed 10,000 at that time. In 1950 there were a total of about 5,000 in all four groups, living for the most part on reservations within the territory they once held. *See* also INDIAN. NORTH AMERICAN; CENTRAL AND NORTH AMERICAN LANGUAGES.

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SHOSTAKOVICH, DMITRI (1906–). Russian composer. was born on Sept. 25. 1906, in St. Petersburg (later Leningrad), Kussia. He received his formal training at the Leningrad conservatory from 1919 to 192j, where he studied pianoforte and composition. His work in advanced composition was done under the direction of Alexander Glazunov.

A child of 11 years of age at the time of the October revolution, Shostakovich associated himself intimately with the "revolutionary tradition." In 1925, when he left the Leningrad conservatory, he became a member of the Union of Soviet Composers, an organization dedicated to the propagation of socialist theory through art. He based his aesthetic principles on the interrelation of music and political philosophy; his art could not be its own end but had to reflect Communist ideology in its struggle with conflicting political systems.

In 1926 Shostakovich's *First Symphony* mas performed; within a short time it became a part of the standard repertory of most major orchestras throughout the world. From that time, save for two or three notable redressings from the Communist party: he rose steadily to a place of eminence both within and without the Soviet Union. In 1930 Shostakovich presented his opera, *The Nose.* It immediately invoked the displeasure of the Communist party for its "decadent formalism." His next opera. *Lady Macbeth oj Minsk,* fared little better within the Soviet Union. The composer was accused of composing music rife with "bourgeois decadence." The opera was. however, received somewhat more favourably by audiences abroad.

For the next several years Shostakovich managed to remain within the good graces of his government. His *Fifth Symphony,* written in 1937, pleased the political critics for its alleged conformance to the national spirit; moreover, it received acclaim throughout the world. In 1941 Shostakovich recorded the siege of Leningrad in his long *Seventh* or *Leningrad Symphony*. In the same year he was awarded the Stalin prize for his piano quintet.

In 1948, along with several other Soviet composers, Shostakovich was sharply rebuked by the central committee of the Communist party for once more falling into "decadent formalism." The composer recanted, again making his peace with his government. In March 1949 he was sent as a delegate to the Cultural and Scientific Conference for World Peace, held in New York city.

Among Shostakovich's other well-known works may be included *The Age of Gold,* a ballet (1930); *The Limpid Stream,* an opera (1935); *Sonata for Cello and Piano* (1935); *Trio in E Minor* (1944); and *String Quartet No. 2* (1945).

SHŌTOKU TAISHI (574–622), regent of Japan, one of the most important contributors to development of Japanese civilization, who brought to it new political, religious and artistic institutions, was a nephew of the empress Suikō. He became crown prince and regent in 593. By means of persuasion and political maneuver, he greatly expanded the power of the imperial house, bringing back into its hands powers that had been delegated to the nobles.

A brilliant scholar, Shōtoku was instrumental in introducing Chinese culture to Japan. His motives were not entirely intellectual and aesthetic, however, for he saw in Chinese political institutions and technology a means of building a stronger central government in Japan. His 17-article constitution expressed the ideals of a centralized bureaucratic state on the Chinese order; he was thus the forerunner of the Taika reform. Shōtoku was a devout believer in Buddhism, and in order to spread that faith through the country he began the building of temples in areas far beyond the capital city. After his death, he was looked upon in popular belief as a Buddhist saint.

See also JAPAN: *History.*

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SHOT PEENING: *see* BLAST CLEANING AND SHOT PEENING.

SHOT-PUT, a sport in which a spherical weight is thrown or put from the shoulder for distance. It derives from the ancient sport of putting the stone. First to use a shot instead of a stone competitively were British military sports groups, and later the idea was adopted by civilians.

While the weight varied from 8 lb. to 24 lb., the 16-lb. shot was adopted for men in Olympic games. national and international competitions. Weight for women's competition is 8 lb. In the United States a 12-lb. shot is used for high school boys' competition. ages 15–19.

Constant improvements in technique resulted in the virtually doubling of record distance in less than 80 years. The International Amateur Athletic federation recognized the first official world record as 30 ft. 11½ in., by J. M. Mann of the United States in 1876. E. J. Borr of Great Britain surpassed 40 ft. in 1880 and Ralph Rose (U.S.), in 1909 became the first to exceed 50 ft. Speculation over man's ability to attain 60 ft. paralleled, in a lesser way, the topic of man's ability to run the 4-min. mile. Interestingly, the 60-ft. shot-put was achieved two days after Roger Bannister, the British runner, broke through the 4-min. barrier.

Parry O'Brien (U.S.) put the shot 60 ft. 5¼ in. on May 8, 1954. In 1960 Bill Nieder of Austin, Tex., who beat O'Brien in the Olympics that year, raised the world record to more than 65 ft., thus breaking another psychological barrier. Athletes from the U.S. proved world leaders in the event, holding records in most of the years after 1876.

In women's competition with the 8-lb. shot, Galina Zybina of the U.S.S.R. brought the record above 50 ft. when she won the 1952 Olyinpic championship. In 1956 Miss Zybina extended the record to 54 ft. 11¾ in.. and in the 1960 Olympics Tamara Press of the U.S.S.R. put the shot more than 56 ft.

The shot generally is made of solid iron or brass, although any metal not softer than brass may be used. It is put from a circle 7 ft. in diameter.

Technique. — The put is started at the back of the circle by shifting the weight of the body to the right foot with good balance. left knee bent and the left toes raised so that the spikes clear the ground. Next, the left knee is brought close to the right knee and the right leg bent gradually as the hips cross the circle. This method of starting the put enables the shot-putter to be in a correct position when he reaches the centre of the circle and thus able to start lifting the shot immediately.

The shot is lifted via the medium of the leg muscles, and the put must always be made upward and not outward by a rhythmic movement of the arm muscles. which can be acquired by constant repetition.

Whereas it was conventional to start from a position at right angles to the direction of the put, O'Brien developed a style of beginning from a backward position. Thus he brought the implement around 180°, rather than 90°. He found that the longer one pushed the shot, applying force against a moving object, the longer the throw would be.

See OLYMPIC GAMES.

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SHOT TOWER, originally a cylindrical tower of brick or masonry about 200 ft. high used for making gunshot. Modern versions are built of structural steel and often incorporated in other buildings. Gunshot is made by dropping molten lead through a sieve at the top into a water tank below. All sizes from the smallest (known as dust shot) up to no. 2 or "BB" size, are made in this manner. Arsenic and antimony are added as alloys to keep the shot spherical and to control hardness. (B. R. L.)

SHOVE-HA'PENNY, the game of pushing a coin or disk along a polished board so that it stops between closely ruled lines. The game originated in the 15th century in England. The modern version, like darts, is mainly and competitively centred on premises licensed to sell liquor. The winner is the player who can first place a disk three times in each of the nine "beds." See SHUFFLEBOARD. (N. D. M.)

SHOVEL, SIR CLOUDESLEY or CLOWDISLEY SHOVELL (c. 1650–1707), English admiral, was baptized at Cockthorpe in Norfolk on Nov. 25. 1650, and went to sea in 1664 under the care of his kinsman Sir Christopher Mynns. He set himself to study navigation. He became a general favourite and obtained quick promotion. In 1674 he served as lieutenant under Sir John Narborough in the Mediterranean, where under the castles and walls of Tripoli. he burned four men-of-war belonging to the pirates of that place. After a long period of service in the Mediterranean, he was present as captain of the "Edgar" (70) at the first fight at Bantry bay (1689), and shortly afterward was knighted. In 1690 he convoyed William III across St. George's channel to Ireland; the same year he was made rear admiral of the blue. In 1692 he was appointed rear admiral of the red, and joined Admiral Russell. under whom he greatly distinguished himself at La Hogue by being the first to break through the enemy's line. When Russell was superseded. Shovel was put in joint command of the fleet with Admiral Killigrew and Sir Ralph Delaval. In 1702 he brought home the spoils of the French and Spanish fleets from Vigo, after their capture by Sir George Rooke, and in 1704 he served under Rooke in the Mediterranean and co-operated in the taking of Gibraltar. As commander in chief of the British fleets he co-operated with Peterborough in the capture of Barcelona in 1705. and commanded the naval part of the unsuccessful attempt on Toulon in Oct. 1707. When returning with the fleet to England his ship, the "Association," struck on the rocks near Scilly (Oct. 22), and was seen by those on board the "St, George" to go down in three or four minutes' time, not a soul being saved of 800 men that were on board. The body of Sir Cloudesley Shovel was cast ashore next day, and was buried in Westminster abbey.

See *Life and Glorious Actions of Sir Cloudesley Shovel* (1707); Burnet's *Own Times;* various discussions in *Notes and Queries,* 5th series, vol. x and xi; and T. H. Cooke, *Shipwreck of Sir Cloudesley Shovel* (1883).

SHOVELER, a word originally applied to the bird later termed spoonbill (*q.v.*), but now used of *Spatula clypeata,* a duck characterized by its broad flat beak, the edges of which are beset with long lamellae by means of which food particles are filtered off from the water just as is done by the baleen in whalebone whales. Its food consists of small aquatic plants and fishes, crustacea, snails. tadpoles. etc.

The shoveler is a surface-feeding duck and the male, with his contrasted plumage of white, brown and bay. dark-green head and speculum and orange feet, is a handsome bird. The female resembles in plumage the ordinary wild duck.

The shoveler breeds locally over the greater part of Europe (including Great Britain), Asia and North America. wintering farther south, where it reaches India, Abyssinia, Central America and even Australia. It nests among the swamp grass and lays 7 to 12 olive-gray or olive-buffy eggs.

Other species inhabit South America, South Africa, Australia and New Zealand. (HT. FN.)

SHOWBOAT, a genuine American folk institution, which for more than a century did much to relieve cultural starvation on river frontiers of the middle west and the south. Long before motion pictures, these entertainment boats penetrated regions where churches, schools, newspapers and theatres had not gone.

The British-born actor William Chapman (1760–1841), built the first showboat, the "Floating Theatre" (14 by 100 ft.). at Pittsburgh, Pa.. in 1831. He and his family floated from landing to landing, playing such dramas as August Friedrich Ferdinand von Kotzebue's *Menschenhass und* Reue (translated as The *Stranger*) and Shakespeare's The *Taming of the* Shrew, with music and dance specialties added. Gpon reaching New Orleans late in winter, they junked the boat and returned by steamer to Pittsburgh, to repeat the pattern the next year. After Chapman's death, showboats first degenerated and then, because of the Civil War, disappeared entirely.

When showboats were revived (1878), they specialized in vaudeville and melodrama. Steamer tows and the calliope greatly increased territory and audiences, and Stephen Foster's songs added sentimental charm to their programs. Such boats as **A.** B. French's "Xew Sensation." McNair's "New Era," E. A. Price's "Water Queen," Thom's "Princess" and dozens of others, with seating capacities of 100 to 300, carried their rich cargoes of humour, music and simple emotion to every river on the Ohio-Mississippi system, from the narrow Monongahela in the northeast to the Atchafalaya bayous (creeks) in the south. Thousands of persons who had never witnessed public entertainment saw for the first time an imaginary world on a stage, and were able to laugh and cry at this simplified battle of good and evil.

With the disappearance of river frontier conditions in the 1900s, and with the coming of better roads, automobiles and motion pictures, the decline of showboats was inevitable. To compete with land entertainment, they became larger and more elaborate. Menke's "Goldenrod" seated 1.400 persons and cost more than $35.000. The "Cotton Blossom." the "Sunny South" and Bryant's "New Showboat" were floating theatre palaces. All emphasized melodrama. With the burlesquing of these programs in the 1930s to attract sophisticated audiences, showboats ceased to perform their original function. The last one to travel the rivers in authentic pattern was the "Goldenrod" in 1943.

See Philip Graham, *Showboats: The History of an American Institution* (1951). (PH. G.)

SHRAPNEL: see AMMUNITION, ARTILLERY: *History* of *Ammunition.*

SHREVEPORT, a city of northwestern Louisiana. U.S., on the Red river, 317 mi. N.W. of New Orleans and 185 mi. E. of Dallas, Tex. Shreveport is the centre of a standard metropolitan statistical area that covers all of Caddo parish and is bordered by Arkansas, Texas and the Red river. The area is slightly hilly except for parts of the river valley, has several lakes and is forested with hardwood and pine. Pop. (1960) city 164,372; standard metropolitan statistical area 281,481.

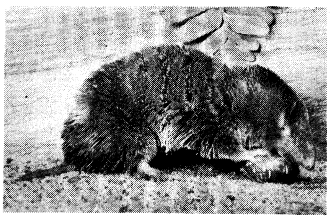
Henry Miller Shreve, after clearing the Red river of a huge natural timber raft, founded the city in 1835 on lands obtained from the Caddo Indians at the head of navigation on the river. Cotton and river traffic formed the economic basis of life, and Shreveport's association with nearby Texas is indicated by the many city streets named for heroes of the Texas revolution. At the end of the Civil War, Shreveport was the Confederate ,state capital and headquarters for the Trans-Mississippi forces of the Confederacy. Using logs to simulate artillery, its defenders constructed Fort Humbug to command the river; but the only major attempt to take the city was halted 40 mi. S. at Mansfield. By 1900 the river was no longer used for commerce but railroads and cotton trade kept the city growing. Discovery of oil in the area in 1906 gave the city new impetus, and oil and gas continue to be of major economic significance.

A police jury administers Caddo parish except for the incorporated places of Shreveport, Vivian, Mooringsport and Oil City. Of the 1950 population of the metropolitan area, 75.6% was urban. 16% rural nonfarm, and 8.4% rural farm; about 66% was native white. 33% Negro, and 1% foreign born.

The area produces lumber, glass. metals, machinery, foods. and chemical and petroleum products. Cotton remains the chief farm crop. and wholesale and retail trade are large. Educational facilities include a modern parish-uide public school system, a state trade school. and Centenary college, a Methodist institution founded in 1825. Shreveport has a public library system. a symphony orchestra and two amateur theatres. The Louisiana state fair and Holiday in Dixie. a spring festival. are major annual festivals. Parks, golf courses, boating and fishing on Cross. Caddo and Wallace lakes. a municipal auditorium, a large stadium and an indoor arena are available.

Three highway bridges connect Shreveport with Bossier City (pop. [1950] 15,470), the location of Barksdale Field, a major air force base. (W. M. Lo.)

SHREW, a term applied to the members of the family Soricidae of the mammalian order Insectivora, which includes also moles, hedgehogs, etc. The common shrews or shrewmice of the northern hemisphere, belonging to the genus *Sorex,* are about the size of mice, although with no resemblance to mice in structure or in habits. They are distinguished externally by the long, pointed muzzle. which projects far beyond the lower lip. The small eyes are almost concealed by fur; the ears are short, broad and provided internally with deep folds; the tail is usually slightly shorter than the body, generally quadrangular in section and thinly haired, often with a small tuft at the tip. The fur is short and velvety, grayish or brownish in colour. On the side of the body there is a gland secreting a fluid with an unpleasant odour, a fact which renders shrews unpalatable to many larger predators. The short-tailed shrews, genus *Blarina*, common to eastern North America, are reputed to have a poisonous bite; the toxin, however, is only powerful enough to affect the shrews' favourite prey.



JOHN H GERARD

AMERICAN SHORT-TAILED SHREW (BLARINA BREVICAUDA) FEEDING ON A SNAIL

Shrews feed largely on insects. snails. worms and small mammals. and are active day and night and in all seasons. They usually live in moist situations, burrowing in leaf mold in search of their food. They must feed almost continuously because of their very rapid metabolic rate. and are said to consume their own weight in food about every three hours. In the sorecine shrews all teeth are tipped with red pigment. while crocidurine shrews of Africa. Asia and part of Europe have white teeth. Skulls of shrews have no cheek arch. Several shrews are minute, among the smallest of mammals. weighing only $\frac{1}{7}$ oz.. about 2 in. long with the tail an additional $1\frac{1}{4}$ in. The largest species is probably one of the Asiatic water shrews, *Chimarrogale,* some 6 in. long, the tail 3 in. See also INSECTIVORA. (J. E. HL.; X.)

SHREWSBURY, EARLS OF. Shrewsbury, one of the most ancient earldoms in the English peerage, dates from the time of William the Conqueror. Roger de Montgomery (c. 1030–1094), son of another Roger de Montgomery, known as "the Great," was a councilor of William, duke of Normandy, before his invasion of England, and was probably entrusted by William with the government of Normandy during the expedition of 1066. Roger received territory in Sussex, including the city of Chichester and the castle of Arundel, he became earl of Arundel, or probably and more correctly earl of Sussex. In 1071 the greater part of the country of Shropshire was granted to him, carrying with it the title of earl of Shropshire, though, from his principal residence at the castle of Shrewsbury, he like his successors was generally styled earl of Shrewsbury. He probably exercised palatine authority. He was the founder of Shrewsbury abbey in 1083. His first wife was Mabel, daughter of the seigneur of Belesme and Alençon; hence his son Robert, who, after the death of another son, Hugh, succeeded to the earldoms of Shrewsbury and Arundel, was generally known as Robert of Belesme (*q.v.*), one of the most celebrated of the feudal nobles in the time of Henry I. Robert having been deprived of all his English estates and honours in 1102, the earldom of Shrewsbury was next conferred in 1442 on John, 5th baron Talbot. whose descendants have borne the title to the present day. (See TALBOT; and SHREWSBURY, JOHN TALBOT.)

SHREWSBURY, CHARLES TALBOT, DUKE OF (1660–1718), English statesman, was born on July 24. 1660. the son of Francis. 11th earl of Shrewsbury. As his parents were Roman Catholics he was brought up in the Catholic faith and educated mainly in France during the years 1674–78. In the spring of 1679, under the influence of John Tillotson, then dean of Canterbury, he joined the Church of England, thus qualifying himself, although under age. to take his seat in the house of lords and to accept appointment as lord lieutenant of Staffordshire.

His real introduction to political life, however, took place in the reign of James II, when he not only resisted every temptation to return to the Roman Catholic Church but took an active part in the conspiracy which led to the Protestant revolution. The early meetings of the conspirators were held in his house; he was one of the famous seven who signed the letter of June 30, 1688, inviting William of Orange to come over with an armed force to England. In September he joined William in Holland and in November returned to England with his expedition, securing Bristol and Gloucester for him. In the convention which assembled on Jan. 22. 1689. he advocated the elevation of William and Mary to the throne, and as soon as the new monarchs had been proclaimed he was rewarded with a seat in the privy council and the post of secretary of state for the southern department.

Although moderately successful in office he was never happy there. Responsibility weighed heavily upon him, and in the party rivalries which followed the Revolution he found himself unable either to give full support to the aims of his Whig associates or to repudiate them altogether. On June 2, 1690, disgusted at the growth of Tory influence in the government, he resigned his secretaryship, and for four years thereafter, on the plea of ill-health, resisted every attempt to induce him to resume office. This obstinacy on his part inevitably exposed him to being called a Jacobite, an imputation somewhat supported by his mother's activity in the Jacobite cause and his intimate association with the earl of Marlborough, whose own conduct was giving great dissatisfaction to the king. On June 23, 1692, accordingly, he and blarlborough were both struck off the privy council. and for a year thereafter he pursued a policy of opposition to the government. criticizing their conduct of the war and advocating in the house of lords an Abjuration bill and a Triennial bill which they considered ill-timed or worse. Nevertheless. William continued to entertain a real trust in and affection for him, and on March 2, 1694, when the Whigs were regaining influence at court, he was persuaded to accept appointment as secretary of state for the northern department, transferring shortly after to his original post in the southern department. On April 25 of the same year he was rewarded with the Garter and on April 30 was created duke of Shrewsbury.

His second period of office, though longer. was no more satisfactory than his first. Ill-health, real or imaginary, continued to worry him, the imputation of Jacobitism still hung over his head. and his chief energies mere directed toward securing permission to retire. Although appointed one of the lords justices entrusted with the administration of the country during the king's absences on the continent in 1695, 1696 and 1697, he was accused during these years both by the conspirator Sir John Fenwick and by the informer Matthew Smith of complicity in Jacobite intrigues. and felt his position so keenly that he practically ceased to take any part in the government. On Dec. 12. 1698, he was allowed to resign his secretaryship, accepting in exchange. a year later. the less responsible post of lord chamberlain: but this also he resigned on June 20. 1700.

Leaving England a few months later, he spent the next five years in travel on the continent where, on Sept. 9, 1705, he made a somewhat unfortunate marriage with Adelaide, daughter of Andrea. Marquis Paleotti of Bologna. On his return early in 1706 he became increasingly dissatisfied with the conduct of his former Whig associates, and in 1710 went over to the Tories. He was appointed lord chamberlain on April 14 and admitted to the privy council on April 16 of that year; appointed lord lieutenant of Ireland on Sept. 22, 1713 and lord high treasurer on July 30, 1714, when Queen Anne was on her deathbed. His possession of this last great office enabled him to exercise a decisive influence in favour of the peaceful recognition of George I, who rewarded his services by appointing him groom of the stole and keeper of the privy purse on Sept. 26. a privy cpuncilor on Oct. 1 and lord chamberlain on Oct. 17, 1714. On Feb. 1, 1718, he died in London of inflammation of the lungs: and as he had no children his dukedom became extinct and his earldom passed to a cousin.

Shrewsbury was generally regarded as one of the finest and most cultured gentlemen of his day, and was endowed with a personal charm which earned for him the title of the "king of hearts": but an excessive sensitiveness and a reluctance to face the harsh realities of life in troublous times greatly impaired his effectiveness as a statesman. On the occasion of the Revolution and on the death of Anne he pursued a bold and determined policy, but as a rule his attitude was weak and vacillating. His declaration that if he had a son he "would sooner breed him a cobbler than a courtier, and a hangman than a statesman," is a reflection on himself no less than on his political world. (A. BG.)

SHREWSBURY, ELIZABETH TALBOT, Countess of (1518–1608), better known as "Bess of Hardwicke," was the daughter and co-heiress of John Hardwicke of Hardwicke. Derbyshire. She was four times married—to John Barlow. Sir William Cavendish, Sir William St. Lo (or St. Loe), and finally, in 1568, to George Talbot. 6th earl of Shrewsbury. With each marriage she made a good settlement, and before she married Shrewsbury was accounted the wealthiest woman in England. She arranged a marriage between her daughter Elizabeth and Charles Stuart, brother of Lord Darnley. without consulting her husband. Since the Lennox family were of royal blood, Elizabeth thought the countess over-ambitious, and sent her to the Tower for a short time. The child of the Stuart marriage was the unfortunate Arabella, a claimant to the throne.

By this time the earl of Shrewsbury and his wife were on very bad terms with one another, and the former tried to obtain a divorce. The countess revenged herself by accusing him of a love intrigue with the queen of Scots, a charge which she was forced to retract before the council. In the meantime she repeated scandal about Elizabeth to Queen Mary. who made use of it in the extraordinary letter she wrote some time in 1384. In 1583 the countess of Shrewsbury went to live apart from her husband. with whom she was afterward reconciled formally by the queen. After his death, in 1590, she lived mostly at Hardwicke. where she buiit the noble mansion which still stands. She was, indeed, one of the greatest builders of her time at Hardwicke, Chatsworth and Oldcoates. It is said that she believed she would not die so long as she was building. Her death came on Feb. 13, 1608, during a frost which put a stop to her building operations. She was buried in All Saints' church. Derby, under a fine monument with a laudatory inscription which she took care to put up in her lifetime.

See White Kennett, *Memoirs of the Cavendish Family* (London, 1708); and Mrs. Murray Smith (Miss E. T. Bradley), *Life of Arabella Stuart* (London, 1889); Mrs. Stepney Rawson, *Bess of Hardwicke* (1910).

SHREWSBURY, JOHN TALBOT, 1st Earl of (c. 1384–1453), English soldier. celebrated for his exploits, in the Hundred Years' War, was the second son of Richard. 4th Baron Talbot, and Ankaret. heiress of the last Lord Strange of Blackmere. By the death of his elder brother Gilbert's daughter Xnkaret (1421) he acquired the baronies of Talbot and of Strange. In or before 1433 he married his second wife, Margaret (d. 1467), eldest daughter of Richard Beauchamp, earl of Warwick, and coheiress of the barony of Lisle.

After campaigns in Wales between 1404 and 1413, Talbot served as lieutenant of Ireland from 1414 to 1419. He was later to be justiciar of Ireland (1425) and lieutenant again (1445–47). In these offices he showed great vigour: the Irish said that "there came not from the time of Herod any one so wicked in evil deeds."

After 1419, however, most of Talbot's career was spent in France. where he became one of the foremost English captains. He fought at Verneuil in 1424 and took part in the siege of Orleans in 1429. His rashness was chiefly to blame for the English defeat at Patay (*q.v.*) in June 1429, when he was captured by the French. Released in 1433, he took Clermont-en-Beauvaisis in 1434 (the countship was then assigned to him). was present at the siege of Saint-Denis in 1435 and suppressed the revolt of the Pays de Caux in 1436. Henry VI made him a marshal of France. The mainstay of the English cause in France for the next five years. Talbot defeated the Burgundians before Le Crotoy in 1437 and took Harfleur in 1440. In May 1442, on a visit to England. he was created earl of Salop (Shrewsbury was the name that he himself used for the title); but the next winter, before Dieppe. he "fared so foul n-ith his men that they would no longer abide with him" and was forced to raise the siege. His fighting qualities, however, made him something of a popular hero: in the rhymes of the day he was "Talbot our good dog," whose valour was frustrated by the duke of Suffolk's treason.

After the iall of Rouen in Oct. 1449, Shrewsbury was held for a time as a hostage by the French (1449–50); a pilgrimage to Rome was stipulated as a condition of his release. In command of the expedition for the relief of Gascony, he landed in the Médoc in Oct. 1452; the Bordelais rose in his favour and Fronsac fell to him in the summer of 1453. The French. however, laid siege to Castillon. Shrewsbury hurried to its relief and on July 17, 1453, attacked the enemy in their entrenched camp without waiting for his artillery. He and the flower of his troops were killed, and English rule in Xquitaine ended with them. (T. B. P.)

SHREWSBURY (Welsh. *Amwythig*), an ancient market centre. municipal borough and the county town of Shropshire (Salop). Eng.. in the Shrewsbury parliamentary division. 153 mi. N.W. of London by road. Pop. (1951) 44,919. Area 12.7 sq.mi. Its position in relation to the routes leading into Wales and along the border has made it a town of great importance. The old and central part of the ton-n lies almost entirely on a peninsula within the remarkable southward loop described by the river Severn. The strategic position of this peninsula rising above the Severn flood lands was recognized from the time of the princes of Powys, who made it their seat. called Pengwern, in the 5th and 6th centuries. At the end of the 8th century it was engulfed in the provinces of Mercia and given its Saxon name Scrobbesbyrig. from which comes Shrewsbury. In the reign of Edward the Elder it had a mint, and in Domesday Book it is styled a city. After the Norman conquest. Shropshire was granted to Roger de Montgomery, who made Shrewsbury his headquarters and founded the abbey. At about this time. alternative names arose, Sloppesbury or Salopsbury, from which comes the modern Salop. In the next 200 years it was frequently involved in wars with the Welsh, and in 1283 Edward I called an assembly of parliament to meet at

Shrewsbury. In 1403 the battle of Shrewsbury was fought close to the town on the north side, when Henry IV by defeating the Percys consolidated his position on the throne. During the late middle ages and again in Tudor and Elizabethan times the establishment of law and order in the Marches and trade with the Welsh in wool and flax resulted in a period of great prosperity. In the Great Rebellion Shrewsbury supported the king. who took up his quarters there in 1642, but the town was captured by parliament in 164j. Subsequent development was continuous and Shrewsbury became the cultural. business and transport centre for a large area of surrounding country.

Shrewsbury is a borough by prescription. The town possesses more than 30 royal charters from the charter of Richard I (1189) to that of James II (1685) and earlier charters were granted by Henry I and II. The charter of Charles I gave to the town a new constitution, and under its authority the first mayor was elected in 1638. The borough returned tn-o members to parliament from 1394 till 1885, when the number was reduced to one. It is now included in the Shrewsbury division of Shropshire.

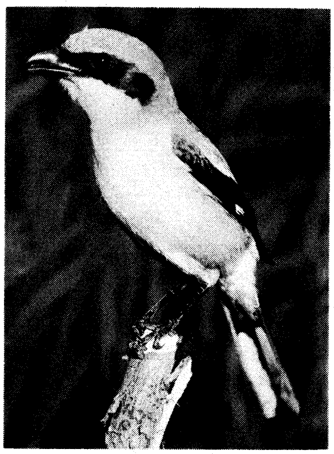
There are many buildings, streets: lanes and "shuts" of architectural and historic merit, including 1jth- and 16th-century timber framed houses of which Ireland's mansion. Owen's mansion, the Abbot's house and Rowley's house are outstanding examples; the latter contains a museum of Roman antiquities from the nearby Roman–British city of Uriconium. The old Market hall is a fine stone building dating from *c.* 1596; there are also many Georgian and regency houses. A considerable length of the old town wall. including one of the watchtowers, still remains. Within the loop of the river (hut outside the ton-n walls) is a public park called the Quarry. Over its two ancient bridges, the English and the Welsh. the town spreads east into Abbey Foregate and around Abbey church and west into Frankwell on the Welsh side. In the Mount. at the top of Frankwell, Charles Darwin was born. St. Mary's church, on high ground south of the castle, is a noble building with a lofty tower and spire dating from early Norman to Perpendicular. It has some remarkable stained and painted glass, including the great Jesse window of English glass dating from about 1345; the St. Bernard glass from the Abbey church of Altenburg. attributed by some to Xlbrecht Dürer (1471–1528); and 15th-century glass from the cathedral of Treves. St. Alkmund's. St. Julian's and St. Giles' are old foundations, much altered subsequently. Old St. Chad's church. dnting mainly from the 12th century. was largely destroyed by the fall of the tower in 1788, and only the 15th-century Lady chapel remains. The new St. Chad's church erected in 1790–92 on another site is built to a circular plan. The restored Abbey church (Holy Cross) retains its massive Korman nave. built of deep-red sandstone, and two Early English arches and a Decorated western tower; of the monastic buildings little is left, save a remarkable roofed outdoor pulpit of ornate Decorated work. Shrewsbury is the seat of a Roman Catholic bishop.

A fortification of some sort probably existed on the site of Shrewsbury castle before the Norman conquest. but the first reliable evidence of a castle being constructed there is in 1067. In 1071 it was given to Roger de Montgomery, then made earl of Shrewsbury. who continued working on it. and it was entirely rebuilt by Edward I. It was held for the king in the Great Rebellion but fell to parliament in 1645. It continued fortified until the reign of James II. but subsequently came into private ownership. The castle was converted to residential use by Thomas Telford toward the end of the 18th century. In 1924 it was bought by the Shropshire Horticultural society, restored as nearly as practicable to its 14th-century condition, and given to the corporation; it is used as a council chamber.

Shrewsbury school (founded by King Edward VI in 1552) occupied buildings opposite the castle until 1882. when it was moved to Kingsland, south of the river. formerly the scene of the Shrewsbury show, a pageant held during the festival of the Trinity. The old school buildings in the town centre were taken over by the corporation and are now used as a library, museum and art gallery. The cross at the junction of Pride hill and St. Mary's street, on the site of the original High cross. was given by the school to the town in 1952 to commemorate the 400th anniversary of the school's foundation.

The cattle market, one of the busiest in England. was enlarged and moved to the north of the town in 1959. Also in the north are most of the main industries which include locomotive. rolling stock and general engineering; the manufacture of machine tools, safes and electrical equipment; and malting. (S. R. H. L.)

SHRIKE (BUTCHERBIRD), the common name for members of the songbird family Laniidae, nhich contains about 73 species. They are robust birds, about thrush size, with a heavy bill hooked at the tip. Their colours are usually boldly patterned and vary from gray, white and black to browns. greens and reds. Their call notes are harsh but some have pleasing songs. Their nests are rather bulky structures, with many twigs in them, and the eggs are spotted. The distribution of the family covers Africa, where most species live; Europe and Asia to New Guinea (one species); and North America (two species).



ALLAN D. CRUICKSHANK FROM NATIONAL AUDUBON SOCIETY

LOGGERHEAD SHRIKE (LANIUS LUDOVICIANUS) A COMMON NORTH AMERICAN SPECIES

The loggerhead shrike, *Lanius ludovicianus* is the common American species, found from southern Canada to Mexico. It is gray above, white below, with a black mask, and is about nine inches long. The more northern birds retire southward in winter. The northern shrike, L. *excubitor*, is similar but larger (ten inches long), with fine barring on the breast. It breeds in northern Canada and Alaska, as well as in the old world. Some winter in the northern United States.

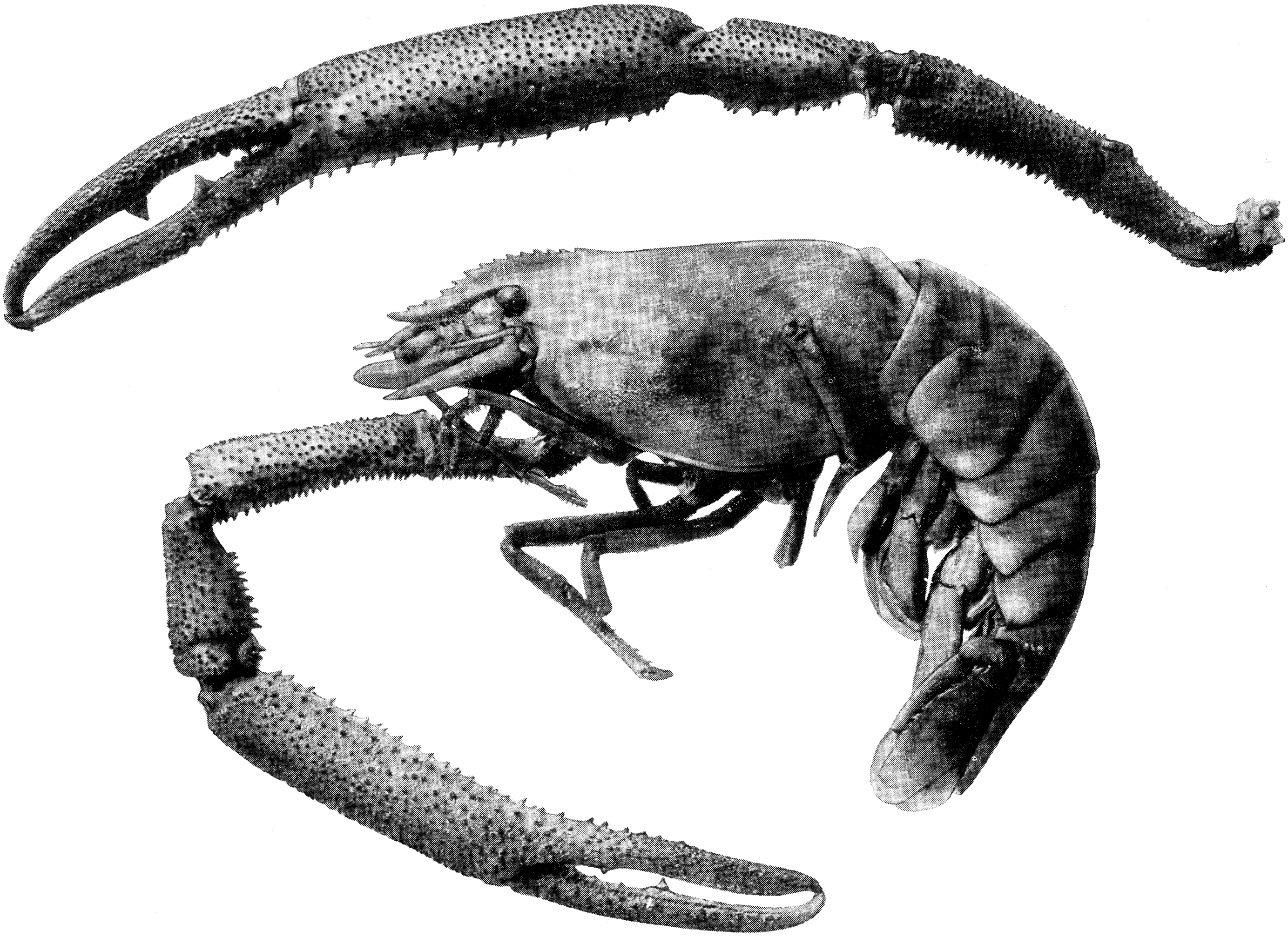
Typical shrikes sit upon vantage points, hawklike. watching for their prey of large insects, small reptiles, mammals or birds. Though predacious in habit, they lack strong feet for holding their prey and some species impale their food on thorns. sometimes leaving part of it uneaten. This fancied resemblance to meat in a butcher shop is the reason for one of their common names. Certain bush shrikes and helmet shrikes of Africa are only doubtfully placed in this family. Birds of an unrelated Australian family of butcherbirds and bell magpies also have the habit of impaling food on thorns. The vanga shrikes of Madagascar and the cuckoo shrikes, widespread in the warmer parts of the old world, form two other unrelated groups of songbirds. (A. L. RD.)

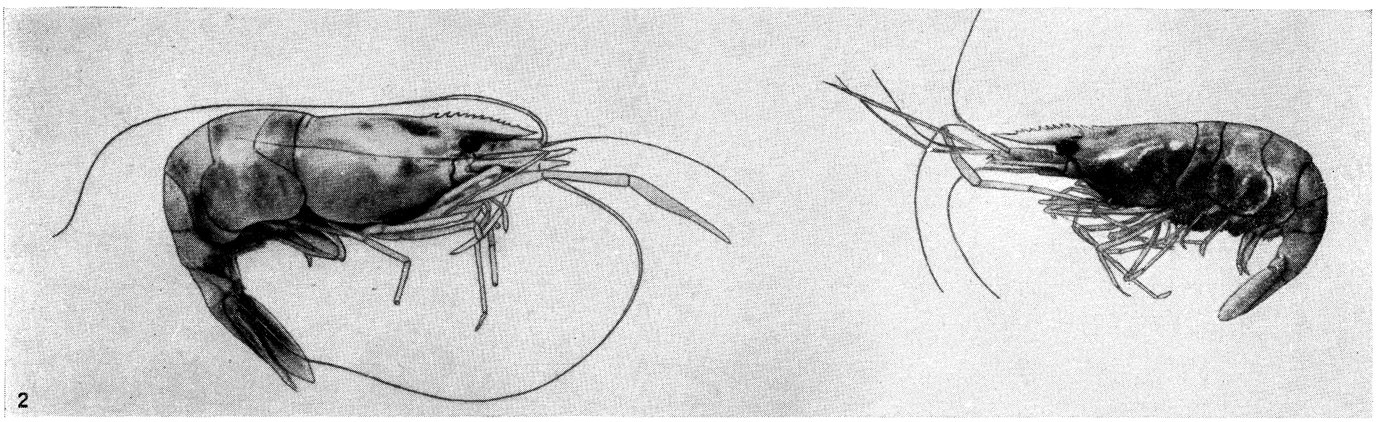
SHRIMP, a common name generally applied to Crustacea distinguished from such other larger long-tailed members of their order (Decapoda) as lobsters and crayfishes. Shrimps (suborder Macrura) differ in greater development of the paddlelike limbs of the abdomen used in swimming and in their thin and sometimes fragile shell or exoskeleton. Like other crustaceans: shrimps wear their skeleton on the outside of the body and, in order to grow, must cast off this shell and replace it with a new and larger one. In the process of shedding, all of the hard structures of the shrimp are cast off and renewed.

The common shrimp swims in a forward direction by the use of the pleopods or abdominal feet. When frightened or when rapid movement is desired. the shrimp with a flexing of the powerful, muscular abdomen, can propel itself backward with remarkable speed and also can leap clear of the water.

Shrimp occur on mud bottoms of inshore and offshore waters in many parts of the world. Important fisheries operate in European. North American and Asian waters. Although often thought of as a warm-water shellfish. shrimp are also found in northern seas, and there are commercial shrimp fisheries in the waters off Norway, Greenland and Alaska. Considerable effort was expended in the search for new shrimp grounds in many parts of the world following World War II, and important new fisheries for the browngrooved shrimp. *Penaeus aztecus*, and the pink-grooved shrimp,

SHRIMP





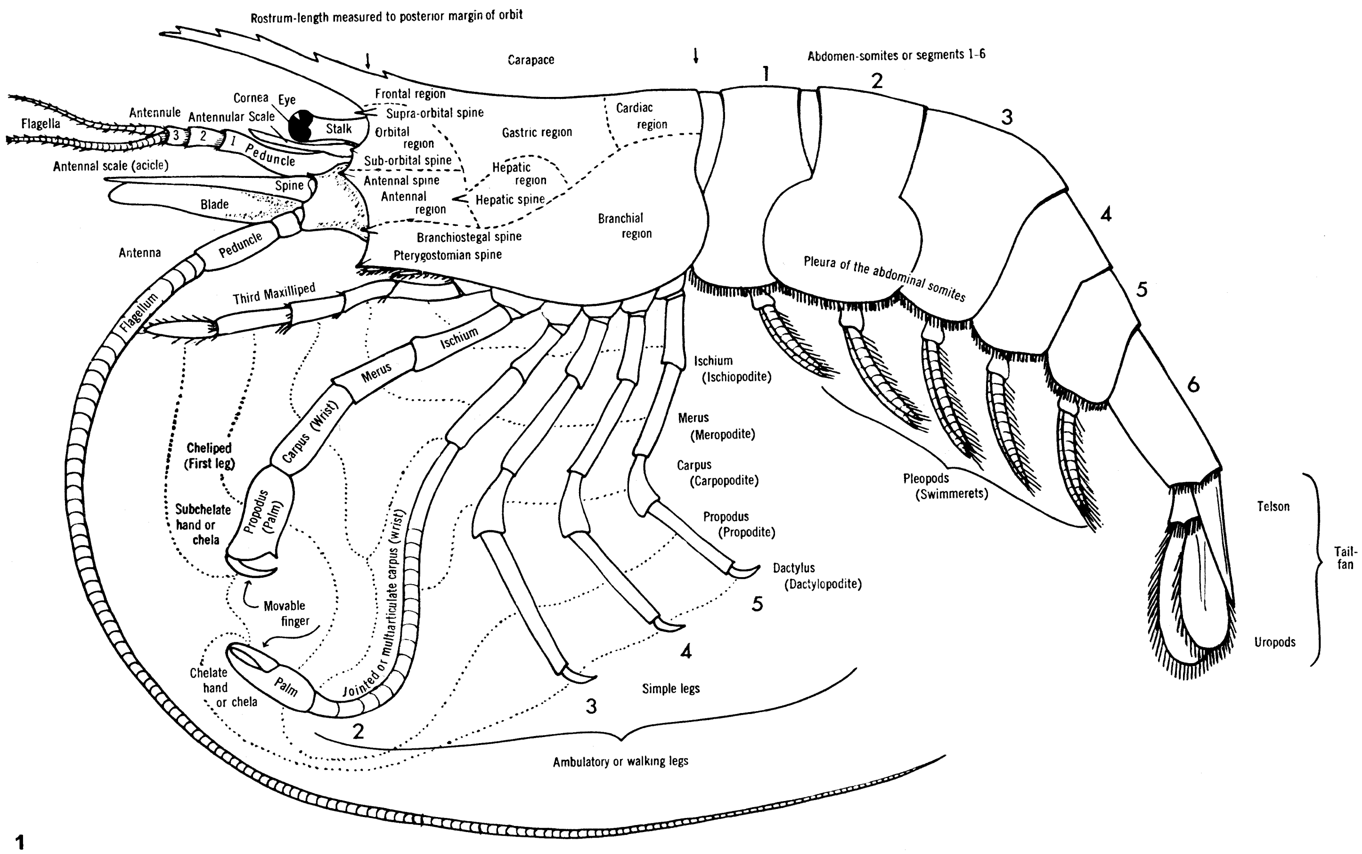
2

BY COURTESY OF THE U.S. NATIONAL MUSEUM

1. Fresh-water shrimp. *Macrobrachiurn jamaicense* (Eucarida, order Decapoda, Natantia) from Devils River, Texas. Length of specimen from tip of extended claws (one placed above the animal) to posterior extremity of tail or abdomen, 20 in.; live weight, 3 lb. This and closely related species are found in America from Florida to Brazil and from Lower California to Peru. The largest known fresh-water shrimp is a specimen of *M. carcinus* from the Philippines, the body of which measured about 13½ in. in length; this species ranges from the Philippines to India. The Macrobrachiums are widely used for food in Latin America and the orient and to some extent in the southern United States

2. Mississippi river shrimp, *Macrobrachium ohionis* (Eucarida, order Decapoda, Natantia), slightly less than natural size. This Mississippi basin species occurs also in the Savannah river, Georgia, where the photographed specimens were taken

SHRIMP



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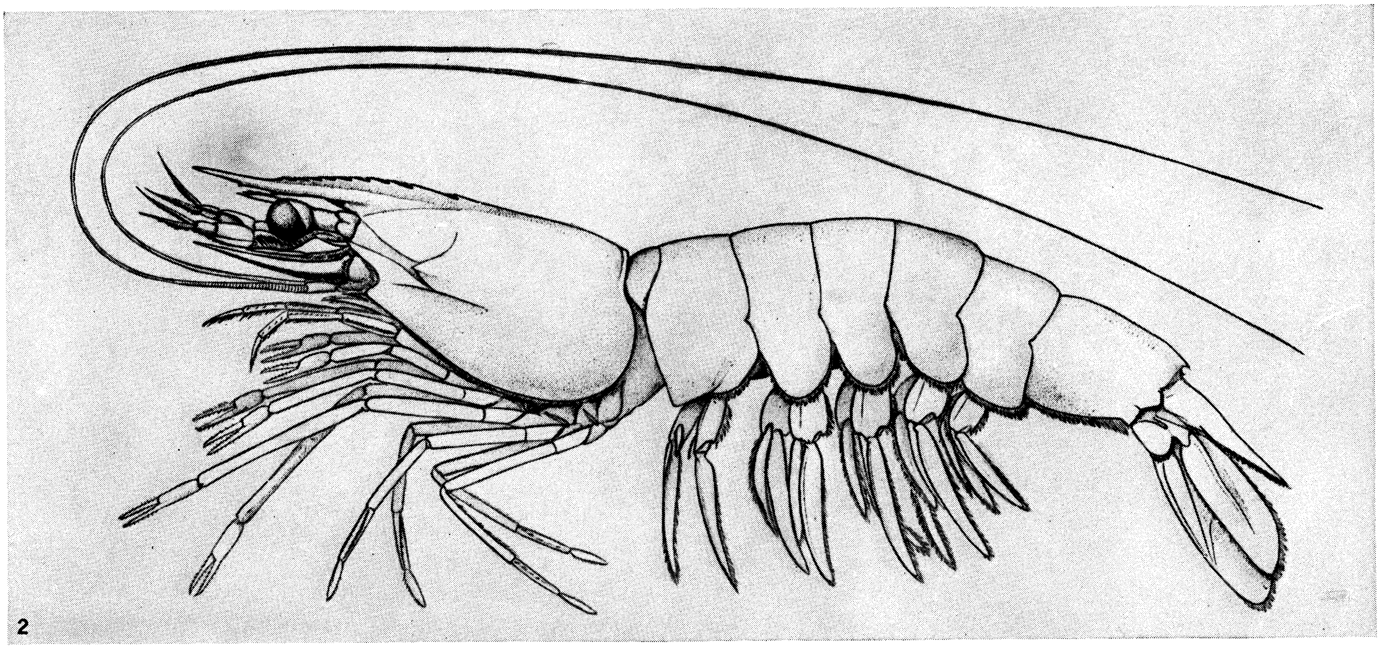

2

BY COURTESY OF THE U.S. NATIONAL MUSEUM

1. Conventionalized shrimp, illustrating terms used in description
2. *Fenaeus setiferus* (Eucarida, order Decapoda, Natantia), commercially the most important species on the South Atlantic and Gulf coasts of the United States. About three-fourths natural size

Penaeus duorarum, were developed in the Gulf of Mexico. A red shrimp, *Hymenopenaeus robustus,* was found in the deeper waters of the gulf at depths of 180 to 3jo fathoms.

There are several hundred species of shrimp. The catch of species of Penaeus probably exceed that of all other crustacean fisheries in magnitude and importance. The world's greatest shrimp fishery, based principally on species of *Penaeus,* is in the Gulf of Mexico, where several hundred million pounds of these shellfish are taken annually by United States, Mexican and Cuban fishermen.

Shrimp are taken in a variety of ways—with hand or cast nets, baited traps, haul seines. stake or channel nets set in tideways and with boat-drawn beam and otter trawls. The trawls. which account for the major portion of the world catch, consist of large, baglike nets which are dragged over the floor of the ocean. scooping up the shrimp in their path.

Shrimp are marketed fresh, frozen, dried, canned and cooked-and-peeled. Shrimp bran, a by-product, is manufactured from dried heads and hulls and sold for animal feed. Development of machines for removing the hulls from the shrimp meat, and the production of fresh-frozen and frozen-breaded shrimp, have assisted in a remarkable expansion in the market for shrimp in the United States, the world's largest producer and consumer of shrimp.

River shrimp or prawns of the genus *Macrobrachium* (*Palaemon*), found in most tropical countries, are also much used for food. (E. A. Pr.)

SHRINE, THE (Ancient Arabic Order of Nobles of the Mystic Shrine), an appendant order of Freemasonry (*q.v.*) in the U.S., was founded in 1870 by William Jermyn Florence (1831–1891) and Walter Millard Fleming (1838–1913). The first Shrine temple was organized in New York city on Sept. 26, 1872, and a parent body, the Imperial Grand council, was formed in 1876 but dropped the word "Grand" from its title 10 years later. Rituals and costumes of the order are supposedly of Arabic origin and the founders, in order to promote the organization, at first claimed that it had descended from a 7th-century secret Arabic society. In the years following its founding, membership: limited to 32nd degree Scottish Rite Masons or Knights Templar of the Pork Rite, increased until the Shriners' red fezzes, jeweled costumes and colourful parades were a common sight throughout the United States.

In 1922 the Shrine: as a philanthropic project, took steps to establish hospitals for the care of crippled children. The first 3 of 17 such hospitals were founded that year at Shreveport. La., St. Louis, Mo., and Minneapolis, Minn. The hospitals are supported by annual assessments on Shrine members, contributions, estate benefits and fund-raising projects. (G. M. Sa.)

SHROPSHIRE or Salop, an English county bordering on Wales and with Cheshire to the north. Staffordshire to the east. Worcestershire and Herefordshire to the south. The geographical area is 1,346.6 sq.mi., with a population (1951) of 289.802. The boundary with Wales was fixed in the reign of Henry VIII: the Staffordshire border was modified in 1657 and Halesowen (Salop detached) annexed to Worcestershire and Farlow (Herefordshire detached) added to Shropshire in 1844. In 1895. Sheriffhales, Tittenley and part of Ludford were added to Shropshire: Dowles transferred to Worcestershire and Leintwardine to Herefordshire. Both names. Shropshire and Salop, derive from O. E. *Scrobesbyrigscir* (shire with Shrewsbury at its head), Salop being the product of a Normanized form.

Physical Features.—Shropshire is crossed by the Serern, which divides the hilly south and west from the undulating plain to the north and east. The upland is composed of a series of ridges including Wenlock edge. View edge. Stiperstones and Stapeley hill. and hogbacks (Ragleth. Caradoc. Lawley, the Wrekin). all running from northeast to southwest with deep valleys between them. Among them lies the Longmynd plateau (1.696 ft.); south of Corvedale is a triangular plateau with two table-topped heights, Brown Clee (1.790 ft.) and Titterstone Clee (1,749 ft.). A third mass of high ground, Clun forest. lies between the rivers Clun and Teme. The northern plain (about 200 ft. or less) is broken by a band of sandstone knobs (Nesscliff, Grinshill. Hawkstone). Streams. such as the Tern, have little fall and large areas mere formerly marsh (*e.g.,* the Wealdmoors). Peat mosses (Whixall) and meres, especially near Ellesmere, Whitchurch and Baschurch. give variety to the landscape. The eastern plain has been cut by rivers—the Worf. Bowhill brook. Claverley brook. etc.—into a series of valleys and low ridges (Shatterford. Tuckhill. High Rock) running from north-northwest to south-southeast.

The geological pattern runs on similar lines. older rocks being found in the uplands and later rocks mainly under glacial drift in the plain. but this pattern was broken by volcanic upheaval. The main series of rocks are: pre-Cambrian in Longmynd. Wrekin and Ercall districts; Cambrian in Church Stretton district; Ordovician in the Shelve area and a strip north of Wenlock edge from the Wrekin in the northeast to Hopesay in the southwest; Silurian in Wenlock edge and the Corvedale area. View edge, Clun forest and the Ludlow district: Carboniferous. limestone poorly represented but seen near the Wrekin. at Lilleshall and Llanymynech: four small coal-measure basins (1) Chirk (2) Hanwood. with continuation northwest (3) Coalbrookdale and (4) Wyre forest. Trias is found principally in two areas (1) north of the Severn above Shrewsbury and north of Wellington (2) east of Shifnal and Bridgnorth. A small area of Lias is exposed round Prees; and glacial drift covers most of the plain.

History.—Considerable prehistoric traffic through Shropshire is indicated by portable antiquities of late Neolithic and Eronze Ages (collections in Rowley's house. Shrewsbury; Clun and Ludlow museums) and by field monuments of the Bronze Age. such as the round barrows on the Longmynd and Old field near Ludlow. stone circles on Stapeley hill and remains in the Clun region. Hill forts of Early Iron Age character abound, especially the Bury ditches. Hopesay Burrow camp, the two Caer Caradocs. the Wrekin. Bury walls and Old Oswestry. Related island sites—the Berth. Baschurch and Kynnersley wall—were possibly occupied later.

Traces of Roman military conquest are rare. but a legionary fortress existed in the 1st century at Viroconium. later the cantorial capital of the Cornovii and one of the largest towns in Britain. There were small towns or posting stations; *e.g.,* Bravonium (Leintwardine), Uxacona (Oakengates), Rutunim (unidentified). The country appears to have been sparsely cultivated, with farms at Acton Scot. Linley Hall, Cruckton. etc.. but silver-bearing lead ores and outcrop coal were probably exploited.

The Saxon conquest was marked by the construction of Wat's dyke and Offa's dyke. Anglo-Saxon villages are recognizable by their names. terminating in "bury." "ton." "ley." etc.. while Celtic place-names include elements like "pentre," "llan," "tre"; and Offa's dyke is generally the linguistic boundary. Some Welsh elements, however, may be attributed to later infiltration which has gone on since the 11th century.

After Danish incursions had been finally repulsed. Edward the Elder divided Mercia into shires, Shropshire being one; and Shrewsbury became a mint town. At the Conquest, large areas of Shropshire were set aside as forests, or hunting grounds, subject to special forest jurisdiction. such as those of Morfe. Mount Gilbert. Shirlet. Clee and Stiperstones. Roger de Montgomery was given extensive estates for the defense of the border. A double line of castles against the Welsh was established during the 12th and 13th centuries, and the history of medieval Shropshire is a chronicle of Welsh incursions and baronial rebellions.

All Shropshire's religious houses, except Brewood. were for men. The most important (with foundation dates) were: Benedictine at Shrewsbury (1083) and Bromfield (refounded 1135): Cluniac at Wenlock (refounded 1080); Cistercian. originally Savigniac. at Buildwas, (1135); Augustinian canons at Haughmond (*c.* 1135), Wombridge (*c.* 1130). Chirbury (from Snead) in the late 12th century; Arroasian canon at Lilleshall (from Donnington Wood) *c.* 1144; Grandmontines at Alberbury (c. 1220–1441); Templars at Lydley (*c.* 1158–1308); Hospitalers at Halston (c. 1221); Dominican friars at Shrewsbury (1222); Franciscan friars. also at Shrewsbury (1245–46) and at Bridgnorth (1244). Augustinian friars at Ludlow (1282). Shrewsbury (1298) and Woodhouse near

Cleobury Mortimer (1250).

The midland system of three open fields was general in Shropshire, but some traces of Welsh land custom are found.

The high quality of Shropshire wool brought prosperity in the 13th century, Ludlow, Shrewsbury and Bridgnorth being the main centres. As trade grew, Shrewsbury became established as the principal market for an area including much of north Wales. There was plenty of heath available for sheep and therefore no outcry was made against conversion of common field to sheep-walk. But Welsh raids, plague depopulation and bad seasons brought a decline in arable farming. In areas of high rainfall, cattle raising became important. From the 15th to the 17th centuries there are indications of a general increase in the size of holdings, piecemeal inclosure of common fields and some attempts to drain and inclose marshes and wastes.

A prerogative court, the council in the Marches of Wales, was established about 1473 with headquarters at Ludlow and jurisdiction in Wales and the four border counties to check disorder and provide quick, cheap, effective remedies for local litigants. It was suppressed in 1642, re-established in 1660 but never regained prestige. and was abolished in 1689. On the outbreak of the Great Rebellion. many families declared for the king. who came in person to recruit, but Puritan influence divided the north and extreme south of the county. While Shrewsbury and Bridgnorth stood siege for the king, Wem and Hopton castle stood siege for parliament. Fortified country houses were skirmishing centres. After the battle of Worcester in 1651, Charles II in his escape found many Shropshire friends.

In 1708, Abraham Darby I came to Coalbrookdale and developed his new method of smelting ironstone with coke from pitcoal. He found a tradition of iron-working. local supplies of ironstone, sulfur-free coal, limestone and charcoal, and an ideal site with water power in the dale and water transport on the Severn. In the 18th century, the Darbys, the Reynolds, John Wilkinson and others introduced many improvements and made Shropshire the greatest iron-producing area in England. The first cast-iron bridge was erected at Ironbridge in 1779; the first iron-built boat floated on the Severn in 1787; the first locomotive engine for use on a railway was built by the Coalbrookdale company for Trevithick in 1802. In the same period: Caughley and Coalport were producing fine china and Broseley became noted for churchwarden pipes.

Architecture.— Good examples of ecclesiastical, military and domestic Brchitecture are to be found in Shropshire. The development of castle-building techniques from the 12th to 14th centuries may be studied at Ludlow. Clun, Bridgnorth, Shrewsbury and Hopton castles, where considerable portions survive. Ludlow and Shrewsbury retain parts of their town walls. In domestic architecture, Shropshire possesses outstanding examples from the 13th century. Shropshire had no dominant noble family but many ancient county families, no great seat but many fine country houses. Stokesay (c. 1260–80) and Acton Burnell (1283) show the fortified manor house; the Old Mint, Shrewsbury, and Forester's lodge, Millichope (c. 1280), are comparable town and country dwelling houses; the Provost's house, Edgmond, is 14th century and the Abbot's house, Shrewsbury, dates from about 1450. Many Shrewsbury houses are partly medieval. There are numerous Elizabethan country houses. either half-timbered (Pitchford, *c.* 1570) or stone, for example, Benthall 1580, Wilderhope 1586, Condover c. 1590. Moreton Corbet (early 17th-century) is a magnificent ruin. A great buildingperiod (c. 1670–1730) produced such houses as Longnor (1670), Court of Hill (1693), Ludstone (1685), Cound (1704) and Davenport (1726). Ludlow and Shrewsbury are rich in 18th-century townhouses.

Agriculture, Industries and Communications.—Shropshire is still an agricultural county. Holdings vary from large farms (1,000 ac. or more) to many highly efficient small holdings. The total area in 1955 of crops and grass was 691,000 ac. (rough grazing 38,700 ac., oats 33,000 ac., wheat 33,000 ac., barley 31,000 ac., sugar beet 16,000 ac., potatoes 13,000 ac.). Potatoes became an important crop in the 1950s because certain traditional potato-growing areas elsewhere became infested with eelworm. There is some intensive tomato cultivation under glass.

The southwestern uplands are devoted mainly to cattle and sheep raising, the native sheep breeds being Clun Forest and Kerry Hill. Shropshire sheep are also bred in the lowlands. The indigenous beef breed is the Hereford, of which there are many famous herds. In the northern plain, dairy farming for the sale of milk off farms is the main industry. There the predominant dairy breed is the British Friesian, followed by Ayrshires and Shorthorns. Shropshire also has a high population of pigs and poultry. The main cattle market towns are Shrewsbury, Oswestry, Wellington, Ludlow and Craven Arms; sheep sales at Craven Arms are among the biggest in the country.

The total area under tree crop in 1955 was about 36,000 ac. (hardwoods 21,610 ac., conifers 12,696 ac., coppice 2,000 ac.), with another 17,000 ac. of scrub and felled woodland. The most heavily wooded district is the southwest. where pine and spruce are found on higher ground, larch and mixed woods on slopes and hardwoods in valleys. Replanting at Walcot and new afforestation round the Anchor was entirely coniferous. Northeastern Shropshire lacks woodland but is heavily timbered with hedgerow trees, and some fine woods are found in the Severn valley below Buildwas, ending with a large remnant of Wyre forest, as yet oak and coppice.

Ironfounding and engineering are major Shropshire industries. In addition to constructional engineering, typical products are large castings, machine tools: locomotives, motor vehicles, wheels and chassis. steel furniture, safes, agricultural machinery, grates and cookers. Other factories produce radios, toys, mats. lenses, aluminum pans. carpets and clothing. The principal collieries working in the 1950s were Granville, Grange, Madeley Wood (Coalbrookdale coal field), Highley (Wye coal field) and Ifton Heath (Chirk coal field); some coal board opencast working: and small private pits. Fireclay is excavated and a large number of refractory products are made. Agricultural limestone is quarried in the Wenlock area, dolomite at Llanyblodwel and road stone at Titterstone Clee, Squilver, Pontesbury, Maddocks Hill. etc.; but the best Grinshill freestone and Stiperstones lead and barytes veins are exhausted. Timber is largely exported; and maltings, breweries, creameries and a sugar factory use local agricultural products. Electricity is obtained from the power station at Buildwas.

The Severn was once navigable for barges up to Welshpool, and in the 18th century a brisk trade was carried on between Shrewsbury and Bristol. while a canal network connected the Severn with the Dee, Mersey and Stour. Both rivers and canals fell into disuse in favour of railways, supplemented by road transport.

Population and Administration.—The population in 1951 was 289,802. Ecclesiastically. Shropshire is divided between Lichfield and Hereford dioceses. It is in the Oxford circuit and assizes are held at Shrewsbury. It has one court of quarter sessions (Shrewsbury borough alone retains its commission of the peace) and 18 petty sessional divisions. There are four parliamentary divisions: Ludlow, Oswestry, Shrewsbury and the Wrekin. The municipal boroughs are Shrewsbury, the county town (pop., 1951, 44,919), Bridgnorth (6,250), Oswestry (10,712), Ludlow (6,456), Wenlock (15,095) and Bishop's Castle (1,290).

Shropshire has many ancient, grammar schools: Ludlow (founded *c.* 1300); Oswestry (1407); Bridgnorth (medieval); Whitchurch (1552); Shrewsbury (1552); Market Drayton (1556); Wem (1650); and Newport (refounded 1657). Some primary schools also have a long history, such as Nesscliff (1753).

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SHROVE TUESDAY, the day before Ash Wednesday, the first day of Lent, so called as the day on which "shrift" or confession was made in preparation for the great fast. Shrove Tuesday is called in French *Mardi gras*, "Fat Tuesday," in allusion to the fat ox which is ceremoniously paraded through the streets.

The Germans know it as *Fastendienstag.* It is celebrated in Catholic countries as the last day of the carnival. with feasting and merrymaking, of which. in England, the eating of pancakes alone survives as a social custom, the day having been called at one time "Pancake Tuesday."

In the United States the festival season preceding Lent, particularly associated with New Orleans. La., is known as the Mardi Gras. The season begins with the New Year and terminates with parades, pageantry ahd a ball on Shrove Tuesday. Celebrations, accompanied by masking, are recorded as among the activities of the soldiers at Ft. Louis de la Louisiane (1702–10), on the first site of Mobile, Ala. Similar festivities were observed by the residents of New Orleans from its foundation. and were continued during the Spanish control of Louisiana. The custom was retained after the United States purchased that territory, but it was not until 1857 that a group of former residents of Mobile. Ala., where masked parades had long been a prominent feature of the celebration, organized "The Mystick Krewe of Comus," and produced the first spectacular parade with floats at New Orleans. Later "King Rex" was introduced to rule the city on Shrove Tuesday from 11 A.M. to sunset. After that Comus takes over accompanied by his "Mystick Krewe of Comus." In the evening the frolic season terminates with brilliantly illuminated pageantry, depicting scenes from literature or history, followed by a ball.

SHRUB, a low, woody plant that usually has several stems instead of a single trunk, as in most trees. The distinction between small trees and large shrubs is often difficult to make because some species of trees tend to assume shrublike habits under severe environmental conditions. Also, some trees bear several trunks or develop branches low on the trunk and are thus shrublike, while some shrubs show a tendency toward one main stem and are then treelike.

In general, a tree is assumed to be at least 20 ft. tall at maturity. while a shrub is normally less than that height when mature. Exceptions are not uncommon in both cases. The terms shrub and bush are frequently used interchangeably.

Shrubs have two important values in the landscape. (1) as individual or single specimens and (2) as part of the whole design of the ornamented space. Some shrubs also have edible fruits. *(See* STEM: TREE; LANDSCAPE ARCHITECTURE.) (J. M. BL.)

SHUBERT, LEE (1875–1953), U.S. theatre manager and producer, was born at Syracuse, N.Y., on March 15, 1875 With his brothers Sam S. (1876–1905) and Jacob J. (1880–), he formed the Shubert Theatre corporation. which came to control a large chain of theatres throughout the United States. The Shuberts began as theatre managers in Syracuse, where they organized several touring companies for the comedies of Charles A. Hoyt. In 1900 they leased the Herald Square theatre in New York city and proceeded to acquire other theatres, from which grew the vast theatrical empire that once was estimated to be worth $400,000,000. Impetus for the growth of this empire came early from David Belasco and other independent producers during the struggle against the theatre trust. headed by Klaw and Erlanger. The Shuberts were in a position to rent theatres to producers discriminated against by the syndicate. Soon, however, the Shubert corporation, originally a booking agency, became a producing organization also. As its productions increased in number, fewer theatres were available to other producers, with the result that the Shuberts were subject to much criticism for their harsh contracts and for their "stifling effect upon the American theatre." Lee Shubert died in New York city on Dec. 25, 1953. (M. Rs.)

SHUFFLEBOARD (SHOVELBOARD; originally SHOVE-BOARD), a game in which plastic or metal disks are shoved by the hand or with an implement so that they come to a stop on or within certain lines. or compartments marked on the "board" or court (on a table, floor, or outdoor hard surface like concrete). It was popular in England as early as the 15th century, especially with the aristocracy, under the names shove-groat, slide-groat or shovel-penny. Some of the great country houses had boards of exquisite workmanship; that at Chartley hall, in Staffordshire, was over 30 ft. long, comprising 260 pieces. It is said that King Henry VIII issued a royal decree forbidding its play because it prevented the proper practice of archery. Shove-ha'penny (*q.v.*), a later version of shovel-penny, is still a popular game in English pubs.

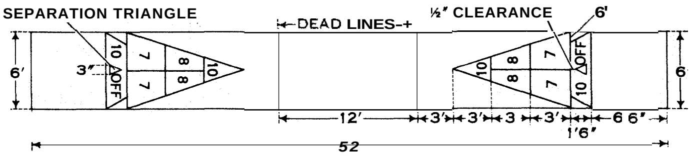

DIAGRAM OF SHUFFLEBOARD COURT

In modern times, a modified form of the old indoor game became popular among travelers on ocean liners as a deck game. For the shipboard version, called shuffleboard, courts of various designs were marked on the deck, with lined sections at either end, numbered one to ten; the section nearest the player, called ten-off, reduced scores by ten. The winning score was 50 points.

U.S. Game.—Shuffleboard was introduced about 1913 at Daytona Beach, Fla. So popular was the game that it spread rapidly through the United States, with each community devising its own rules of play. The modern form of shuffleboard mas defined at St. Petersburg, Fla., in 1924, when Pierce V. Gahan, city recreation director, called a conference of all state shuffleboard clubs.

The rules adopted at that meeting defined the size and shape of courts (concrete or terrazzo, 6×52 ft.); the maximum length of the cues (6 ft. 3 in.) and the disks (either wood or composition, 1×6 in.; four red, four black). The rules also set forth the method of choosing partners, rotation of play, method of scoring and a list of penalties for violations of good sportsmanship, and introduced methods of strategic play. Though it is played by persons of all ages, and is a popular family game, shuffleboard is especially well-suited for elderly persons and others interested in light physical exercise.

Modern shuffleboard may be defined as a competitive game in which disks are propelled by means of cues onto a scoring diagram at the opposite end of a court. in order to score, to prevent opponent's scoring or both. It may be played by two persons (singles) or four (doubles). Interest is sustained as shots are made alternately by "red" and "black."

Strategy may play an important part in the game; the player's first shot (the red disk is shot first) may place a "pilot" or blocking disk in opponent's line of play just outside the scoring section, for example; or he may place a "sleeper" in the part of the scoring section nearest himself so that later he may "sneak" behind it a disk his opponent cannot reach. The blocking play may be met with a carom shot to remove the disk; or the opponent may elect to place a sleeper shot on his side of the court. In singles, when eight shots have been made from the head of the court, players move to the opposite end or foot of the court and continue play in turn until game score is made. In doubles, team players remain at the ends they occupy at the beginning of the game, though play alternates as in singles. Game may be 50, 75 or 100. as players desire. To count, disks must be entirely within scoring sections. clearing all lines. In match play (best two out of three games) the second game is started with a black disk.

During the depression of the 1930s, there was a revival of table shuffleboard in the United States. Played usually in amusement halls. it was often accompanied by gambling, and, being largely a game of chance, soon declined in popularity. (G. B. W.)

SHUMEN (KOLAROVGRAD), incorrectly SHUMLA, a town of Bulgaria, 50 mi W. of Varna, on the Sofia-Varna railway. Pop. (1956) 41,670. The toun is built within a cluster of hills, northern outliers of the eastern Balkans, which curve round it on the west and north in the shape of a horseshoe. As a centre of communications in the southern Danube valley, Shumen has great strategical importance. In the picturesque upper quarter is the magnificent mausoleum of Jezairli Hassan Pasha. The principal mosque is the largest in Bulgaria. The town has an important trade in grain and wine, besides manufactures of clothes and copper and tin wares.

In 811 Shumen was burned by the emperor Nicephorus, and in 1087 besieged by Alexius I. In 1387 it was taken by the Turks. In the 18th century it was enlarged and fortified. Three times, in 1774, 1810 and 1828, it was unsuccessfully attacked by Russian armies. The Turks consequently gave it the name of Gazi ("Victorious"). In 1854 it was the headquarters of Omar Pasha and the point at which the Turkish army concentrated (*see* CRIMEAN WAR). On June 22, 1878, it capitulated to the Russians and ceded to Bulgaria. It was renamed Kolarovgrad in 1950.

SHURUPPAK (modern FARA), an ancient city of Mesopotamia situated on the old course of the Euphrates, 50 mi. N.W. of Lagash in 31° 30′ N., 45° 30′ E. The city is of special importance in the prehistoric period. It was famous as the home of Zuisudu, the hero of the flood story, and the Semitic version actually places the construction of the ark and all the details of the story at Shuruppak, which, with Sippar, Larak and Eridu are mentioned as the only cities before the flood. The town entirely disappears from ancient records after the last dynasty of Ur, somewhere before 2300 B.C. Excavations have thrown considerable light on the earliest period. Burials have been found with the bodies folded in the so-called embryonic position and wrapped in a reed mat. Clay coffins have also been found with the mat burials. The goddess of the city was Ninlil, the earth mother of Nippur, and the chronology of the town was kept by calling the year after the annual magistrate. A few tablets have been found before the time of Urnina. The town probably belonged to the southern kingdom of Lagash, and Langdon believes that it is not included in the dynastic list because there was the contemporary kingdom of Unzi of Akshak. He suggests that there was an extensive Sumerian kingdom at Lagash for a short period before Urnina, and cites the evidence of the similarity of legal terms in the business documents of Shuruppak, Lagash and Akkad.

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SHUSHTAR, a town in Khuzistan, Iran, about 32° N. and 49° E., in the angle formed by the bifurcation of the Karun river into the Ab-i-Gargar and Ab-i-Shatait, about 40 mi. below the point where the Karun debouches into the plains from the Bakhtiari mountains. The town covers a larger area than its population (1956) of 18,548 warrants, being in large part in a ruinous and deserted condition; it has indeed been described as one of the most tumble-down places in all Iran. Many of the houses, of stone and brick, have cellars, called *Zir Zamin,* in which the inhabitants shelter in the excessive heat of summer, which on occasion reaches 128° F. The bazaar is a poor one and the few permanent shops are to be found in the street leading through the centre of the town to the Pul-i-Bulaiti (bridge). Even the mosques are devoid of special architectural features except perhaps the oldest one built under the Abbasids. On the other hand, the citadel, or Qal'ah Salasib, is a most imposing though ruinous mass, crowning the cliff, covering an area 350 by 150 yd., and described by P. M. Sykes as "the finest fort he had ever seen in Persia."

Water Works.—Shushtar is most famed for the great works constructed in ancient times for the disposal of the voluminous water of the Karun river. These comprise (1) the Ab-i-Gargar canal (the Masruqan of the middle ages). (2) The great barrage called the Band-i-Qaisar which is thrown across the Ab-i-Shatait (the principal arm of the river) west of the town. It is about 440 yd. long and supports a bridge, the Pul-i-Dizful. (3) The canal called Minau, which takes off above the barrage by a tunnel cut out of the rock on the western side of the town below the citadel, the purpose of which was to irrigate the Miyanab.

Tradition says that the Minau canal was built by Darius the Great and that it was Ardashir I (the Sasanid) who began to construct the barrage after the canal mouth had dried up. The barrage was only completed under Shapur II by the Roman prisoners with Valerian II. The Ab-i-Gargar was first dug simply to divert the volume of the water of the main river; the Band-i-Qaisar was then constructed, and the bed of the river above the barrage was paved with huge stone slabs bound with iron, to prevent further erosion. This paving was called *Shadurwan,* a term also applied to the barrage itself. Ultimately, a new barrage is said to have been built across the Gargar.

Population and Industries.—The population is a mixture of Arab and Iranian or proto-Iranian elements, known locally as Shushtaris, speaking a patois of their own and all Shi'ah Moslems. A few Bakhtiaris are the only other element. Travelers speak of the disagreeable and fanatical character of the inhabitants; but among the Persians their devoutness earned for the town the honorific title of *Dar al Muminin.* Its position gives the town a considerable commercial as well as strategic importance. It stands on a trunk road from Mohammerah via Ahwaz, Dizful, Khurramabad and Qum to Tehran. The industries are carpet weaving called *gilim,* the making of coarse cotton canvas and turbans, glazed earthenware, pack and riding saddles; copper, brass and silver work; tanning and dyeing.

History.—In the Umayyad period Shushtar became a stronghold of the Kharijites, one of the earliest religious sects of Islam. Under the Caliphs it was the capital of one of the seven provinces into which Khuzistan was then divided. When Baghdad became the centre of the empire, Shushtar, by its proximity was advantageously affected. The town was conquered by Timur and remained in the hands of the Timurids until 1514, when it fell to a Shi'ah dynasty of Sayyids under the suzerainty of the Safavids and became a centre of Shi'ah propaganda. In the beginning of the 19th century it was governed by a son of Fath Ali Shah who restored the barrage and the bridge; at that time it was said to have a population of 45,000.

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SHUTTLE: *see* WEAVING.

SHUVÁLOV or SCHOUVALOFF, **PETER ANDREIVICH,** COUNT (1827–1889), Russian diplomatist, was born in 1827 of an old Russian family which rose to distinction and imperial favour about the middle of the 18th century. Several of its members attained high rank in the army and the civil administration, and one of them may be regarded as the founder of the Moscow university and the St. Petersburg Academy of the Fine Arts. As a youth Count Peter Andreivich showed no desire to emulate his distinguished ancestors. He studied just enough to qualify for the army, and for nearly 20 years he led the agreeable life of a fashionable officer of the guards.

In 1864 court influence secured for him an appointment as governor general of the Baltic provinces, and in that position he gave evidence of so much natural ability and tact that in 1866, when the revolutionary fermentation in the younger section of the educated classes made it advisable to place at the head of the political police a man of exceptional intelligence and energy, he was selected by the emperor for the post.

In addition to his regular functions, he was entrusted with much work of a confidential, delicate nature, including a mission to London in 1873. The ostensible object of this mission was to arrange amicably certain diplomatic difficulties created by the advance of Russia in central Asia, but he was instructed at the same time to prepare the way for the marriage of the grand duchess Marie Alexandrovna with the duke of Edinburgh, which took place in January of the following year. At that time the emperor Alexander II was anxious to establish cordial relations with Great Britain, and he thought this object might best be attained by appointing as his diplomatic representative at the British court the man who had conducted successfully the recent matrimonial negotiations.

Count Shuválov accordingly was appointed ambassador to London; he justified his selection by the extraordinary diplomatic ability he displayed during the Russo-Turkish War of 1877–78 and the subsequent negotiations, when the relations between Russia and Great Britain were strained almost to the point of rupture. After the publication of the treaty of San Stefano, which astonished Europe and seemed to render a conflict inevitable, he concluded with Lord Salisbury a secret convention which enabled the two powers to meet in congress and find a pacific solution for all the questions at issue. In the deliberations and discussions of the congress he played a leading part and defended the interests of his country with a dexterity which excited the admiration of his colleagues; but when it became known that the San Stefano arrangements were profoundly modified by the treaty of Berlin, public opinion in Russia condemned him as too conciliatory and reproached him with having given up needlessly many of the advantages secured by the war, For a time Alexander II resisted the popular clamour, but in the autumn of 1879, when Bismarck assumed an attitude of hostility toward Russia, Count Shuválov, who had been long regarded as too amenable to Bismarckian influence, was recalled from his post as ambassador in London. After living for nearly ten years in retirement, he died at St. Petersburg in 1889. (D. M. W.)

SHWEBO, town and district in the Sagaing division of Burma. The town is situated on a railroad about 50 mi. N.N.W. of Mandalay. It is of historic interest as the birthplace and capital of Alompra, the founder of the last Burmese dynasty. Formerly it was an important cantonment.

The area of the district is 5,735 sq.mi.; pop. (1941) 496,185, showing an increase of 49,395 in the decade 1931–41. The population of the town (1953) was 17.842. The district lies between the Katha, Upper and Lower Chindwin and Mandalay districts. The Irrawaddy forms the dividing line on the east. The physical features of the district vary considerably. The Minwun range runs down the whole eastern side. skirting the Irrawaddy. In the north it is a defined range, but at Sheinmaga, in the south, it sinks to an undulation. West of the Mu river, in the centre of the district. there is a gradual ascent to the hills which divide Shnebo from Upper Chindmin. Between these ranges and on both sides of the Mu is a plain, unbroken except for some isolated hills in the north and northeast and the low Sadaung-gyi range in the southeast The greater part of this plain is a rice-growing tract, but on the sloping ground maize, millets, sesame, cotton and peas are raised. A good deal of sugar is also produced from groves of the *tari* palm. The Mu river is navigable for three months of the year, from June to August, but in the dry season it can be forded almost anynhere. Extensive irrigation works existed in Shwebo district. but they fell into disrepair in King Thibaw's time. Chief of these was the Blahananda lake. The old works were later restored and extended, and in 1906 the main canal was formally opened. The district is on the northern borders of the dry belt; the southern tracts have between 25 and 40 in. of rain, the northern tracts rather more. The Mandalay-Myitkyina railway mas built through the heart of the district.

SHYOK, a large tributary of the upper Indus Kashmir. which rises near the southern foot of the great pass of the Karakoram range, on the route from Leh to Yarkand Tno important streams uith affluents, flon south from the Karakoram until they reach one of the great longitudinal troughs north of and parallel to the Himalaya system and the Indus-Brahmaputra line and north of the latter. They both join the stream along this trough. nhich, flowing northwestward, makes a sharp bend and joins the Indus in Baltistan. Below a station called Yapchan, situated about 35 mi. S. of the Karakoram pass, at a junction of valleys, the river bed begins to encase itself in a deep, narrow gorge, in which, normally, it receives the drainage of the Little Khumdan glacier. In 1926 this glacier pushed its way into and across the gorge, and thus built an ice dam 480 ft. high. The ice-dammed lake above had grown to a length of 9 mi., an average breadth of 1,000 yd. and a depth of 25 ft. by July 1928. At the beginning of August the level of the lake rose steadily, and on Aug. 4, 1928, a crack in the dam had developed. This caused widespread anxiety, and elaborate beacon-signalling arrangements were improvised and some villages below were evacuated. The alarm was intensified as a beacon fire was seen, but it proved to be a fire kindled by a Yarkandi caravan. Subsequent reports showed that the lake was leaking slowly through the crack in the ice dam, and the danger of flood passed away.

SIALKOT (SEALKOTE), a municipality and military cantonment, *tehsil* (subdivision) and district in the Lahore division of West Pakistan. The town, which is on the North-Western railway, is 67 mi. N.E. of Lahore. Pop. (1951) 167,543 (municipality 135,401; cantonment 32,142). It is the seat of Murray college, connected with Panjab university, Lahore. There are remains of a fort dating from about the 10th century, but the mound on which they stand is traditionally supposed to mark the site of a much earlier stronghold, and some authorities identify it with the ancient Sakala or Sagal. The town has an extensive trade and manufactures sporting implements, boots, paper, cotton, cloth and shawl edging.

SIALKOT TEHSIL had a population in 1951 of 418,393.

SIALKOT DISTRICT has an area of 2,071 sq.mi.; pop. (1951) 1,474,253. It is an oblong tract of country occupying the submontane portion of the Rechna (Ravi-Chenab) Doab. Sialkot is above the average of the Punjab in fertility. The upper portion is very productive, and the southern portion, though less fertile, now receives irrigation from the upper Chenab canal. Sialkot is reputed to be salubrious; it is free from excessive heat, judged by the common standard of the Punjab, and its average annual rainfall varies from 35 in. near the hills to 22 in. in the parts farthest from them. The principal crops are wheat, barley, maize, millets and sugar cane.

The early history of Sialkot is closely interwoven with that of the rest of the Punjab. It was annexed by the British after the second Sikh war in 1849; thereafter its area was considerably reduced, assuming its present proportions in 1867.

SIAM (officially named THAILAND in Bfay 1949; Siamese name MUANG THAI), an independent kingdom in southeast Asia occupying an area of 198,263 sq.mi. The country lies on the north and west shores of the Gulf of Siam. On its southern extremity it is bounded by Malaya; on the southwest by the Andaman sea; on the west and north by Burma; on the northeast and east by Laos; and on the southeast by Cambodia. Siam extends from approximately 6° to about 20° N. lat. and thus has a north-south extension of a little more than 1,000 mi. Its greatest east-west extent is about 480 mi. (along the 15th parallel of latitude).

PHYSICAL FEATURES

On its land side Siam is almost completely enclosed by surrounding mountains. which reach their maximum elevation in the northwest in Doi Inthanon (8.514 ft) near the Burmese border. The central portion of the country is occupied by the great, low alluvial plain of the Mae Nam Chao Phraya (or Menam Chao Phya; often incorrectly called the Menam; *menam* or mae *nam* means river).

Climate.—Siam lies in that portion of the world affected by the so-called tropical monsoon climate—a zone of marked seasonal wind shifts. From May to October (the rainy season) winds are prevailingly from the southwest, bringing rain to most of the country. From October to February (dry season) winds are from the northeast. This is generally a cool, dry period except along the east coast of the peninsula which receives the full force of the northeast winds. From March until May a transitional season (hot season) occurs. During this period the northeast winds lose force and, except in the peninsula, a hot. dry condition prevails until the return of the southwest monsoons. Temperatures at this season are the highest of the year. Except in the elevated interior northern section of the country minimum temperatures seldom go below 65° F. Maximum temperatures above 100° F. are rare. In the north frost may occur in the mountains during the cool season, and most homes are equipped with fireplaces.

Total annual rainfall ranges from 30 to more than 100 in. Most of it occurs in the form of convectional showers. Rainfall in the north averages about 50 in. per year. In the northeast it is about the same, with somewhat drier conditions prevailing in the western portion. Central Siam also gets about jo in. annually. The heaviest rainfall occurs in southern Siam. The peninsula has rainfall every month of the year. Despite the apparent abundance of Siam's rainfall, there are many areas on the lee side of mountains which are too dry for rice culture. Such a region is the western portion of the central plain.

Flora and Fauna.—Flora and fauna of Siam are similar to those of adjacent areas. Along the coast are mangroves. *Pandanus,* rattans and similar palms. Extensive rice cultivation has left little natural vegetation in the central region. In the temperate uplands of the interior oaks, pines, chestnuts, raspberries, honeysuckle, saxifrages, Cichoraceae, anemones and Violaceae are found. There are also many valuable timber trees—teak. sapan, eaglewood, wood oil (Hopea) and other Dipterocarpaceae, Cedrelaceae, Pterocarpaceae, *Xylia,* ironwood—as well as dyewoods and resinous trees.

Among the big game animals are the elephant, tiger, leopard, fishing cat, leopard cat and other species of wildcat, honey bear, large sloth bear and one-horned rhinoceros. Wild cattle include the gaur, banting and water buffalo. The goat antelope, several varieties of deer, wild pig. rats, bats and monkeys also exist. There are 56 varieties of snakes, of which only 12 are poisonous. Crocodiles haunt the rivers and estuaries. Fresh- and salt-water fish are numerous and, after rice. form the main food of the population. The country is rich in birds, many of which are common to Burma and Cambodia.

Regions.--On the basis of difference in topography, climate and human activity. Siam may be divided into four regions: (1) northern. (2) northeastern, (3) central basin and (4) peninsula.

Northern Siam is that area between the Salween and Mekong rivers and north of 18° N. lat. The central part of this region is drained by the four chief tributaries of the Chao Phraya. This is a region of parallel mile-high north-south limestone ranges interspersed with deeply cut valleys which lie at an elevation of about 1,000 ft. The region occupies an area of about 35,000 sq.mi. Approximately 7% of the land is under cultivation. Rice is the predominant crop. with tobacco and sugar cane of secondary importance. Where irrigation waters are available, two crops of rice per year are obtained. Teak is the chief export of the region. Chiengmai (pop. 75,715) is the chief town. a railroad terminus and the centre for the teak trade. Other urban centres are Tak (26,761 pop.), a timber station and the starting point of a Burmese trade route, and Muang Lampang, the terminus of the once-important road in the north.

Northeastern Siam occupies an area of about 63,000 sq.mi. Sometimes known as the Korat plateau (after the ancient name of the town of Nakhon Ratchasima), this low, southeast-sloping plateau is underlain with nearly horizontal beds of sandstone and shale. Although elevations do not exceed 600 ft., its isolation, poor soil and unreliable rainfall handicap its development. Only about 7% of the land is under cultivation and population is generally sparse. Aside from a small surplus of rice, crops primarily are consumed locally. Because of the shortness of the rainy season most crops are grown under irrigation. They include, in addition to rice, corn, cotton. tobacco and mulberry, the latter providing the basis for a modest sericulture industry. The raising of cattle, hogs, buffaloes and horses is more important than crop agriculture. Cattle and pigs provide export items from the region. The chief towns in this area include: Nakhon Ratchasima, or Korat (114,296), centre of silk weaving; Muang Ubon (72,230), the eastern terminal of the rail line from Ayutthaya (Ayuthia) ; and Nong Khai (54,919), an ancient place on the Mekong.

The *central basin* covers an area of about 70,000 sq.mi. and includes the southern portion of the Chao Phraya valley, the valley of the Mae Klong and the coastal areas of the southeast. This is the heart of the country in terms both of population and economic productivity. The region is one of alluvial plains surrounded by hills. Relief is especially monotonous in the central plain. In the 180 mi. from the southern edge of the northern region (18" N. lat.) to the sea, the difference in elevation is of the order of only 150 ft.

Of the entire region about 15% or 16% is under cultivation. Paddy rice occupies about three-fourths of all the land in crops. About 10% is in peas, tobacco, corn, sesame and pepper. Gardens and orchards occupy another 15%. Rice is generally sown broadcast at the beginning of the rainy season and is irrigated by the streams when they attain flood proportions. Away from the flooded areas along the streams the land is generally not utilized and is a wild jungle. These lands cannot be worked with the crude pointed plow used in the rice lands. A steel plow is needed. Moreover, the water buffalo used in the rice fields is not suited to work in dry fields, because it does not perspire through the skin and cannot stand the work.

The chief town of central Siam is Bangkok (Krung Thep), the capital, chief port and major city of the country. It had a population, according to the 1947 census, of 620,830. It is located 15 mi. from the sea on the Chao Phraya. A bar at the mouth of the river forces larger steamers to anchor outside and transfer their cargoes to lighters. Parts of Bangkok are thoroughly modern, with wide streets, large warehouses, a modern transport system and most of the other accoutrements of a western-style city. It does maintain an oriental atmosphere, however, with its numerous Buddhist temples and narrow streets crowded with shops.

In addition to Bangkok other important towns in central Siam include Muang Phitsanulok (66,783), a centre of agricultural activity and historical interest; Samut Prakan (50,679), naval fortifications at entrance to the Chao Phraya (Phya) ; Nonthaburi (34,815), a big market centre; Ayutthaya (49,717), former capital of Siam, located on an island in the Chao Phraya, of great historical interest; Lop Buri (78,931), capital before Ayutthaya, famous for its ruins and revitalized as a military and railway centre; Suphan Buri (70,530) and Rat Buri (77,674), ancient cities; Nakhon Pathom (85,063), famous for its huge pagoda on the site of the capital of Sri Wichaiya, a kingdom of the pre-Christian era, and now important for military, agricultural and other schools; Chon Buri, a fishing centre; Rayong (34,258) and Chanthaburi (Chantabun) (28,472), which produce gems and pepper.

Peninsular Siam is a region of about 28,000 sq.mi. lying within the Malay peninsula. Low mountains, seldom more than 3,000 ft., divide the area lengthwise and account for difference in the rainfall regime east and west of the mountains. Although rain falls the year around, it is rainier on the western side of the peninsula from May to October and rainier on the east coast from October to February. Sea breezes tend to moderate the high temperatures.

Rice is the chief crop, though only about 7% of the land is under cultivation. Much of the land is not suited to agriculture, but much that is has not been brought under cultivation. Production methods there are generally inefficient.

Peninsular Siam is the locale of the principal mineral deposits of the country. Tin is the chief metal and is a leading export of the region. It is mined on Phuket and Phangnga islands and at Ranong and Yala. Other minerals of lesser importance are tungsten (found in association with tin), lead and coal.

In addition to tin, coconuts and rubber are the chief exports of the peninsula. (W. F. Cs.)

HISTORY

The town of Muang Lamphun (Labong or Haribunchai), the first Lao capital in Siam, was founded about A.D. 575. The fusion of races may be said to have begun then, and the Siamese language, written character and other racial peculiarities were in course of formation. But the finishing touches to the new race were supplied by the great expulsion of Lao-Tai from southwest China by Kublai Khan in A.D. 1250. Thereafter the north, the west and the southwest of Siam, comprising the kingdom of Swankalok-Sukhotai and the states of Suphan and Nakhon Sithammarat (Ligore), with their subfeudatories, were reduced by the Siamese (Thai), who, during their southern progress, moved their capital from Sukhothai to Muang Nakhon Sawan, thence to Kamphaeng Phet and thence again to Suvarnabhumi near the present Kanchanaburi. A Sukhothai inscription of about 1284 states that the dominions of King Rama Kamheng extended across the country from the Mekong to Phet Buri, and thence down the Gulf of Siam to Ligore; and the Malay annals say that the Siamese had penetrated to the extremity of the peninsula before the first Malay colony from Menangkabu founded Singapore; *i.e.,* about 1160. Sano also was attacked, and its fall completed the ascendancy of the Siamese (Thai) throughout the country. The city of Ayutthaya which rose in A.D. 1350 upon the ruins of Sano was the capital of the first true Siamese king of all Siam. This king's sway extended to Moulmein, Tavoy, Tenasserim and the whole Malacca peninsula. About this time Siam attacked Cambodia, seized Angkor and carried off 90,000 prisoners. This was the beginning of a series of wars lasting about 400 years, until Cambodia fell entirely under Siamese rule and influence. Vigorous attacks were also made during this period on the Lao states to the northwest and northeast, and Siamese supremacy was pretty firmly established in Chiengmai and its dependencies by the end of the

18th century and over the great eastern capitals, Luang Prabang and Vien-chang, by about 1828.

Phra **Naret.**—During the 15th and 16th centuries Siam was frequently invaded by the Burmese and Peguans, who, attracted probably by the great wealth of Ayutthaya, besieged it more than once without success, the defenders being aided by Portuguese mercenaries, till about 1555, when the city was taken and Siam reduced to dependence. From this condition, however, it was raised a few years later by the great conqueror and national hero, Phra Naret, who after subduing Laos and Cambodia invaded Pegu, which was utterly overthrown in the next century by his successors. But after the civil wars of the 18th century the Burmese, having previously taken Chiengmai. which appealed to Siam for help, entered Tenasserim and took Mergui and Tavoy in 1764, and then advancing simultaneously from the north and the west destroyed Ayutthaya after a two years' siege (1767).

The intercourse between France and Siam began about 1680 under Phra Narain, who, by the advice of his minister, the Cephalonian adventurer Constantine Phaulcon, sent an embassy to Louis XIV. An interesting episode was the intercourse, chiefly commercial, between the Siamese and Japanese governments from 1592 to 1632. Japan in 1636 was closed to foreigners; but trade was carried on down to 1745 through Dutch and Chinese and occasional English traders. In 1752 an embassy came from Ceylon, desiring to renew the ancient friendship and to discuss religious matters. After the fall of Ayutthaya a great general, Phaya Takh Sin, collected the remains of the army and restored the fortunes of the kingdom, establishing his capital at Bangkok; but, becoming insane, he was put to death and was succeeded by another successful general, Phaya Chakkri, who founded the present dynasty. Under him Tenasserim was invaded and Tavoy held for the last time by the Siamese in 1792, though in 1825, taking advantage of the Burmese difficulty with England, they bombarded some of the coast towns. The supremacy of China is indicated by occasional missions sent, as on the founding of a new dynasty, to Peking, to bring back a seal and a calendar.

European **Contacts.**—Of European nations the Portuguese first established intercourse with Siam (1511). They were supplanted gradually in the 17th century by the Dutch. English traders were in Siam very early in the 17th century; there was a friendly interchange of letters between James I and the king of Siam, who had some Englishmen in his service, and, when the ships visited "Sia" (which was "as great a city as London") or the queen of Patani, they were hospitably received and accorded privileges. The important items of export were, as now, tin, varnish, deerskins and "precious drugs." Later on, the East India company's servants, jealous at the employment of Englishmen not in their service, attacked the Siamese, which led to a massacre of the English at Mergui in 1687, and the factory at Ayutthaya was abandoned in 1688. A similar attack is said to have been made in 1719 by the governor of Madras. After this the trade was neglected. Pulo Penang, an island belonging to the Siamese dependency of Kedah, was granted on a permanent lease to the East India company in 1786, and treaties were entered into by the sultan of Kedah with the company. In 1822 John Crawfurd was sent to Bangkok to negotiate a treaty with the suzerain power, but the mission was unsuccessful. In 1824, by treaty with the Dutch. British interests became paramount in the Malay peninsula and in Siam, and two years later Captain Burney signed the first treaty of friendship and commerce between England and Siam. A similar treaty was effected with the United States in 1833. Subsequently trade with British possessions revived, and in time a more elaborate treaty with England became desirable. Sir James Brooke opened negotiations in 1850 which came to nothing, but in 18jj Sir John Bowring signed a new treaty whereby Siam agreed to the appointment of a British consul in Bangkok and to the exercise by that official of full extraterritorial powers. Siam entered into treaties with Japan in 1898 and Russia in 1899. A further convention afterward provided for a second British consular district in northern Siam, while England and France both appointed vice-consuls in different parts of the country.

France and England. — For centuries Siam had been distracted by wars with Cambodians, Peguans and Burmese, but the incorporation of lower Cochin-China, Annam and Tongking by the French, and the annexation of lower and upper Burma successively by the British, freed it from all further danger on the part of its old rivals. But later, disputes with frontier tribes led to complications with France, which asserted that the Siamese were occupying territory that rightfully belonged to Annam, which was then under French protection. France, while assuring the British government that it laid no claim to the province of Luang Prabang, which was situated on both banks of the upper Mekong, roughly between the 18th and 20th parallels, claimed that farther south the Mekong formed the true boundary between Siam and Annam, and demanded the evacuation of certain Siamese posts east of the river. The Siamese refused to yield, and early in 1893 encounters took place in the disputed area in which a French officer was captured and French soldiers were killed. The French then dispatched gunboats from Saigon to enforce their demands at Bangkok, and these made their way up to the capital in spite of an attempt on the part of the Siamese naval forces to bar their way.

In consequence of the resistance with which they had met, the French now greatly increased their demands, insisting on the Siamese giving up all territory east of the Mekong, including about half of Luang Prabang, on the payment of an indemnity and on the permanent withdrawal of all troops and police to a distance of 25 km. from the right bank of the Mekong. Ten days' blockade of the port caused the Siamese government to accede to these demands, and a treaty was made, the French sending troops to occupy Chanthaburi (Chantabun) until the provisions of this treaty should have been carried out.

In 1895 lengthy negotiations took place between France and England concerning their respective eastern and western frontiers in farther India. These negotiations bore important fruit in the Anglo-French convention of 1896. By this convention Siam's independence was guaranteed by the two European powers which alone had interests in the Indochina peninsula. Encouraged by the assurance of the Anglo-French convention, Siam now turned its whole attention to internal reform and to such good purpose that, in a few years, improved government and expansion of trade aroused a general interest in its welfare, and gave it a stability which had before been lacking. With the growth of confidence, negotiations with France were reopened, and, after long discussion, the treaty of 1893 was set aside and Chanthaburi evacuated in return for the cession of the provinces of Bassac, Melupré and the remainder of Luang Prabang, all on the right bank of the Mekong, and of the maritime district of Krat. These results were embodied in a new treaty signed and ratified in 1904.

Meanwhile, in 1899, negotiations with the British government led to agreements defining the status of British subjects in Siam and fixing the frontier between southern Siam and the British Malay states, while in 1900 the provisions of Bowring's treaty of 1855, fixing the rates of land revenue, were abrogated in order to facilitate Siamese financial reform.

In 1907 a further convention was made with France, Siam returning to the French protectorate of Cambodia the province of Battambang, conquered in 1811, and in compensation receiving back from France the maritime province of Krat and the district of Dansai, which had been ceded in 1904. This convention also modified the extraterritorial rights enjoyed by France in Siam and disclosed an inclination to recognize the material improvements of the preceding years. In 1907 also negotiations were opened with Great Britain, the objects of which were to modify the extraterritorial rights conceded to that power by the treaty of 1855 and to remove various restrictions regarding taxation and general administration, which, though diminished from time to time by agreement, still continued to hamper the government. These negotiations resulted in a treaty, signed and ratified in 1909, by which Siam ceded to Great Britain its suzerain rights over the dependencies of Kedah, Kelantan, Trengganu and Perlis, Malay states situated in southern Siam just north of British Malaya, containing in all about 1,000,000 inhabitants, and obtained the practical abolition of British jurisdiction in Siam proper.

In July 1917 Siam entered World War I with a declaration against Germany and Austria-Hungary. All enemy subjects were interned and a quantity of German shipping taken as prize.

King Prajadhipok (1893–1941) succeeded his brother Rama VI in Nov. 1925. On June 24. 1932, a small group of middle-class soldiers and civilians engineered a revolution whereby Siam became a constitutional monarchy. Royalist opposition was effectively eliminated when the revolt of Prince Bovaradej was crushed in Oct. 1933. Prajadhipok. progressively shorn of many of his powers. abdicated in March 1935 in favour of his 10-yr.-old nephew Ananda Mahidol. for whom a three-member council of regency was established. A succession of coups d'état and conspiracies in the ensuing years showed, however, that there was a growing cleavage between the civilian and the military leaders of the revolution. This cleavage. together with public reaction against two major scandals in which high officials were involved, served to enhance the prestige of the newly created national assembly.

Under the absolute monarchy a legislative council of 45 nominated members had been established by a royal decree of Jan. 1895. Prajadhipok. however. at the beginning of his reign instituted the supreme council of state. an advisory body of five princes that met every week to consider secret business and matters affecting the royal family. This supreme council. with the cabinet of ministers and the department of legislative redaction of the ministry of justice, had taken over the functions of the legislative council, which in fact was seldom assembled. The revolution, then. by its provisional constitution of June and its constitution of Dec. 1932, set up a unicameral national assembly with legislative power, control over the budget and ministerial actions, freedom of speech and the right to override the royal veto. It was specified that for 10 years this assembly was to be composed of 156 members, half to be appointed on the advice of the government and half to be chosen by popular election. Elections were to be held every four years. candidates had to be 23 years old or over and to satisfy certain educational and residential requirements. The supreme council of state was dissolved. Executive power was to be shared between the king and the state council. The latter body, combining the functions of cabinet and of privy council. was to comprise 15–2j members, two-fifths of their number being nominated by the king.

World War II created a situation in which the military leaders were able to assume control of affairs. Increasingly nationalistic legislation in the economic sphere, including measures designed to replace foreigners (especially the Chinese) by Siamese in the country's industries and commerce. was followed by a revival of claims to those areas of Indochina which had been taken by the French between 1893 and 1907. Synchronizing its demands with Japanese pressure on French Indochina. from Sept. 1940 to March 1941, the state became involved in spasmodic warfare on its eastern border. Through Japanese mediation the French ceded in May 1941 about 21.000 sq.mi. to Siam. namely that part of the protectorate of Laos nhich lay west of the Mekong river and three-fourths of the Cambodian province of Kampong Thom (the new frontier there running through Battambang and Siemréap). Although not wholly satisfied with these Japanese-arranged terms and desirous above all of maintaining its independence. Siam was swinging increasingly into the Japanese orbit and away from its traditional friendship with Great Britain. On Dec. 8, 1941, after five hours of fighting, Siam agreed to permit Japanese troops passage through the country to invade British Malaya. This was followed by Japanese occupation of the country. (*See* World War II.)

On Jan. 25, 1942, Siam declared war on Great Britain and the Cnited States. The United States did not declare war on Siam. In R'ashington the Siamese ambassador: Seni Pramoj, organized a free Thai movement to counteract the Japanese. Through its offices about 90,000 guerrillas were organized in Siam under the leadership of the regent Pridi Phanomyong. In July 1943 Japan transferred 30.164 sq mi of territory to Siam. This included the four Malay states that had been ceded to the British in 1909 and tno Shan states from Burma.

With the defeat of Japan the declaration of war of 1942 mas declared null and void. In 1946. peace treaties between Siam and Great Britain and between Siam and France were signed on Jan. 1 and on Nov. 1;; territories and properties acquired during the war were returned; and on Dec. 16 Siam joined the United Nations. From 1950, Siam participated in the Korean War in support of the United Nations. In Sept. 1954 Siam was one of the signatories of the Southeast Asia collective defense treaty.

Internal politics after the war were marked by another series of coups d'état and attempted coups. and by a number of changes in the constitution. The first postwar constitution (May 1946) established a bicameral legislature, comprising an elective house of representatives and a nominated senate or house of elders. Then. on June 9, 1946. King Ananda Mahidol was found shot dead in circumstances that gave rise to suspicion of murder. As his brother Phumiphon Adundet (1927–) who succeeded him was a minor. a new regency had to be set up. Meanwhile the governments since the end of the war had been dominated by Pridi Phanomyong, but he was forced to flee from Siam by the coup of Nov. 1947. The power behind this coup was Marshal Pibul Songgram, who had emerged as a leader of the army politicians in the 1930s and had been prime minister from Dec. 1938 to July 1944. Under the provisional constitution of Nov. 1947 the legislature remained bicameral, with 100 members to either house; but membership to the upper house was reserved to nominees of the crown. By a further coup in April 1948. Pibul Songgram made himself again prime minister. The constitution promulgated in March 1949 embodied most of the features of that of 1947. In the last days of Nov. 1951, on the eve of the young king's return from Switzerland where he had been completing his education. the ruling group of politicians organized a new coup. whereby the constitution of 1932 was restored (Dec. 1951). The unicameral assembly was to comprise 123 elected and 123 nominated members, the latter alone sitting until elections would take place; the real point of the change seemed to be to reduce the royal power. In March 1952, however. a somewhat modified version of this constitution was promulgated. The nominated members were gradually to be replaced by elected members until in 1962 the whole assembly would be elected. In Sept. 1957 Pibul was forced to flee the

C. R. SIEGEL, JR.

"TEMPLE OF THE FLOWER GARDEN," CHIENGMAI, NORTHERN SIAM country following a coup d'état led by Marshal Sarit Thanarat, the commander in chief of the army, who then became supreme commander of the armed forces. In Jan. 1959 he was elected prime minister by the national assembly.

(A. . J. W.; . TN.; A. S B. O.)

THE PEOPLE

Population.—Siam is not densely populated in comparison with many countries of the east. The density is about 100 per square mile for the country as a whole but varies widely from section to section, being less than 12 per square mile in one of the northern provinces but more than 500 per square mile around Bangkok. There is little or no pressure on the land. though it is believed that by the late 1950s most of the more fertile land was occupied. The population, estimated at 22,811,701 in 1956 (17,442,689 in 1947; 14,464,489 in 1937), is predominantly rural. The urban population. however, increases more rapidly.

Oi the total population the great majority (about 94%) belongs to the Thai group of peoples. These may be divided into the southern Thai or Siamese and the northern Thai or Lao. The two groups are closely related, though there are minor physical differences. The Chinese, who constitute the largest minority group (2.8% of the total) and tend to retain their own customs. are found mostly in the port cities and are active in retail trade, commerce, industry and mining (since 1947 Chinese immigration has been vigorously discouraged). Moslem Malays account for about 3% of the population. the majority of them living in peninsular Siam. Cambodians. Annamese. Shans and Burmese make up most of the balance. Sumerous but small remnants of ancient tribes. and tribal groups that mav have entered Siam from the north in the 19th century. inhabit the remote hill sections of the north. west and south.

The typical Siamese is of medium height and has an olive complexion (darker than the Chinese, fairer than the Malays), eyes slightly inclined to the oblique. a broad. flat nose, prominent lips. a face wide across the cheekbones and a short chin. A thin moustache is common: beards are plucked out. Hair is black. coarse and cut short. Lips are often deep red and teeth black as a result of chewing betel, though the habit is declining. The social position of women is good. Polygamy is common only among the upper classes: the first wife is the head of the household.

For the language *see* SIAMESE LANGUAGE AND LITERATURE.

Religion. — Buddhism is the prevailing religion of the Siamese and Lao. but the Malays of the peninsula are Moslem. Buddhism in Siam is tinged by Burmese and Sinhalese influences and. in most country districts. by the spirit-worship characteristic of the hill peoples of Indochina. In Bangkok. Brahmanical influence is still noticeable. and Brahman priests assist at all acts of public importance. The Siamese. as southern Buddhists, pride themselves on their orthodoxy: and when Burma. Cambodia and Ceylon had fallen under, European influence the king of Siam came to be regarded as the sole defender of the faith. A close connection exists between the laity and the priesthood, as the Buddhist regulation that every man should enter the priesthood for at least two months is very widely observed. Many of the temples were placed under the direct supervision of the king, and in these a stricter rule of life is observed. Some of the priests are learned in the Buddhist scriptures, and most of the Pali scholarship in Siam is to be found in the monasteries.

According to the 1947 census, Buddhists made up 89% and Moslems 4% of the population. Under Rama VI and under the constitutional regime. Buddhism was pressed into the service of the state to create national unity. Temple-building and expensive, time-consuming ceremonials were curtailed; the state intervened in the administration of clerical and monastic affairs; but the priests did not concern themselves with politics. and the new regime could proceed with secularizing education and democratizing institutions without encountering much monkish opposition.

Education. — Up to the beginning of the 20th century education in Siam was mainly in the hands of the monks. King Chulalongkorn, who inaugurated the state educational system in the 1870s and 1880s, had at first to rely on monastic help, and even in the 1950s. though monks were no longer responsible for the teaching. nearly 50% of the state schools were still housed within temple precincts. The department of education. founded in 1887, became a ministry in 1889. The first teachers' training college was founded in 1892 and the first university, Chulalongkorn. in 1917. Some Christian missionary schools were also opened in the 19th century.

LI KAI—PIX

YOUNG GIRL IN TRADITIONAL COSTUME OF SIAMESE DANCERS

A law to make education compulsory for children between the ages of 7 and 14 was passed in 1921. In 1935, when the system was practically complete. the age limits were changed to 8 and 15. In 1937, in which year 31.1% of the population aged 10 and over were reckoned to be literate. a new scheme of national education was introduced covering preprimary schools, elementary schools. secondary schools. technical schools. teachers' training institutions. higher education and adult education.

In 1954 the numbers enrolled were: preprimary. 11.634: primary. 2,937.j34; secondary. 251.934; vocational. 40.073: teachers' training institutions. 4.232: higher education. 21.078. These totals included 1,388,820 girls at the primary stage. 82,242 at the secondary and j.194 at the higher. By 1954 literacy had risen to 53.7% of those aged 10 and over.

In 1950 a plan to add three years of compulsory secondary education to the four years of primary education already compulsory under the existing scheme and to re-organize educational methods was drawn up. At that time more than 60% of the districts were without secondary schools. Rut qualified teachers were scarce. teaching methods inadequate and school attendance irregular. with the result that many children failed to complete the existing four-year program before the age of 15. The immediate introduction of the additional program all over the country was therefore not practicable. but with United Nations' help a pilot scheme mas begun in 1950 in Chachoengsao province.

The administration of education is strongly centralized. All books used in the schools have nominally to receive official approval. Yet private schools have been encouraged provided that they conform to certain government requirements, especially with regard to the language of instruction. This requirement has caused difficulties with the numerous Chinese schools, one of whose main purposes is the maintenance of Chinese rather than Thai ideas and culture.

GOVERNMENT AND ADMINISTRATION

The constitution of March 1952 was based ultimately on that of 1932 as reintroduced in Dec. 1951 (see above. *History*). The principal modifications that it stipulated were that within ten years the nominated half of the assembly should be replaced by elected members to make the assembly wholly elective; that there should be a privy council of nine, chosen by the king, and that the royal family should be allowed to take part in politics.

For administrative purposes the country was divided, from April 1, 1926, into *monthon* (divisions) which were in turn subdivided into *changwats* (provinces). Following the 1932 coup d'etat the *monthon* were abolished and the *changwat* became the primary administrative division. Each *changwat* was in charge of a commissioner responsible to the minister of the interior and was in turn subdivided into *amphur* (districts), *tambol* (communes or groups of villages j and *moo ban* (villages). There were 71 *changwats* in 1957.

Justice. — A ministry of justice was instituted in 1892. Thereafter the old tribunals, in which customary law had been corruptly administered by ignorant satellites of the great, were replaced by organized courts with judges appointed from the Bangkok law school and under the direct control of the ministry (except in the most outlying parts). A provincial judicial scheme provided a court at the headquarters of each *changwat*, and a central court at the chief town of each *monthon*. A supreme court was established at Bangkok. In 1915 a bar association was formed.

Meanwhile the independence of the Siamese courts was still compromised by international treaties under which extraterritorial rights were secured to foreigners until the national law should be fully codified. After the absolute monarchy had dallied years over the work of codification, the constitutional regime rushed it to completion. enabling Siam to denounce the international treaties in 1936 and to be freed from extraterritoriality within 14 months. Further legislation by the constitutional government was designed to reform procedure. to introduce the western type of will, to strengthen the status of the judiciary and to extend the course in the law school to three years. The spread of crime, stimulated by the political changes. provoked a reorganization of provincial justice. The *gendarmerie* courts were replaced by district courts and police authority was strengthened. Prison reform mas begun. penal colonies were established and reformatories for juvenile delinquents constructed.

Siam is divided into four divisions for judicial purposes, though certain courts in Bangkok are excluded. There is a court of appeal and a final court of appeal to deal with points of law. Civil cases and serious criminal cases have to be heard by at least two judges. There is no jury system.

Defense. — Something of the part played by the armed forces in Siamese politics is indicated in the paragraphs on history above. Conspiracies in 1912 and in 1917 foreshadowed the struggle between civil and military elements that dominated the early constitutional period and culminated in the army's supremacy from 1938, save for the interval 1944–47. Symptomatic of this military influence was the Yuvajon movement, started in 1935, for the military training of schoolboys. A law of 1937 made all males between the ages of 18 and 30 liable for military service.

The navy. which had been officered wholly by Siamese since 1906, had its strength doubled in the first decade of the constitutional regime, when modern warships were bought from Italy and Japan. The traditions of the national air force go back to 1912, when Rama VI sent some of his subjects to France for training as pilots and mechanics and to World War I, when Siamese aviators were sent to the western front.

ECONOMY

Siam is well endowed with rich alluvial soil in the central basin. Mineral wealth exists to a limited degree. with tin the most important. Associated with the tin are deposits of tungsten. Gold, antimony and precious and semiprecious stones are produced in small quantities. Salt is produced by evaporation of sea water. Also present are limited deposits of other minerals, largely unworked or mined on a small scale. They include coal. iron, copper, lead, zinc, silver and manganese. Water power resources remain largely undeveloped. By far the most important economic activity of the country is agriculture.

Agriculture. — Of the 51,400.000 ha. of land in Siam about 7,793.000 were devoted to agriculture in 1954. Of the latter total. 846.500 ha. (11%) were irrigated. The area of irrigated land increased to 977.400 ha. in 1955. Rice and agriculture are almost synonymous terms in Siam, since rice dominates all farming. In 19jh some 6,000,000 ha. were under rice. this figure being inflated in relation to total land in agricultural use since land cropped twice is counted twice. Production in 19j6 amounted to 8,179,700 metric tons. In 1947, 84.78% of the population was engaged in agriculture, forestry and fishing.

The agricultural policy of the constitutional regime was directed externally to finding new markets for rice and other exports; internally to improving agricultural technique, diversifying production. relieving the farmers' dangerous indebtedness by fostering the co-operative movement and by eliminating the Chinese middleman, establishing agriculturist colonies and finally to placing the whole rice industry under state control in production and marketing. The sowing and planting season is from June to August and the reaping season from December to February; 40 or 50 varieties of paddy are grown, and Siam rice is of the best in the world.

Advised by an irrigation expert loaned by the government of India. the Siamese began work in 1915 on the Prasak South Canal system. This. completed in 1924 at cost of £1,200,000, provided not only for the irrigation of nearly 100.000 ha. but also for navigation in a practically roadless region. The dubious success of this first canal system delayed until 1932 completion of the complementary Jiengrak and Bang Hai drainage by the construction of a 32-mi. dike permitting the irrigation of more than 533,000 ha. Various other schemes were also undertaken. An important project inaugurated after World War II was the great Chainat scheme, for which a loan of U.S. $18,000,000 was received from the International bank in 1950. By the beginning of 1958 the Chainat dam across the Chao Phya river had been completed together with some of the distributory canals. Efforts were also made to improve water supplies in the arid northeastern provinces.

The government encouraged the development of crops other than rice. Cotton, tobacco. soybeans, sugar. peanuts and maize were produced in larger quantities after World War II. In 1956 the 39.087 ha. under cotton yielded 32,339 metric tons, principally near Nakhon Pathom. The yield of tobacco. grown to some extent in every province. but mainly in the valleys of the north. amounted to 58.211 metric tons in 1956; the industry is largely under state control. Pepper growing had declined because of high production costs and a blight which ruined most of the Chanthaburi plantations. With about 6.000.000 coconut palms. Siam produced only 15,000 metric tons of copra in 1953, the industry being little developed. The area under soybeans was about 22.000 ha. in 1956, and the crop 22,000 metric tons. Sugar cultivation. formerly important. was found to need official support from the government in 1936, when a refinery was built at Muang Lampang. About 30.000 metric tons of crude brown sugar were produced in 1955. The government tried to foster the declining silk industry by building a silk-spinning factory at Nakhon Ratchasima in 1937.

The output of rubber was rapidly expanded after World War II. Net exports. which stood at 41,600 metric tons in 1939, amounted to 110,600 in 1950 and then, after falling to 97,100 in 1953, rose to 136,700 in 1956. The rubber however was neither uniform in quality nor scientifically produced: the industry was chiefly in Chinese hands. Peanuts are an important secondary crop: in 1956, from 76,000 ha. sown, production was 101,000 metric tons. Maize, occupying 81.66; ha.. yielded 114,770 metric tons in 1956.

Forestry. — In 1949 approximately 60% of Siam was under forest. but much of this contributed little to national economy. Teak is the chief forest product and is found in all the hill lands north of lat. 15° N. Normally production amounts to about one-third of the world's total. The industry has been operated mainly by British firms and the Siamese government. A rotation system of cutting was developed: half the area is set aside for reforestation over a 1j-yr. period and half is under active exploitation at any one time. In the mid-1950s production amounted to about 400,-000 cu.m. The next most important timber is yang (*Dipterocarpus alatus*), of which about 290.000 cu.m. were produced in 1954. Other forest products include stick-lac, thingan wood (*Hopea odoratus*) used for boatbuilding, dammar oil from the *Dipterocarpus*, eaglemood, sapan, rosewood, ironwood, ebony and rattan.

Livestock and Fisheries. — Livestock is poor in quality and small in quantity. According to the region, bullocks or buffaloes predominate as draught animals; they are raised principally on the Korat plateau. Horses are used extensively only by the mountain tribes of the northwest. In 1955 there were 178,000 horses. 5,862,000 cattle! 2,859,000 pigs and 5,960,000 buffaloes.

Fisheries, both marine and riverine, ordinarily rank second to agriculture in extent and value. The prosperity of the gulf's fisheries depends chiefly on mackerel, but there are also many kinds of anchovies. molluscs and crustaceans. In 1956 the total catch. including molluscs. amounted to 217,900 metric tons. Progressive governmental intervention attempted to conserve fish resources. to modernize methods of catch and preservation and finally to reserve fishing rights to Siamese nationals.

Mining. — Mining, except for tin, is not of major importance in the country's economy. Siam. however, usually ranks fifth among world producers of tin and accounts for 5%–7% of the world's output. The production of tin concentrates amounted to 12.661 metric tons in 1956 This was considerably belon the annual level obtaining immediately before World War 11 (I 5,000 in 1938) but well above that of the early 1930s. Deposits of tungsten, found in association nith tin, yielded 1,180 metric tons in 19j6. Control of the mines is largely shared between British and Chinese interests the latter being the less numerous, though virtually all the labour is Chinese. The industry's development was hampered by the comparative inaccessibility of the mines, which made the cost of transport high, by the obligation to pay royalties and by certain effects of speculation. Tin is mined at Phuket. Phangnga. Ranong and Yala. Other minerals include lead (9,434 tons mined in 1956), found in association with tin at Pattani and also in the form of galena at Kanchanaburi; coal in the peninsular provinces; silver and gold at To Mo, Bang Saphan, Muang Lom Sak and Wattana; semiprecious stones at Chanthaburi, Bo Phloi and Chiang Khong. and copper at Chanthuk. Iron occurs in 30 of the 70 provinces, but most of it is low grade; 6,775 metric tons were mined in 1956. The mining of lignite, at Me Moh in the north, began in 1955.

Manufacturing. — Manufacturing in Siam is of little consequence. It is confined largely to food processing for local use and to production of building materials. matches, cigarettes. furniture and native handicraft. Most manufactured goods are imported. The installed capacity of electricity in 1956, at only 69,000 kw., was low as compared, for instance, with that of Belgium. which had 3,603,000 kw. uith a population less than half that of Siam. Production of cement increased from 92,000 metric tons in 1938 to 397.608 in 1956.

Communications. — Central Siam is traversed by natural waterways; and east-to-west canals link the three main river systems and connect distant parts of the kingdom with Bangkok. In 1903 a department of government was formed to control the canals, the traffic being so great that the collection of a small toll is more than enough to pay for maintenance. Both on the soft soil of the low-lying areas and in the mountains road building is difficult. Although highways have been constructed to join the railways at the main trading centres. travel in the remoter parts is still uncomfortable. The road-building program of 1936 proposed the construction of 9,250 mi, of roads connecting the principal towns. Military roads (notably three radiating from Bangkok to Don Muang, to Nonthaburi and to Samut Prakan) were to receive immediate attention. By April 1941, 20 roads had been built at a cost of about 30,000,000 baht. By 1954 there were about 4,700 mi. of roads, and the government had undertaken a program designed to provide 3,400 mi. of new trunk roads and an additional 5,400 mi. of provincial trunk roads. Some of this work was to be undertaken with the financiai and technical assistance of the United States. The country had 23,200 passenger cars and 27,600 commercial vehicles in 195j.

Work on the first state railway (from Bangkok to Nakhon Ratchasima) was begun in 1892. Bangkok is the terminus of ail main lines. The main line to the northwest terminates at Chiengmai; the southern line threads the Malay peninsula to Ban Hat Yai, whence one branch goes to join the Malayan railway from Penang at Padang Besar and another serves the east coast. also connected with the Malayan railway (Kelantan lines). A line from Nakhon Ratchasima to Muang Khon Kaen (11j mi. to the north) was opened in 1933 and an express service between Bangkok and Muang Uhon in the east in 1938. In 1941 the extension from Muang Khon Kaen to Udon Thani (74 mi.) was opened, as well as the double track from Ayutthaya to Ban Phachi junction. After World War 11 damage sustained by the railways called for laborious repair. and the line to Burma constructed by the Japanese was abandoned. In 1955, however, the extension of the line from Muang Khon Kaen to Nong Khai. on the Mekong opposite Vientiane, was at last completed, with U.S. assistance. In 1955 there were more than 2,000 mi. of metre-gauge track, 374 locomotives, 6.212 freight cars and 637 passenger cars. Siam was an oriental pioneer in the use of diesel locomotives — the first diesel engines were put on the Malayan run in Dec. 1931 and were drawing the northern express to Chiengmai two years later.

In 1919 Siam became one of the first signatories to the International Convention for Aerial Navigation, and the development of international aviation made this previously isolated country the aerial gateway to the far east. An internal air service to the northeastern provinces, started in 1922, was operated at first by the army but from 1930 by a private company. with a wholly native personnel. In conjunction with Air France and with Imperial Airways, this company operated a line between Burma and Hanoi, which was extended to Hong Kong in 1938. The government cooperated in this development by constructing aerodromes at Uttaradit, Muang Phitsanulok, Muang Lom Sak, Udon Thani. Ban Perm and Nern Teng, as well as emergency landing fields. In 1930–34 Siam so modernized Don Muang that it became one of the largest and best-equipped aerodromes in Asia.

After World War II Siamese air services expanded rapidly. Bangkok became the civil airline centre for southeastern Asia. Secondary airfields mere built all over the country and air services to the main provincial centres were developed. International services were also expanded. The number of passenger-kilometres flown rose from 14,000 in 1938 to 11,190,000 in 1948 and to 60,108,758 in 1956.

Siam joined the Universal Postal union in 1885. Thereafter postal, telegraphic and telephonic communications were steadily developed throughout the kingdom. Foreign telegraph lines communicate with Saigon, Singapore (via Penang) and Moulmein. In 1935 a telephone service with Singapore was opened; services with Berlin were started in 1930 and with Japan and London in 1934. A wireless telephone service between Bangkok and Nakhon Ratchasima was inaugurated in Sept. 1940.

Foreign Trade. — Siam's principal exports are rice and teak (both shipped irom Bangkok), tin (shipped irom Phuket) and rubber (shipped from Songkhla). Rice is by far the chiei export: 1,555,500 metric tons were exported in 1951 and 1,264,986 in 1956. The latter quantity mas below the yearly average of 1,388,000 tons for the period 1934–38, and the decrease irom 1951 was accompanied by a fall in price. Exports of rubber amounted to 132,610 metric tons in 1955 and to 135,000 metric tons in 1956. Exports of tin, 17,000 metric tons in 1956, represent practically the whole of Siam's production. Cotton textiles, metal manuiactures. foodstuffs, electrical goods and petroleum products are the principal imports. Before World War II and for several years after 1948 Siam had a favourable balance of trade. In 1955, however, imports were valued at 7,288,700,000 baht against exports at 7,120,500,000; and in 1956 the corresponding figures were 7,562,100,000 and 6,923,200,000 respectively.

Finance. — In 1955 the Siamese budget showed total expenditures of 6,344,100,000 baht and total receipts of 5,120,000,000 baht. The two main expenditures were for economic development and defense. Import and export duties, indirect taxes and fiscal monopolies provided the major sources of revenue. The unit oi currency is the *baht* or *tical*. Originally it was a gold-standard unit fixed at 11 baht to the pound sterling. In 1932 the gold standard was abandoned and the unit was fixed in silver at the equivalent of 11 baht to £1. In 1949 the gold value mas fixed at 12.50 baht to the U.S. dollar; but in March 1955 the government altered the rate from 12.50 to 20 for the valuation of currency reserves. The free market value stood at 20.83 baht to the U.S. dollar in Jan. 1958. Currency in use is mainly in the form of notes, of which the first issue was made in 1902.

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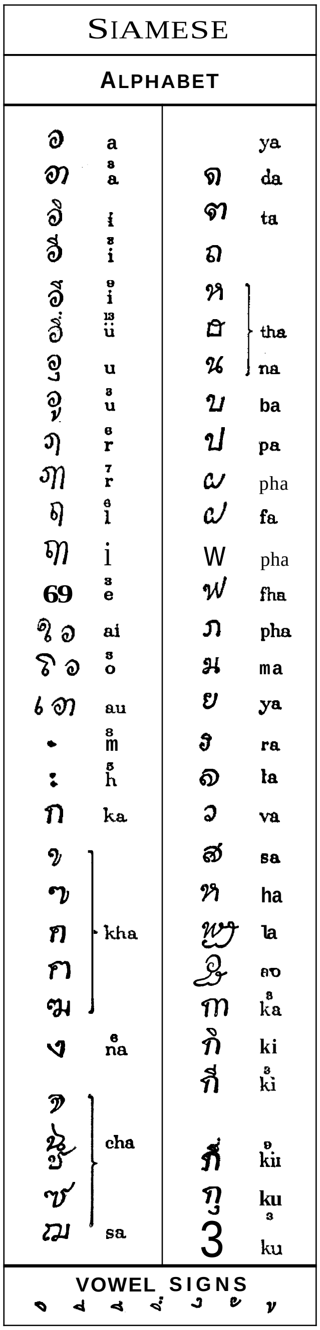
SIAMESE LANGUAGE AND LITERATURE. Siamese belongs to the Tai group of the Siamese-Chinese family of languages. Its connection with Chinese is distant but with other languages of the Tai group very close. It is spoken throughout central Siam, in all of southern Siam except Patani Monton, in northern Siam along the river-banks as far up as Gtaradit and Raheng, and in eastern Siam as far as the Korat Monton. Siamese was purely monosyllabic, each true word consisting of a single vowel sound preceded by, or followed by, a consonant. Of such monosyllables there are less than 2,000, and therefore many syllables have to do duty for the expression of more than one idea, confusion being avoided by the tone in which they are spoken.



The current Siamese characters are derived from the Cambodian alphabet, which owes its origin to the alphabet of the inscriptions, an offshoot of the character found on the stone monuments of southern India in the 6th and 8th centuries.

The Siamese alphabet consists of 44 consonants, in each of which the vowel sound "aw" is inherent, and of 32 vowels all marked not by individual letters, but by signs written above, below, before, or after the consonant in connection with which they are to be pronounced. Several of the 44 consonants express each a slightly different intonation of what is practically the same consonant, the sound of "kh," for instance, being represented by six different letters and the sound of "t" by eight. Other letters are present only for use in certain words imported from Pali. The vowel signs have no sound by themselves, but act upon the vowel sound "aw" inherent in the consonants, converting it into "a," "i," "o," "ee," "ow," etc. Each of the signs has a name, and some of them produce modulations so closely resembling those made by another that at the present day they are scarcely to be distinguished apart. Only vowel or diphthong sounds, or the letters "m," "n," "ng," "k," "t," and "p" are permissible at the end of words. Hence the final letter of all words ending in anything else is simply suppressed or is pronounced as though it were a letter naturally producing one or other of those sounds. Thus many of the words procured from foreign sources are more or less mutilated in pronunciation, though the entirely suppressed or altered letter is still retained in writing.

Siamese is written from left to right. In manuscript there is usually no space between words, but punctuation is expressed by intervals isolating phrases and sentences.

The **Tonal** System.—Of the simple tones there are five—the even, the circumflex, the descending, the grave, and the high—any one of which when applied to a word may give it a quite distinct meaning. Four of the simple tones are marked in the written character by signs placed over the consonant affected, and the absence of a mark implies that the one remaining tone is to be used. The consonants are grouped into three classes, to each of which a special tone applies, and consequently the application of a tonal sign to a letter has a different effect, according to the class to which such letter belongs. Though many syllables have to do duty for the expression of more than one idea, the majority have only one or at most two meanings, but some are used with quite a number of different inflections, each of which gives the word a new meaning. Thus, for example, the syllable *khao* may mean "they," "badly," "rice," "white," "old," or "news," simply according to the tone in which the word is spoken. Words are unchangeable and incapable of inflection. There is no article, and no distinction of gender, number, or case. These, when necessary, are expressed by explanatory words after the respective nouns; only the dative and ablative are denoted by subsidiary words, which precede the nouns, the nominative being marked by its position before, the objective by its position after, the verb, and the genitive (and also the adjective) by its place after the noun it qualifies. Occasionally, however, auxiliary nouns serve that purpose. Words like "mother," "son," "water" are often employed in forming compounds to express ideas for which the Siamese have no single words, *e.g.* *lûk cân,* "the son of hire," a labourer; *mê mü,* "the mother of the hand," the thumb. The use of class words with numerals obtains also. In Siamese the personal pronouns are mostly represented by nouns expressive of the various shades of superior or lower rank according to etiquette. The verb is, like the noun, perfectly colourless—person, number, tense, and mood being indicated by auxiliary words only when they cannot be inferred from the context. Such auxiliary words are *yû,* "to be," "to dwell," (present); *dai,* "to have"; *leao,* "end" (past); *cǎ,* "also" (future); the first and third follow, the second and fourth precede, the verb. *Hài,* "to give" (prefixed), often indicates the subjunctive. There are compound verbs; thus, *e.g., pai,* "to go," is joined to a transitive verb to convert it into an intransitive or neuter; and *thûk,* "to touch," and *tòng* "to be compelled," serve to form a sort of passive voice. The number of adverbs, single and compound, is very large. The prepositions mostly consist of nouns.

In Siamese the subject of the sentence precedes the verb and the object follows it. The possessive pronoun follows the object. The adverb usually follows the verb. In compound sentences the verbs are placed together as in English, not separated by the object as in German. When an action is expressed in the past the word which forms, with the verb, the past tense is divided from the verb itself by the object.

In addition to the ordinary language of the people there is a completely different set of words ordained for the use of royalty, to avoid the employment of downright expressions of vulgarity or of words which might be capable of conveying an unpleasant or indelicate idea other than the meaning intended. Words of Sanskrit origin have been freely adopted and many Cambodian words are also used. The language is so complete that the dog, pig, crow, and other common or unclean animals are all expressed by special words, while the actions of royalty, such as eating, sleeping, walking, speaking, bathing, dying, are spoken of in words quite distinct from those used to describe similar actions of ordinary people.

See O. Frankfurter, *Elements of Siamese Grammar* (1900); *Linguistic Survey of India,* vol. ii. (1904).

LITERATURE

The genius of the Siamese finds its best literary expression in verse which contains a great variety of metre, but the three commonest metres are called *Kton, Kap* and *Klong.* The tones of the language play a very important part in Siamese poetry—indeed they may be said to take the place of rhymes; the *Kap,* however, has rhymes in addition. Every subject is material for the Siamese poet and the verses are comparable with those of almost any land. *Klong* and *Kap* forms are combined in the style known as *Nirat* poetry, or extended narrative love-verse, and the *Klon'pet ton* or thumb-nail love-songs are numbered by hundreds. They are unrivalled for elegance of diction and sweet sound, perfectly balanced little pieces of eight lines divided into two stanzas; each line having eight syllables. This form of verse is confined to the treatment of love and passion. The other metres are of interest only to the academician.

Siamese is rich in quasi-historical and mythological literature. The purely native material is informed by an imagination far less vivid than that of the Indian *Ramayana (Ramakien)*, but is decidedly interesting as an index of the Siamese mind. It is sometimes very difficult to decide whether a story is purely native, as Sian drew upon the mighty sources of India, Cambodia and China; where the material was not too definitely alien, the Siamese pressed it very closely into their own mould, producing a very different piece of literary effort from the original. *Wet ya Sun yin* and *Wo ra loongs* are examples of stories originally borrowed from India. Semi-magical stories are numerous and nature-stories abound. A study of the mythological literature sheds a flood of light on the origin and development of Indo-Chinese superstition. *Phum hon*, a very popular tale, tells of a young woman loved by an elephant, and *Prang tong* is a story of a princess who was prenatally betrothed to a giant. Siamese cosmogony is enshrined in the *Nok khum*, and these mythological works may be considered the earliest examples of native literature.

There exists much religious material in Siamese—almost the whole of the Buddhist canon having appeared. some parts of it existing in many different versions: *Pattama Sompothiyan* is the standard Siamese life of Buddha. There is often great difficulty in distinguishing between Buddhist literature proper and *Niti* or traditional literature. Much of this is from the Bali language and from Javanese, which in their turn were inspired from India. The outstanding work in this division is called the *Maxims of Phra Ruang*. Phra Ruang was the national hero-king and he is held up to Siamese youth as the mighty ideal of manhood.

It is in law that Siamese literature shows its best early prose. Five ancient canons, some of them founded on the *Law of Manu*, exist and present the earliest form of Siamese law and a very early style of Siamese literary composition. A large collection of early royal edicts has come down to our day although a modern code of laws has long since superseded the old statutes. A penal code based on foreign procedures was issued in 1908 and additions are made periodically. Never has Siam published so lavishly; every month new legal codes, translations of religious texts, new versions of foreign classics or translations of alien literature roll from unwearied presses. More especially versions from the Pali scriptures of Buddhism abound and there is nowadays a movement on foot to supply the lacunae in historical literature.

The wars of the middle ages and early modern times in Siam have robbed us of much literary material which must have existed centuries ago. There is as yet no reliable, connected history of Siam in the native tongue, although we have a fairly complete history of the Aguthia dynasty and of the modern line of kings. The cause for dissatisfaction with these histories is almost entirely concerned with the earlier parts which have drawn largely upon the quasi-historical and legendary literature. Modern works on general history are of almost daily publication. however. and histories of Siam, based on material drawn from foreign contemporary sources are in course of preparation. The educational department of the Siamese government is indeed the modern fairy godmother of the people in matters of dissemination of general knowledge. (See *Catalogue of the India Office Library*, London.) (A.. J. W.)

SIAN (HSI-AN), capital of China's northwest province of Shensi and in early history the site of China's capital for a total of 970 years during the western Chou, the Ch'in, the Western Han. the Sui and the T'ang dynasties. Its earlier names were Changan and Siking and it reverted to its Manchu name Sian (meaning "western peace") in 1043. The city is situated on a broad loess terrace at the northern foot of the Tsinling Shan not far from the south bank of the Wei Ho. In the 14th century. Marco Polo. who called it Kenjanfu or Quengianiu. described it as a thriving trade centre. Its significant position derives from the productivity of the Wei plain and its natural topographic defenses. as well as its strategic command over radiating communications routes to Kansu and Turkistan in the west, Szechn-an in the south, the Ordos desert in the north, Shansi and the Yellow plain in the northeast and east. It was there in 1936 that Chang Hsiieh-liang kidnaped Chiang Kai-shek in the "Sian incident" leading to a united front between Nationalist and Communist forces to resist Japan (see CHINA: *History*). However, during the Chinese-Japanese war, a strong Nationalist army was garrisoned at Sian, not only against the Japanese, but also to contain, the Communists who had established a base at Yenan in north Shensi after 1935 under Gen. Hu Tsung-nan.

The city is surrounded by a rectangular wall, (approximately 3.1 mi. by 1.8 mi.) with a city pate on each side except the east which has two gates. Suburbs extend from each gate. The 1939 population of about 209.000 grew to iYi.300 by 1953, because of industrial developments extending from the western suburbs. The expansion has resulted from new economic developments in China's northwest, including the completion of the trans-Tsinling railroad and the extension of the now doubled-tracked Lung-hai railroad passing Sian into Sinkiang.

Sian was one of the key cities in the Communist First Five-year plan. A small iron and steel mill was constructed. a cotton textile combine set up, and a new thermal electric power plant built which supplies nearby cities and Sian with power. Also constructed were a cement plant, with a seamless steel tube rolling mill, and a moderate-size chemical plant.

Historically important. the city contains temples; tombs and monuments. The collection in the Shensi provincial museum (formerly the Pei-lin) is noteworthy, and the Nestorian tablet disco\-wed in 1625 was housed there. Sian is the seat of Northrestern university and Medical college, and the location of the Northwestern Institutes of Art and Music. (H. J. Ws.)

SIANG FRONTIER DIVISION is the central of the five divisions constituting the North East Frontier Agency of the Republic of India. It is through the heart of this division that the Dihang river (a section of the Brahmaputra) passes in a series of stupendous gorges from the plateau of Tibet to disgorge on the valley plain of upper Assam less than 1.000 ft. above sea level. Navigability on the Brahmaputra ceases at Pasighat; from there a rough track runs alongside of the valley west of the river. eventually passing into Tibet and linking with the motor road to Lhasa. The Abor is the principal tribe living in this division. They were first visited by the British in 1826. From 1848 they carried out numerous raids and outrages on the neighbouring territory and several expeditions were sent against them. From 1912–13 the territory known as the Abor hills formed part of the Sadiya frontier tract (from Sadiya, near the confluence of the rivers Lohit and Dibang with the Dihang) and was loosely administrated by the government of India. Eventually it was included in the North East Frontier Agency (*q.v.*). (L. D. S.)

SIBAWAYH, the nickname of ABU BISHR 'AMR IBN 'UTHMAS IBN QANBAR (*c.* 760–793), the most celebrated Arabic grammarian. He was a Persian client of an Arab tribe. and studied under Khalil (*q.v.*) in Basra. He wrote the first known full-scale Arabic grammar, called *al-Kitab fi'l nahwi,* on which all subsequent Arabic grammars were based. The book defines three parts of speech — noun. verb and particle — and explains *i'rab,* or accidence. as applied to noun. and verbs. Then the parts of speech and their use are dealt with in great detail. with supporting quotations from the Koran and from Arabic poetry.

Editions of the *Kitab* are by H. Derenbourg, *Le Livre de Sibawaihi* (1883); and by G. Jahn. with commentary and German trans.. 2 vol. (1895–1900).

See also G. L. Flügel, *Grammatische Schulen der Araber (1862)*; C. Brockelmann, *Geschichte der arabischen Litteratur,* vol. 1 (1898), suppl. vol. 1 (1937). (J. A. HD.)

SIBELIUS, JOMAN JULIUS (1865–1957), Finnish composer. known as Jean Sihelius. was born at Tavastehus on Dec. 8. 1865. He studied music under Martin Wegelius at Helsingfors 1885–89, under Albert Becker 1889–90 in Berlin. and under Robert Fuchs and Karl Goldmark in Vienna 1890–91. He showed imagination and power of expression and a respect for his art which never allowed him to abuse his profound technical powers for the display of mere virtuosity.

Sibelius' compositions include symphonic poems. seven symphonies. a violin concerto. a string quartet. *Voces Intimae, Valse*

Triste, Finlandia, orchestral works, incidental music to *Pélléas et Mélisande, As You Like It, The Tempest,* the pantomime. *Scaramouche,* numerous songs and miscellaneous pieces.

Sibelius died on Sept. 20, 1957, at Traeskaenda, near Helsinki.

ŠIBENIK, a port of Croatia, Yugoslavia, on the Adriatic sea (Ital. *Sebenico*). Pop. (1961) 26,253. Sibenik, full of Venetian Gothic and Renaissance architecture, is built on a steep hill, and is partly walled. On the seaward side are two forts, now dismantled, and the castle of St. Anna. There is a beautiful cruciform church built entirely of stone, even the wagon vaults over the nave, choir and transepts being unprotected by lead or tiles.

Electric power is supplied by the celebrated falls of Kerka. Industries include weaving: woolen mills, oil refining, the preparation of dyes. wine and honey. Fishing is also carried on.

Sibenik is said to have been founded by the Uskoks fleeing from Turkish oppression, who then took to piracy. Later the town became famous as a favourite residence of the Croatian kings. In 1117 it was captured by Venice, but held by Hungary from 1351 to 1412, when it again became Venetian. In 1647 it was unsuccessfully besieged by the Turks, and after the fall of Venice in 1797 it became French. From 1815 to 1918 it was Austrian, and in the latter year it was occupied by the Italians, before incorporation in Yugoslavia.

SIBERIA (Russian SIBIR), a conventional term used to describe the Asian part of Russia, excluding the Central Asian Turkic-populated lands. For the geography of Siberia *see* RUSSIA.

History. — The earliest-known inhabitants of Siberia were the Finno-Ugrian Nentsy (called Samoyeds by the Russians), Khanty (Ostyaks) and Mansi (Voguls). They came from the Mongolian plateau in the 3rd century B.C. To them must be assigned the remains dating from the Bronze period which are scattered over southern Siberia. Iron was unknown to them. but they were expert in bronze. silver and gold work. They also practised irrigation.

In the 5th century A.D. the Turkic peoples, Khakass (later known as Kirghiz) and Uigurs. were compelled to migrate northeastward from their homes. They subdued the Finno-Ugrians and established themselves on the upper Yenisei. They too left many traces of their sojourn. They were acquainted with iron and learned from their subjects the art of bronze-casting. which they used for decorative purposes and which they raised to a still higher artistic level. The Khakass empire lasted until the beginning of the 13th century when it was destroyed by the Mongols.

At the end of the 15th century Tatar fugitives from Turkistan subdued the loosely associated tribes of Mansi and Khanty inhabiting the lowlands to the east of the Crals and founded a Siberian khanate with its capital at Kashlyk (or Sibir) on the Irtysh river, near its junction with the left-bank tributary, the Tobol. At the same time Muscovy was expanding eastward and northeastward and at the beginning of the 16th century it extended to the estuary of the Ob river. an area populated by the Nentsy. This extension brought the Russians and the Tatars into collision. In 1555 the Siberian khan Yadiger sent envoys to Moscow and consented to pay yearly *yasak,* or tribute, of 1,000 sables. Three years later Ivan the Terrible authorized Grigory Stroganov to establish a settlement on the upper Kama river. In 1 j68 Yakov Stroganov was allowed to extend Russian colonization along the Chusovaya river, a left-bank tributary of the Kama. Many adventurers were escaping to the Stroganov frontier settlements and tradition has it that in order to get rid of their embarrassing guests the Stroganovs hired a Cossack ataman, Yermak Timofeyevich, and suggested to him that he should recruit a small army and, following the Chusovaya valley. cross the Urals and conquer new lands for the tsar. They promised to help with supplies of food and arms. Termak started with a band of 840 men in Sept. 1581. The following year. progressing along the Taghil, Tura and Tobol rivers, he successfully laid siege to the residence of Khan Kuchum at Sibir, on the Irtysh. 12 mi. southeast of what is now Tobolsk. Kuchum fled southward to the steppe while Yermak on Oct. 26, 1582, entered Sibir.

In 1584 Yermak was drowned in the Irtysh while fighting Kuchum's counter-oiieasive. After the death of their leader, the Russians abandoned the country they called Siberia. New bands of hunters and adventurers. however, thronged across the Urals every year and were supported by Moscow. The fort of Tyumen was founded on the Tura river in 1585, that of Tobolsk in 1587, Tara on the Irtysh in 1594, Narym on the Ob river in 1596 and Tomsk on a right-bank tributary of the Ob in 1604. At the beginning of the 17th century Russian expansion reached the Yenisei river east of which lived the Tunguses (Evenki), nomadic hunters related to Manchus and scattered between the Yenisei and Lena rivers. They were subdued and by 1628 the Russians reached the middle Lena, an area occupied by the Yakuts, a Turkic tribe with Mongolian elements. The fort of Yeniseisk was founded in 1618, that of Krasnoyarsk in 1628. Kirensk on the upper Lena in 1630 and Yakutsk on the middle Lena in 1632. The Sea of Okhotsk was reached in 1639, 57 years after the conquest of Sibir by Yermak. Such rapid progress toward the Pacific is explained by the fact that the Russians advanced across sparsely populated areas and that they moved generally in boats along the rivers across the Siberian *taiga* (dense coniferous forest without shrub).

The area west and east of Lake Baikal, populated by the Buryats (Mongols), who offered some opposition, was subjugated in 1641–52. Vasily Poyarkov's expedition (1643–46) descended from Yakutsk to the Amur, returning to its point of departure by the Sea of Okhotsk and the Aldan river, a right-bank tributary of the Lena. In 1648–49 Semen Dezhnev, leaving the estuary of the Kolyma river, sailed around the Chukotsky peninsula, the homeland of the Chukchi. discovered the strait named So years later by Vitus Bering (*q.v.*), and landed at the estuary of the Anadyr river. In 1651–53 Yerofey Khabarov occupied the banks of the Amur river and the so-called Daur land lying to the north of it: but according to the Russo-Chinese treaty of Nerchinsk (1689) Russia had to retreat from there. Only in 1858 did Count N. N. Muraviev-Amursky, governor-general of eastern Siberia. conclude a treaty with the local Chinese authorities at Aigun fixing the Russo-Chinese frontier along the Xmur and its right-bank tributary, the Gssuri. Two years later this was recognized by Peking.

Vlndivostok, a port which with the help of ice-breakers is open to navigation all the year round, was founded in 1860. Started from Chelyabinsk in 1891, the construction of the trans-Siberian railway played a decisive part in the economic development of the country. By 1895 Omsk was linked with the Russian railway system and three years later the rail was extended to Irkutsk. By 1894 the Vladivostok-Khabarovsk line was built. In 1897 Vladivostok was linked with Chita via Manchuria, but the 4,498-mi. trans-Siberian railway was completed only in 1917.

Administration and Population. — In 1803 the whole of Siberia was organized as a single *guberniya* with a governor-general residing at Irkutsk. Count Mikhail Speransky (*q.v.*), governor-general in 1819–21, drew up a comprehensive scheme of administration and policy for the huge province and one of his acts, fixing relations between the Russian government and the *inorodtsy*, or native populations, was in force until 1917. It aimed at maintaining the patriarchal system among subjugated nationalities.

In 1824 the population of Siberia was estimated at 1,698,000 and in 1851 at 2,681,000. The Siberian *guberniya* was subsequently divided into smaller but still large administrative units. In 1897, at the time of the first Russian census. Siberia n-as composed of four *guberniyas* (Tobolsk, Tomsk. Yeniseisk and Irkutsk) and five territories or *oblasts* (Transbaikal, Yakut, Amur. Primorski or Maritime and the island of Sakhalin). Together these nine administrative units covered 4,795,900 sq.mi. and had in 1897 a total population of 5,758,800.

This did not, however, represent the total population of Siberia, because about half of the Perm *guberniya,* with Ekaterinburg (now Sverdlovsk), and about a third of the former Orenburg (now Chkalov) *guberniya* with Chelyabinsk lie east of the Urals. If the Ekaterinburg-Chelyabinsk region is added, Siberia covers an area of about 4,858,800 sq.mi. which in 1897 had a total population of 7,788,000.

After the 1917 revolution the Soviet government continued to subdivide Siberia into provinces called *oblasts* and into territories (*krai*). By 1956 there were 12 oblasts (Kurgan, Tyumen, Omsk, Tomsk. Novosibirsk, Kemerovo, Irkusk. Chita, Magadan, Amur, Kamchatka and Sakhalin) and 4 krais (Altai, Krasnoyarsk, Khabarovsk and Primorski).

The areas inhabited by non-Russian peoples were organized into two autonomous Soviet Socialist Republics namely Buriat-Mongol and Yakutsk; four autonomous *oblasts* namely Gorno-Altai, Khakass. Tuva and Yevrey (formerly the Jewish autonomous *oblast*); and eight national okrugs namely Taimir, Evenki, Khanti-Mansi, Yamalo-Nenets, Chukot, Koryak, Ust-Orda and Aginsk, the last two named inhabited by Buriat-Mongols.

All Siberia lies within the Russian Soviet Federated Socialist Republic and by the 1926 census it had 14.747.000 inhabitants. A 1956 estimate placed the population at 22.701.000 and the 193'9 census showed the population to number 24.797.000. The area of Siberia as constituted by the above listed political units is 4,956,-868 sq.mi. with an average density of 5 per square mile, but the population is concentrated mainly in the southern fringe of the region. In the late 1950s the Soviet government inaugurated a program of development of the virgin. and sometimes marginal; land of the region. creating a movement of people into the area.

From the reign of Peter the Great, Siberia was used by the government for the deportation of political convicts and ordinary criminals sentenced by the tribunals to forced labour (*katorga*). It was also used for the administrative deportation (*ssylka*) of persons considered by the minister of the interior dangerous to public order. Both practices continued until World War I, and both were meant to supplement the policy of organized emigration. But the percentage of deportees as opposed to migrants was small.

This policy changed when the Soviet government launched in 1928 its first five-year plan. Siberia's resources of coal, ores and timber were often situated in uninhabited places far away from all means of transport.

The Soviet government found the way to dispose of political opponents; supply cheap manpower for transport and industrial projects and forestry undertakings and populate vast empty areas, even beyond the Xrctic circle. Russian and Ukrainian peasants resisting collectivization in the early 1930s were the first to be deported there; after 1939 they were joined by the Polish. Estonian, Latvian, Lithuanian! Ukrainian and Rumanian intelligentsia from the annexed territories.

From 1934 there existed a *Glavnoye Upravlenye Lagherey* (main administration of labour camps, or GULAG). Estimates of the number of inmates in these "corrective labour camps" by 1947 varied between 5,000,000 and 12,000.000, at least half of them being in Siberia.

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SIBERIAN AREA, a former administrative unit of Asiatic Russia, with an area of 1,555,448 sq.mi. The Arctic ocean. from Gyda bay to Khatanga bay forms its northern, and Mongolia and the Kazakh S.S.R. its southern boundary. To the west lies the Uralsk Area, and to the east the Yakutsk and Buriat-Mongol republics.

The area coincides roughly with the former Yeniseisk. Tomsk and Irkutsk *guberniya* of Imperial Russia. The name Siberia (Sibir) n-as the Russian name given to the chief settlement. Isker on the Irtysh, of the Tatar Khan Kuchum, and was subsequently extended to include the whole of the Russian dominions in Asia.

After the 1917 revolution various republics and areas, each having a good deal of local autonomy were separated off and now the name Siberia is limited to the central region which was not thus split off. Much of it consists of the basin of the Yenisei river (*q.v.*). Stretching from the Sayan alpine regions in the south (lat. 51° 45' K.) to Cape Chelyuskin in the north (77° 38' N.), it displays much orographical variety. The West Sayan mountains have their southern base on the plateau, and their northern at a much lower level, and reach heights of 10,000 feet. Around and north-east of Lake Baikal well-marked ridges fringe the plateau, with steep north-western slopes turned toward the valleys (*e.g.,* the beautiful and fertile valley of the Irkut river between the Tunka Alps and the Sayan).

An Alpine region, 100 to 150 mi. in breadth, fringes the plateau to the north-west. and is called in east Siberia the taiga: it consists of separate chains of mountains (4,800 to 6,500 ft.) clothed with dense forest, except on the highest parts, and having narrow marshy valleys, thickly strewn with boulders, *e.g.,* the Altai in the west, the Kuznetskiy Ala-tau, the Us and Oya mountains in West Sayan, the Nizhne-Udinsk taiga, and several chains pierced by the Oka river. North of these alpine regions is the broad belt of fertile black-earth high plains (1,200 to 1,700 ft.) stretching from Tomsk eastwards, and from Kansk penetrating in a great arc south-eastwards to Irkutsk.

North of the town of Yeniseisk, and east of the Yenisei river is a broad belt of Alpine tracts of Archaean origin reaching their greatest elevation in the Yeniseisk taiga. between the Angara (Upper Tunguska) and the Middle or Stony Tunguska. North of this region begins the slope towards the Arctic plains. interrupted by the north-west to south-east ranges of the Upper Inbatsk district and the Syverma, beyond which lie the bleak tundra plains. The Taimyr peninsula is strictly the name of the northward projection from Taimyr bay on the west to Khatanga gulf on the east. but it is often applied to the whole district between the Yenisei gulf and the Khatanga gulf. The northern coast and the islands off it are not yet accurately known; the Russian explorer Vilkitski, in 1913–14. discovered the islands named after him. lying south of the Nordenskjöld archipelago. East of Cape Chelyuskin good harbours are scarce. A rolling treeless tundra plain (100 to 150 ft.) covers Taimyr except for the Byrranga mountains (1.600 to 1.900 ft.) and. though comparatively well drained. is difficult to cross except in winter: erratic blocks are widely distributed. Polar bears and seals are found in summer, and in that season Samoyede reindeer breeders migrate to Taimyr Land with their herds, avoiding the Taimyr gulf region, which is deficient in reindeer "moss."

Ethnology.— The majority of the population in the Siberian Area is Russian. but there are still survivals of earlier immigrants. Of the Palaeo-Siberians. the most interesting are the Yenisei Ostyaks living along the Yenisei and its tributaries from Yeniseisk to the Lower Tunguska. and most numerous about Sumarokovo, near the confluence of the Stony Tunguska. They are probably a remnant of the primitive aborigines of Siberia, and their race and language are unrelated to any other. They are in no way connected with the Ostyaks of the Ob basin. and are not Mongolian in appearance. They are fairer than the other Yenisei races and sometimes have long, oval faces and fine hair. They call themselves Tindigyet, Kanacket or Din (people), and live in birch bark tents and use hollowed trees for boats. They are a hunting and fishing people, apparently from the Tom basin.

Of the Neo-Siberians, the Samoyedes are the most widespread They have migrated from the Altai. driven north by the Turco-Tatars in the 5th century A D and may be the descendants of the people nhose civilization can be traced in the Cpper Yenisei. They are closely related to the Finno-Ugrians and Samoyede may be a corruption of *Suomi*, the name the Finns give to their native land The three chief branches in the Siberian Area are the Tavgi reindeer nomads of the Taimyr region. the hunting Ostyak Samoyedes between the taiga and the tundra, and the fishing and hunting Samoyedes along the banks of the Yenisei They are meso- to brachycephalic. have straight black hair, sallon skin, narrow oblique eyes and broad flat faces and noses They are short. stout and muscular. Related to them are the Beltirs of the Abakansk steppe, the Kaibals of the Upper Yenisei. the

Kamassins of Kainsk, the Karagasses, Motors, and Soyots of the Sayan district. These southern peoples are being absorbed; they frequently speak Tatar and have become settled cultivators or herdsmen. Of the Tatars, the chief branches are those of the Baraba steppe and the Chulim river, who are gradually becoming Russianized, the Altai Tatars, including the Teleuts or Telengites of the Kuznetsk district, the Chern or Black Forest Tatars of the Biya river, and the Tatars of the Abakansk steppe. The Tatars of the Altai mountains are successful cattle and horse breeders, and have large flocks of sheep and goats. There are some Tungusic tribes between the Lower and Middle Tunguska, the best known being the Chapogir. Their original home was Manchuria and they are of the Ural-Altaic group to which the Manchus belong, and are nomad reindeer breeders. The Russian population is mainly settled in the rich agricultural belt through which the trans-Siberian railway passes.

Agriculture and Stock Raising.—Cultivation is densest round Omsk, especially to the south, and in the region to the south of the railway from Lake Chany eastwards to Tomsk. Eastward from that region there are scattered patches along the railway, and along the courses of the Upper Yenisei and its tributaries, especially in the Abakan and Tuba valleys. From Irkutsk a belt of cultivation extends along the Angara and its tributaries as far north as lat. 55° N. The chief crops are wheat, rye, barley, potatoes, flax, hemp, sunflower seed, beans and grasses. In the Minusinsk district beet is successfully grown and there are beet sugar factories; water melons also thrive. In Irkutsk rye is the predominant crop. The sandy black soils of the Kainsk and Mariinsk districts near Tomsk, and of the Altai favour wheat production, as does the black earth of the Baraba steppe, and wheat in these districts forms 50 to 75% of the harvest. The brown, less fertile soils of Tomsk are favourable to barley and spring rye. Winter rye and oats flourish east of Tomsk. The long winter and slight snowfall everywhere make spring corn a better crop than winter corn, and fruit growing is rarely successful. Makhorka tobacco is grown along the Irtysh, south of Omsk, and supplies the Omsk tobacco factory.

Of wild produce, the cones of the *Pinus* Cembra of the northern Tomsk *oblast* and Mari A S.S.R. and of the mountain regions of Bisk and Kuznetsk find a ready market in the oil-pressing factories of Tomsk, bilberries. cranberries and dried mushrooms are also exported. The introduction of agricultural machinery and of fertilizers is improving the harvest. Novosibirsk and Omsk are the chief centres of distribution, and there is a machine-testing station at Novosibirsk. Grain elevators are increasingly common. Most grain is exported unmilled, but Tomsk, Bisk, Barnaul and Novosibirsk have extensive milling industries. Freightage costs militate against the export of Siberian grain. Dairying is the most productive occupation, though only introduced in 1893. There are technical dairy schools at Omsk, Kainsk, Barnaul and Zmyeinogorsk, in addition to a central laboratory at Tomsk and other small local laboratories. The reasons for its success are its small bulk which lessens transport difficulty, and the fact that Siberian milk contains a high proportion of fat owing to the rich pasture; the average yield is 1 lb. of butter to 20.05 lb. milk as against 1 lb. to 28 lb. in Denmark. Ice trucks for butter leave Novosibirsk several times a week during the summer and collect from the various butter transit centres en route. Siberian cheese is increasingly finding its way on to the market. East of Krasnoyarsk dairy farming is of little importance; the cattle are few in number, small and yield little milk.

Horses and working cattle are raised, especially in the west, for local use; the Kuznetsk breed is famous, but the number of horses fell after World War I. The stock-raising districts of Minusinsk, Achinsk and Turukhansk recovered more rapidly. Sheep-breeding, especially of the newly introduced merino sheep, is rapidly developing on the Yenisei plains, where the hay is excellent.

Pig-breeding has developed with the increasing dairy industry, which provides buttermilk as pig food, and bacon and sausage factories are springing up. Reindeer are valuable in the Turukhansk district, while in the southern hill regions the *maral*, a kind of wapiti, is bred in farms for the sake of its horns, which are in demand in China for the preparation of a drug called panty. Bee-keeping is of very ancient origin, and is profitable in the Achinsk, Minusinsk, Kuznetsk, Bisk and Zmyeinogorsk districts; the destruction of the forests and the desiccation of the steppe have diminished it elsewhere. In spite of the vast forest wealth of the region the timber industry is little developed, mainly owing to the lack of transport facilities; the Tomsk district is markedly deficient in timber and receives some of its timber from camel transport across the Kirghiz steppe. If the Yenisei sea-route comes into regular use, a timber export may spring up on that river. There are timber mills at Omsk, Novosibirsk and Tomsk; those at Novosibirsk use the wood from the district between Barnaul and the railway, but these mills supply local needs only, as do the mills at Irkutsk.

Mining.—The mineral wealth of the region is great, but little worked at present. Rich deposits of magnetic iron ore exist on the Telbes, a tributary of the Kondoma near Kuznetsk, with beds of good coking coal 20 mi. away. Gold exists in quantity, but is hampered by lack of proper dredging apparatus. The Mariinsk taiga gold mines are prosperous, and the first dredger in west Siberia was established here, but the Altai placer mining is declining. The Bogom-Darovanni reef gold mine near the Abakan river is up-to-date and flourishing. The Yenisei gold areas, one in the region between the Pit and the Angara rivers, and one in the upper basins of the Teya and Kalami, tributaries of the Stony Tunguska, are less fully developed in the absence of roads. They are, however, able to get food from the rich Minusinsk district and do not suffer from the danger of starvation, as do some mines in Yakutsk.

The Bodaibo district on the Vitim river lies within the Siberian Area and produces 25% of all the gold in U.S.S.R. The gold is alluvial and 13 tons can be produced per annum; transport is a difficulty, since necessaries have to be brought from Irkutsk, but a light railway to the Vitim river somewhat lessened the costs. There is an assaying and gold-smelting laboratory at Bodaibo. Silver is produced in quantity in the Altai region, and platinum from Verkhoture in the Tara river district. Platinum occurs with the gold in the Pitski Mountains and in the Vitim district. Asbestos is worked in the Angara district and from the dolomite veins of the left bank of the Kamishta, a tributary of the Abakan. It is reported from other places in the Altai. Graphite of good quality exists near Turukhansk on the Yenisei and on the Lower Tunguska, but is little exploited.

Mica is spasmodically worked in the Krasnoyarsk district.

There are antimony mines in the Yeniseisk district and in Minusinsk also, while radium has been found on the Ayakhta, a tributary of the Pit, and osmiridium is known in the Nizhne-Udinsk district. Coal is mined in the Kuznetsk beds which extend from Sudžhenka on the railway to 40 mi. S. of Kuznetsk and the output consists mainly of coking or semianthracite coal used on the railway. The hlinusinsk region and Dudinsk on the Lower Yenisei have rich deposits. Copper exists in the Rlinusinsk district, and near Plan Ude (formerly Verkhne-Udinsk).

Salt is obtained from salt lakes in the Baraba steppe; from Lake Abakanskoe, which produces about 7,500 tons per annum; and from Ussolye near Irkutsk where the annual output is about 10,000 tons. Glauber's salt (sulphate of sodium) is found in the lakes of the Baraba steppe. Hot mineral springs exist near Bisk. Lime, building-stone and clays are abundant, and the Irkutsk district produces kaolin and white clay for porcelain. The jasper and porphyry of the Altai region are famous. The above is an indication only of the great mineral wealth of the Siberian Area; much of the region is as yet unsurveyed and of the mineral wealth reported, little is worked. Increasing colonization and consequent improvement of transport may lead to a great development of mining.

Industries and Communications.—Factories are springing up in the larger towns, the chief occupations being distilling, brewing, tanning, soap- and tallow-making, flour-milling, saw-milling, weaving, oil-milling, glass-making, brick- and cement-making and pottery. There are printing works at Omsk, Tomsk and

Irkutsk, and the latter town has cigarette-case factories, steam sausage and pearl-barley factories. Rope-making is usually a koustar (peasant) industry, but Barnaul and Minusinsk have rope factories. The most famous glass factory is that 28 mi. from Krasnoyarsk, established in 1840. Of timber industries, apart from saw-milling, Minusinsk has boat-building, and Omsk, Tomsk and Irkutsk, carriage-building; Omsk also manufactures railway sleepers. At Tomsk and Bisk are match factories. In the western districts *koustar* industries carried on in the peasants' cottages are common; they are less so in the east. The most noted of these are the smiths and joiners of Kuznetsk and Tomsk, the making of metal pots for milk and *barnaulkas,* or skin coats of the Barnaul district, the cedar-nut oil of Bisk, the pottery of Yeniseisk, the boot-making of the Irkutsk district. Woodwork, the dressing of sheepskin and wool products, weaving and metal work are widespread peasant industries in the Yenisei basin and the Irkutsk district.

The Yenisei and its tributaries form the main avenue of communication north of the trans-Siberian railway, but rivers and roads alike are impassable during spring and autumn. The great military road or *Trakt* of Siberia passes through the south from Omsk via Tomsk and Krasnoyarsk to Irkutsk, and traffic along it is by post horse in summer and sledge in winter. Even this road is difficult and in places impassable in spring and autumn. In many places there are no bridges and ferries are used. The effect of the building of the railway in 1891–1905 in these conditions was marked and immediate; villages became towns with large populations in a few years, colonization and settlement near the railway increased, and the possibilities of export produced remarkable developments, *e* g., the dairy industry. In 1915 a branch from Novosibirsk to Barnaul and Semipalatinsk was opened, with a branch line to Bisk and this line was later prolonged to link up with the Turkestan and Chkalov-Tashkent railways. The effect on the development of Siberian products, especially grain and coal, should be marked. and settlement further increased. Other branch lines link Tatarskaya, 105 mi. E. of Omsk, with Slavgorod and the Kulundinsk steppes, practically uninhabited in 1907. but rapidly settled during 1907–12, Taiga with Kuznetsk, and Achinsk with Minusinsk. No branch lines go northward except a short one to Tomsk.

Colonization.—The administrative centre was Novosibirsk (*q.v.*), and other towns are Barnaul. Irkutsk, Krasnoyarsk, Omsk and Tomsk (*qq.v.*), with populations from 249.000 to 579,000. Bisk has a population of 146,000 and Minusinsk of over 20,000. It will be noted that all these towns are on the railway.

Colonization did not begin to any extent, in the west, until the 18th century. when forts were constructed from Omsk southeastwards along the Irtysh to protect the settlers from Kirghiz raids. Criminal, political and religious exiles were banished to Siberia up to 1900; the first mention of such exile is in 1648. In 1904 exile for political offenses was again restored. Between 1823 and 1898. 700,000 exiles, with 216,000 voluntary followers, passed through Tobolsk.

Of the religious exiles the raskolnik (Old Believers), or dissenters from the ecclesiastical changes introduced by the Patriarch Nikon in the second half of the 17th century, and from the changes introduced by Peter the Great, formed a valuable element among the colonists, being ascetic, industrious and abstemious. Some colonists were peasants ordered to settle at certain places so as to maintain road communication. But the largest element and the most important was the voluntary immigrants. who are still pushing eastwards in great numbers and gradually bringing all the fertile regions of the south of the Siberian Area under cultivation.

Between 1896 and 1909 over a million immigrants settled in the Altai region and few returned. Of those settling east of the Yenisei and in the Irkutsk district, many found the climatic conditions impossible and returned westwards. Education varies with accessibility. The large towns on the railways have schools and technical institutions, but the more remote settlements and the nomads present a difficult problem and among them the illiteracy rate is high. (R. M. F.)

SIBI, a town and district in the Quetta division of West Pakistan. The town is near the south end of the Bolan pass. 73 mi. S.E. of Quetta, at the junction of the main Sukkur-Jacobabad-Quetta railway with the Harnai line. Pop. (1951) 11.832.

SIBI DISTRICT consists of: (1) areas of Baluchistan assigned to the British by the treaty of Gandamak, 1879, with the Afghans; (2) small areas formerly under lease from Kalat; (3) Bolan pass subdivision. separate till 1950; (4) the Mari and Bugti tribal country; and (5) Lahri tehsil, transferred from Kalat in 1955. Total area 11.864 sq.mi.; pop. (1951 census) 208.971.

SIBIU (Ger. HERMANNSTADT, Hung. NAGYSZEBEN), a town of Rumania. in the region of Stalin. Pop. (1956) 90.475. of which Germans and Rumanians form the majority, with a Magyar minority.

Sibiu is beautifully situated in the fertile valley of the Sibiu! surrounded by mountains. An old Saxon colony, it still retains a medieval Germanic appearance. The Gothic Protestant church, begun in the 14th century and finished in 1520. contains a beautiful font (1438) and a mural painting of the Crucifixion by Johannes von Rosenau (1445). The "new church," a 15th century addition, comprising the western part of the building. contains many beautiful monuments of Saxon notables. The fine 15th century town hall contains the archives of the Saxon nation. Sibiu is the seat of an Orthodox archbishopric and of the superintendent of the Transylvanian Protestants.

It contains a good museum. an Orthodox seminary, a law academy, several secondary schools and manufactures of cloth. linen, leather, caps, boots, soaps, candles, ropes and breweries and distilleries.

Sibiu was a Roman colony (Libinium) refounded by colonists from Nürnberg in the 12th century. Its history is bound up with that of the Saxon communities in Transylvania (*q.v.*).

SIBLEY, HIRAM (1807–1888), a founder and second president of the Western Union Telegraph company, was born at North Adams. Mass., Feb. 6, 1807. When he was 16 his family moved to western New York where he later operated a foundry and machine shop and w s in 1843 elected sheriff of Monroe county.

Visiting Washington, D.C., Sibley met Samuel F. B. Morse, the telegraph inventor, and helped obtain congressional backing for construction of the first telegraph line in 1844. Recognizing the need for a national telegraph system, Sibley and other Rochester, N.Y., citizens in 1851, formed the New York and Mississippi Valley Printing Telegraph company, which bought 11 small lines north of the Ohio river. In 1856 the company was renamed The Western Union Telegraph company.

Sibley became president of Western Union later that year. Under his leadership, the first transcontinental telegraph line was built in 1861, to help hold the western states in the Union in the Civil War and to develop the west.

Sibley began building a line to Europe via Russian America, the Bering strait and Siberia in 1865. When he was in St. Petersburg, negotiating to buy right-of-way, the tsar's nephew offered to sell what is now Alaska to Western Union. Sibley refused, but launched a campaign to persuade the United States to buy it, which was done in 1867. The expedition was abandoned when the first permanently successful transatlantic cable was laid in 1866, but it had mapped and reported Alaska's vast resources.

Sibley retired as president of Western Cnion in 1865 and became a builder of railroads in the middle west and south and owner of vast farm holdings. Part of his fortune was used to establish the Sibley College of Mechanic Arts Engineering (later Mechanical Engineering) at Cornell university. of which with Ezra Cornell (*q.v.*) he was one of the incorporators. He died in Rochester on July 12, 1888. (G. P. O.)

SIBONGA, a municipality of the province and island of Cebu, Republic of the Philippines, on the east coast 30 mi. S.W of Cebu, provincial capital. Pop. (1959 est.) 23,588. It is a port for the coasting trade and is connected by rail with Cebu. The chief agricultural products are maize (corn) and tobacco. Cebuano is the vernacular.

SIBSAGAR, a town and district in Assam, India. The town is on the Dikhu river, 8 mi. from the Brahmaputra, and connected by rail with Nazira, 12 mi. S.E. on the main Assam line of the North-Eastern railway. It is situated round a small lake. Pop. (1951) 10.622. Sibsagar college is connected with the University of Gauhati.

SIBSAGAR DISTRICT has an area of 3,454 sq.mi.; pop. (1951) 1,212,224. It consists of a level plain, much overgrown with grass and jungle, and intersected by numerous tributaries of the Brahmaputra. Reserved forests extend over 1,100 sq.mi. Sibsagar is the chief centre of tea cultivation in the Brahmaputra valley. There are also several timber mills.

SIBYLLA, a proper name, afterward used as a common noun (as we say. "a Daniel"); the derivation and meaning are unknown but certainly are not Greek; they are possibly Semitic. In the disturbed period preceding the development of the full classical culture, *i.e.*, about 800–600 B.C., religious movements of all sorts were common in Greece and Asia Minor, and especially, inspired prophets were numerous. Of these one of the most famous was Sibylla of Marpessus, a village near Troy, also claimed as a native of Erythrae; of her Heracleitus says (Frag. 12. Bywater) that "with her maddened mouth . . . she reaches a thousand years with her voice by the power of the god," *i.e.*, Apollo, by whom this real or imaginary person was thought to be inspired. Numerous prophecies. generally in hexameter verse, the usual metre of Apolline oracles, were attributed to her, and her great popularity led ultimately to her multiplication, numerous places claiming, from about the 4th century on, to be her native city, or to have been visited by her, or to be the birthplace of another Sibyl of like inspiration. Varro (*ap.* Lactantius, *divin. instit.* i, 6) gives a list of ten, which includes the famous Cumaean Sibyl, often identified with the Erythraean.

She was supposed to be the authoress of the Sibylline oracles, which were kept in the temple of *Iuppiter Capitolinus* at Rome under the care of the *quindecimviri*, and consulted in emergencies by order of the senate. Apollo loved her and granted her the gift of prophecy, and also a life of as many years as she had grains of dust in her hand; but she forgot to ask for youth, and so gradually withered away almost to nothing. It was presumably she who offered Tarquinius Superbus nine books of prophecies, and, on his declining to pay the price asked. burned first three and then three more, finally selling the remainder for the sum she originally demanded for all. (Ovid. *Metam.*, xiv, 130 et seq.; Dionysius Hal. iv, 62). Of the official collection supposed thus to have originated, one or two fragments still survive (see Diels, *Sibyllinische* Blatter).

Finally. Jewish and Christian apologists discovered a Judaean or Babylonian Sibyl, to whom were attributed the numerous prophecies, still extant, containing Judaeo-Christian propaganda.

SIBYLLINE ORACLES, a collection of Apocalyptic writings. composed in imitation of the heathen Sibylline books by the Jews and. at a later date. by the Christians in their efforts to win the heathen world to their faith. The fact that they copied the form in which the heathen revelations were conveyed (Greek hexameter verses) and the Homeric language is evidence of a degree of external Hellenization, which is an important fact in the history of postexile Judaism.

Book III contains Jewish oracles relative to the Golden Age established by Roman supremacy in the east about the middle of the 2nd century B.C. (especially 175–181: cf. I Macc. viii. 1–16). The evacuation of Egypt by Antiochus Epiphanes at the bidding of the Roman ambassadors suits the warning addressed to "Greece" (lines 732–740) against overweening ambition and any attempt upon the Holy City, which is somewhat strangely enforced by the famous Greek oracle, "Let Camarina be, 'tis best unstirred." Older than these are the Babylonian oracle (97–154) and the Persian (381–387). A later Jewish oracle (46–62) refers to the wars of the second Triumvirate of Rome, and the whole compilation seems to come from a Christian redactor.

Book IV is a definite attack upon the heathen Sibyl (the Jews and Christians did not attempt to pass off their "forgeries" as genuine) as the mouthpiece of Apollo by a Jew who speaks for the Great God and yet uses a Greek review (49–114) of ancient history from the Assyrian empire. There are references to the legendary escape of Nero to Parthia (119–124) and the destruction of Jerusalem in A.D. 70 (130–136).

Book V contains a more developed form of the myth of *Nero redivivus* in which a panegyric on him (137–141) has been brought up to date by some Jew or Christian. and eulogies of Hadrian and his successors (48–51) side by side with the legend of the miserable death of Titus in quittance of his destruction of Jerusalem (411–413) which probably represents the hope of the zealots who survived it. The remaining books appear to be Christian (some heretical) and to belong to the 2nd and 3rd centuries.

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SICANI, in English SICANS, the ancient inhabitants of western Sicily. Sikania, as the Greeks called the island, is mentioned in the Odyssey (xxiv, 307). The name appears to be a doublet of *Sicilia* (Greek *Sikelia*, from *Sikeloi*, Siculi or Sicels), and archaeologically there is no substantial difference between Sicans and Sicels in historical times; but ancient authorities distinguish the two peoples and assign a different origin to them. The Sicans were driven by the invading Sicels, c. 1000 B.C.. into the western and southern parts of the island (Thucydides, vi, 2). The Greek colonists of Gela and Acragas on the south coast had to fight Sican wars; the people of this part of the interior retained more cultural independence of the Greeks than the Siculi of eastern Sicily did. In the Roman period no distinction is drawn between Sicans and other inhabitants of Sicily. (T. J. DN.)

SICILY, in Italian SICILIA, the largest island (9,925 sq.mi.) in the Mediterranean, is separated from continental Italy by the Straits of Messina, which at their narrowest point are less than 2 mi. wide; it lies almost in the centre of the Mediterranean, and the Straits of Sicily between the island and Cape Bon in Tunisia are shallow and only about 90 mi. wide. Geographically and administratively Sicily includes the groups of small islands off its coasts—the Aeolian or Lipari Islands, Ustica, the Aegadean Islands, Pantelleria and the Pelagean Islands—the administrative region so constituted being the largest in Italy.

PHYSIOGRAPHY

Sicily may be roughly described as a plateau with a northern edge ranging from 3,000 to 6,000 ft. in height, which drops abruptly to the sea on the north and slopes gradually to the south and southwest to heights of about 1,000 ft. near the south coast. Two-thirds of the island are more than goo ft. above sea level and only 15% is below 330 ft. The only real plain is that of Catania on the east coast between Etna and the Iblei mountains; it is an alluvial plain intersected by rivers and irrigation channels, much of it intensively cultivated with vineyards and groves of citrus fruit.

The most distinctive feature of Sicily is the active volcano of Etna (10,705 ft.), composed like Vesuvius of layers of lava and ash. It forms a distinct region cut off from the other hills and mountains by the Simeto and Alcantara rivers and contains three clearly marked zones of widely different climate and vegetation. The lowest zone, up to 4,000 ft., is very fertile, well watered by springs and closely cultivated. and is one of the most densely populated areas in Sicily. In this zone the southern and eastern slopes are covered with vineyards and citrus groves, which grow up to 1,500 ft.. while the northern and western slopes mainly produce olives and cereals. The second zone, lying between 4.000 and 6,000 ft., is known as the forest zone; it was once covered with oak, chestnut, birch and, in the higher parts, pine; but there is little forest left, except on the less accessible northwestern slopes, and there is little water and very few houses. Between 6,000 and 9,000 ft. there is thorny mountain scrub, and above 9,000 ft. only ash and lava and only one building, the observatory (9,670 ft.).

North of Etna is the long northern ridge of Sicily formed by the Peloritani, Nebrodi and Madonie mountains. which constitute a barrier 100 mi. long from east to west crossed by high road passes and by only one railway line. The lower Monti Erei, flat-topped hills with steep sides, which run in a southeasterly direction from Gangi down to Caltagirone, form the watershed between the Ionian sea and the Straits of Sicily. There are crossings at either end of the Erei, but only one gap in the range, the deep valley just north of Enna. Through this gap goes the main road from Catania to Palermo and the only inland east-west railway.

In western Sicily, between the hills where they run out into the sea, there are small coastal plains and terraces; by far the most famous of these is the Conca d'Oro behind Palermo, closely cultivated with fruit trees and ground crops beneath them. The coastal plain from Trapani south to Marsala and thence east to Sciacca is about 5 mi. wide with a low plateau behind it; both plain and plateau are covered with vineyards, which produce Marsala wine.

Climate. — Sicily is warm both in winter and summer. Near the coast the mean January temperatures are more than 50° F. and even inland more than 40°. In summer the temperature rises considerably: near sea level the mean temperatures are 75° to 79° F. with extremes of 100°. The effects of the heat are accentuated by the low rainfall. The rainy season is confined to the late autumn and winter; the total rainfall on the north and south coasts and in much of the interior is less than 25 in., in the extreme south only 15 in. The result of this low rainfall, combined with deforestation and failure to systematize the mountain torrents, is that most of Sicily suffers from severe lack of water. The frequency of the dry type of sirocco is a scourge of the island; it is oppressive to everyone and can be dangerous to young children.

Vegetation. — The only natural vegetation left in Sicily occurs in the scanty remains of forest, in the hill pastures and on the coast. Forests now cover only about 3½% of the island, the largest areas being on the northern slopes of the northern highlands, particularly those of the Nebrodi, where oak and beech and *macchia* are found; the Madonie, where there are evergreen and deciduous oaks, holly and beech; the northern slopes of Rocca Busambra round the upper part of Etna, chiefly covered with oak; and the basin of the Acate river in the southeast. The lower limits of the deciduous forest trees are high: for oak 2,000 ft., for chestnut 1,600 ft., while beech is only common above 4,000 ft. There is *macchia* on the dry hill slopes containing, in the southeast and southwest, dwarf palms. Papyrus grows along the low-lying banks of the rivers Anapo and Ciane near Syracuse, and the reed grass Arundo *donax* is used for vine stakes. (M. M. C.)

ARCHAEOLOGY

The pre-Hellenic inhabitants of Sicily, are called by classical authors Sicani or Siculi, and it is convenient to retain these two names for designating those early cultures which have been revealed in the course of years since Paolo Orsi began investigation in 1889. The term Sicanian is applied to that period of the Stone Age which followed the palaeolithic period exemplified in the remarkable rock engravings of the cave near Palermo (first published in 1953); the term Siculan is applied to the Chalcolithic, to the Bronze and to the Iron Ages, the first Siculan period being Chalcolithic, the second being Bronze Age, the third, from 900 to 700 B.C., being Iron Age and the fourth from c. 700 B.C., being the period when the native civilization was hybridized with the Greek. The earlier cultures tended to persist in "retarded" communities,

The Sicanian Period. — The Sicanian period is known principally from two sites, Stentinello and Matrensa. Stone implements from these places were of poor quality, and there were no other objects of interest except the pottery. This was handmade and baked in an open fire. Its surface is blackish-gray, and the geometrical ornament upon it, which appears merely incised, has in parts a strange regularity produced by real stamps — not by puncture by bone a ls — a phenomenon unique at this early time. There were hemispherical bowls, basins with ring handles and conical vases with a ring foot. The pottery of the caverns at Villafrati and Moarda belongs to a later stage of the neolithic. The finding of bell beakers connects it with the civilization of the dolmen builders.

The First Siculan Period. — So far as the present material goes, the first Siculan period does not seem to have been evolved from the Sicanian, or, if it was, the steps are still missing; all the outward and material evidence of the two civilizations shows them to be very different, and the affinities of the Siculi were with the Italian mainland. A few rock-hewn tombs of the first Siculan period have been discovered near Palermo and a considerable number near Agrigento, but the largest cemeteries were found by Paolo Orsi in the Syracusan district. The principal sites are those of Castelluccio, Melilli, Monte Racello, Monte Tabuto, Vallelunga and Monte Salia. The typical burial was in a rock-hewn chamber, the construction varying according to the nature of the ground, so that at Monte Tabuto the dead were buried in disused flint-mines, while at Monte Racello natural caverns were enlarged for the purpose, and actual surface graves were even formed out of slabs on the top of the broken ground. At Castelluccio, however, which may be taken as the standard case, the circular or elliptical chambers were hewn in a vertical face of rock and entered by a short horizontal corridor.

Each chamber contained many skeletons, in one case no less than 26. They were invariably buried in the squatting position, accompanied by a small number of weapons and ornaments and a regular equipment of pottery. It seems that the idea was to seat them as at a banquet, with large jars beside them to hold water and smaller decorated cups out of which to drink it. The weapons and implements were sometimes of stone, especially flint, sometimes of copper in primitive forms as if the neolithic period was only just past and hardly forgotten. Of personal ornaments there were few. Of pottery, all handmade, there were three kinds: a rough household ware; pots of a better clay coated with a red or yellow slip; and — far the most important — a ware covered either with a cream-coloured or dark-red slip on which very simple geometric patterns were executed in dark brown. This painted ware is the peculiar distinction of the first period. Nothing very closely resembling it is known anywhere else.

The Second Siculan Period. — The second Siculan period of the full Bronze Age is represented at its best by the cemeteries of Plemmirio, Milocca, Cozzo Pantano and Thapsos close to Syracuse and by Caldare and Cannatello near Agrigento. All these contain Mycenaean imports, of which the earliest are clearly to be dated as late Minoan third period. (See AEGEAN CIVILIZATION.) Bronze swords from the same sites are also quite definitely of Mycenaean origin and prove the existence of a considerable direct trade with the Aegean. To Aegean influence is probably due the remarkable development in tomb construction which characterizes the second Siculan. All the cemeteries consist of rock-hewn tombs, a natural evolution from the rock tombs of the first Siculan. The roof of the chamber, however, is sometimes of tholos form, which again recalls Aegean precedents. Inside it is usually elliptical; a raised bench cut in the rock runs round it, and niches are often hewn in the walls. Within this chamber the dead were buried as if seated at a stately banquet with the finest products of Sicilian potters for their table service and the rarest of foreign drinking cups. The size of the great food basins is remarkable; they are often 2½ or 3 ft. in height.

The native pottery is made principally in a gray-faced ware ornamented with moulded strips or with a few sparsely incised lines; there is also a yellow-faced ware. Painted ware is unknown. The shapes are very few — a high stand, a biconical cup with side handles, a conical cup, a jug and one or two large water jars. Foreign trade added the amphora, pyxis, pedestalled cup and stirrup-handled vase and gave a great impetus to metalworking. Swords, daggers and even basins were imported, but the various hoards of bronze objects show that a great quantity of native work must have existed. The tombs, however, mere systematically ransacked for metals after the Roman time. Another proof of foreign influence is the introduction of the fibula, which appears at Cozzo Pantano for the first time. The earliest fibulae are of two types, the plain violin bow with bamboo knots and the harp-shaped or elbowed fibula. each made in a very massive form.

The four cemeteries near Syracuse must be assigned on the evidence of the foreign imports to the 14th and 13th centuries B.C. Caldare and Cannatello, farther inland, date from the 12th to the 11th centuries. Latest of all and marking the last stage of the Bronze Age is Cassibile, a large cemetery near Syracuse, in which there were no Mycenaean products and the fibulae were perceptibly less archaic.

Intermediary Period. — Next in chronological order come four sites between Syracuse and Agrigento which span the gap between the Bronze and Iron Ages, the later graves in them belonging entirely to the early Iron Age. On Orsi's system they are to be classed as intermediate between the second and the third Siculan. These are Pantalica, Grammichele, Caltagirone and Monte Dessueri. Here the form of the tomb is already beginning to be modified, the number of burials in each grave is smaller, and the tomb furniture is later in character. This is especially perceptible in the personal ornaments; the fibulae have quite changed, for in place of the primitive violin bow the simple rounded bow is predominant and more sophisticated forms, like the eyed harp fibula, begin to appear.

In addition to arm rings and finger rings and mirrors of bronze there are now found, though rarely, gold rings, silver armlets and silver rings. Rectangular bronze razors come into use, like those known in Italy but of different origin. There are no weapons, perhaps because of the rifling of the graves, but flame-shaped and leaf-shaped bronze knives occur. The native pottery is very varied in form at this time, the best of it being in a ware faced with red haematite. Feather-patterned ware soon goes out of fashion; the impulse toward originality is killed by a fondness for geometrically painted wares, the products of new Greek schools. These begin to appear sporadically about 900 B.C.

The Third and Fourth Siculan Periods. — On a site like Pantalica, with a range of several centuries, we pass into the Iron Age without any striking changes. Modifications occur in the types of the fibulae and there is a gradual, but quite perceptible, deterioration of the pottery. All the Bronze Age types of fibulae gradually give way to later forms, of which the most general and popular is the two-eyed serpentine, which continues in use down to 500 B.C.

The first appearance of this fibula marks a distinct chronological point; it is the beginning of the early Iron Age, and if the contents of tombs belonging to this stage are isolated and examined separately from the rest, then certain definite characteristics begin to appear. The old Siculan civilization of the great days survives in a much impoverished form; it has entered upon its decadence. The architecture has lost all its beauty and elaboration of detail. Within a very simple chamber the dead are no longer seated at a banquet but extended at full length on the ground with their heads resting on a block of stone; and the objects buried with them consist of little but a few small water jars and trumpery pots. We now pass into Orsi's third period. The partial regeneration of Siculan life which begins gradually in the 9th century is entirely due to Greek influence, through trade, which preceded any actual colonization by fully 150 years. Thus everything of interest in Siculan life from the 9th century to the 5th B.C. is either a Greek importation or the direct imitation of a Greek original.

From a number of sites, the most important of which were Lentini (the ancient Leontini), Licodia and Finocchito, were obtained examples of geometrically painted vases, the earliest of which are of pure Dipylon style, while the latest are a hybridized product which may be termed Graeco-Siculan. A characteristic vase shown from Lentini belongs to the third Siculan period. If not an actual importation it is a close copy of some Dipylonic original at least as early as the 8th century B.C. At Lentini there were still earlier types, little oenochoai and askoi painted with the simplest kind of linear designs. This style is not found even in the first of the Greek colonies and must therefore precede the period of colonization. Orsi is evidently justified in assigning it to the 8th and possibly to the 9th century B.C.

The introduction of these new models led to the imitation of purely Greek shapes by the native potters, so that oenochoai and askoi were copied in the rough country ware, and to a closer study of decorative designs, which resulted in the production of a new kind of white-faced ware with geometrical patterns painted upon it. This gradually improved in technique until it reached its high-water mark in the late third and early fourth Siculan periods. The Graeco-Siculan ware continued in use until it was finally replaced about 500 B.C. by purely Greek imported vases. For this whole period. the stratigraphic investigations at Megara Hyblaea in 1949 and the following years yielded valuable results.

(D. R.–M.; A. W. V. B.)

Classical Archaeology. — After having long been relegated to secondary rank in art as merely a provincial area in relation to Greece proper, Sicily in recent years has steadily emerged as an artistic entity in its own right. The earliest works of sculpture confirm the literary tradition of a Daedalic school; and the art of the later archaic period, including clay statues and statuettes, pursues a course of development parallel to that of the schools of the motherland, with which it clearly remained in contact while achieving considerable freedom in style and technique. "Nowhere more forcibly than in its mouldings does the architecture of the West stand forth as a vigorous, original architecture, based on, but independent from, the forms of Greece, the Aegean, and Asia Minor" (L. T. Shoe, *Profiles of Western Greek Mouldings*, American Academy in Rome, 1952). Down to the beginning of the 5th century B.C., when the traditional terra-cotta revetments were superseded by marble. the coloured adornment of the temples showed features distinctly characteristic of this area. Throughout the 5th and the early 4th centuries, the issues of coins exhibited an exuberance and a standard of artistic excellence all their own; clearly the die cutters stood in close relation to the gem engravers and, in some cases, were identical with them. Although the rich ceramic yields of the cemeteries consist largely of imported products, first of the Corinthian and later of the Athenian potteries, there is an abundance of local wares as well, revealing several clearly defined schools of the 4th century and later; some of the painted decoration suggests the influence of the Western Greek theatrical plays. The island is rich in remains of villas and other edifices of the Roman period; and the architecture and mosaic art of late antiquity are nobly represented in the establishment at Piazza Armerina. (*See* further GREEK ARCHITECTURE; ROMAN ARCHITECTURE; GREEK ARCHAEOLOGY; GREEK ART; ROMAN ART; NUMISMATICS: *Italy and Sicily.* For some of the outstanding architectural monuments, see AGRIGENTUM; GELA; HIMERA; SEGESTA; SELINUS; SYRACUSE.)

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HISTORY

At the coming of the Greeks three peoples occupied the island of Sicily: in the east. the Siculi (*q.v.*) or Si'cels (*Sikeloi*), who gave their name to the island but were not long arrived in it and had relatives of the same name in Latium and in southern Italy; to the west of the river Gelas. the Sicani (*q.v.*); and in the extreme west the Elymians, a people to whom a Trojan origin was assigned, with their chief centres at Segesta (*q.v.*) and at Eryx with its temple of Aphrodite. The Siculi spoke an Italic dialect; there are no remains of the languages of the other peoples.

Thucydides says (vi.2) that the Greeks were preceded in Sicily by Phoenicians, who established trading stations on promontories and small islands all round the coast. But no material remains of such settlements have been found. Thucydides adds that when the Greek colonization began, the Phoenicians withdrew to the western comer of the island, where they had the Elymians as allies and the support of Carthage. Here they had three towns, Motya, Soloeis and Panormus (now Palermo, *q.v.*). Hostilities between Greeks and Phoenicians are not heard of earlier than the Cnidian attempt to settle on the westernmost point of Sicily c. 580 B.C. (see below).

Greek Sicily, to 413 B.C.—Mycenaean traders had already visited Sicily and the Lipari Islands between the 15th and 13th centuries B.c., and at a later date the fibula was introduced by direct or indirect importation from the Aegean (see above, *Archaeology*). There is then a long period when Sicily was beyond the horizon of Greek sailors (the few references in the Odyssey need be no older than the early period of colonization). Toward the middle of the 8th century intercourse was resumed, and the first colony was planted c. 734 B.C. at Naxos on the east coast, by Chalcidians from Euboea, who had already founded Cumae near Naples. (Precise dates for the foundation of the Sicilian colonies are given by Thucydides; and though some modern scholars suppose that these are based only on calculations made about 300 years after the era of the first colonies, they may be accepted as approximately correct.) In the year after Naxos, according to Thucydides, the Corinthians founded Syracuse, the greatest city of ancient Sicily, and at the same time occupied Corcyra (Corfu) which commanded the way thither. The east coast was rapidly occupied: the Chalcidians founded other colonies at Leontini and Catana (both c. 729) and held the Straits of Messina by the foundation of Zancle (later Messana, Messina) on the Sicilian side and Rhegium (or Regium, *q.v.*) on the Italian side (both probably in the last quarter of the 8th century). The Megareans founded Megara Hyblaea (*q.v.*), at about the same time as Leontini. On the south coast, the earliest colony was Gela, a joint Cretan and Rhodian settlement (c. 688). The southeastern corner was occupied by the secondary Syracusan foundations of Acrae (c. 663), Casmenae (c. 643) and Camarina (598), the last of which was the most important. In or about 628 the Megareans founded Selinus, the westernmost Greek city of Sicily, facing the coast of Africa. Between Gela and Selinus was Acragas (Agrigentum, *q.v.*) a Geloan colony, the last of the foundations of the great age of colonization (580), which rapidly rose to be the second city of Sicily. On the north coast there was long only a single Greek city, the Chalcidian Himera (c. 649). About 580 the Cnidians founded Lipara, after an unsuccessful attempt to settle in the neighbourhood of Eryx. The defeat of this attempt by the Elymians and Phoenicians marks the first recession of the tide of Greek settlement, and the Greeks never succeeded in occupying the western part of the island. The mountainous centre remained in the hands of Siculi (Sicels) and Sicani, who were increasingly hellenized in ideas and material culture.

After the foundation of the colonies, little is known of them until the 5th century. They prospered materially, building temples whose remains, at Syracuse, Acragas and Selinus, are among the finest monuments of archaic and classical architecture. Their sculpture and other arts are vigorous. though provincial and largely dependent on impulses from mainland Greece. There is some reason to believe that they had a colonial economy. producing food (corn, sheep and cattle, fish) and importing manufactured objects (of which clay vases are the chief survivors) from Greece —in the peridd before 550 B.C. mainly from Corinth, after this from Athens. The broad acres of the colonies and, at Syracuse and probably also elsewhere, the use of Sicel serfs gave rise to a life of easy circumstances and, in the 5th century, to the great wealth of the tyrants (see below). The fine series of Sicilian coins begins toward the middle of the 6th century (see NUMISMATICS: Italy and *Sicily*). The poet Stesichorus of Himera, who retold many of the stories of epic with a new spirit reflected in archaic vase paintings, belongs to this period.

There were many tyrants — unconstitutional monarchs — in the 6th century, especially in those towns which were pressed by the growing hostility of the Carthaginians; the most famous is Phalaris (*q.v.*) of Acragas; in general, however, this is a period of aristocratic or oligarchical constitutions. The early 5th century saw tyrants in most cities. The tyranny of Gela was founded in 505, and Hippocrates (498–491) carried his arms over most of eastern Sicily; his successor Gelon (*q.v.*; otherwise Gelo) took Syracuse in 485 and transferred his seat thither, enlarging the city with men from other colonies and settlers from old Greece. This is the beginning of Syracusan rule over Greek Sicily. The families of Gelon and of Theron (tyrant of Acragas, 488–472) were united by marriage. Theron seized Himera, expelling its tyrant Terillus, who with his father-in-law, Anaxilas of Rhegium (494–476), ruler also of Zancle, formed a coalition against Gelon and Theron and invited Carthaginian support. The Carthaginian invasion was defeated in a single battle at Himera (480), and its commander Hamilcar son of Hanno (his mother was a Syracusan) killed. The victory opened a short period of brilliant prosperity for Greek Sicily. The courts of Gelon and of his brother and successor Hieron or Hiero (*q.v.;* 478–467) and of Theron were visited by Pindar. Aeschylus, Simonides and Bacchylides; the leading artists of Greece were commissioned to make rich offerings at Olympia and Delphi; fine temples were built as thank offerings for the victory of Himera. Hieron extended his activity to Italy, where he protected Locri against Anaxilas of Rhegium and defeated the Etruscans at sea off Cumae (474). The darker side of the tyrants' rule is seen in forced movements of population from city to city and in the destruction of many Greek cities (*e.g.*, Megara Hyblaea). Hieron refounded Catana with great splendour, under the name of Aetna, after expelling the Chalcidian inhabitants; he set up his son Deinomenes as king and hoped that this would be a refuge for his family; but within a few years of his death the original inhabitants returned, and the new settlers carried the name Aetna to a small town inland, on the slopes of Mount Etna.

These tyrannies were short-lived. Theron's power fell to pieces when his son Thrasydaeus succeeded. Hieron's brother Thrasybulus was overthrown by a combined movement of Greeks and Sicels (466). They were succeeded by uneasy democracies in most cities, Syracuse still taking the lead. The Sicels now for the first time formed a united power, under Ducetius, who founded a new city at Palici in the plain of Catana and developed a serious threat to Syracuse and to Acragas. He was defeated and his political work largely undone, except for the foundation of Cale Acte on the north coast. The Sicels did not again attempt to combine as a force, but their hellenization continued; many Sicel cities now began to coin on the Greek model.

The extent of the native contribution to Sicilian culture is disputed. The Sicels may have had a worship akin to the cult of Demeter and Persephone, which was widely spread over both Greek and native Sicily; but the localization of the rape of Persephone at Enna is due to Greek influence. The material culture of the Greek colonies shows no Sicel elements. Some words of Italic origin were taken into the Greek dialects of Sicily; and the racy comedies of Epicharmus and the mimes of Sophron may show some kinship of spirit to Italian comedy. The main Sicilian contribution to Greek literature and thought in the 5th century was in the development of rhetoric and its transference to Athens by Gorgias (*q.v.*). A more original philosopher mas, it appears, Empedocles of Acragas, who was poet, physician, politician and perhaps something of a charlatan.

The Athenians looked for allies in Sicily at least as early as 458–457, when they made a treaty, still extant, with Segesta. At the beginning of the Peloponnesian War they sought for means to cut off supplies from Sicily to their enemies and allied themselves with the Ionian cities, Leontini and Rhegium. In 427–426 they sent a small squadron to Sicily but accomplished little. In 415, during the peace of Wicias, they were led by expansionist ideas, expressed by Alcibiades, to send a large force in answer to an appeal for help from Segesta and Leontini. The ultimate object of this expedition was the subjection of the whole of Sicily. The Athenians were received with suspicion, even by some of their allies, and Naxos and Catana were the only Greek cities to support them; they also had help from some of the Sicels. The utter defeat of the Athenian force under the walls of Syracuse (see

PELOPONNESIAN WAR; SYRACUSE) was achieved in part by the arrival of the Spartan leader Gylippus and was followed by the dispatch of small forces from Syracuse and other Sicilian cities to help the Spartans against Athens.

Carthaginian Wars.—The failure of Athens left the field open for Carthage, with whom the Athenians had sought an alliance. In 409 an army under Hannibal, son of Gisgo, landed to support Segesta against Selinus. Selinus and Himera were taken and destroyed; Himera, where Hannibal sacrificed 3,000 of the citizens to avenge his grandfather Hamilcar, was never rebuilt but was replaced by a new town, Thermae Himeraeae. In 406 Acragas fell also. Dionysius (*q.v.*) rose to power at Syracuse as its military leader but was forced to evacuate the populations of Gela and Camarina before he could obtain a peace with the Carthaginians, which left him in control of Syracuse. For the rest of his life he fought a series of inconclusive wars with the Carthaginians. In 397 he took Motya, the chief Phoenician city in Sicily (which had a considerable Greek element within its walls) and seemed on the point of driving the Phoenicians out of the island. But in the following year the tables were turned by the arrival of a Carthaginian fleet under Himilco in the harbour of Syracuse. A pestilence, spread among Himilco's troops from the marshes of Lysimeleia, assisted Dionysius in winning a complete victory, which confirmed his position as ruler of Syracuse and master of most of Sicily. But he had to fight other Carthaginian wars in 392–391, 383–378, and 368–367, the year of his death. In the peace which followed the last war, the boundary between Greek and Carthaginian Sicily was fixed at the river Halycus. Selinus and Himera remained on the Carthaginian side, Acragas became a frontier town. Lilybaeum (the modern Marsala) replaced Motya in 396 and became the chief centre of the Phoenicians in Sicily.

Dionysius used his position as defender of Greek Sicily to build up a personal power which anticipates the Hellenistic monarchies in many ways. The transplantations of population and refoundations of cities which had been a feature of the rule of Gelon and Hieron continued. New foundations were Tauromenium (modern Taormina), which replaced Naxos, and Tyndaris on the still rather empty north coast. The Sicel towns of Hadranum near Mount Etna and Halaesa on the north coast were also refounded, one by Dionysius, the other by his Sicel ally Archonides of Herbita. Dionysius made considerable use of the forces of Sicel allies, and the distinction of barbarian from Greek Sicily begins to disappear. He also employed large mercenary forces, some of them from Gaul and Spain.

After 390 he intervened in the affairs of Magna Graecia, in alliance mith the Lucanians, who had recently pressed donn into the foot of Italy. Locri was his base in Italy. He took Rhegium and Caulonia and defeated the forces of Croton and Thurii, thus winning control over most of Greek Italy, except Tarentum. He sent a fleet into Etruscan waters, nhich plundered the wealthy temple at Caere. His activities in the Adriatic were of more permanent importance; he planted a colony at Lissus to control the crossing of the Ionian sea; he helped the Parians to colonize the island of Pharos; and Syracusan exiles founded Ancona, perhaps with his consent and backing. He had as ally the Molossian Alcetas and engaged Illyrian mercenaries. These activities appear to have been in preparation for intervention in the affairs of Greece.

The rule of Dionysius at Syracuse depended on foreign mercenaries and on secret police, and many of the typical features of Plato's and Aristotle's accounts of Greek tyrants are no doubt derived from him. But he was well served by efficient ministers, such as Philistus the historian (who however went into exile at Adria). He was himself a poet and, like earlier tyrants. kept a court, which mas visited by Plato and other philosophers and poets. He made Syracuse the greatest power in the Greek world, and it became the largest and, probably, the most populous of Greek cities. with its extensive fortifications (*see* SYRACUSE). His poner, however did not long survive him. Most of his conquests in Italy fell to the Lucanians and Bruttians, and at Syracuse his son Dionysius II was expelled after ten years' rule (367–357) by his uncle Dion (*q.v.*). Dion was killed in 354, and there follows ten years' confusion: fighting in Syracuse between Dionysius II and the citizens; tyrannies in other cities; and renewed danger from Carthage, allied with Hicetas, tyrant of Leontini and rival of Dionysius. The Syracusans appealed to their mother city Corinth, and Timoleon (*q.v.*) came as a deliverer. He freed the cities from tyrants and defeated the Carthaginians at the battle of Crimissus (341); but the boundary remained at the river Halycus. Timoleon's reputation was high because he restored the democracy at Syracuse and retired after his work of liberation was done; but his settlement did not last long after his death (c. 336). The Carthaginians, who had already played off one city against another, continued this policy, while the Greeks consumed their energies in struggles between would-be tyrants. They found another leader in Agathocles (*q.v.*), one of the ablest soldiers of the time, who made himself tyrant of Syracuse in 317. Acragas, strengthened by Syracusan exiles, stood out again as the rival of Syracuse; and Hamilcar son of Gisgo won many Greek cities to the Carthaginian alliance and blockaded Agathocles in Syracuse. Agathocles broke through and carried the war into Africa, where he won many successes (310–307), but was finally completely defeated and had to flee back to Sicily. In spite of this defeat he maintained his position at Syracuse and made peace on the old terms with Carthage. He formed marriage alliances with Ptolemy I of Egypt and with Pyrrhus of Epirus, who married his daughter. He was the first of the Sicilian tyrants to take the title of king. He died in 289. In spite of his reputation for treachery and massacre, his rule was remembered as a period of prosperity.

In the troubles which followed Agathocles' death, his disbanded Campanian mercenaries seized Messana and called themselves the Mamertines, children of Mamers or Mars. The fortunes of Sicily were thus linked with Rome. Another new foundation of this time is that of Phintias (Licata) at the mouth of the southern Himeras, named after the Agrigentine tyrant Phintias (289–279). New Carthaginian attacks called forth another liberator from overseas. Pyrrhus (*q.v.*) of Epirus, but his Sicilian war (278–276) was a mere interlude between the two acts of his war with Rome. When he left Sicily to fight for Tarentum against Rome, he had to fight his may out through Carthaginians and Mamertines, the latter already allied with Rome; he said, in true prophecy, that he left Sicily as a wrestling ground for Romans and Carthaginians.

The Syracusans chose as leader Hieron II (Hiero II, *q.v.*), who defeated the Mamertines and came near to capturing Messana; he won the title of king of Syracuse (269). In 264 his attack on the Mamertines led to the intervention of Rome and the First Punic War (264–241). The war began as a three-comered event between Rome. the Carthaginians and Hieron; but in 263 Hieron turned from the Carthaginians to Rome and formed an alliance to which he remained loyal for the rest of his long life. The Romans were thus free to use Greek Sicily as a base for war with Carthage. The western part of the island, both Greek and Phoenician. suffered greatly in this long nar (for its course *see* PUNIC WARS). By the treaty which ended it Carthage ceded to Rome all its possessions in Sicily, which thus became the first Roman province (241). Hieron retained possession of eastern Sicily, south of Messana. His rule mas able and enlightened, and his financial enactments, particularly his corn lams. were taken over when Rome incorporated his kingdom. This period of peace was the last golden age of free Sicily: the great theatre at Syracuse was rebuilt by Hieron, and Theocritus sang the pastoral pleasures of his native island and offered an encomium to Hieron (*c.* 275):

Roman Sicily.—At the outbreak of the Second Punic War Hieron held firm to the Roman alliance, but after his death in 216 his grandson Hieronymus repudiated it. Hieronymus was overthrown by revolution at Syracuse (215), but the city had to stand a siege from the Romans. The great fortress of Euryelus (*see* SYRACUSE: *Archaeology)* perhaps took its final form now, under the inspiration of Archimedes, not in the time of Dionysius I as used to be believed. Syracuse was taken and sacked in 212, Acragas after a further campaign in 210. The whole of Sicily was now Roman.

Little is known of the early organization of the Roman province. It was governed by a praetor sent out yearly from Rome, who after the annexation of Syracuse had his capital there. Two quaestors were appointed, one with his office at Syracuse, the other at Lilybaeum. The province included a number of free cities: Messana, with Tauromenium and Netum, were allied cities (the two latter had probably taken the Roman side in the Second Punic War); a number of others, including allies from the First Punic War, were also free—Segesta, Halicyae, Panormus, Halaesa and Centuripe. The rest paid tithe to the Roman people according to the law of Hieron, which was extended to the whole island. Sicily had long had a surplus of corn for export, and Livy records occasional dispatch to Rome as early as the 5th century B.C.; the island now became the granary of the Roman people. The rolling country of the central part of the island was suitable for pasture and cultivation on a large scale, in *latifundia*, and slave gangs were introduced on the estates both of rich Sicilians and of Roman citizens. Hence rose the two great slave revolts of the second half of the 2nd century B.C., the first from 135 to 132, with Enna and Tauromenium as its centres, the second from 104 to 100; both periods of internal and external stress at Rome. The settlements after these two wars by Publius Rupilius (131) and Manius Aquilius (99) modified the organization of the province, which is well known from Cicero's speeches against Verres.

In spite of slave wars and the burden of Roman provincial governors and tax farmers, Sicily was not unprosperous under the Roman republic. It was free from external dangers; and even the unprivileged cities kept their own laws, magistrates and assemblies, and provision was made for lawsuits between Romans and Sicilians and between Sicilians of differentcities. There seems not to have been much commercial exploitation; tax collecting was normally in the hands of the Greeks themselves, not of Roman *publicani;* and smallholdings continued to be the rule in many cities. The wealth of the cities, both free and tributary, may be seen from the speeches of Cicero in prosecution of the propraetor Verres, who in three years' rule (73–71) had plundered widely, with especial attention to works of art. He also failed to defend the province against pirates.

Sicily was again a battlefield between 43 and 36 B.C., when Sextus Pompeius held Messana and cut off the corn supply of Rome. In the division of provinces between Augustus and the senate, Sicily fell to the latter. It had perhaps received Latin rights from Julius Caesar. Augustus planted colonies at Panormus, Syracuse, Tauromenium, Thermae, Tyndaris and Catana. But the island remained Greek; not only the old Greek cities, but also the old Sicel towns. which had long been completely assimilated to the Greek, used Greek as their everyday language, though Latin was used for official purposes. Christianity was early introduced to Syracuse. where the catacombs and early churches (belonging mainly to the Byzantine period) are second only to those of Rome. The island has little history in the Roman imperial period; its continued prosperity is shown by the Roman amphitheatres of Syracuse and Catana and by Roman remains in other cities large and small; a few cities declined and show now only Greek remains, but these were in general replaced by others. The tourist traffic in Sicily is as old as the Roman period. Cicero praises the climate of Syracuse, and the emperor Hadrian climbed Etna in A.D. 126 to see the sunrise. In the late 3rd century a rich Roman, perhaps a high court official, perhaps even an emperor (the name of Maximian has been suggested), retired and built a huge villa, with floor mosaics with lively pagan scenes, near the modern town of Piazza Armerina. In the division of Constantine, Sicily became one of the provinces of Italy and, together with Africa, Raetia and western Illyricum, was made part of the Italian prefecture; with Sardinia and Corsica, it was part of the Italian diocese.

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The Byzantine Period, to 827.—The earlier Germanic invaders of the Roman empire did not reach Sicily, though Alaric had designs upon it. The Vandals under Gaiseric, however, raided and invaded Sicily from Africa for about 40 years intermittently until in 476 they ceded the greater part of it to Odoacer, the barbarian king of Italy, against the payment of an annual tribute. The Ostrogothic successors of the latter paid no tribute to the Vandals after 491, but Theodoric gave Libybaeum to the Vandal king Thrasamund, to whom his daughter Amalafrida was married in 500. Belisarius, having destroyed the Vandal kingdom in 533–534, occupied Sicily in 535, when the Byzantine emperor began hostilities against the Ostrogoths in Italy; and though Totila recovered part of the island in 550, it was lost again before the final overthrow of the Ostrogothic kingdom at Taginae (552).

Sicily had thus come under Byzantine rule. When the emperor Heraclius and his successors divided the empire into themes, Sicily became one of them, placed between the exarchate of Ravenna in the north and that of Carthage in the south; it was administered by a *patricius* responsible to the government at Constantinople. Probably after the Italian revolt of 726 and certainly after the fall of the exarchate in the middle of the 8th century, the Byzantine dominions in southern Italy were incorporated in the theme of Sicily, an arrangement which lasted until the time of the Arab conquest, when the mainland dominions were formed into the themes of Calabria and Longobardia.

Ecclesiastically, Sicily remained at first under the papacy, which in addition to rights of jurisdiction had considerable interests in the island, arising from its vast Sicilian estates. Gregory I's letters admirably illustrate the importance attached to them by the pope. The iconoclastic controversy and the ensuing revolt against Byzantine rule under papal leadership (726) led to the confiscation by the emperor of the papal estates in Sicily and southern Italy; soon after, the ecclesiastical jurisdiction of these regions passed to the patriarch of Constantinople.

These political and ecclesiastical changes corresponded to demographic and cultural developments of longer standing. In Sicily and southern Italy, the Greek element had been greatly strengthened since the end of the 6th century as a result of emigration from other Byzantine provinces after the Avar and Slav invasions of Greece and, later, of the Persian and Arab conquests. The Hellenization of Sicily, which appears to have been all but complete in the 8th century, is revealed in the history of the Sicilian church. The Greek rite, already used at the time of Gregory I, spread during the 7th century from the eastern coast over the whole of the island. By the time of its separation from Rome, the Sicilian church was virtually Greek. Sicily was thus well on the way to becoming a fully integrated part of the Byzantine empire when the Arab conquest, which began in 827, interrupted this development.

Ever since the 7th century, Arab expansion in North Africa had constituted an immediate threat to Sicily and to southern Italy, the occupation of which would moreover expose Greece, the exarchate of Ravenna and Dalmatia to Saracen attack. Sicily consequently became a vital link in the imperial defense against Islam. Constans II (641–668) was the first Byzantine emperor fully to appreciate this; in 663–668 he tried to strengthen the Byzantine position in Sicily by his own presence. Constans, however, was assassinated during a rebellion at Syracuse in 668. Mizizes, who was then proclaimed emperor by the Byzantine militia, fell from power in 669.

This rebellion was followed by other risings in Sicily in 718 and in 781, which, although primarily of a military nature, doubtless also reflected separatist tendencies. A more dangerous revolt, that of the naval commander Euphemius about 826, was to be the immediate cause of the final conquest of Sicily by the Arabs.

Sicily under the Arabs.—Following the conquest of North Africa, Arab descents from Africa began in 'jog. They were interrupted for the invasion of Spain (710), and the next serious attacks were probably not made before 740 and 752–753. Energetic Byzantine reaction on this last occasion was followed by a respite lasting more than 50 years. But in 827 Euphemius, who had been proclaimed emperor in Sicily, appealed for help to the Aghlabite amir of Africa. But once the Arabs had landed they began the conquest on their own account. Euphemius was murdered by Sicilians in 828; and Palermo fell in 831 and became the base for further conquests. When a stronger policy was adopted under the emperor Michael III, it was too late; after the Byzantine defeat near Butera in *c.* 845, the whole of the Val di Noto fell into Arab hands; its occupation was practically completed with the capture of Enna in 859. A Byzantine offensive under Basil I led to some temporary successes. but the fall of Syracuse in 878 all but sealed the fate of Sicily; when they captured Taormina in 902, the Arabs were practically masters of Sicily. Local resistance and insurrections however continued. Together with internal discords in the Arab camp, they did much to slow up the Arab advance, despite the scant help from Constantinople. The Val Demone (*i.e.,* the region between Etna, Messina and Caronia) held out longest; and the last Byzantine stronghold. Rametta, was not lost until 965. The Byzantines, however, did not abandon hope of reconquering Sicily. Basil II was planning a Sicilian expedition at the time of his death (1025); it was actually dispatched in 1038 under the gieat Byzantine general, George Maniaces. The campaign was highly successful, and a large part of eastern Sicily, including Messina and Syracuse, was recaptured; but after Maniaces had been suddenly recalled, the Byzantine position on the island collapsed.

The Arab conquest separated Sicily not only from Constantinople but also from the Italian mainland, where the Arabs did not succeed in establishing themselves permanently. The history of Arab Sicily, on the other hand, is marked by growing independence from Africa. Until 909, it was under the Aghlabites; after their fall, it passed under the Fatimites, who moved their capital to Cairo in 972. But from the middle of the 10th century the office of the governor (amir) became hereditary in the dynasty of the Kalbites. until the anarchy after Maniaces' conquests led to the fall of that dynasty and to the division of Sicily into a number of principalities, while Palermo acquired self-government.

During and after the conquest, large Arab immigration from Africa took place; this, together with the conversions of Christians, contributed to make Sicily not only politically but also culturally part of the Arab world. However, the Greek Christian element remained predominant in the Val Demone; and even after the Arabs gained a majority in the rest of Sicily, Christian groups remained scattered over the island.

As in other Arab countries, the Christians, although placed in a position of legal inferiority, enjoyed religious toleration and a measure of self-government, against the payment of taxes that may have been often less burdensome than those levied by the Byzantines. Relics of the Greek episcopate seem to have survived to the end of the Arab period; so did a number of Basilian monasteries; both provided the principal link with the Byzantine world outside (particularly with Calabria, where the Greek population had been strengthened by emigrants from Sicily). As far as the Sicilian clergy, secular and regular, was concerned, this emigration seems to have been less the result of persecutions than of the gradual spread of Islam over Sicily.

The Norman Conquest: Roger I.—When the Normans began to conquer Sicily in 1060, they were at first welcomed as liberators and their progress was doubtless assisted by the Christian population. They were no newcomers to the island. Norman mercenaries from the mainland, among them two sons of Tancred of Hauteville, had fought in George Maniaces' army and had taken part in the capture of Messina. In 1059, Pope Nicholas II invested another son of Tancred, Robert Guiscard (*q.v.*), with his past and future conquests not only in Apulia and Calabria, but also in Sicily. In his oath of allegiance, Robert styled himself "by the grace of God and St. Peter duke of Apulia and Calabria and. with their help, hereafter of Sicily."

The conditions under which the Norman expedition took place were to leave a profound mark on the history of Sicily. The papal enfeoffment of Robert with Sicily may have been legally contestable — it mas naturally not recognized by Constantinople—but it forged a link between the papacy and Sicily, which long outlasted Norman rule.

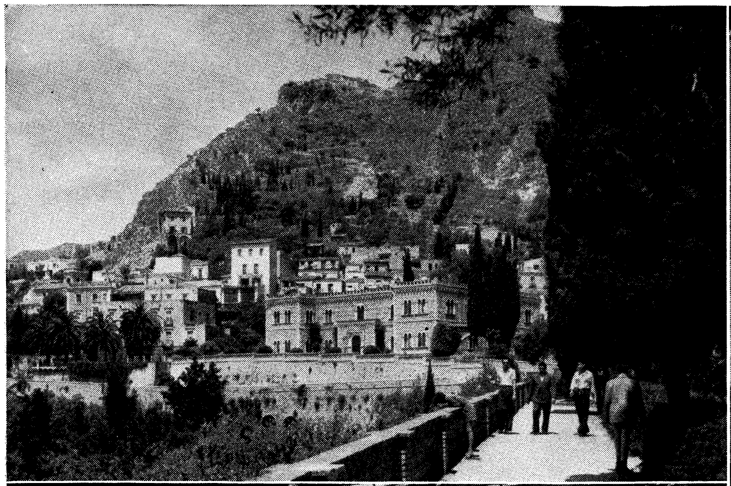
It was Robert's brother, Count Roger I (*q.v.*), who as the former's vassal and with his assistance became the real conqueror of Sicily. Internal conflicts among the Arabs served him well The amir of Syracuse and Catania, at war with his brother-in-law, the amir of Girgenti and Castrogiovanni (as Enna came to be called), went so far as to offer Roger his help to conquer the island. The first landing (1060), near Messina, was followed by an equally inconclusive attack on that town in 1061; the third, made in greater strength and with the participation of Robert, succeeded (summer, 1061). The possession of Messina gave the Normans control of the straits and a military base for further advance; the capture of Palermo (1072) concluded the first phase of the conquest; and the capture of Noto (1091) completed it. Although Robert's assistance was at first all-important, Roger soon assumed the leading role. After the conquest, Robert probably retained only Palermo — apart from the suzerainty over the whole island, which suzerainty became entirely nominal under Roger Borsa, Robert's weak successor as duke of Apulia (1085–1111), who in 1091 surrendered half of Palermo to his uncle.

If Roger was the real conqueror of Sicily, he was also the founder of the Norman Sicilian state. By distributing fiefs sparingly, he gave feudalism a less important place in Sicily than it had acquired on the mainland, where Robert Guiscard had established his ducal power by making the Normans accept him as their ruler. At the same time, he accepted much of the existing law and institutions. In his treatment of the Arab majority, his policy of religious toleration resembles that previously practised by the Arabs. Their legal conditions varied considerably, ranging from the liberties that they enjoyed at Palermo, where they had their own quarter and mosques, to the serfdom of the mass of the country population. Roger made use of their military and administrative services; many leading Arabs, however, seem to have left the country after the conquest.

Roger showed much favour to the Greeks, as appears from his lavish patronage of Basilian monasticism. He founded or restored at least 14 Greek monasteries as against 4 Benedictine ones. The Norman conquest was followed by an increase of the Greek population, Basilian monks from Calabria forming only one element of the new immigration. The Sicilian church, however, became Latin, according to the promise made by Robert Guiscard to Pope Nicholas II in 1059. But the papacy was left only little influence in it; the concession of the apostolic legation to Roger (1098) made the Sicilian church practically independent of Rome by sanctioning an already existing state of monarchical control.

Roger II and the Foundation of the Kingdom. — The survival of Roger I's work during the difficult period after his death (1101) was a measure of his success. Roger's son and heir Simon died in 1105 and was succeeded by his brother Roger II; but their mother Adelaide ruled as regent from 1101 until Roger attained his majority in 1112. Roger continued his father's efforts to take advantage of the difficulties of the duke of Apulia (Roger Borsa had been succeeded by his son William in 1111), not only by eliminating the last relic of ducal authority on the island. obtaining the second half of Palermo in 1122, but also by extending his lands and influence in the duchy of Apulia and in Calabria. After Duke William's death in 1127, Roger II crossed over to the mainland to assert his claims as his heir.

Roger's expedition opens a period of struggles which lasted until 1139. His claims were opposed not only by many lords and towns but also, until 1128, by Pope Honorius II. By supporting the antipope Anacletus II after the disputed papal election of 1130, Roger obtained the royal title for Sicily. Apulia and Calabria (1130). But this led to an alliance of Innocent II and the emperor Lothair against the ruler who by his support of the antipope nas primarily responsible for the prolongation of the schism. Lothair's invasion of the kingdom in 1136 in alliance with Pisa and Venice and, perhaps, Byzantium brought Roger's fortunes to their lowest point. But after Lothair's withdrawal, Roger soon recovered lost ground, and aiter the death of Anacletus (1138), Innocent II confirmed him in the royal title. The treaty of Mig-



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VIEWS OF SICILY

Top left: Taormina, formerly Tauromenium established at the time of the Carthaginian wars, 4th century B.C.
Top right: Mt. Etna seen from a distant building
Centre left: Sardine fishermen of Palermo spreading their nets
Bottom left: Adano. The church of S. Angelo is shown in the background
Bottom right: The Duomo, Palermo, built in the 12th century

nano (1139) meant the final acknowledgment by the papacy of the Norman kingdom, which included the mainland provinces of Apulia, Calabria and Capua as well as Sicily.

The political problems of the kingdom were, to no small extent, a legacy of the different territories of which it was formed. Thus the conflicts with the German and Byzantine emperors belong largely to the history of the South Italian provinces; while Roger's and his successor's African policy is rooted in the earlier history of Sicily. The first expeditions against the Zeirite prince of Mahdia in North Africa (1118, 1123) were failures; but in 1134–35 internal discords in the Zeirite state provided Roger with fresh opportunities for intervention, which was facilitated by the growth of the Sicilian navy; the expedition led to the occupation of the island of Jerba. The capture of Tripoli in 1146 initiated a series of conquests which culminated in that of Mahdia in 1148; by that year, Roger's African empire extended from Tripoli to Tunis, from the desert of Barca to Kairwan. That it was short-lived was primarily due to the failure to check the growing power of the Almohades; and the death of the grand admiral George of Antioch, the conqueror of Africa, in 1151–52 and that of Roger II in 1154 jeopardized its survival. The crisis was to begin in 1156 with an Arab rising in Africa; by 1160, the African empire was lost. The Norman kings, however, did not abandon their African ambitions: William II was to send a fleet to lay siege to Alexandria in 1174, and further expeditions were to be undertaken against the North African coast in the following years.

Expansion in Africa had sharpened the antagonism between Norman Sicily and Constantinople. At first, when the Byzantines had received support from the western emperors, the alliance of the two empires constituted a formidable threat to the Sicilian kingdom; but the clash between Byzantine and western imperial claims led, after Frederick I Barbarossa's accession (1152). to the end of the alliance, Frederick continuing an anti-Norman policy of his own. Roger took the initiative against Byzantium in 1147 and 1149, seized Corfu and invaded Greece. The Byzantines, on the other hand, reconquered part of Apulia in 1155, after Roger's death; but they lost the conquered territories again after their crushing defeat at Brindisi (1156). Peace was concluded in 1158 and was not broken until 1185, when King William II invaded the Byzantine empire, took Durazzo and Thessalonica and advanced toward Constantinople, with the ultimate aim of seizing the eastern imperial crown. But the counteroffensive under the new emperor Isaac II Angelus put an end to this expedition. It was the last great enterprise of the Norman kings.

Internal Development under the Normans.—Roger II's internal policy was based on that of his father and was continued by his son William I (1154–66) and by the latter's son William II (1166–89); but his own contribution to the building of the Sicilian state was very great. The combination of Norman, Arabic and Byzantine elements is perhaps the most striking but at the same time a very natural characteristic of the government and civilization of the kingdom. Roger's Assizes (1140) derive largely from Justinian and later Byzantine law; very strong Byzantine influence can be found in the judicial and fiscal administration and in the central financial department, the duana (diwan), the personnel of which was originally Arabic. The Norman chancery issued documents in Latin, Greek and Arabic. On the other hand, the curia was primarily modelled on that of the northern European states; and not only were feudal institutions accepted, but feudal barons also played an important part in the provincial and local administration. At the same time, some of the most influential ministers of the Norman period, the grand admirals or amirs of amirs such as George of Antioch were Greeks. Roger's capital was cosmopolitan Palermo.

But despite the role played by Greeks and Arabs in the bureaucracy, Sicily became progressively latinized. While the Moslem population was decreased by conversions, the Latin element was strengthened by the settlement of colonies of "Lombards" (*i.e.*, mainlanders), Greeks and Arabs being gradually reduced to small minorities. This process is also reflected in the large number of Latin monasteries founded by the kings, after the initial favour shown to the Basilian monks. But Sicilian civilization retained the composite character that it had possessed from the beginning; Sicilian scholars translated Greek classical texts into Latin; Idrisi (*q.v.*), on the orders of Roger II, composed one of the outstanding works of Arab geography; and Sicilian architecture was the product of Roman, Byzantine. Arabic and Norman influences.

The **Hohenstaufen** Accession.—The death of William II (1189) was followed by a struggle for the succession. William I and William II had long supported Pope Alexander III in his conflict with Frederick Barbarossa; but a truce had been concluded in 1177, and the subsequent rapprochement between king and emperor had resulted in William II's sanctioning the betrothal of Frederick's son Henry to Constance, daughter of Roger II and heiress apparent to the kingdom (1184). This created a situation of great potential danger for the papacy, as it strengthened imperial claims on the kingdom of Sicily by the addition to them of Constance's rights. On William's death, however, there was strong Norman opposition to the prospect of German rule, and Tancred, an illegitimate grandson of Roger II, was crowned king. Frederick's son, who had succeeded his father as Henry VI, failed to assert his claims in 1191, when he was forced to raise the siege of Naples; but the sudden death of Tancred early in 1194 proved a turning point. The reign of his young son, William III, under the regency of Queen Sibylla lasted only ten months; Henry VI finally occupied the kingdom and was crowned king at Palermo in 1194. A new period in the history of Sicily had begun.

Henry aimed at including Sicily permanently in the empire, which he unsuccessfully tried to make hereditary in his family, the house of Hohenstaufen; and the distribution of high offices and lands among his followers was to strengthen his control of the kingdom. His death in 1197 temporarily put an end to imperial domination. Constance, as ruler with her young son, the future emperor Frederick II (*q.v.*), returned to a strictly Norman policy. But she died in 1198, leaving Frederick under the guardianship of Pope Innocent III. The following years were marked by growing anarchy, due to the weakness of the monarchy, to the attempts of German lords to seize hold of the kingdom, to the Arabs' endeavours to improve their position and to the commercial expansion of Pisa and Genoa. In 1208, Innocent handed the government to Frederick on his reaching his majority.

The Emperor Frederick **II** (Frederick I of Sicily).—Three years later, the pope saw himself forced to support Frederick's renewed election as king of the Romans in order to defeat Otto IV. Frederick promised Innocent, just before the latter's death in 1216, to renounce the kingdom in favour of his son Henry after his imperial coronation; but the papacy's hope to prevent in this way the reunion of Sicily and the empire was not fulfilled. for in 1220 Frederick succeeded in having Henry elected German king. The eventual union of the German and Sicilian crowns, foreshadowed by this election, made papal insistence on Frederick's renunciation obsolete; and when Frederick was crowned emperor, in the same year, Honorius III tacitly recognized him also as Sicilian king.

Frederick devoted the following years to the restoration of royal power in the kingdom; and in this formidable task he revealed himself the true successor of Roger II. In Sicily, Frederick acted as Norman rather than German ruler: symptomatically, his edict on the resignation of privileges (1220) put the deadline at the death of William II, not of Henry VI. His preoccupation with the affairs of the kingdom was largely responsible for the postponements of his crusade, which led in 1227 to his excommunication. Papal troops invaded the kingdom during his absence in Syria (1228–29); but Frederick's return meant his immediate victory, and the peace of San Germano (1230) was followed by further internal reforms. The outstanding legislative achievement of this period mas the constitution of Melfi (1231), a legal code which, inspired by Roger II's Assizes, gives a remarkable insight into the organization of the kingdom and also into the political ideas of its ruler. Frederick carried the evolution of the Sicilian administration considerably beyond what had been achieved by the Normans; on the other hand, the use that he made of assemblies of estates was a landmark in the history of the Sicilian parliament (see below). In his highly centralized government. Frederick was the heir to his Norman predecessors, whose work he continued.

The same continuity can also be seen in Sicilian culture; but at Frederick's brilliant cosmopolitan court Italian poetry provided a new formative element.

The End of Hohenstaufen Rule: Manfred.—Frederick's work was jeopardized and his dynasty ruined by the union of Sicily with the empire. The conflicts with the papacy and with its allies, the Lombard communes, meant a serious strain on the Sicilian economy and started a chain of events which was finally to lead to the establishment of the house of Anjou in the kingdom. Innocent IV, having deposed Frederick from the imperial throne (1245), desired to deprive him and his descendants of the Sicilian crown as well. Frederick's death in 1250 and that of his son Conrad IV in 1254 provided the papacy with new opportunities, but the success of Manfred, one of Frederick's illegitimate sons, in establishing control over the kingdom even before Conrad's death complicated the situation and gave rise to lengthy and tortuous negotiations in which papal offers of the Sicilian crown to foreign princes alternated with rapprochements to Conrad and to Manfred. Manfred was crowned king at Palermo in 1258—a usurpation of the rights of Conradin, Conrad IV's young son and heir. In 1263, after negotiations with Manfred had broken down for the last time, Pope Urban IV announced the choice of Charles of Anjou (*see* CHARLES I of Naples), brother of Saint Louis, as king of Sicily (Edmund, son of Henry III of England, who had been invested by the papacy with the kingdom in 1255, had failed to substantiate his claims). In 1265, Charles was invested with the kingdom by Pope Clement IV in Rome; at Benevento, in 1266, he defeated Manfred, who was killed in the battle.

Charles of Anjou.—After Benevento, there was no serious resistance to Charles in the kingdom. But his rule had still to stand its test when Conradin came to Italy in 1267 to seize his inheritance. A rising in his favour swept the kingdom and showed the fragility of Charles's position. In 1268, however, Conradin was defeated at Tagliacozzo and executed at Naples. There followed severe suppression of the revolt, especially in Sicily, where it had been more widespread than on the mainland. Charles tried to put his power on a firm foundation by a large-scale distribution of fiefs among his French nobility. At the same time he preserved, in its main outlines, Frederick's system of government. The "French colonization," however, and the sense of grievance that it caused among the Sicilians was partly responsible for the great Sicilian revolt of 1282, the Sicilian Vespers (*see* VESPERS, SICILIAN), which severed Sicily once more from the mainland.

The House of Aragon and Spanish Rule.—On the outbreak of the revolt a parliament at Palermo offered the crown to Peter III of Aragon, son-in-law of Manfred, who became Peter I of Sicily; and the 20 years' war that followed led to the permanent establishment of the Aragonese dynasty in Sicily. However, the treaty of Caltabellotta (1302) did not put an end to the attempts of the house of Anjou, whose state was now limited to the mainland, to reconquer the island (*see* NAPLES, KINGDOM OF). The Italian expedition of the emperor Henry VII (1310–13) led to a renewal of hostilities and was followed by several Neapolitan expeditions against Sicily; in 1356 the house of Anjou even succeeded in occupying Messina for a short period.

From 1296 to 1402, Sicily was ruled by the Sicilian branch of the Aragonese dynasty: by Peter's third son Frederick II, who styled himself Frederick III (*q.v.*; 1296–1337), crowned after four years' regency for his brother James (king of Aragon since 1291); by Frederick's son, Peter II (1337–42); by Peter's son, Louis (1342–55); by Louis's brother, Frederick III the Simple (1355–77); and by Frederick's daughter, Mary (1377–1402), who from 1392 reigned together with her husband, Martin I, son of the future Martin I of Aragon. After Mary's death in 1402, her husband Martin I became sole ruler; after his death in 1409, his father Martin I of Aragon became king of Sicily as Martin II but died in 1410; and in 1412, the crowns of Sicily and Aragon passed to Ferdinand I. Thus Sicily came under direct Spanish rule; and when Alphonso V of Aragon, who had succeeded Ferdinand in 1416, conquered the kingdom of Naples from René of Anjou in 1442, the old Sicilian kingdom was reconstituted. The political union of Sicily and the mainland was, however, again broken when Alphonso (d. 1458) left the "kingdom of Naples" to his illegitimate son Ferdinand, while his brother John succeeded in Aragon and Sicily. In 1500, the treaty of Granada divided the kingdom of Naples between Ferdinand the Catholic, who had become king of Aragon and Sicily in 1479, and Louis XII of France; and after the expulsion of the French (1503), the union of Sicily and the kingdom of Naples under the Spanish monarchy lasted until 1707. Continuous Spanish rule in Sicily came to an end in 1713.

The power of the Sicilian nobility increased considerably during the early Aragonese period at the expense of the monarchy and of the towns, thanks to the lavish grants of lands and privileges by the kings; and the 14th century was marked by feudal struggles —which were largely determined by the conflicts between the older nobility and the families which had immigrated from Spain— until order and strong government were restored by the Spanish Aragonese. The kings of Aragon ruled Sicily through viceroys from 1415 onward; Ferdinand I refused the Sicilian request to make the viceroy a separate king (1416), and the governor remained the representative of the Aragonese monarch. His very extensive powers, and indeed those of the monarchy itself, were, however, to some extent limited by the Sicilian parliament, whose growth was the most outstanding constitutional development of the Aragonese period. The importance of the Sicilian parliament had increased greatly from the time when the emperor Frederick II had given municipal representatives a place in his general assemblies (1232); in the 14th century, under the influence of the Aragonese assemblies of estates, the parliament was formed into an assembly of three houses (*bracci*), the third being composed of towns of the royal domain, which by the end of the next century was meeting regularly every three years.

By the middle of the 15th century it had become a basic principle of the Sicilian constitution that no new taxes should be levied without the consent of the parliament. As elsewhere in Europe, the voting of subsidies could be used by the parliament to influence policy and legislation; and the Sicilian estates thus became the most important obstacle to the absolute power of the Aragonese monarchs and their viceroys.

For later history, up to the incorporation of Sicily in the kingdom of Italy, *see* NAPLES, KINGDOM OF, and articles on the persons therein mentioned. *See* also MAFIA and, for the invasion and occupation of the island in 1943, WORLD WAR II.

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POPULATION, GOVERNMENT AND ECONOMY

Population.—The census of Nov. 1951 showed that Sicily had a population of 4,486,749 (2,206,031 males and 2,280,718 females), an increase of 486,671 or 12.2% on the census of 1936, to be compared with an increase of 10.5% for Italy. The average density was 175 per square kilometre (452 per square mile), to be compared with Italy's 159 per square kilometre (409 per square mile). The population of the several provinces of the region is tabulated in the article ITALY: *Population.* The distinctive feature of the population distribution is the small number of people living in scattered houses. In 1936 only 10% of the population was given as scattered (*cf.* 26% in Italy as a whole). About one-third of the population lives closely packed together in the towns and villages on the Tyrrhenian and Ionian coasts and on the lower slopes of Etna; in the interior most people live at an average height of 1,000 ft. in towns having not less than 5,000 inhabitants and mostly more than 10,000, built on the flat hilltops.

The birth rate fell from 27 per 1,000 in 1938 to 22.6 in 1955 (*cf.* Italy's 17.7), but the death rate also showed a big drop, from 15.3 to 8.7 per 1,000, so that the natural increase was 13.9 per 1,000 (*cf.* Italy's 8.6). The rate of infant mortality dropped steadily and had fallen to 57.3 per 1,000 live births in 1954, a high figure compared with Liguria's 36.4 and Tuscany's 37.1 but a great improvement on that of 127.1 for 1938 The gloomy side of this picture is Sicily's continuing overpopulation. During the first ten years of the 20th century vast numbers of Sicilians emigrated. The annual average number of overseas emigrants from 1906–10 was more than 80,000, about 22% of Italy's total; in 1955 about 21,500 were able to emigrate.

Government.—Sicily is one of the five regions or *regioni* of Italy which obtained a special form of local autonomy under the constitution of 1948 (*see* ITALY). The Sicilian regional statute was conferred by an Italian constitutional law on Feb. 26, 1948. The capital of the region is Palermo.

The background of regional government in Sicily is totally different from that of the other regions enjoying local autonomy. The history of Sicily, occupied by many invaders and for long periods separated politically from the mainland, had produced a people differing greatly in character and habits from the inhabitants of the mainland. Sicily accepted incorporation in Italy in 1860, but the political institutions of Piedmont were not well suited to it, and the centralized control imposed by the government in Rome, afraid of any threat to Italy's recently won unity, checked the possibility of local autonomy. There was no political separatist movement before 1940, but there was a general feeling of discontent and a widespread belief that the interests of Sicily were sacrificed to those of the industrial north.

The sense of neglect and isolation accentuated by the unsettled conditions arising from the fall of the Fascist government and the Allied occupation in World War II produced the separatist movement of the summer of 1943. It gradually became clear that very few Sicilians wanted separation from Italy but that a large number wanted a considerable measure of local autonomy. The Italian government installed a high commissioner with plenary executive powers in Jan. 1944; and a royal decree law of May 15, 1946, granted Sicily a statute of autonomy which was converted unchanged into the constitutional statute of Feb. 26, 1948.

The statute gave Sicily a very considerable degree of self-government. The regional assembly (the local parliament) can be dissolved only for persistent violation of the statute and then only after a debate in the Italian parliament. The assembly's legislative powers are more extensive than those of any other region. Elementary education is in its hands, and legislation on higher education (including university education) is limited only by the need to conform to the general principles of national education. Without prejudice to the national parliament's plans for agrarian and industrial reform, the regional assembly has exclusive power to legislate on all questions concerning agriculture, land reclamation, industry and commerce.

The president of the region, elected by the assembly from among its members, is an important person. He not only represents the region, promulgates regional laws and, together with the *giunta* (the executive committee of the assembly), constitutes the government, but also has the right to attend meetings of the Italian council of ministers with the rank of minister and to speak when Sicilian questions are under discussion (though he has not the right to vote). He also represents the national government in the region, although the government may send temporarily special commissioners to explain particular functions which belong to the state. The president and *giunta* are invested by the statute with the supremely important executive function of maintaining public order by means of the national police force, although at their request the national government can act jointly with them.

Sicily has a high court of justice of its own in Rome, half of whose members are nominated by the Italian parliament and half by the regional assembly. This court decides on the constitutionality of laws issued by the regional assembly and of national laws which affect the regional statute.

The financial provisions of the statute are peculiar to Sicily. The island is expected to provide for its own expenditure by raising its own taxes. but the Italian state has agreed to hand over to the region a share of the taxation raised from firms which have factones or offices in Sicily though their central offices are not in the island. The state has also to pay over a lump sum annually for public works in Sicily.

The first regional parliament of 90 members was elected in April 1947; at the elections, held in June 1955, the Christian Democrat party obtained 37 seats, the Communists 20, the Socialists 10, the neo-Fascist *Movimento Sociale Italiano* 9 and the Monarchist party 8, while the other 6 seats were divided among Liberals, Social Democrats and the Popular Monarchist party.

The Sicilians are jealous of their independence and intolerant of any interference, but their experiment in regional autonomy began under difficult conditions and had to be carried on against a background of agrarian unrest, extreme poverty and a general feeling of resentment against Rome.

Agriculture and **Stockraising.**—In 1936 more than half the employed population of Sicily were engaged in agriculture. World War II did not materially alter the economic structure of the island and in 1951 the proportion was 51%. The outstanding feature of Sicilian land use is the very high proportion of the total area given over to agriculture and forest, more than 95% (cf. Italy's 92%).

Sicilian agriculture is dominated by the lack of water, which limits production and restricts the use of modern technical methods. Both intensive and extensive methods of cultivation exist in Sicily. Water and irrigation produce marvels of intensive farming, which is found along the narrow coastal fringe of the north and east coasts, on the slopes of Etna and of the Iblei mountains, in the immediate neighbourhood of towns in the south such as Xgrigento and Sciacca, around Marsala in the west and in the Conca d'Oro behind Palermo. Citrus fruits and vegetables grow in abundance and provide the main source of the island's exports. In these fertile areas small holdings are important and the majority of the farms are small (less than seven acres). Extensive farming prevails all over the interior, where the practically treeless land produces the wheat for which Sicily has been famous for more than 2,000 years.

The characteristic estates of the interior were the *latifondi*, large extensively cultivated estates frequently owned by absentee landlords and run on capitalist lines by middlemen who employ a few workers engaged by the year (*salariati*) and large numbers of badly paid day labourers. Before 1939 farms of more than 125 ac., which constituted less than 1% of the total number of farms in Sicily, occupied 36% of the land. Large areas were also sublet in fragmentary holdings to peasants who farmed the land extensively and thus created what is known as the *latifondo contadino* (the peasant's *latifondo).*

Subject to general conformity with the Italian parliament's plans for land reform, the regional government of Sicily has exclusive power to legislate on all agrarian questions. To change the system of extensive *latifondo* farming, however, was a difficult proposition : the shortage of water throughout the interior meant that any scheme for abolishing the great estates and for establishing peasant proprietors would be meaningless unless it made provision for a regular and sufficient water supply, which alone would make it possible to grow other crops than wheat; and supplies of water and better local roads were also required if the peasants were to be persuaded to live in small villages near their fields. Yet the Sicilian regional government made a beginning. On Dec. 27, 1950, a law was issued on the expropriation of land applicable to the whole island: 69,500 ac. were listed for expropriation (this amount was expected to rise to 250,000 ac.). Intensively cultivated land was exempt. The work of expropriation and redevelopment was entrusted to the Sicilian Land Reform agency in Palermo under the general supervision of the Italian ministry of agriculture.

Sicily's most important crop is wheat. In 1955 there were nearly 1,500,000 ha., or 3,750,000 ac. of arable land (61% of the cultivable area), of which 680,000 ha. were sown to wheat; production amounted to 774,300 metric tons or 10% of the total Italian wheat production. The yield, however, was low: Sicily produced only 11.4 quintals per hectare. as compared with an average of 19.6 for the whole of Italy and 35.0 for Lombardy. The second most important crop consists of citrus fruits, particularly lemons, of which Sicily produced 286,000 metric tons in 19jj, about 90% of Italy's total crop. The island also produces large quantities of fresh vegetables, particularly tomatoes, artichokes, peas and beans, and their early season makes them a profitable export crop. Quantities of wine are produced, mostly for local consumption; Marsala, however, is a valuable export wine.

The estimated number of cattle in Sicily had risen from 168,000 in 1930 to 238,000 in 1955; although the latter figure could be compared favourably with those for the southern regions of continental Italy it was admittedly much too low. The supply of fodder is poor, there are few permanent meadows, and much of the pasture is rough, only suitable for sheep and goats, both of which abound. The characteristic animals of Sicily are the donkeys and mules; there are enormous numbers of them (295,000 in 1955) and the sound of their bells and the size of their packs, often surmounted by a large peasant, are striking features of Sicilian life.

Fisheries.—In 1955, about one-quarter of the Italian fishing fleet was registered in Sicily (11,381 vessels, with a total tonnage of 35,750 metric tons), and fishing was an important source of employment. The most valuable fish caught is tunny (tuna); some is eaten fresh in Sicily, but most is canned for export. In 1935 the total Sicilian catch amounted to about one-third of Italy's, the tunny catch to one-half.

Industry.—The small canning industry of fish, fruit and vegetables was greatly expanded after 1945. The only important industry, sulfur mining. was adversely affected by the high cost of production and by the need for heavy capital expenditure to modernize the mines, so that the output of sulfur in 1950 only amounted to about half what it had been in 1938.

Communications.—Sicily's three chief ports are Palermo, Messina and Catania. A regular steamer connects Palermo with Naples, and Messina is linked to the mainland by the train-ferry service across the straits. The three chief ports are connected by three main railway lines, all single-track: one along the north coast from Palermo to Messina; one along the east coast from Messina to Catania and Syracuse; and one running inland from Catania to Palermo via Enna. The remarkable narrow-gauge circum-Etna railway, which climbs to 3,196 ft., is not a mere tourist line but carries heavy loads of agricultural produce. There are other secondary lines, but severe gradients and curves make traveling difficult. Main roads between important towns are good, but there is a dearth of good secondary roads, and some small hill towns or villages can only be reached by steep mule tracks. (M. M. C.)

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SICKERT, WALTER RICHARD (1860–1942), influential British painter, was born at Munich on May 31, 1860, the son of Oswald Adalbert Sickert, a Danish-born German draftsman who settled in England in 1868. After some years on the stage, Sickert went in 1881 to the Slade school of art in London; he retained, however: something of the make-up of a late Victorian actor-manager. He studied under Alphonse Legros but through his father knew the works of Thomas Couture and Gustave Courbet. In 1832 he became a pupil of Whistler and in 1883 met Degas in Paris; these artists much influenced his work and personality. His first pictures of London music-hall interiors appeared in 1886, and, at the New English Art club, founded in that year. Sickert exhibited until 1917. Like Whistler, Sickert used tonal methods to' gain his effects, and his colours up to about 1904 are sombre. To Degas he was indebted for the ability to establish a situation merely by the attitudes of the figures—an innovation in England, where narrative painting was then governed by literary principles. Sickert coupled this with a refreshing vein of satire.

Between 1885 and 1905 Sickert spent most summers at Dieppe and worked in Venice. Returning to London in 1905 he became the focus of a group of painters which included Lucien Pissarro, Spencer Gore. Harold Gilman and Augustus John. Through Gore's and Pissarro's influence, Sickert's work began to show the influence of Neuimpressionism, though he was unmoved by the more advanced French styles then beginning to be known in London. He was a founder of the Camden Town and London groups (1911 and 1913) and was made a royal academician in 1934, resigning in 1935. He painted at Brighton and Kath in the 1920s and 1930s and wrote occasional criticism) supporting the principles of drawing observed by Degas. Such principles, and Sickert's own style, have been vital to English art and teaching. He died at Bath, Somerset, on Jan. 22, 1942. His grandfather, Johann Jürgen Sickert (1803–64) and his brother Bernhard Sickert (1862–1932) were also painters.

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SICKINGEN, FRANZ VON (1481–1523), German knight, was born at Ebernburg near Worms on March 2, 1481. He fought for the emperor Maximilian I against Venice in 1508, inherited large estates on the Rhine and increased his wealth and reputation by numerous feuds. In 1513 he took up the quarrel of Balthasar Schlör, a citizen who had been driven out of Worms, and attacked this city with 7,000 men. He made war upon Antony, duke of Lorraine, and compelled Philip, landgrave of Hesse, to pay him 35,000 gulden. In 1518 he interfered in a civil conflict in Metz, ostensibly siding with the citizens against the governing oligarchy. He led an army of 20,000 men against the city, compelled the magistrates to give him 20,000 gold gulden and a month's pay for his troops. In 1518 Maximilian released him from the ban, and he took part in the war carried on by the Swabian league against Ulrich I, duke of Württemberg. In the contest for the imperial throne upon the death of Maximilian in 1519, Sickingen accepted bribes from Francis I, king of France, but when the election took place he led his troops to Frankfurt, where their presence assisted to secure the election of Charles V. For this service he was made imperial chamberlain and councillor, and in 1521 he led an expedition into France, which ravaged Picardy, but was beaten back from Mezières and forced to retreat. About 1517 Sickingen became intimate with Ulrich von Hutten, and gave his support to Hutten's schemes. In 1519 a threat from him freed John Reuchlin from his enemies, the Dominicans, and his castles became in Hutten's words a refuge for *righteousness.* Here many of the reformers found shelter, and a retreat was offered to Martin Luther. After the failure of the French expedition, Sickingen, aided by Hutten, formed, or revived, a scheme to overthrow the spiritual princes and to elevate the order of knighthood. He declared war against his old enemy, Richard of Greiffenklau, archbishop of Trier, and marched against that city. Trier was loyal to the archbishop, and the landgrave of Hesse and Louis V., count palatine of the Rhine, hastened to his assistance. Sickingen fell back on his castle of Landstuhl, near Kaiserslautern, collecting much booty on the way. On Oct. 22, 1522 the council of regency placed him under the ban, to which he replied, in the spring of 1523, by plundering Kaiserslautern. The rulers of Trier, Hesse and the Palatinate decided to press the campaign against him, and having obtained help from the Swabian league, marched on Landstuhl. On May 6, 1523 he was forced to capitulate, and died the next day.

SICKLES, DANIEL EDGAR (1819–1914), American soldier and diplomatist, was born in New York city on Oct. 20, 1819. He learned the printer's trade, studied in the University of the City of New York (now New York university), and was admitted to the bar in 1846. In 1833 he became corporation counsel of New York city, and from 1857 to 1861 was a Democratic representative in Congress. At the outbreak of the Civil War, Sickles was active in raising United States Volunteers in New York, became a brigadier-general of volunteers in Sept. 1861, led a brigade of the Army of the Potomac with credit up to the battle of Antietam, and then succeeded to a divisional command. He took part with distinction in the battle of Fredericksburg, and in 1863 as a major-general commanded the III. Army Corps. His energy and ability were conspicuous in the disastrous battle of Chancellorsville (*q.v.*); and at Gettysburg (*q.v.*) the part played by his corps in the desperate fighting around the Peach orchard was one of the most noteworthy incidents in the battle. He himself lost a leg and his active military career came to an end. Sickles was one of the few successful volunteer generals who served on either side. In 1869 he was retired with the rank of major-general (U.S.A.). He was minister to Spain from 1869 to 1873, and took part in the negotiations growing out of the "Virginius affair." In 1893–95 he was again a representative in Congress His last years were disturbed by financial difficulties. He died in New York city on May 3, 1914.

SICULI, ancient Sicilian tribe (Gr. *Sikelói*). In historical times it occupied the eastern half of the island to which it gave its name. It plays a large though rather shadowy part in the early traditions of pre-Roman Italy. There is abundant evidence that the Siculi once lived in Central Italy east and even north of Rome (*e.g.* Servius ad Aen. vii. 795; Dion. Hal. i. 9. 22; Thucydides vi. 2). Thence they were dislodged by the Umbro-Safine tribes, and finally crossed to Sicily. They were distinct from the Sicani (q *v.;* Virg. Aen. viii. 328) who inhabited the western half of the island.

The towns of the Siculi were under independent rulers. They played an important part in the history of the island after the arrival of the Greeks (see SICILY). Their agricultural pursuits and the volcanic nature of the island made them worshippers of the gods of the nether world, and they have enriched mythology with some national figures. The most important of these were the Palici, protectors of agriculture and sailors, who had a lake and temple in the neighbourhood of the river Symaethus, the chief seat of the Siculi; Adranus, father of the Palici, a god akin to Hephaestus, in whose temple a fire was always kept burning; Hybla (or Hyblaea), after whom three towns were named, whose sanctuary was at Hybla Gereatis. The connexion of Demeter and Kore aith Henna (the rape of Proserpine) and of Arethusa with Syracuse is due to Greek influence. Their chief towns were: Agyrium (*San Filippo d'Argiró*); Centuripa (or Centuripae; *Centorbi*); Henna (Castrogiouanni, a corruption of Castrum Hennae through the Arabic Casr-janni); Hybla, three in number, (a) Hybla Major, called Geleatis or Gereatis, on the river Symaethus, probably the Hybla famous for its honey, although according to others this was (b) Hybla Minor, on the east coast north of Syracuse, afterwards the site of the Dorian colony of Megara, (*c*) Hybla Heraea in the south of the island. For authorities see SICILY.

SICYON (or SECYON, the older local form), an ancient Greek city in northern Peloponnesus between Corinth and Achaea, on a low triangular plateau about 2 m. from the Corinthian Gulf, at the confluence of the Asopus and the Helisson. Between city and port lay a fertile plain with olive-groves and orchards. Its primitive name was Aegialeia "beach-town"; its original population Ionian; the myth and cult of Adrastus show early connection with Argos; and in the Iliad it is a dependency of Agamemnon. After the Dorian invasion it had the three Dorian tribes with an equally privileged tribe of Aigialeis (probably old Ionian) and a class of land-serfs (*κορυνηφόροι* or *κατωνακοφόροι*). For some centuries Sicyon remained subject to Argos, and acknowledged a certain suzerainty as late as 500 B.C. But virtual independence was established in the 7th century by anti-Dorian tyrants, known after their founder as the Orthagoridae, whose mild rule lasted longer than any other Greek tyranny (about 665–565 B.C.). The founder's grandson Cleisthenes held intercourse with many commercial centres of Greece and south Italy and gave his heiress in marriage to Megacles of Athens, whose son was the Athenian legislator of that name. Cleisthenes (*q.v.*) besides reforming the city's constitution and replacing Dorian cults by the worship of Dionysus, was chief instigator of the First Sacred War (590) in the interest of Delphi. After the fall of the tyranny, Cleisthenes' institutions survived till the end of the 6th century, when Dorian supremacy was re-established, and the city joined the Peloponnesian League. Henceforth its policy was usually determined by Sparta or by its powerful neighbour Corinth. During the Persian wars Sicyon furnished 3,000 heavy-armed men; its school of bronze sculptors produced Canachus (*q.v.*) a master of the late archaic style. In the 5th century it suffered like Corinth from the commercial rivalry of Athens and was repeatedly harassed by Athenian ships. In the Peloponnesian war Sicyon followed Sparta and Corinth. Again in the Corinthian war Sicyon sided with Sparta. In 369 when it was captured and garrisoned by the Thebans a powerful citizen Euphron established himself tyrant by popular support. His deposition by the Thebans and subsequent murder freed Sicyon for a while, but new tyrants arose with the help of Philip II. of Xiacedon. Nevertheless during this period Sicyon reached its zenith as a centre of art: its school of painting under Eupompus attracted Pamphilus and Apelles as students; its sculpture culminated in Lysippus and his pupils. After participating in the Lamian war and the campaigns of the Macedonian pretenders the city was captured (303) by Demetrius Poliorcetes, who transplanted the inhabitants to the Acropolis and renamed the site Demetrias. In the 3rd century it passed from tyrant to tyrant, until in 251 it was liberated and enrolled in the Achaean League (*q.v.*). The destruction of Corinth (146) brought an acquisition of territory and presidency over the Isthmian games; yet in Cicero's time Sicyon had fallen deep into debt. Under the empire it was quite obscured by the restored Corinth and Patrae; Pausanias (A.D. 150) found it almost desolate. In Byzantine times it became a bishop's seat, and its later name "Hellas" reveals it as a refuge for Greeks from Slavonic immigrants of the 8th century.

An insignificant village, Vasiliko, now occupies the site. Ancient fortifications are still visible, and remains of a theatre, a stadium, aqueducts and foundations of buildings.

SIDDONS, SARAH (1755–1831), English actress. the eldest of 12 children of Roger Kemble, was born in the "Shoulder of Mutton" public house, Brecon. Wales, on July 5, 1755.

She became attached to William Siddons. whom she married at Trinity church, Coventry, on Nov. 26. 1773. In 1774 she played Belvidera in Otway's *Venice* Preserved at Cheltenham, and moved to tears a party of "people of quality" who had come to scoff. Garrick then sent his deputy to see her as Calista in Rowe's Fair Penitent, the result being that she was engaged to appear at Drury Lane at a salary of £5 a week.

After a very successful engagement at Bath, beginning in 1778 and lasting five years, she again appeared at Drury Lane. when her acting as Isabella in Garrick's version of Southerne's Fatal Marriage (Oct. 10) was a triumph, only equaled in the history of the English stage by that of Garrick's first night at Drury Lane in 1741 and that of Edmund Kean's in 1814

As Lady Macbeth. Mrs. Siddons found the highest and best scope for her gifts. It fitted her as no other character did, and as perhaps, it will never fit another actress Her tall figure. brilliant beauty, expressive eyes and her dignity of demeanour heightened the tragedy of the part. After Lady Macbeth she played Desdemona. Rosalind and Ophelia, all with great success; in Queen Catherine—which she first played on the occasion of her brother John Kemble's spectacular revival of *Henry VIII* in 1788—she discovered a part almost as well adapted to her peculiar powers as that of Lady Macbeth. As Volumnia in Kemble's version of *Coriolanus* she also secured a triumph. Her last appearance was on June 9, 1819, as Lady Randolph in Home's *Douglas.* Mrs. Siddons died in London on June 8. 1831.

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SIDE (mod. ESKI ADALIA), an ancient city on the Pamphylian coast about 12 mi. E. of the mouth of the Eurymedon. Possessing a good harbour in the days of small craft, it was the most important place in Pamphylia. Alexander visited and occupied it, and there the Rhodian fleet defeated that of Antiochus the Great, and in the succeeding century the Cilician pirates established there their chief seat. An inscription shows it had many Jews in early Byzantine times. The great ruins cover a large promontory, fenced from the mainland by a ditch and wall which has been repaired in medieval times and is singularly perfect. Within this is a maze of structures out of which rises the colossal ruin of the theatre. built up on arches like a Roman amphitheatre.

SIDEBOARD. Originally the sideboard was what its name implies—a side table. Then two- or three-tiered sideboards were in use in the Tudor period, and were perhaps the ancestors, or collaterals, of the court cupboard, which in skeleton they much resembled. Early in the 18th century they began to be replaced by side tables properly so called. In the beginning these tables were entirely of wood and comparatively slight. but before long it became the fashion to use a marble slab instead of a wooden top. which necessitated a somewhat more robust construction. Many of the sideboard tables of this period were exceedingly handsome. with cabriole legs, claw or claw and bill feet, friezes of acanthus, much gadrooning and mask pendants. Many such tables came from Chippendale's workshops, but he had no influence upon the evolution of the sideboard. which arose from the growth of domestic needs. Save upon its surface, the sideboard table offered no accommodation; it usually lacked even a drawer. Even, however. in the period of Chippendale's zenith separate "bottle cisterns" and "lavatories" for the convenience of the butler in washing the silver as the meals proceeded were. no doubt, sometimes in use. By degrees it became customary to place a pedestal. which was really a cellarette or a plate warmer, at each end of the sideboard table. One of them would contain ice and accommodation for bottles: the other would be a cistern. Sometimes a singie pedestal would be surmounted by a wooden vase lined with metal and filled with water, and fitted with a tap. To whom is clue the brilliant inspiration of attaching the pedestals to the table and creating a single piece of furniture out of three components there is nothing to show with certainty. It is most probable that the credit is due to Shearer, who unquestionably did much for the improvement of the sidebosrd; Hepplewhite and the brothers Adam distinguished themselves in the same field but it was Sheraton who brought it to its full bloom. By the use of fine exotic woods, the deft employment of satin wood and other inlays, and by the addition of gracefully ornamented brasswork at the back. sometimes surmounted by candles to light up the silver. Sheraton produced effects of great elegance. But for sheer artistic excellence in the components of what presently became the sideboard, the Xdams stand unrivaled: some of their inlay and brass mounts were almost equal to the first work of the great French school.

SIDERITE (Chalybite), a mineral consisting principally of ferrous carbonate, but frequently containing substantial amounts of manganese and magnesium and lesser amounts of calcium substituted for iron. Also known as spathic iron ore. its principal use is as a source of iron for the manufacture of iron and steel, especially in Great Britain and Austria (*see* Iron: *Compounds of Iron;* Iron and Steel: *Iron Ore).* Ferrous carbonate, not necessarily produced directly from siderite, is used in the treatment of anemia and in the preparation of other iron compounds. 'The composition is expressed by $FeCO_3$. 'The hardness is $3\frac{1}{4}$–$4\frac{1}{4}$, the specific gravity is 3.96 (for pure $FeCO_3$) and the colour is usually a shade of brown because of partial oxidation.

Siderite is found in small amounts in cavities in basaltic igneous rocks and as a subordinate gangue mineral in hydrothermal metallic veins and in some pegmatites. It is widely distributed as a fine-grained concretion (*q.v.*) and in thin beds associated with shales and coal seams. The organic matter preserved in the latter rocks has been taken to indicate that they were formed in chemically reducing environments, and indeed siderite has been observed in some swamps forming under such conditions. Siderite is also found in sedimentary rocks of Jurassic age in England and western Europe admixed with varying amounts of calcitic shells and oolites of the iron silicate chamoisite. It is a constituent of the banded iron ores of the Lake Superior district.

(D. L. G.)

SIDEROSTAT, an instrument which. like the coelostat and heliostat (*q.v.*), reflects a portion of the sky in a fixed direction notwithstanding the diurnal motion of the heavens. The name is applied especially to the polar siderostat, a form of telescope in which the observer looks down the polar axis on to a mirror; by adjusting the mirror he can bring any part of the sky into the field of view without changing his own position.

SIDGWICK, HENRY (1838–1900). English philosopher. best known for his theories concerning ethics. was born at Skipton in Yorkshire on May 31. 1838. He was educated at Rugby and at Trinity college. Cambridge. In 1859 he was elected fellow of Trinity and then lecturer in classics. In 1869 he exchanged this lectureship for one in moral philosophy, but resigned his fellowship on religious grounds.

He was appointed praelector in 1875 and elected to an honorary fellowship in 1851. In 1883 he was appointed Knightsbridge professor of moral philosophy: and in 1885, the religious test having been removed, Trinity again elected him to a fellowship on the foundation. He died on Aug. 29, 1900.

Sidgwick took an active part in university business and especially in promoting the higher education of women through the foundation of Newnham college. He had married in 1876 Eleanor Mildred Balfour (sister of A. J. Balfour) who succeeded Miss A. J. Clough as principal of Newnham in 1892. He was active in social and philanthropic work and deeply interested in psychical phenomena. being a founder and first president of the Society for Psychical Research. But his energies were mainly directed to the study of religion and philosophy.

Sidgwick's major work was *Methods of Ethics* (London, Cambridge. 1874; 6th ed., London. 1901; reissue of 7th ed.. 1930). His three "methods" are egoism. utilitarianism and intuitionism. Egoism is the theory that justifies an action by its contribution to the greatest happiness of the agent, utilitarianism by its contribution to the greatest happiness of all those affected by it. Sidgwick uses "intuitionism" to designate all theories which recognize ultimate ends other than happiness or ultimate rules other than the rule that the maximum happiness ought to be promoted. In support of intuitionism, Sidgwick admits that ordinary men regard many rules as binding on them independently of the happiness produced and also that they often regard ends other than happiness (ends such as knowledge, beauty and virtue) as intrinsically desirable. Rut he argues that the rules of common sense are vague and indefinite: they allow exceptions and conflict with each other. Thus they cannot be regarded as providing an adequate rational basis for conduct. Most of them can, however, be justified as tending to promote general happiness, and the principle of utility can always be invoked to render their application more precise, to explain their exceptions and to resolve their conflicts.

While rejecting psychological hedonism. Sidgwick points out that any action can be rationally justified by demonstrating its contribution to the happiness of the agent. This egoistic principle, indeed, if taken as the sole guide to life, seems repellent to the moral sentiment; and when a man's private good conflicts with the general good most men agree that the former should yield. Yet even such lofty moralists as Joseph Butler and Samuel Clarke are found suggesting that enlightened self-love is the supreme principle of rational conduct. Utilitarianism appears to Sidgwick to be the only principle capable of giving rational unity to moral consciousness. But he finds it difficult to reconcile its moral claims with the rational supremacy of self-love. There is no empirical evidence that a man's achievement of the greatest general happiness will in fact entail his own greatest happiness. Some thinkers, such as Plato and Kant. relied here on a belief in the divine ordering of the world to guarantee this coincidence. Sidgwick concludes that only such a belief (whether based on theology or imported as an ad *hoc* postulate) will serve to bring unity to the world of rational conduct.

Sidgwick's claim to distinction does not rest on the originality or conclusiveness of the doctrines summarized above. His work is marked by caution and thoroughness, a masterly exposure of confusions and ambiguities, an acute and balanced presentation of complex argument and an open-minded candour and honesty.

Sidgwick's chiei works are *Principles of Political Economy* (1883; 3rd ed., 1901); *The Scope and Method of Economic Science* (1885); *Outlines of the History of Ethics* (1886; 6th ed., 1931), enlarged irom his article "Ethics" in the *Encyclopædia Britannica,* 9th ed., vol. viii (1879); *Elements of Politics* (1891; 2nd ed., 1897; reissue of 4th ed., 1929). The following were published posthumously: *Philosophy: Its Scope and Relntions* (1902); *Lectures on the Ethics of T. H. Grern, Mr. Herbert Spencer and J. Martineau* (1902); *The Development of European Polity* (1903); *Miscellaneous Essays and Addresses (1904); Lectures on the Philosophy of Kant (190.5).*

SIDGWICK, NEVIL VINCENT (1873–1952). English chemist whose conception and elaboration of electronic bonding was a valuable interpretation of chemical union, was born on May 8. 1873, at Oxiord. Sidgwick received his M.A. at Oxford university and his Ph.D. at Tubingen. He became fellow and tutor at Lincoln college. Oxford. in 1901, reader in chemistry at Oxford in 1926 and professor in 1935, a position which he held until 1945. His books are. *Organic Chemistry of Nitrogen* (1910), *Electronic Theory of Valency* (1927), *The Covalent Link in Chemistry* (1933) and *The Chemical Elements* (1950) in two monumental volunies. Sidgwick was Baker lecturer at Cornell (N.Y.) in 1931, vice-president of the Royal society in 1935–37, president of the Faraday society in 1932–34 and president of the Chemical society in 1935–37. He received the Royal medal of the Royal society in 1937 and the Longstaff medal-in 1945. He died March 1j, 1952, at Oxford.

(V. Bw.)

SIDI-BEL-ABBÈS, chief town of an *arrondissement* in the *département* of Oran. Alg., 48 mi. by rail S. of Oran. 1,552 ft. above the sea. on the right bank of the Mekerra. It lies in what was once a barren area but which is now a great cereal-producing region. The town is the headquarters of the 1st regiment of the Foreign Legion. It is encircled by a crenelated and bastioned wall with a fosse. and has four gates, named after Oran. Daia. Mascara and Tlemçen respectively. Starting from the gates. two broad streets, shaded by plane trees, traverse the town east to west and north to south. Pop. (1960) 101,000 (commune).

SIDMOUTH, HENRY ADDINGTON, 1st Viscount (1757–1844), English statesman. son of Anthony Addington, a physician, was born on Play 30, 1757. Educated at Winchester college and at Rrasenose college, Oxford, he became a member of parliament for Devizes in 1784. He was a personal friend and strong supporter of William Pitt. and in 1789, with Pitt's support, became speaker of the house of commons. Rejecting offers of a position in the cabinet. he held this post until 1801. In that year, after Pitt had quarrelled with the king on the question of Catholic emancipation. the more pliable and very Protestant Addington became prime minister. He held the position until April 1804. when Pitt returned to office. As prime minister. Addington was responsible for the treaty of Amiens in March 1802, a settlement which increased his popularity in the country. hut. when it proved only temporary. Addington's Fortunes became less favourable. When the war was renewed in May 1803. it was clear that Addington lacked the necessary gifts of a war leader, and Pitt. who began openly to oppose the government, took his place. Addington's continued importance in politics depended not on his personality and his abilities so much as on the little group of about jo followers in the house of commons. who provided an important element in political calculations. In Jan. 1805 Addington and his group supported Pitt, and Addington himself. who was created Viscount Sidmouth. re-entered the cabinet as lord president of the council. In July 1805 he broke away again but entered the opposition ministry of Charles James Fox and George Grenville in Feb. 1806 as lord privy seal. Remaining true to his Protestant. Church of England allegiance. he left the new ministry also in 1807. when the government proposed to throw open commissions in the army and navy to Roman Catholics and dissenters. As a spokesman of the Church of England party he attempted in 1811 to bring in a private bill requiring all dissenting ministers to be licensed, and restraining unlicensed preachers. The bill was unsuccessful. but a year later he returned to the cabinet under the prime ministership of Spencer Perceval. After Perceval's assassination in June 1812 and the formation of the earl of Liverpool's ministry. Sidmouth became home secretary. He held this post until Dec. 1821. As home secretary Sidmouth had to deal with a discontented population disposed to demonstration and riot. The first year of his office was one of high prices. commercial difficulties and large-scale unemployment: to control the situation, in face of demonstrations both by manufacturers and by Luddites. he increased the power of the magistrates. After 181j he carried this policy of firmness much farther. In 1817, for instance. he issued a circular to the lords lieutenant declaring that magistrates might apprehend and hold to hail persons accused on oath of seditious libels. and was supported by parliament even after William Hone had been acquitted by a jury on charges which followed Sidmouth's instructions. He was mainly responsible for the later policy embodied in the "Six Acts" of 1819, which. among other provisions, limited the rights of public meeting and the circulation of political literature. His instructions to magistrates and his use of police spies made him detestable to radicals and liberals of every shade. Exhausted by his efforts, he resigned office in Dec. 1821. but, with the strong support oi the king, he remained a member of the cabinet until 1824, when he resigned because of his disapproval of the recognition of the South American republics. Subsequently he took little part in public affairs. although he remained a strong supporter of church and king, in 1829 speaking against Catholic emancipation and in 1832 voting against the Reform bill. He died at Richmond Park on Feb. 15, 1844.

Sidmouth was a statesman of limited imagination and no outstanding ability, but his character and integrity could not be questioned: his inability to assess the forces of change in English politics prevented him from leaving any permanent mark on English history.

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SIDMOUTH, a seaside town and urban district in the Honiton parliamentary division of Devon, Eng.. 15 mi. E.S.E. of Exeter by road. Pop. (1961) 11,139. Area 17.9 sq.mi. It lies in the valley formed by the Sid in the red sandstone cliffs edging the western end of Lyme bay. Traces of a Bronze Age camp have been found on High Peak; on Salcombe hill is the Norman Lockyer observatory, now belonging to the University College of the South West. The beach is of shingle with sand at low tide. and most of the houses were built during the Regency period when Sidmouth became a watering place. Catering for visitors and agriculture are the main industries

SIDNEY or (Sydney) **ALGERNON** (1622–1683), English politician second son of Robert 2nd earl of Leicester and of Dorothy Percy daughter ot Henry 9th earl of Northumberland was born at Penshurst Kent As a boy he showed much talent. which was carefully trained under his iather s eqe In 1632 with his elder brother Philip he accompanied his father on his mission as ambassador extraordinary to Christian IV ot Denmark In May 1636 Sidney nent with his father to Paris nhere he became a general favourite and from there to Rome In Oct 1641 he was given a troop in his father's regiment in Ireland of which his brother knonn as Lord Lisle was in command In Aug 1643 the brothers returned to England At Chester their horses were taken by the Royalists, ahereupon they again put out to sea and landed at Lirerpool Here they nere detained by the Parliamentarq commissioners and by them sent up to London for safe custody From this time Sidney ardently attached himself to the Parliamentary cause On May 10 1644 he was made captain of horse in Manchester's army under the Eastern Association He mas shortly afterward made lieutenant-colonel, and charged at the head oi his regiment at Marston Moor (July 2) where he was wounded, and rescued with difficulty. In April 164j he was given the command of a cavalry regiment in Cromwell's division of Fairfax's army, was appointed governor of Chichester on May 10, and in December was returned to parliament for Cardiff. In July 1646 he went to Ireland, where his brother was lord-lieutenant, and was made lieutenant-general of horse and governor of Dublin. He had hardly reached Ireland when he was recalled and stationed at Dover castle as governor. He was at this time acting with the Independents, and was nominated one of the commissioners for the trial of Charles I. But he took no part in the trial, and remained at Penshurst until the trial was over. He states that he opposed the proceedings on the grounds, "first, that the king could be tried by no court; second, that no man could be tried by that court." In 1651 he lost his governorship of Dover castle, and spent some months in Holland. In the autumn he became a member of the council of State, but he disapproved of Cromwell's assumption of the supreme power, and retired to Penshurst, and then to The Hague, where he became a close friend of De Witt

Upon the restoration of the Long Parliament, in May 1659, Sidney again took his seat, and was placed on the council of

State. He was now, as before, especially concerned with the foreign work of the council. In June he was appointed one of three commissioners to mediate for a peace between Denmark, supported by Holland, and Sweden. He was probably intended to watch the conduct of his colleague, Admiral Montagu (afterwards 1st earl of Sandwich), who was in command of the Baltic squadron. Upon the conclusion of the treaty he went to Stockholm as plenipotentiary; and in both capacities he behaved with resolution and address. Meanwhile the Restoration had taken place and Sidney, instead of returning to England, went to Copenhagen, and then to Hamburg to await the turn of events. He then travelled by way of Venice to Rome. His father sent him very little money. Five shillings a day, he says, served him and two men very well for meat, drink and firing in Rome. He devoted himself to the study of books, birds and trees, and speaks of his natural delight in solitude being largely increased. In 1663 he left Italy, passed through Switzerland, where he visited Ludlow and came to Brussels in September, where his portrait was painted by van Egmondt; it is now at Penshurst. He had thoughts of joining the imperial service, and offered to transport from England a body of the old Commonwealth men; but this was refused by the English court. The enmity against him was so great that now, as on other occasions, attempts were made to assassinate him. On the breaking out of the Dutch war, Sidney, who was at The Hague, urged an invasion of England, and shortly afterwards went to Paris, where he offered to raise a rebellion in England on receipt of 100,000 crowns. Unable, however, to come to terms with the French Government, he once more went into retirement in 1666.—this time to the south of France. In Aug. 1670 he was again in Paris, and Arlington proposed that he should receive a pension from Louis; Charles II. agreed, but insisted that Sidney should return to Languedoc.

His father was now very ill, and after much difficulty Sidney obtained leave to come to England in the autumn of 1677. Lord Leicester died in November; and legal business connected with other portions of the succession detained Sidney from returning to France as he had intended. He soon became involved in political intrigue, joining, in general, the country party, and holding close communication with Barillon, the French ambassador. In the beginning of 1679 he stood for Guildford, and was warmly supported by William Penn, with whom he had long been intimate, and whom he is said (as is now thought, erroneously) to have helped in drawing up the constitution of Pennsylvania. He was defeated by court influence, and his petition to the House, complaining of an undue return, never came to a decision. His *Letters to Henry Savile,* written at this period, are of great interest. He was in Paris, apparently only for a short while, in Kov. 1679. Into the prosecution of the Popish Plot Sidney threw himself warmly, and was among those who looked to Monmouth, rather than to William, to take the place of James in the succession, though he afterwards disclaimed all interest in such a question. He now stood for Bramber (Sussex), again with Penn's support, and a double return was made. He is reported on Aug. 10, 1679, as being elected for Amersham (Buckingham) with Sir Roger Hill. When parliament met, however, in Oct. 1680, his election was declared void. But now, under the idea that an alliance between Charles and William would be more hostile to English liberty than would the progress of the French arms, he acted with Barillon in influencing members of parliament in this sense.

Upon the dissolution of the last of Charles's parliaments the king issued a justificatory declaration. This was at once answered by a paper entitled *A Just and Modest Vindication, etc.,* the first sketch of which is imputed to Sidney. It was then, too, that his most celebrated production, the *Discourses concerning Government,* was concluded, in which he upholds the doctrine of the mutual compact and traverses the High Tory positions.

For a long while Sidney kept himself aloof from the duke of Monmouth, to whom he was introduced by Lord Howard. After the death of Shaftesbury, however, in Nov. 1682, he entered into the conferences held between Monmouth, Russell, Essex, Hampden and others. That treasonable talk went on seems certain, but it is probable that matters went no further. The watchfulness of the court was, however, aroused, and on the discovery of the Rye House Plot, Sidney, who had always been regarded in a vague way as dangerous, was arrested while at dinner on June 26, 1683. His papers were carried off, and he was sent at once to the Tower on a charge of high treason. For a considerable while no evidence could be found on which to establish a charge. Jeffreys, however, was made lord chief-justice in September; a jury was packed; and, after consultations between the judge and the crown lawyers, Sidney was brought to listen to the indictment on Nov. 7.

The trial began on Nov. 21; Sidney was refused a copy of the indictment, in direct violation of law, and he was refused the assistance of counsel. Hearsay evidence and the testimony of the perjured informer Lord Howard, whom Sidney had been instrumental in introducing to his friends, were first produced. This being insufficient, partial extracts from papers found in Sidney's study, and supposed only to be in his handwriting, in which the lawfulness of resistance to oppression was upheld, were next relied on. He was indicted for "conspiring and compassing the death of the king." Sidney conducted his case throughout with skill. Against the determination to secure a conviction, however, his courage, eloquence, coolness and skill were of no avail, and the verdict of "guilty" was given. On Nov. 2j, Sidney presented a petition to the king. The necessity, however, of checking the hopes of Monmouth's partisans caused the king to be inexorable. The last days of Sidney's life were spent in drawing up his *Apology* and in discourse with Independent ministers. He was beheaded on the morning of Dec. 7, 1683. His remains were buried at Penshurst.

An edition of the *Discourses concerning Government,* containing his letters, the report of his trial, and the "Apology" written in his last hours, was published in 1763, and reprinted in 1772, with corrections and additions. There is a notice of Algernon Sidney in the preface to Collins's *Sidney Papers,* and some letters of his appear in that collection. *See* also A. C. Ewald, *Life and Times of Algernon Sidney* (2 vols., 1873); and the life by C. H. Firth in the *Dictionary of National Biography.* (O. A.; X.)

SIDNEY, SIR HENRY (1529–1586), lord deputy of Ireland, was the eldest son of Sir William Sidney, a prominent politician and courtier in the reigns of Henry VIII. and Edward VI. from both of whom he received extensive grants of land, including the manor of Penshurst in Kent, which became the principal residence of the family. Henry was brought up at court as the companion of Prince Edward, afterwards King Edward VI.; and he continued to enjoy the favour of the sovereign throughout the reigns of Edward and Mary. In 1556 he went to Ireland with the lord deputy, the earl of Sussex, who in the previous year had married his sister Frances Sidney; and from the first he had a large share in the administration of the country, especially in the military measures taken by his brother-in-law for bringing the native Irish chieftains into submission to the English Crown. In the course of the lord deputy's Ulster expedition in 1557 Sidney devastated the island of Rathlin; and during the absence of Sussex in England in the following year Sidney was charged with the sole responsibility for the government of Ireland, which he conducted with marked ability and success. A second absence of the lord deputy from Ireland, occasioned by the accession of Queen Elizabeth, threw the chief control into Sidney's hands at the outbreak of trouble with Shane O'Neill, and he displayed great skill in temporizing with that redoubtable chieftain till Sussex reluctantly returned to his duties in August 1559. About the same time Sidney resigned his office of vice-treasurer of Ireland on being appointed president of the Welsh Marches.

In 1565 Sidney was appointed lord deputy of Ireland in place of Sir Nicholas Arnold, who had succeeded the earl of Sussex in the previous year. He found the country in a more impoverished and more turbulent condition than when he left it, the chief disturbing factor being Shane O'Neill in Ulster. With difficulty he persuaded Elizabeth to sanction vigorous measures against O'Neill; and although the latter successfully avoided a decisive encounter, Sidney restored O'Neill's rival Calvagh O'Donnell to his rights, and established an English garrison at Derry which did something to maintain order. In 1567 Shane was murdered by the MacDonnells of Antrim *(see* O'NEILL), and Sidney was then free to turn his attention to the south, where with vigour and determination he arranged the quarrel between the earls of Desmond and Ormonde, and laid his hand heavily on other disturbers of the peace; then, returning to Ulster, he compelled Turlough Luineach O'Neill, Shane's successor, to make submission, and placed garrisons at Belfast and Carrickfergus to overawe Tyrone and the Glynns. In 1367 Sidney went to England. On his return he urged Cecil to improve the economic condition of Ireland, to open up the country by the construction of roads and bridges, to replace the Ulster tribal institutions by a system of freehold land tenure, and to repress the ceaseless disorder prevalent in every part of the island.

Sidney left Ireland in 1571, aggrieved by the slight appreciation of his statesmanship shown by the queen; but he returned thither in September 1575 to find matters in a worse state than before, especially in Antrim, where the MacQuillins of the Route and Sorley Boy MacDonnell (*q.v.*) were the chief fomenters of disorder. Having to some extent pacified this northern territory, Sidney repaired to the south. where he was equally successful in making his authority respected. He made shire divisions on the English model, having earlier combined the Ardes and Clandeboye to form the county of Carrickfergus, and converted the country of the O'Farrells into the county of Longford; in Connaught the ancient Irish district of Thomond became the county Clare, and the counties of Galway, Mayo, Sligo and Roscommon were also delimited. He suppressed a rebellion headed by the earl of Clanricarde and his sons in 1576, and hunted Rory O'More to his death two years later. Meantime Sidney's methods of taxation had caused discontent among the gentry of the Pale, who carried their grievances to Queen Elizabeth. Greatly to Sidney's chagrin the queen censured his extravagance. He was recalled in September 1578, and died at Ludlow Castle on May 5, 1586.

SIDNEY, SIR PHILIP (1554–1586), the finest English example of the Renaissance ideal of the perfect gentleman. He was virile and cultivated: a soldier. statesman, courtier, poet and patron of scholars and poets. The eldest son of Sir Henry Sidney and Mary Dudley, he was born at Penshurst, Kent, on Nov. 30, 1554. On Oct. 17, 1564, he and his lifelong friend Fulke Greville were entered at Shrewsbury school. Sidney's training was based on the assumption that he would be heir to his uncle, the earl of Leicester. He visited Kenilworth. Leicester's home, in Aug. 1566 and with Leicester took part in Queen Elizabeth I's progress to Oxford. In 1568 he went to Christ Church, Oxford. As lord deputy Sir Henry was much in Ireland and Sidney spent some vacations with the Cecils: a match was proposed in 1569 with Sir William Cecil's daughter Anne, but came to nothing.

On May 2j, 1572, Queen Elizabeth granted Sidney a licence to travel for two years to learn foreign languages. He left England in the earl of Lincoln's suite and reached Paris, where he lodged with the English ambassador, Sir Francis Walsingham, on June 8. The massacre of St. Bartholomew's day caused his departure for Frankfurt, where he lodged with the scholar-printer, Andrew Wechel, and met Hubert Languet, an ardent Huguenot who, like other mature scholars and men of affairs, conceived warm affection and admiration for Sidney. In the early summer, 1573, he went on to Heidelberg, Strasbourg and Vienna and in October left for Italy, spending some time in Venice where his portrait was painted by Paolo Veronese. In Oct. 1574 he returned to Vienna, and after a second visit to Prague in Feb. 1575, to England. He spoke French and Italian well, and his letter to Lord Burghley (Dec. 1574) shows that he had also a firm grasp of European politics.

Insufficient use was made of his training and exceptional ability during the next ten years. His father had once more been sent to Ireland, and this brought Sidney into touch with the earl of Essex, earl marshal for Ireland, who desired a marriage between Philip and his daughter, Penelope—the "Stella" of his sonnets. But nothing came of this, and Essex died in 1576. In 1577 Sidney was sent on an embassy to the emperor Rudolph II. He met Don John of Austria at Louvain, proposed a Protestant league to the emperor at Prague and on the way back was warmly received by William of Orange. On his return he defended his father's government of Ireland, particularly from the attacks of Lord Ormond, writing the *Discourse on Irish Affairs* for the queen. In 1580 he was bold enough to oppose the queen's proposed marriage to the duc d'Alençon in a *Letter to the Queen.* He was knighted in 1583 to enable him to receive the Garter as Prince John Casimir's proxy.

Sidney divided his time between his uncle's town residence, Leicester house, and Wilton, where his sister Mary. now countess of Pembroke, lived. He took part in the court festivities and composed *The Lady of May* for Leicester's entertainment of the queen at Wanstead in 1578. In this year he met Spenser at Leicester house and discussed with him and Edward Dyer the use of classical metres in English verse. Spenser's *Tlze Shepheardes Calender* (1579) was dedicated to Sidney. During these years he himself wrote the *Arcadia, An Apologie for Poetrie* and *Astrophel and* Stella—some of the sonnets in this cycle would seem to have been written after Penelope Devereux's enforced marriage to Lord Rich toward the end of 1581. Sidney's literary output was the result of his lack of employment in serious affairs, and it is unlikely that his untimely death prevented further imaginative works.

In the autumn of 1583 he married Frances Walsingham; Elizabeth stood godmother to the daughter born in 1585. Sidney still desired active service and took an interest in the colonizing enterprises of Martin Frobisher, Richard Hakluyt and Sir Walter Raleigh. He advocated a direct attack on Spain, and was himself preparing to sail with Drake in 1585 when the queen recalled him and appointed him governor of Flushing. Leicester, in command of the English forces in the Netherlands, leaned heavily on his advice during the next difficult months.

In July 1586 Sidney made a successful raid on Axel, near Flushing; on Sept. 22 he was with a small force under Sir John Norris which Leicester ordered to intercept a convoy of provisions near Zutphen. According to Fulke Greville, Sidney cast off his cuisses because Sir William Pelham was without his, and so received the fatal bullet wound in his thigh. Greville is also responsible for the story that he refused a cup of water in favour of a wounded soldier with the words, "Thy necessity is yet greater than mine." Greville was not present, but both stories are in keeping with Sidney's character. He died at Arnhem on Oct. 17.1586.

Sidney's death was an occasion for universal mourning. The most famous of some 200 elegies is Spenser's *Astrophel,* published, with others by the countess of Pembroke, Fulke Greville, Raleigh, Matthew Roydon and Lodowick Bryskett, in his *Colin Clouts Come home againe* (1595).

Writings.—None of Sidney's works was printed during his lifetime. Between 1577 and 1580 Sidney wrote the first version of his prose romance *Arcadia,* in five books or acts, for the entertainment of his sister and her friends. This version remained in manuscript until A. Feuillerat printed it from the Clifford manuscript in 1926. Between 1580 and 1584 Sidney embarked on a radical revision, using nearly all the old material, but enlarging books i and ii with many additional episodes and writing a new book iii, which breaks off in the middle of a sentence before he had reached the point where the old book iii began. This version was published as The *Countesse of Pembrokes Arcadia* (1590), probably under the supervision of Fulke Greville, who claimed that it truly' represented Sidney's serious and moral intentions. In 1593 Hugh Sanford prepared a folio edition which included the 1590 version and books iii–v of the old *Arcadia* with some changes which may represent Sidney's intentions,'but were probably made by his sister. This was the *Arcadia* known to countless later writers and readers. Sidney's early pastoralism seems to have been mainly influenced by Jacopo Sannazaro's *Arcadia* (poems with short prose links) and his later epic narrative by Heliodorus' *Aethiopica* (a Greek novel with a complicated "Chinese box" structure of stories within the main story). The golden world of innocent shepherds and shepherdesses is combined by Sidney with a sterner world of violent action and crime. The main narrative concerns the adventures of two princes, Musidorus and Pyrocles, who fall in love with Pamela and Philoclea, the daughters of Basilius and Gynecia. The characters of the two girls are well differentiated and in her struggle with illicit passion Gynecia has been likened to Phèdre. There are some good comic and dramatic episodes, and many serious debates on such topics as justice, atheism and suicide. The sentences are long and laden with rhetorical devices, for example:

> There were hills which garnished their proud heights with stately trees; humble valleys whose base estate seemed comforted with refreshing of silver rivers; meadows enameled with all sorts of eye-pleasing flowers; thickets, which bring lined with most pleasant shade, were witnessed so to by the cheerful disposition of many well-tuned birds; each pasture stored with sheep feeding with sober security, while

the pretty lambs with bleating oratory craved the dams' comfort; here a shepherd's boy piping, as though he should never be old; there a young shepherdess knitting and withal singing, and it seemed that her voice comforted her hands to work, and her hands kept time to her voice's music.

Sidney's use of this style was deliberate. In all his work he observed the principle of decorum, suiting style to subject. That he could be plain and direct is shown in this letter to his father's secretary:

I assure you before God that if I know you do so much as read any letter I write to my Father, without his commandment, or my consent, I will thrust my dagger into you. And trust to it, for I speak it in earnest.

Many poems in which Sidney experimented in metrical forms are introduced into the *Arcadia;* they include a few sonnets. These, however, do not reach the high standard of those in his *Astrophel and Stella.* Sir Thomas Wyat and the earl of Surrey had introduced the sonnet into English poetry, but *Astrophel and Stella* was the first English *canzoniere*—a series of songs and sonnets telling a love story. Sidney's sonnets were partly autobiographical, but they were also indebted to Petrarch, Du Bellay, Ronsard, Desportes and others. His metre is extremely regular. The rhyme scheme of the octave is that adopted in Europe; Sidney usually followed Surrey in ending the sestet with a couplet. He often adopted Wyat's colloquial tone; for example.

"Fool," said my Muse to me, "look in thy heart and write!"

The fondness for word play and the use of personification apparent in the *Arcadia* reappear here. More striking is the freshness he managed to infuse into the stale Cupid imagery.

With how sad steps, o Moon, thou climb'st the skies,
How silently, and with how wan a face'
What, may it be that even in heav'nly place
That busy archer his sharp arrows tries?

After Shakespeare's sonnets, *Astrophel and Stella* is the finest Elizabethan sonnet cycle. Thomas Newman published a faulty quarto edition, with preface by Thomas Nashe and some sonnets by other writers, in 1591. He followed this with a better text in the same year. The 1598 *Arcadia* folio offered a still better text and included *Certain Sonnets* and *The Lady of May.* To the 1613 folio was added *A Dialogue Between Two Shepherds. Two Pastorals* appeared in Francis Davison's *Poetical Rhapsody* (1602). (On the authenticity of these last two items, *see* W. Ringler, "Poems Attributed to Sir Philip Sidney," *Studies in Philology,* xlvii. pp. 126–151; 1950.)

Sidney seems to have had Stephen Gosson's *The Schoole of Abuse* (1579) in mind when he sprang to the defense of poetry, though the exact date of his treatise is not known. It mas published in 1595, by W. Ponsonby as *The Defence oj Poesie* and by H. Olney as *An Apologie for Poetrie,* and Ponsonby included it in the 1598 *Arcadia.* It is the first work to introduce the critical ideas of Renaissance theorists into England. Sidney's arguments for the lofty nature of poetry and against its detractors have been repeated countless times—partly by reason of the easy and persuasive style. He is urbane and courteous where Gosson was shrill and abusive. He wrote just before the great Elizabethan age of poetry and drama, and without the example of Shakespeare, he cannot be blamed for missing the English genius for tragicomedy. He praised the best English works available.

A Woorke Concerning the Trewnesse of the Christian Religion, translated from Duplessis-Mornay, was completed and published by Arthur Golding in 1587. Sidney was responsible for the first 43 psalms in the metrical versions completed by his sister. His translations of the first *Semaine* of G. Du Bartas and of the first two books of Aristotle's *Rhetoric* are lost. Sidney's letters. especially the Latin correspondence with Languet (trans. and ed. by S. A. Pears: 1845), and his three political treatises, not published in his lifetime, the *Discourse on Irish Affairs,* the *Defence of Leicester* and the *Letter to the Queen,* are of historical interest.

Sidney's *Complete Works,* including both versions of the *Arcadia,* were ed. by A. Feuillerat, 4 vol. (1912–26). The texts are not, altogether satisfactory. and for *Astrophel and Stella* see the edition of M. Poirier (1957). A modernized text of *The Countess of Pembroke's Arcadia* with the linking passage in bk. iii supplied by W. Alexander in 1621, and the vith bk.. added by R. Beling in 1627, mas ed. by E. A. Baker (1907).

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SIDON (modern SAIDA), once the chief city of Phoenicia, is now the principal town of the southern district of Lebanon. Pop. (1956 est.) 20.000. As well as being an agricultural trading centre it is a fishing and trading port. From 1950 it acquired importance as the Mediterranean terminus of the pipeline from the Saudi Arabian oil fields, and has large storage tanks from which the oil is transferred to offshore tankers. The silting up of the harbour was a major problem facing the government in the late 1950s.

History.—Older than Tyre and acknowledged as its mother, Sidon has had an eventful history. The Homeric poems laud the skill of its artisans. The Philistines destroyed its fleet and laid the city in ashes. Assyria and Babylonia coveted the wealth of Sidon's bazaars and a splendid succession of monarchs led armies against the city to disturb the peace and loot its treasures. In the 7th century B.C. during a pause in Babylonian oppression Egypt intervened. The Persian yoke in due course supplanted the Babylonian and an injudicious revolt against Artaxerxes Ochus met with condign punishment. Unlike Tyre it submitted without resistance to Alexander the Great. The Seleucids of Syria, the Ptolemies of Egypt and the Romans exercised lordship in turn. Herod the Great, as was his wont, embellished the town. Jesus visited its neighbourhood and St. Paul on his way to Rome was permitted to land to visit his friends and refresh himself. Sidon's bishop attended the Council of Nicea. To maintain its independence it leagued itself with the Crusaders (1107), and four years later Baldwin dealt faithfully with the city for bad faith. Saladin took and dismantled it after Hattin. The Franks were back again within it in 1197, only to see it relapse quickly into Moslem hands and be turned to ruins. The Franks rebuilt (1228), the Saracens redevastated (1249). King Louis restored it (1253); the Mongols ravaged it (1260). Once more assisted to rise by the Templars it was abandoned after the fall of Acre (1291). It blossomed into vigorous existence. in the 17th century under Fakhru'd-din Maan II. the Druse emir, who encouraged and protected its commerce. Jezzar Pasha drove the French forth from its gates (1791). In 1840 it was bombarded by the allied fleets (Britain, Austria, Turkey), and British troops occupied it Oct. 6, 1918.

Archaeology.—A large necropolis was discovered southeast of the town in 1855, and yielded numerous sarcophagi and wall paintings. The most important were the sarcophagi of two Sidonian kings, Eshmunazar, and Tabnith. Both have valuable Phoenician inscriptions. A further discovery of 17 sarcophagi was made in 1887, including the famous "Alexander" sarcophagus.

See F. C. Eiselen, *Sidon* (1907); C. C. Torrey, "A Phoenician Necropolis at Sidon," *Annual Amer. Sch. Or. Research Jerusalem* (1919–20); G. Contenau, *La Civilisation Phénicienne* (1949); A. Poidebard and J. Lauffray, *Sidon: Aménagements antiques du Port de Saida* (1951). (E. Ro.)

SIDONIUS APOLLINARIS, SAINT (GAIUS SOLLIUS APOLLINARIS SIDONIUS) (*c.* 430–*c.* 480), Christian writer and bishop of Clermont, was born in Lyons about A.D. 430. He married (about 452) Papiania, the daughter of Avitus, who was consul and afterward emperor. After Majorian deprived Avitus of the empire and took the city of Lyons (457), Sidonius fell into the hands of the enemy. Majorian treated him with the greatest respect, however. and in return Sidonius composed in his honour a panegyric that won for him a statue at Rome and the title of count. In 467 the emperor Anthemius raised Sidonius to the post of prefect of Rome and afterward to the dignity of a patrician and senator. In 472, moie for his political than for his theological abilities, he was made bishop of Arverna (Clermont). On capture of that city by the Goths in 474 he was imprisoned, but afterward restored to his bishopric by Euric, king of the Goths. His feast day is Aug. 21.

Sidonius' extant works are his *Panegyrics* on different emperors (in which he draws largely upon Statius, Ausonius and Claudian); and nine books of *Letters* and *Poems*, whose chief value consists in the light they shed on the political and literary history of the 5th century. The *Letters*, which are very stilted, reveal him to have been a man of genial temper, fond of good living and of pleasure. The best edition is that in the *Monumenta Germaniae Historica* (1887), which gives a survey of the manuscripts. There is an English translation of the *Poems and Letters* by W. B. Anderson in the "Loeb Classical Library" (1936).

See C. E. Stevens, *Sidonius Apollinaris and His Age (1933).*

SIEBENGEBIRGE ("The Seven Hills"), a group of hills on the Rhine, 6 mi. above Bonn. They are of volcanic origin. The hills are as follows: Drachenfels (1.053 ft.) surmounted by the ruins of an old castle; immediately behind it, Wolkenburg (1.063 ft.); and to the north Petersherg (1.086 ft.), with a pilgrimage chapel, then, to the south, a chain of four—viz. Ölberg (1.522 ft.), the highest of the range; Lonenburg (1.493 ft.); Lohr-Berg (1,427 ft.); and, farthest away, Nonnen-Stromberg (1,101 ft.).

SIEBOLD, KARL THEODOR ERNST VON (1804–1885), German zoologist who investigated the morphology and life history of lower animals, mas born in Il'iirzburg on Feb. 16, 1804. Aiter practising medicine briefly, Siebold was professor of zoology at Erlangcn, Freiburg, Breslau and Munich. In 1848 he founded the *Zeitschrift für wissenschaftliche Zoologie*. He died at Munich on April 7, 1885.

Siebold was probably the first to discover that the Protozoa consist of a single independent cell. This important finding emphasized the cell as a basic unit of living matter, and suggested that evolution from one- to many-celled organisms, and also embryonic development, involved a progressive specialization and division of labour among cell units. Siebold also clearly showed that eggs of some insects were normally parthenogenic, developing without iertilization. His studies on the life histories of tapeworms demonstrated to medical men oi his day the bearing of basic zoological research on certain clinical problems. His work on the anatomy oi invertebrates was one oi the first important texts on the comparative anatomy of lower animals. His major works include *Lehrbuch der vergleichenden Anatomie der Wirbellosen Thiere* (1845–48; Eng. trans., W. I. Burnett, *Anatomy of thr Invertebrata,* 1854); *Über die Band- und Blasenwürmer* (1833); *Wahre Parthenogenesis bei Schmetterlingen und Bienen* (1856; Eng. trans., W. S. Dallas, On *a True Parthenogenesis in Moths and Bees,* 1857). (H. H. S.)

SIEDLCE, a town of Poland in the province of Warsaw, 56 mi. E.S.E. of Warsaw. It is a Roman Catholic episcopal see. The Oginskis, to whom it belonged, embellished it with a palace and gardens. Pop. (1960) 32,000. Siedlce was occupied by Germany in World War II and was returned to Poland in 1945.

SIEGBAHN, KARL MANNE GEORG (1886–), Swedish physicist, awarded the 1924 Nobel prize in physics for his discoveries and investigations in X-ray spectroscopy, was born in Örobro, on Dec. 3, 1886. He obtained his doctor's degree in 1911 from the University of Lund. He served as assistant to J. R. Rydherg in the physics institute of the university from 1907 to 1915 and in the latter year was appointed deputy professor of physics. On Rydberg's death in 1920 he succeeded to the chair. In 1923 he became professor of physics at Uppsala and in 1937 he accepted the corresponding chair at Stockholm and became director of the Nobel Institute of Experimental Physics of the Swedish Royal Academy of Sciences, Stockholm. His early researches were mainly concerned with problems in electricity and magnetism, but after 1914 he was engaged in the systematic investigation of the X-ray spectra of the different elements. In 1916 he discovered a new spectral series, the long-wave M-lines. With the aid of high vacuum spectrographs and other apparatus of his own invention he carried the measurement of wave lengths to an extraordinary level of accuracy. In 1923 he and his colleagues succeeded in furnishing proof of the diffraction of X-rays in prisms: he later investigated the immediate field between X-rays and ultraviolet rays. (W. J. BR.)

SIEGBURG, a town in North Rhine-Westphalia (former Prussian Rhine province), Germany, on the Sieg, 16 mi. S.E. of Köln (Cologne) by the railway to Giessen. Pop. (1959 est.) 32,617. The town, founded in the 11th century, attained great prosperity in the 15th and 16th centuries because of its pottery wares.

SIEGEN (SECHTEN), **LUDWIG VAN** (1609–*c.* 1680), Dutch engraver, the inventor of mezzotint (*q.v.*), was born in Utrecht. He spent most of his early life in the services of the landgravine Amelia Elizabeth and the landgrave William of Hesse-Kassel. He lived in Amsterdam from 1641 to about 1644 and here it is supposed he was influenced by Rembrandt. Later he served Johann Philipp von Schönborn, elector of Mainz, and the duke of Brunswick while in Wolfenbüttel, where he is mentioned for the last time in 1676. His first mezzotint was a portrait of Amelia Elizabeth, in the dedication of which he claims the invention of the process as one not of lines, but of dots. There are seven known rouletted mezzotint plates by him.

See A. M. Hind, *History of Engraving and Etching, From the 15th Century to the Year 1914 (1923).* (H. Es.)

SIEGEN, a town in North Rhine-Westphalia (former Prussian province of Westphalia), Germany, 63 mi. E. of Köln (Cologne) by rail, on the Sieg, a tributary entering the Rhine opposite Bonn. Pop. (1959 est.) 48,025. Siegen mas the capital of an early principality belonging to the house of Nassau. In 1815 the congress of Vienna assigned it to Prussia. The town contains two palaces of the former princes of Nassau-Siegen. The surrounding district, to which it gives its name, abounds in iron mines, and iron founding and smelting are the most important industries of the town. Rubens is said to have been born there in 1577.

SIEGFRIED (SIGURD), a figure from the heroic literature of the ancient Teutons, known to us as Sigurd in Old Norse and as Siegfried in German literature, although these two branches of the tradition do not always agree. He plays a part in the story of Brunhild (*q.v.*), in which he meets his death, but in other stories he is the leading character and triumphs. A feature common to all is his outstanding strength and courage. One story tells of his fight with a dragon, and another of how he acquired a treasure from two brothers who quarreled over their inheritance. These two stories are combined into one in the *Eddn* (*q.v.*) and told in detail, whereas in German, where they arc kept entirely separate, the information is scant and largely contained in allusions. Siegfried plays a major part in the *Nibelungenlied* (*q.v.*), where this old material is used but much overlaid with more recent additions. *Das Lied voni hürnen Seyfrid,* not attested before about 1500, still retains it in identifiable form, although the poem's central theme is the release of a maiden from a dragon; and an *Edda* poem tells how Sigurd awakened a maiden, a valkyrie (*q.v.*), from a charmed sleep. Here, too, many critics have tried to establish a connection between German and Norse; not only, however, are there many important differences, but there is great doubt, on internal evidence, about the antiquity of both poems.

In the original stories Siegfried was presented as a boy who, although of noble lineage, grew up bereft of parental care; this shows through clearly, although in the full accounts in both Norse and German it is overlaid with elaborate accounts of his courtly upbringing. As with Brunhild, it is still disputed whether the figure is of mythical or historical (Merovingian) origin.

See *Das Lird vom hürnen Seyfrid,* edited by K. C. King (1958). (K. C. K.)

SIEMENS, a German-born family best known as engineers, inventors and manufacturers in the electrical industry.

WERNER VON SIEMENS (1816–1892), the chief founder of the electrical firm of Siemens and Halske, was born on Dec. 13, 1816, at Lenthe, Hanover. Between 1838 and 1848 he held a commission in the artillery, was entrusted with many specialized works and in particular became acquainted with the recently developed electric telegraph. In 1847 he founded, together with a skilled mechanic, J. G. Halske, the firm of Siemens and Halske for the manufacture of telegraphic apparatus. This firm under Siemens' guidance became one of the most important electrical undertakings in the world, with branches in different countries of which those in England and Russia were particularly important. It carried out many large telegraphic projects and later expanded into other electrical fields, as new applications of electricity were developed.

Many of Werner von Sikmens' inventions relate to telegraphic apparatus. He used gutta-percha as an insulant for telegraphic cable in 1847; this form of insulation was later widely used for electric light cables. The Siemens armature, which he invented in 1856 for use in telegraphy, afterward found further application in larger generators for electroplating and lighting and, following the invention of the ring armature, was modified by F. von Hefner-Alteneck. Siemens' designer, into the basic form of the modern armature. One of the most important of Siemens' discoveries was that of the dynamo-electric principle. the principle governing the self-excitation of the dynamo. This idea was also put forward by C. A. Varley and by Sir Charles Wheatstone about the same time, but Siemens appears to have more fully appreciated the possibilities of the invention and was certainly more responsible for their development. He died at Charlottenburg, Berlin. on Dec. 6, 1892.

SIR WILLIAM SIEMENS (KARL WILHELM; 1823–1883). brother of Werner. is known for his work in electricity and in the application of heat. In both fields he combined the functions of innovator, manufacturer and successful man of business. He was born at Lenthe, Hanover. on April 4, 1823. After attending the University of Gottingen he entered, as a pupil, the manufacturing concern of Count Stolberg at Magdeburg. At the age of 19 he first visited England in the hope of introducing an electroplating process invented by himself and Werner and which he succeeded in selling to Rlessrs. Elkington of Birmingham. He returned to Germany. but in 1844 was again in England. this time with another invention, the "chronometric." or differential, governor. Finding that British patent law afforded the inventor a protection then lacking in Germany, he henceforth made England his home.

The next few years were spent in trying to develop his inventions, of which at this time his water meter was commercially the most successful. His activities made him a respected figure in scientific circles: his paper "On the Conservation of Heat Into Mechanical Effect" read to the Institution of Civil Engineers in 1853 gained him the Telford medal: and in 1862 he was elected a member of the Royal society. William's chief work in the field of heat was concerned with regenerative heating and consequent improvements in steelmaking processes. He invented the regenerative condenser in 1848 and, together with his brother Friedrich. first tried to apply it to the steam engine, using the heat from the regenerator to preheat the boiler feed water. When this did not meet with success, other applications were sought and the idea occurred of applying the principle to furnaces, using the heat regained from the flue gases to heat the air supply to the iurnace. This was patented in Friedrich Siemens' name in 1856 and met with great success for use both in glassmaking and in steel manufacture. Later the use of gas instead of solid fuel greatly extended the use of the regenerative furnace.

At that time the quality and reliability of steel was much inferior to that of iron and Siemens did much to develop steelmaking processes, using a large-scale trial plant equipped with regenerative furnaces. This work led to the Siemens-Martin process, shown at the Paris exhibition of 1867, and to the founding of the firm of Landore-Siemens, which was established for the application of the process.

In the field of electricity William, though making no great inventions, became an acknowledged authority and leader. From 1848 onward he represented the firm of Siemens and Halske in London. and when the separate firm of Siemens Brothers was established in 1865 he became a partner and director. At first the chief business was the erection of overland telegraph lines and the laying of submarine telegraph cables. William was, however. in constant close liaison with all the ideas and projects of his brother Werner in Berlin and, when the latter discovered the dynamo-electric principle, William introduced it to England by reading. in Feb. 1867, a paper to the Royal society entitled "On the Conversion of Dynamical Electric Force Without the Aid of Permanent Magnetism." Gradually in the late 1870s and 1880s the electric-light side of the business grew. One of the last projects with which William was associated was the Portrush electric railway in the north of Ireland, opened in 1883, which utilized water turbines driving a Siemens dynamo. The power so produced was transmitted to another machine acting as a motor on the tramcar. William Siemens was knighted in 1883 and died in London on Nov. 19 of the same year.

ALEXANDER SIEMENS (1847–1928), nephew of William, was born in Hanover on Jan. 22. 1847. In 1867 he went to England, nhere he worked first in the workshops of Siemens Brothers at Woolwich, and consequently in the erection of the Indo-European telegraph line in Persia (1868) and in the laying of the Black sea cable (1868). In 1878 he became a naturalized British subject. The following year he took over the management of the electric-light department of Siemens Brothers, and was responsible for the installation of electric light at Godalming, Surrey, the first English town to be so lighted. Like many other members of the family. Alexander patented several inventions. After the death of Sir William he became a director of the company, a position he retained until 1918. He took an active part in public activities associated with his profession. was a member of several important committees and was twice president of the Institution of Electrical Engineers. He died at Milford-on-Sea, Hampshire, on Feb. 16, 1928. (M. K. W.)

SIENA, a city and archiepiscopal see of Toscana, Italy, capital of the province of Siena, 31 mi. S. of Florence. Pop. (1951) 39.906. The city possesses a university, founded in 1203 and limited to the faculties of law and of medicine.

The horse races of Siena known as the "Palio delle Contrade" have a European celebrity. They are held in the public square, the curious and historic Piazza del Campo (now Piazza di Vittorio Emanuele) in shape resembling an ancient theatre, on the 2nd of July and the 16th of August of each year; they date in their present form from the 17th century and were instituted in commemoration of victories and in honour of the Virgin Mary (the old title of Siena having been "Sena vetus civitas Virginis").

Siena is divided into 17 *contrade* (wards), each with a distinct appellation and chapel and flag of its own; and every year 10 of these contrade, chosen by lot, each send one horse to compete for the prize *palio* or banner. The aspect of Siena during these meetings is very characteristic, and the whole festivity bears a mediaeval stamp in harmony with the architecture and history of the town.

Among the noblest fruits of Sienese art are the public buildings adorning the city. The cathedral, one of the finest examples of Italian Gothic architecture, obviously influenced in plan by the abbey of S. Galgano (infra), built in black and white marble, was begun at the end of the 12th century, but interrupted by the plague of 1248 and wars at home and abroad, and by 1325 a great part of it and the baptistery of San Giovanni were completed; a further enlargement (which would have made what had been already built into merely a transept of a larger church) was begun in 1339 but never carried out and a few ruined walls and arches alone remain to show the magnificence of the uncompleted design, which would have produced one of the largest churches in the world. In 1355 the construction of the older church was resumed.

The splendid west front, of tricuspidal form, enriched with a multitude of columns, statues and inlaid marbles, dates from 1377 seq.: it closely resembles that of Orvieto, which is earlier in date (begun in 1310). Both façades have been recently restored, and the effect of them not altogether improved by modern mosaics. The fine Romanesque campanile belongs to the first half of the 14th century. Conspicuous among the art treasures of the interior is the well-known octagonal pulpit by Nicolò Pisano, dating from 1265–68. It rests on columns supported by lions and is finely sculptured. Numerous statues and bas-reliefs by Renaissance artists adorn the various altars and chapels. The cathedral pavement is inlaid with designs in colour and black and white, representing biblical and legendary subjects; the finest portions beneath the domes, with scenes from the history of Abraham, Moses and Elijah, are by Domenico Beccafumi and are executed with marvellous boldness and effect. The choir stalls also deserve mention: the older ones (from S. Benedetto, a church long ago destroyed) are in *tarsia* work; the others, dating from the 16th century, are carved from Riccio's designs. The Piccolomini library, adjoining the duomo, was founded by Cardinal Francesco Piccolomini (afterwards Pius III.) in honour of his uncle, Pius II. Here are Pinturicchio's famous frescoes of scenes from the life of the latter pontiff, and the collection of choir books (supported on sculptured desks) with splendid illuminations by Sienese and other artists. The church of San Giovanni, the ancient baptistery, beneath the cathedral is approached by an outer flight of marble steps built in 1451. It has a beautiful but incomplete façade designed by Giovanni di Mino del Pellicciaio in 1382, and a marvellous font with bas-reliefs by Donatello, Ghiberti, Jacopo della Quercia and other 15th-century sculptors. The Opera del Duomo contains Duccio's famous Madonna (or Maestà) painted for the cathedral in 1308–11, and other works of art.

Among the other churches are S. Maria di Provenzano, a vast building of some elegance, designed by Schifardini (1594); Sant' Agostino, rebuilt by Vanvitelli in 17jj, containing a Crucifixion and Saintes by Perugino, a Massacre of the Innocents by Matteo di Giovanni and the Coming of the Magi by Sodoma; the beautiful church of the Servites (15th century), which contains another Massacre of the Innocents by Matteo di Giovanni and other good examples of the Sienese school; San Francesco, recently restored, containing fine paintings by the two Lorenzetti and others, close to which is the 15th century oratory of S. Bernardino, with fine frescoes by Sodoma, Pacchia and Beccafumi (1518–32) and a good ceiling (1496); San Domenico, a fine 13th-century brick building with a single nave and transept, containing Sodoma's splendid fresco, the Swoon of St. Catherine, and a contemporary portrait of the saint in a fresco by Andrea di Vanni. This church crowns the Fontebranda hill above the famous fountain of that name immortalized by Dante, and in a steep lane below stands the house of St. Catherine, now converted into a church and oratory, and maintained at the expense of the inhabitants of the Contrada dell' Oca. It contains some good works of art, but is chiefly visited for its historic interest. The Accademia di Belle Arti contains a good collection of pictures of the Sienese school, illustrating its development.

The Palazzo Pubblico in the Piazza del Campo (1288–1309) built of brick. is a fine specimen of pointed Gothic, and was designed by Agostino and Agnolo. The light and elegant tower (Torre del Mangia) soaring from one side of the palace (1338–48) is 334 ft. high, and the chapel standing at its foot as a public thank-offering after the plague of 1348 was begun in 1352 and completed in 1376. The interior is lined with works of art. The two ground-floor halls contain a Coronation of the Virgin by Sano di Pietro and a splendid Resurrection by Sodoma. In the Sala dei Nove or della Pace above are the noble allegorical frescoes of Ambrogio Lorenzetti, representing the effects of just and unjust government; the Sala del Mappamondo is painted by Simone Martini and others, the Cappella della Signoria by Taddeo di Bartolo, and the Sala di Consistoro by Beccafumi. Another hall, the Sala di Balia, has frescoes by Spinello Aretino (1408) with scenes from the life of Pope Alexander III., while yet another has been painted by local artists with episodes in recent Italian history. The former hall of the grand council, built in 1327, was converted into the chief theatre of Siena by Riccio in 1560, and, after being twice burnt, was rebuilt in 1753 from Bibbiena's designs. Another Sienese theatre, that of the Rozzi, in Piazza San Pellegrino, designed by A. Doveri and erected in 1816, although modern, has an historic interest as the work of an academy dating from the 16th century, called the Congrega de' Rozzi, that played an important part in the history of the Italian comic stage.

The city is adorned by many other noble edifices both public and private, among which the following palaces may be mentioned: Tolomei (1205); Buonsignori, an elegant mediaeval brick construction; the Palazzo del Capitano di Giustizia; Sansedoni; Marsili; Piccolomini, now belonging to the Government and containing State archives; Saracini; Piccolomini delle Papesse, like the other Piccolomini mansion, designed by Bernardo Rossellino, and now the Banca d'Italia; the enormous block of the Monte de' Paschi, a bank of considerable wealth and antiquity, enlarged and partly rebuilt in the original style between 1877 and 1881; the old Dogana and Salimbeni palaces; the Palazzo Spannochi, a fine early Renaissance building by Giuliano da Maiano; the Loggia di Mercanzia (1417–28) imitating the Loggia dei Lanzi at Florence, with sculptures of the 1jth century; the Loggia del Papa, erected by Pius II.; and other fine buildings. We may also mention the two celebrated fountains, Fonte Gaia and Fontebranda; the former in the Piazza del Campo, by Jacopo della Quercia (1409–19), but freely restored in 1868, the much-damaged original reliefs being now in the Opera del Duomo; the Fonte Nuova, near Porta Ovile, by Camaino di Crescentino, also deserves notice (1298). Thanks to all these architectural treasures, the narrow Sienese streets with their many windings and steep ascents are full of picturesque charm, and, together with the collections of excellent paintings, foster the local pride of the inhabitants and preserve their taste and feeling for art. The mediaeval walls and gates are still in the main preserved. The ruined Cistercian abbey of S. Galgano, founded in 1201, with its fine church (1240–68) is interesting and imposing. It lies some 20 m. south-west of Siena.

A kind of marzipan, known as *panforte,* is a speciality of Siena, and ironwork and wood carving are still carried on.

Literary History.—The literary history of Siena begins (13th century) with Folcacchiero the humorist, Cecco Angiolieri, and Bindo Bonichi. Next comes St. Catherine (Benincasa) of Siena (1347–80: *q.v.*) and St. Bernardino (Albizzeschi) of Siena (1380–1444), a popular preacher. Pope Pius II. (*q.v.*) may also be mentioned, as well as several members of the Sozzini family, one of whom, Lelio (1525–62), founded the sect of the Socinians; Bernardino Ochino (1487–1564), a supporter of Protestantism, the satirist Girolamo Gigli (1660–1722) and the economist Sallustio Bandini (1677.–I760).

Art.—Lanzi happily designates Sienese painting as "Lieta scuola fra lieto popolo" ("the blithe school of blithe people"). The special characteristics of its masters are freshness of colour, vivacity of expression and distinct originality. The Sienese school of painting owes its origin to the influence of Byzantine art; but it improved that art, impressed it with a special stamp and was for long independent of all other influences. Consequently Sienese art seemed almost stationary among the general progress and development of the other Italian schools, and preserved its mediaeval character down to the end of the 15th century, when the influence of the Umbrian and—to a slighter degree—of the Florentine schools began to penetrate into Siena, followed a little later by that of the Lombard. The first master of real significance was Duccio di Buoninsegna (*c.* 1260–1318); then followed Simone Martini (or Memmi), Lippo Memmi, Pietro and Ambrogio Lorenzetti, and Taddeo di Bartolo, to name only the principal painters. In the 15th century we have Domenico di Bartolo, Sano di Pietro, Giovanni di Paolo, Stefano di Giovanni (I1 Sassetta) and Matteo di Giovanni di Bartolo, who fell, however, behind their contemporaries elsewhere, and made indeed but little progress. The 16th century boasts the names of Bernardino Fungai, Guidoccio Cossarelli, Giacomo Pacchiarotto, Girolamo del Pacchia and especially Baldassare Peruzzi (*q.v.*) (1481–1536), who while especially celebrated for his frescoes and studies in perspective and chiaroscuro was also an architect of considerable attainments; Giovanni Antonio Bazzi, otherwise known as I1 Sodoma (1477–1549), who, born at Vercelli in Piedmont, and trained at Milan in the school of Leonardo da Vinci, came to Siena in 1504 and there produced some of his finest works, while his influence on the art of the place was considerable; Domenico Beccafumi, otherwise known as Micharino (1486–1551), noted for the Michelangelesque daring of his designs; and Francesco Vanni.

There may also be mentioned many sculptors and architects, such as Lorenzo Maitani, architect of Orvieto cathedral (1275–1330), Camaino di Crescentino and his son Tino di Camaino, sculptor of the monument to Henry VII in the Campo Santo of Pisa; Lando di Pietro, entrusted by the Sienese commune with the proposed enlargement of the cathedral (1339), and perhaps author of the famous Gothic reliquary containing the head of S. Galgano in the Chiesa del Santuccio, which, however, is more usually attributed to Ugolino di Vieri, author of the tabernacle in the cathedral at Orvieto, or Jacopo della Quercia (1371–1438), the creator of the Fonte Gaia, in the Piazza del Campo; Lorenzo di Pietro (Il Vecchietta), a pupil of Della Quercia; Antonio Federighi (d. 1490); Neroccio di Bartolommeo (1447–1500); Francesco d'Antonio, a skilful goldsmith of the 16th century; Francesco di Giorgio Martini (1439–1502), painter, sculptor, military engineer and writer on art; Giacomo Cozzarelli (1453–1515); and Lorenzo Mariano, surnamed Il Marrina (1476–1534). Wood carving also flourished here in the 15th and 16th centuries, and so also did the ceramic art. According to the well-known law, however, the Renaissance, made for the people of the plains, never fully took root in Siena, as in other parts of Tuscany, and the loss of its independence and power in 1555 led to a suspension of building activity, so that the baroque of the 17th and the classicism of the 18th centuries have had hardly any effect here; and few towns of Italy are so unspoilt by restoration or the addition of incongruous modern buildings, or preserve so many characteristics and so much of the real spirit (manifested to-day in the grave and pleasing courtesy of the inhabitants) of the middle ages, which its narrow and picturesque streets seem to retain. Siena is, indeed, unsurpassed for its examples of 13th and 14th century Italian Gothic, whether in stone or in brick.-

See W. Heywood, *Our Lady of August and the Palio* (Siena, 1899) and other works; R. H. Hobart Cust, *The Pavement Masters of Siena* (London, 1901); Langton Douglas, *History of Siena* (London, 1902); E. G. Gardner, *The Story of Siena* (London, 1902); *St. Catherine of Sienu* (London, 1908); W. Heywood and L. Olcott, *Guide to Siena* (Siena, 1603); A. Jahn Rusconi, *Siena* (Bergamo, 1904); C. Chledowski, *Siena* (1923); *M*. Kirchstein, *Siena* (1923). (C. PA.; T. A.)

HISTORY

Siena was an ancient city of the Etruscans; in the time of Augustus it was a Roman colony, known as *Saena* Julia. There are, however, very few relics of antiquity found there. The present city is almost entirely mediaeval. It has been the seat of a bishopric since the 7th century and possibly earlier; and the development of Sienese history is closely connected with the growth of the Church and the power of the episcopate. Under the rule of the Lombards in the 8th century Siena was governed by Gnstaldi and was not subject to the dukes of Tuscany; in the quarrel between the bishops of Siena and of Arezzo, the Gastaldi were supported by the people in their adherence to the cause of their bishops; and the counts who, in the time of Charlemagne, superseded the Gnstaldi, were also faithful to the church in civic matters, until in the 11th century, after 1056, the bishops gradually made themselves independent, at any rate within the city, of the counts and the consuls who succeeded them. During the 12th century the consuls, who were patricians, had to make conccssions to the plebeians; and in 1137 there was a government by 100 nobles and 50 plebeians. Just as the power of the counts yielded to the bishops', and the bishops' to the consuls', so the nobles had to give way, until in 1199 there was a government by a foreign *podestà;* so Siena became a feudatory of the Italian kingdom, and was a tenant in *capite* of the emperor. Her rule was admitted by the lords of the neighbouring country, who were in the same relation to her as was Siena to the emperor, who welcomed on his side, as against Florence, the growing power of the city and contado.

Florentine Wars.—Yet the great quarrel between Siena and Florence in the 13th century would have probably occurred if there had been neither pope nor emperor, neither Guelf nor Ghibelline. The conflict was primarily economic. Siena at the beginning of the 13th century mas the bank and trade-capital of Italy; for the freedom of trade the Sienese bankers and traders desired to keep safe the master roads to Rome, to the sea, and to the North It was for this purpose that she made feudatories of the neighbouring lords, in an effort to associate them with her enterprise. Florence, desiring also a commercial supremacy, was Siena's natural enemy. She supported those lords who were irked by their allegiance to the city, and resisted the efforts of the Sienese to establish themselves in such key positions as Montepulciano in the south, or Poggibonsi in the north. So the history of Siena in this century is a history of futile and ultimately hopeless wars—wars to secure the fidelity of her feudatories, a struggle which must involve her in conflict with Florence. In 1254 a treaty was concluded between the two cities; but three years later Florence found a pretext of war in the fact that Siena had given shelter to Ghibellines she had expelled. Siena appealed to Manfred for military assistance while Florence equipped a large citizen army. The first victory, though small, was Florence's, whose forces on May 18, 1260 conquered a small force outside Siena; but on Sept. 4 the Florentines were signally defeated, and the Guelf cause for the moment lost.

Had Manfred lived the course of history might have been different: but his death, and a defeat at Benevento (1266) badly damaged the Ghibellines. The cause of the Guelfs made more and more adherents throughout Italy. Lucca, Pistoia, Volterra joined the party and the succession of Charles of Anjou to the throne of Naples added greatly to its prestige. Siena was disheartened, too. by the death of Provenzano Salvani, who was killed in cold blood by his captor in the battle of Calle do Valdelsa (1269), and Siena's loyalty to the Ghibellines was also shaken by the growth in the city of a strong Guelf and popular party. There was war in the contado and unrest in the city, and in 1273 when Charles of Anjou visited Siena, there was nothing but sentiment left for the Ghibelline side; Siena had lost any chance of wresting the supremacy from Florence by espousing the cause of the Guelfs. For while Siena might have gained a position of power as leader of the Ghibellines she was hopelessly outclassed by other cities when she joined the increasing party of the Guelfs.

To her wars with Florence were added internal dissensions. The rule of the nobles had become so tyrannical that in 1277 it was decreed that no patrician could occupy the chief magistracy; power was to remain in the hands of the middle-classes and traders who were adherents of the Guelfs. The size of the magistracy—which had varied from 24 to 36 members—was reduced to 15 in 1280, and seven years later to nine. This government by nine merchants was successful for about 70 years, and under it Siena, while she may have lost in political importance, gained much in peace and prosperity. Florence was no longer alarmed at a possible rival, trade flourished, the university was reorganized with the help of scholars from Bologna, great buildings were constructed—indeed for this period Siena is as good an example as one could wish of a successful oligarchic plutocracy.

The 14th Century.—In the early years of the 14th century there were many minor riots and battles, and in 1355 when the Emperor Charles IV. passed through Siena he gave his blessing to an irregular government of 12 which had been set up by the reformers against the nine. Power was given to the proletarians —the lower classes called *ordini* and *monti;* but they depended for not a little of their authority on the backing of the nobles. It was really a rising of the patricians and the plebeians against the tradesmen. The whole city was faction-ridden, and there is nothing but a dreary passing back of power from one set to another. Charles IV. intervened in 1368 on behalf of a rebellion; and he with Malatesta di Rimini attacked the public palace and was completely defeated by the Sienese who rallied to the call of the 1j. The emperor was captured, and used his imprisonment to borrow money from Biccherna, for which he granted Siena a *privilegium* and appointed the magistrates imperial vicars for ever in Siena and the district. After this the new government had the usual difficulties with the dissatisfied and the unenfranchised, and took refuge in the usual device of creating a special police, whose chief was called esecutore, which should repress the activities of the nobles. The continuance of internal disorders was naturally an incentive to those forces outside the city proper. The lords, who had once been feudatories to the growing power of the Ghibelline city, threw off its yoke and were helped in their disloyalty by mercenary companies from Brittany and Gascony.

The age-long quarrel between Siena and Arezzo gained a new impetus from the contentions between Carlo di Durazzo and Louis of Anjou for the crown of Naples. First Durazzo held Arezzo and then Louis; but when the Sienese hoped to win the city, Louis sold Arezzo to Florence (1384). Disappointed. the Sienese turned on the reformers. A successful revolution was concluded in 1385 and resulted in the expulsion of many families on uhose industry and experience in trade the prosperity of Siena depended. In 1387 there was a renewal of war between Florence and Siena, who called to aid her Gian Galeazzo, duke of Milan, who made himself master of Siena until 1403.

The 15th Century. — The city now became involved in the schism which was threatening the very life of the Papacy. Siena, as well as Florence, declared itself against Gregory XII (1409); and Ladislaus of Naples, his supporter, attacked Sienese territory. His death ended this war; and then came another conflict with Florence, which supported Venice and Eugenius IV, while Siena favoured Milan and the king of the Romans. In 1433 the warring parties made peace. There was another affray with Florence in 1454; and in a year or two later some of the citizens plotted to hand over Siena to Alphonso of Naples, whose death ended the conspiracy. In these years the magistracy was strengthened by the creation of an extraordinary body, the balia, which could act independently of the ordinary council. When Aeneas Sylvius Piccolomini was elected pope in 1455. the Sienese readmitted the nobles to a share in the government, a special concession which came to an end with the pope's death in 1464; although any members of the Piccolomini house were declared, eo ipso, to be popolani and privileged. In 1480, Alphonso, duke of Calabria, tried to obtain suzerainty of Siena. An alliance between the *noveschi* and some of the plebeians favoured his claims, and a revolt (June 1480) ended in a reorganization of the government. The old reformers as such were excluded, and the power vested in the hands of the popolani and a body called aggregoti, consisting of nobles, and citizens of other orders who had not before been allowed to take office. The Neapolitan royal family, however. fell out of favour in 1487. For nine months there were riots in the city which culminated on Feb. 20, 1483. The popolani took again the spoils of office. But in 1487 the noveschi, prosperous, influential tradesmen, returned. and overthrew the popolani, and placed Siena under the patronage of Our Lady.

The 16th Century. — Her legate in government was a returned exile, Pandolfo Petrucci. who was till his death in 1512 master of Siena. He was a thoroughly sensible tyrant. Expelled by Cesare Borgia in 1502, he was restored through the intervention of the Florentine government and the king of France in March 1503. In 1522 Siena became a free city under the protection of the Emperor Charles V. On Aug. 5, 1552, the Spanish "protection" ended. To attain this end Siena had called in Cosimo of Florence as well as France, and once more she suffered from the possession of powerful friends.

There were battles and desperate diplomacies; until in 1555 the Spaniards. having defeated the French, took possession of the town; Philip II of Spain then gave Siena to Cosimo I de'Medici.

The separate history of Siena as a city-state ceased, though it retained a separate administration for more than two centuries. until the general reforms of the grand-duke Pietro Leopoldo, the French domination, and finally the restoration swept away all differences between the Sienese and Florentine systems of government. In 1859 Siena was the first Tuscan city that voted for annexation to Piedmont and the monarchy of Victor Emmanuel II.

See also references under "Siena" in the Index volume.

SIENKIEWXCZ, HENRYK (1846–1916), Polish novelist, born on May 5, 1846, received his schooling in Warsaw and graduated in 1870 from the philological faculty of the university there. He reviewed books in various newspapers in 1869. His first novel, *Na marne* (Run to *Waste*), appeared in 1872, his first short story, Stary *sluga* (An Old Retainer), in 1875. Between 1876 and 1878 he traveled in the United States as a special correspondent. On his return via Italy and France he published more short stories, including Janko *muzykant* (Janko the *Musician*) in 1881 and Bartek *zwyciezca* (*Bartek* the *Conqueror*) and Latarnik (The *Lighthousekeeper*) in 1882. In 1882–83 he was co-editor of the daily newspaper *Slowo*. His Listy z Afryki (Letters from Africa) are the fruits of a journey made in 1891. For his 30th anniversary as a writer (celebrated in 1900) he received from the Polish people the gift of the small estate of Oblegorek, near Kielce, where he resided until 1914. In 1905 he was awarded the Nobel prize for literature. During the early years of World War I he promoted the cause of Polish independence and organized relief for Polish war victims. He died on Nov. 15, 1916. at Vevey. Sienkiewicz's great trilogy, which began to appear in Slowo in 1883, was written, in his own words, "to fortify the hearts" of his countrymen. It comprised Ogniem *i* mieczem (*With* Fire and Sword), published separately in 1884; Potop (The Flood), 1886; and Pan *Wolody*jowski (Pan Michael), 1887–88. Historians differ over the trilogy's value as a picture of Poland's struggles against its enemies in the third quarter of the 17th century, but critics are unanimous in their praise of its literary qualities. Bez dogmatu (Without Dogma), a penetrating if lengthy psychological novel, appeared in 1891. Rodzina Polanieckich (The Polaniecki Family), a didactic *roman* de *moeurs,* in 1895. Quo Vadis, a historical novel of Rome under Nero, came out in 1896. Sienkiewicz's other works include Krzyzacy (The Knights of the Cross), 1900, and W *pustyni i puszczy* (In Desert and Wilderness), 1911, a children's novel.

See M. M. Gardner, *The* Patriot *Novelist of* Poland, *H.S.* (London, 1926); J. Birkenmajer, "H.S.," *Thought,* xiv, pp. 579–593 (London, 1939). (L. R. Lr.)

SIERRA LEONE, west Africa, since April 1961 an independent sovereign state within the Commonwealth of Nations, is bounded north and east by the Republic of Guinea, south by Liberia, and west by the Atlantic ocean. Area 27,925 sq.mi. The area formerly known as the colony is wholly coastal, consisting of the Sierra Leone peninsula (at the northern end of which stands the capital and chief port of Freetown), Sherbro and smaller islands (with the town of Bonthe) and Turner's peninsula. The former protectorate included the headwaters of the Niger river, which flows northeast (away from the Atlantic), eventually reaching the Gulf of Guinea in Nigeria.

PHYSICAL GEOGRAPHY

Relief and Drainage. — The mountains of the Sierra Leone peninsula, consisting of igneous (norite) rocks, run parallel to the sea for about 25 mi., with a maximum width of 12 mi., and reach 2,912 ft. in Picket hill. They are well watered, thickly wooded and much dissected by deeply cut ravines. The name Sierra Leone derives from that given to the range by the Portuguese explorer Pedro da Cintra in 1462. Along the Atlantic coast there extends a flat, low-lying and frequently flooded coastal plain, composed of sands and clays and 20–40 mi. wide. The numerous estuaries are fringed below high-tide mark by extensive mangrove swamps. In the south the plain gives way inland to rolling wooded country with isolated hills rising to more than 1.000 ft. In the north the plain is backed by an upland plateau reaching to 1.500 ft. or more. The plateau is bounded westward by a narrow outcrop of metamorphic rocks, the Kambui schists, in which valuable metal ores, including gold. iron and chromite, occur, but which is principally composed of granite. Above the plateau surface rise several mountain ranges, reaching 6.390 ft. in Bintimane (Loma mountains) and 6,080 ft. in Sankan Biriwa (Tingi hills).

Numerous rivers rise in the well-watered Fouta Djallon plateau and flow down its steep slopes southwest to the Atlantic ocean. Their middle courses are interrupted by rapids, but they are navigable in parts and those in the south are important for the commercial movement of goods, particularly during the rains. From north to south the principal rivers are the Great Scarcies (or Kolenté), Sierra Leone's northwestern boundary with the Republic of Guinea; Little Scarcies (Kaba); Rokel (Seli), known in its lower course as the Sierra Leone river, with the large, sheltered harbour of Freetown at its mouth; Jong (Taia); Sewa (Bum); Waanje; Moa; and Mano (Moro), forming the country's boundary with Liberia.

Climate. — Conditions are generally hot, with average temperatures of 75°–85° F. on the coast and between 69° and 95° in the interior. and, during the rains (May–October), very wet. During the dry season (November–April) the harmattan wind from the northeast frequently blows, bringing with it fine Saharan dust, poor visibility and very low relative humidity. The rainy season is introduced by a series of squalls, known locally as tornadoes, with thunder and lightning. Relative humidity during the rains may be as high as 90% for considerable periods, particularly during the wettest months, July to September. Annual average rainfall totals range from more than 150 in. in the peninsula mountains to 80 in. in the north. Freetown (128 in.) recorded 13.40 in. in one day in July 1948 and 5.91 in. in an hour in September 1944.

Sierra Leone was formerly known as "the white man's grave" but during the 20th century living and health conditions greatly improved, although at times the climate is distinctly trying, especially for Europeans.

Vegetation. — Forest probably covered most of Sierra Leone in the past, but has been greatly reduced in area, particularly through felling for cultivation. The wetter areas are still forest-covered, but savanna woodland (often termed orchard bush) and grassland are increasingly common, especially where forest reserves have been constituted, as on the hills of the peninsula and in the Gola forest near the Liberian boundary. Valuable timber trees exploited include species of Khaya (African mahogany) and African teak (*Oldfieldia africana*). In the interior there is much secondary forest, where trees have at some time been felled to permit cultivation; in these areas the African oil palm (*Elaeis guineensis*) is often common and has great economic value as a source of palm oil and palm kernels. Where the annual rainfall decreases, savanna woodland with fire-tolerant trees, such as lophira, and grassland become increasingly common. Grassland has developed throughout the country where the soils are too thin or the slopes too steep for tree growth and is particularly characteristic on lateritic patches. Swamps, which flood seasonally, abound along the beds of streams, and mangroves flourish in the saline tidal areas of river estuaries. though they are being drained and cleared in places for the cultivation of swamp rice. The swamps of the southern coastlands are important producers of the fibre piassava, used in the manufacture of strong brooms and obtained from the swamp palms Raphia *vinifera* and R. *gaertneri*.

Animal Life. — The relatively few large game animals are rarely seen because of the density of the vegetation; they include elephant, leopard, bush cow or dwarf buffalo (*Syncerus nanus*) and antelope (including duiker, the harnessed antelope and. in the Gola forest. the bongo). Tiger cats, civets, chimpanzees, various species of monkey, porcupines, bush pigs and cane rats (always called "cutting grass") are common. Some of these are responsible for much damage to growing crops. During the dry season lions occasionally come in from Guinea in search of game. Birds and insects abound, the latter including mosquitoes. tsetse flies, termites, locusts and sand flies. Hippopotamuses, both normal and pygmy, crocodiles and manatees are common in the rivers, and the estuaries are often shark-infested. Fish, caught both in the rivers and at sea, include tarpon, barracuda, mullet and "bonga" (a species of shad). The coastal waters off Sierra Leone constitute an excellent fishing ground, which is as yet little exploited.

(**R.** W. SL.)

THE PEOPLE

The Mende, Lokko, Kono, Vai, Koranko, Susu and Yalunka tribes belong to the Mande linguistic group (see MANDINGO), and the Temne. Limba and Bulom (Sherbro) to the semi-Bantu group. The tribes have many cultural features in common, from long association with the Muslim Fulani and Mandingo. the dominating influence of the two largest tribes (Mende and Temne) and contact with Europeans. The Mende in the centre and south, and the Temne in the north, divide into 60 and 44 chiefdoms respectively, each ruled by a paramount chief and a council of section chiefs. The main economic activity is agriculture; in most areas rice is the staple crop, but the Sherbro grow cassava and fishing is important among them. Descent is normally patrilineal, although there are close links with certain maternal relatives. The Temne divide into 25 patriclans. The Poro and Sande secret societies (for men and women respectively) sanction behaviour in most aspects of life; the Temne have the Ragbenle society in addition. The population in the former colony area also includes the Creoles, the descendants of repatriated slaves mainly from Nova Scotia and the West Indies.

The only lingua franca is a form of pidgin English which is fairly widespread, though by no means universal. There are diverse animist beliefs, rites and practices among tribes and families The Muslim religion is followed in parts of Sierra Leone and Christianity is well established. Freetown is the seat of the Anglican archbishop of west Africa and also of a Roman Catholic bishop. (ME. F.)

Population and Towns. — In 1957 the population was estimated to be 2,253,000 with a density of about 81 per square mile and included 1,000 Europeans and 2,000 Asians.

Freetown (*q.v.*) is the capital and chief port, but iron ore is shipped from Pepel, a short distance up the Sierra Leone river. The other chief towns are Bo (the former capital of the protectorate) in Southwestern province, the diamond-mining centre of Kenema in Southeastern province and the trading centre of Makeni in Northern province. Lunsar, near the Marampa iron mines, grew rapidly in the 1950s. Other important settlements are Waterloo, a Creole town on the peninsula, Kabala in Northern province and Kambia in the Scarcies river rice district. (R. L.)

HISTORY

Sierra Leone was originally divided into many small independent kingdoms or chiefdoms; each had its own ruler whose power was checked by his council of subchiefs. In many areas there were also secret societies, of which the Poro society is the best known, which maintained law and order as well as instructing initiates in the traditions and customs of the country. The Bulom (or Sherbro) people have been settled immemorially on the coast. The Temne, by tradition migrants from the north, were well established on the coast by the 15th century. The Mende only reached it by slow migration in the 19th century.

Portuguese voyagers named the mountainous peninsula at the mouth of the Rokel river, Serra Lyoa (Lion mountain), corrupted later to Sierra Leone. From the late 15th century European ships of all nationalities put in regularly, near the site where Freetown now stands, to take on water and firewood and to trade manufactured goods for slaves and ivory. Though English trading posts were built on Bunce Island and York Island in the 17th century, no European power exercised jurisdiction in Sierra Leone. Traders settled there under the protection of the African rulers, who welcomed them for the goods they brought. In the early 18th century the Fulani and Mandingo (Mandinka) Muslim peoples in Fouta Djallon (Futa Jalon), north of Sierra Leone (later in Guinea), started a holy war of conversion. From Fouta Djallon. Islam spread gradually to the coast. By the end of the 19th century it was firmly established in northern Sierra Leone and in the 20th century began to spread among the Mende.

A group of freed slaves of African birth or origin arrived in Sierra Leone from England to form a settlement in 1787. Its sponsor, Granville Sharp, the English slave abolitionist, called it "the Province of Freedom" and hoped it would become a base against the slave trade. King Tom. a Temne subchief, gave them a strip of land, but his successor, King Jimmy, drove them away in 1789. The settlement was revived in 1791 by the Sierra Leone company, a trading company sponsored by opponents of the slave trade, with headquarters in London. The town was rebuilt and named Freetown. The company brought from Nova Scotia. as settlers, some former slaves who had gained their freedom by serving the British in the American Revolutionary War. They were joined in 1800 by "Maroons," free Negroes from the mountains of Jamaica, who had been deported to Nova Scotia for insurrection. These settlers, African in origin, were English-speaking and many were literate and Christian. After the British parliament made the slave trade illegal in 1807, the British government took over the settlement (Jan. 1, 1808) as a naval base against the slave trade and as a centre to which slaves, captured in transit across the Atlantic, could be brought and freed. Between 1807 and 1864, when the last slave ship case was adjudicated in the Freetown courts, the British navy brought in more than 50.000 "recaptives." Drawn from all over west Africa, these heterogeneous people lacked any common language or culture. Inspired by Sir Charles MacCarthy, governor from 1814 to 1824, the government undertook a deliberate policy of turning them into a homogeneous, Christian community. Missionaries of the Church Missionary society (C.M.S.) and Methodist Missionary society, and the pastors of the Freetown settler churches, worked among them with such success that within a generation the policy was virtually fulfilled. As well as opening boys' and girls' secondary schools, the C.M.S. founded an institution at Fourah bay, near Freetown, to train teachers and missionaries (see Education, *Welfare, Defense* below). The recaptives and their children (known as "Creoles") prospered as traders. opening stores or bartering imported European goods in the neighbourhood for exportable palm produce. Many left the colony to trade along the coast or to work there as clerks, teachers or missionaries. At their suggestion, English missions were started in the Yoruba country (later part of Nigeria) the homeland of many recaptives. Thus they formed an educated west African elite, bringing the new ways they had learned to their distant homeland.

The most famous recaptive was Samuel Adjai Crowther, who became an Anglican priest in 1845 and bishop in the Niger territories in 1864. Among distinguished Creoles were Africanus Horton and William Davies who qualified in Britain in 1859 as doctors and served as officers in the British army; and Samuel Lewis, a barrister, who served many years on the colony's legislative council and was knighted in 1896.

Colony and Protectorate.— The colony made treaties of friendship with most of the neighbouring chiefs and gradually acquired jurisdiction over the adjoining coastline. The Creoles wanted to extend the colony inland, but the British government was unwilling to accept ne west African responsibilities. However by 1890 it was realized in London that the French, rapidly advancing inland. would soon hem the colony into a tiny enclave and destroy Freetown's value as a naval base. A more expansive policy was sanctioned, frontiers were delimited with the French and Liberian governments and a British protectorate was proclaimed in 1896 over the area within the frontier lines. The British government made no contribution toward governing the new protectorate, so Sir Frederic Cardew, governor from 1894 to 1900, introduced a hut tax to raise extra revenue to pay for the enlarged administration. The chiefs, who had not been consulted about the protectorate, objected. A revolt broke out in the north in 1898 under an experienced war chief, Bai Bureh. It spread among the Mende but was suppressed by the end of the year. There was no further armed rising against the British.

The protectorate was governed on the principles of indirect rule, later introduced by Frederick (later Lord) Lugard into Nigeria. The chiefs retained much of their power, under the supervision of British district commissioners. Traditional ways were encouraged, and for the first decades of the 20th century little was done to extend education in the protectorate. During the 19th century many Creoles held senior official posts and looked forward to governing themselves ultimately. But after the protectorate was assumed they were gradually removed from office and both colony and protectorate were ruled by British administrators. A new constitution in 1924 allowed a few Creoles to be elected. and protectorate chiefs nominated, to the legislative council. but this did not satisfy nationalist aspirations.

Independence.——After World War II British policy changed. In Sierra Leone, as elsewhere in west Africa, it was agreed to constitute democratic institutions through which the dependent territories could evolve into independent states. The Creoles, a small educated minority, hoped to entrench themselves politically, lest under a fully democratic constitution they should be overwhelmed by the protectorate peoples. But the 1951 constitution gave power to the majority. The government elected under it was led by Dr. Milton (later Sir Milton) Margai, leader of the Sierra Leone People's party, a predominantly protectorate party. In succeeding years, under his leadership, responsible government was gradually introduced, by peaceful evolution. The last stage was reached in 1961. and Sierra Leone became an independent state within the Commonwealth. (C. FY.)

ADMINISTRATION AND SOCIAL CONDITIONS

Under British rule the country was administered as a crown colony and protectorate, the governor being assisted by an advisory council of ex officio and appointed members until 1863, and thereafter by executive and legislative councils. A protectorate assembly, composed mainly of paramount chiefs, nominated members to the legislative council. The development of parliamentary institutions modeled on the British pattern was continuous, and amendments to the constitution in 1951, 1956 and 1958 increased the measure of responsible government. The ministerial system was introduced, the chief minister being the leader of the majority party in the legislative council, which itself became the house of representatives. At the 1957 general election almost all adult males and all adult female taxpayers or property owners were eligible to vote. In 1958 ex officio members were excluded from the administration and in 1960 the constitutional changes involved in the granting of complete independence were agreed upon in London.

The constitution provides for a governor general appointed by the British sovereign on the advice of the Sierra Leone prime minister; for a house of representatives of not fewer than 60 members and a normal life of five years; for universal adult suffrage; and for executive responsibility by a cabinet of ministers appointed by the prime minister and presided over by him. There are a supreme court and a court of appeal, with further appeal lo the judicial committee of the British privy council in certain cases. The cliief justice is appointed by the governor general on the advice of the prime minister; other judges are appointed on the advice or' the judicial service commission. The constitution includes the customary provisions governing citizenship and safeguarding individual rights and freedoms.

In the 1957 election the Sierra Leone People's party led by Sir Milton Margai formed an alliance (the United Front) with the United Progressive party, the National Council of Sierra Leone, the Independent Progressive party and the People's National party; the United Front was elected by a large majority. The administration was reconstituted in 1960 from members of parties within the United Front, which also won the 1962 election.

Local government is organized on the British pattern, with elected town councils composed of a mayor and aldermen and district councils in the rural areas. Each chiefdom has its own revenues from taxes and the district councils have powers to raise revenue as well as to obtain grants for local services from the central government.

Education, Welfare, Defense.—Fourah Bay college, the institution that was reconstituted in 1960 as the University College of Sierra Leone, was founded at Leicester near Freetown by the Church Missionary society in 1827. In 1876 it was affiliated to Durham university, Eng., and in the 1950s moved to Mt. Aureol overlooking Freetown. It has 300–400 students. Other missions conduct teacher training colleges, high schools, secondary schools and hospitals. Illiteracy is still widespread, but by the date of independence there were about 600 primary schools (80,000 pupils). 30 secondary schools (7,000 pupils), 6 teacher training colleges and 2 technical institutes (Freetown and Kenema). Hospital beds in establishments conducted by the government, missions and mining companies exceeded 1,500 and there were in addition about 50 government dispensaries and health centres, as well as treatment centres attached to the Endemic Diseases Control unit. Wages and conditions of employment are regulated by joint industrial councils and wages boards. By the early 1960s there were a number of registered trade unions, including mineworkers, railway workers and maritime and waterfront workers. The army consisted of headquarters, one battalion of the Sierra Leone regiment, a signal troop and service units.

THE ECONOMY

Although since the 1930s minerals have been of increasing importance. the economy is still largely a subsistence one based on rice growing on the upland slopes or in the swamps and estuaries.

Agriculture.— Agriculture occupies about 80% of the population. Besides rice, the main food crops are palm oil and cassava.

The chief export crops are palm kernels (about 60,000 tons annually), cocoa (3,000 tons), *Robusta* coffee (4,500 tons) and piassava (5,000 tons). Cultivation, transport and marketing are assisted hy co-operatives and by marketing and credit societies. Market gardening is carried on around Freetown and in the Northern province around Kabala in the Koinadugu district, which is the centre of the livestock industry.

Mining. — Iron ore (about 1,500,000 tons annually) is extracted from opencast workings at Marampa; deposits of rutile and bauxite exist near the coast in Southwestern province. Diamonds, the country's most valuable product, were first found in river gravels of the Kono district. about 140 mi. E. of Freetown. Subsequent prospecting revealed diamondiferous deposits over much of the Bafi-Sewa river system and in 1935 a British company obtained a 99-yr. concession covering the whole country. Following World War II, local poverty combined with boom prices for diamonds encouraged illicit mining, which was carried on not only by the inhabitants but also by thousands of immigrants (largely from French Guinea) and organized by the Lebanese community. The company's monopoly was in 1955 rescinded except for 450 sq.mi. around Yengema in Southeastern province. The government thereafter opened up the surrendered area to licensed Sierra Leonean diggers and in 1959 established its own buying office. By these measures, illegal exports of diamonds (estimated in the mid-1950s to exceed half the output) were materially reduced. The Sierra Leone deposits lie in gravel layers up to 4 ft. thick beneath a shallow alluvial covering and about 50% of the diamonds they yield are gem stones. The concessionary company produces between one-quarter and one-third of the total output; during the dry season about 30.000 licensed diggers are at work. Total exports of diamonds were estimated at £15,250,000 in 1960.

Industry and Power. — The main industrial undertakings are those concerned with the processing of agricultural and forest products (oil mills, rice mills, sawmills). Furniture. cigarettes, soft drinks, nails and industrial gases are produced locally. but further industrial development depends chiefly on power supplies. By the early 1960s the generating capacity in Freetown was less than 15.000 kw. and there mere 15 small power stations in the provinces. Fishing is important and village industries include fish curing and smoking, hand-expressing of palm oil and cracking palm kernels.

Trade and Finance. — Sierra Leonean overseas trade expanded substantially in the 1950s. More than 50% of imports come from other commonwealth countries (the bulk from the U.K.); the main imports are manufactured goods, machinery. cement, coal. petroleum products and tobacco. Minerals account for about 70% of total exports by value and agricultural products for about 16%; most of the exports went to the U.K. Currency at par with sterling (W.A.sh.20 = £1) is issued by the West African Currency board. in notes of W.A.sh.100, 20 and 10 and in coins of smaller denominations.

Transport and Communications. — A state-owned railway of 2 ft. 6 in. gauge runs east from Freetown to Pendembu ($227\frac{1}{2}$ mi.) near the Liberian frontier. A branch line from Bauya runs northeast to Makeni. The railway has many difficult gradients, limited carrying capacity and has never covered its capital costs. An iron-ore railway of 3 ft. 6 in. gauge joins Marampa with Pepel. Inland waterways total about 500 mi. and there is a considerable volume of river traffic, carried by launches. including coastwise routes from Freetown southward to Bonthe and northward on the Great and Little Scarcies rivers. Freetown, the finest natural harbour in Africa, is a regular port of call for numerous shipping lines and can accommodate large ships alongside the Queen Elizabeth II wharf. opened in 1954. The international airport of Lungi is on the north bank of the Sierra Leone river opposite Freetown, but domestic air services use Freetown's smaller Hastings airfield. The principal towns are accessible by road and the majority of villages can be reached by truck; in the early 1960s the system comprised about 1,700 mi. of main roads and 1,800 mi. of secondary roads.

The Sierra Leone Broadcasting service (founded 1934) transmits in English and a number of indigenous languages.

See also references under "Sierra Leone" in the Index volume.

(R. L.)

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Current history and statistics are summarized annually in the *Britannica Book of the Year.*

SIERRA MORENA, THE, Spain, is so called because of the long dark line of the southern scarp of the Meseta as seen from the Andalusian plain. It has a mean elevation of about 2.500 feet rising above this in the east toward the steppe region of Albacete. The easternmost and loftiest ridge is called the Sierra de Alcaraz (5.899 ft.), while some of those in the extreme west are classed together as the Sierras de Aracena. The great breadth of the Sierra Morena long rendered it a formidable barrier between Andalusia and the north; as such it has played an important part in the social, economic and military history of Spain. It separates the plateau region of Castile and Estremadura from the Andalusian plain and the highlands of the Sierra Nevada system, and forms the watershed between two great rivers. the upper Guadiana on the north and the Guadalquivir on the south. Parts of the Sierra Morena are rich in minerals; the central region yields silver, mercury and lead, while the Sierras de Aracena contain the celebrated copper mines of Tharsis and Rio Tinto (*q.v.*).

SIERRA NEVADA, is a range of high mountains south of the basin of Andalusia in southern Spain. It is a well-defined range. stretching from the upper valley of the river Genil or Jenil eastwards to the valley of the river Almería. It owes its name, meaning "the snowy range." to the fact that several of its peaks exceed 10.000 feet in height and are thus above the limit of perpetual snow. Its culminating point, the Cerro de Mulhacen (11,-411 ft.) reaches an altitude unequalled in Spain. while one of the neighbouring peaks, called the Picacho de Veleta (11.128 ft.). is only surpassed by Aneto (11.168 ft.), the loftiest summit of the Pyrenees. The Sierra Nevada is composed chiefly of soft micaceous schists. sinking precipitously down on the north, but sloping more gradually to the south and southeast. On both sides deep transverse valleys (*barrancas*) follow one another in close succession, in many cases with round, basin-shaped heads like the cirques of the Pyrenees (*q.v.*). In many of these cirques lie alpine lakes, and in one of them, the Corral de Veleta, there is even a small glacier. the most southerly in Europe. The transverse valleys open on the south into the longitudinal valleys of the Alpujarras (*q.v.*). On the north, east and west are the Sierras of Parapanda. Harana. Gor. Baza, Lucena. Cazorla. Estancias. Filabres, etc.. connected with the main range, sometimes collectively termed the Sierra Nevada system.

SIERRA NEVADA (Spanish. "Snowy hlountains"). of California, one of the major ranges of the United States, extends from Tehachapi pass north-northwestward 400 mi. to Lake Almanor. Its breadth varies from 40 to 80 mi. The highest peak is Mt. Whitney. 14.495 ft.

The range consists chiefly of granite, flanked in places by belts of metamorphosed sediments. and overlain elsewhere by Tertiary volcanic materials. The range was created by block faulting: this great section of the earth's crust was broken apart from its surroundings. raised and tilted into a new position. The eastern edge became a massive escarpment. towering nearly three miles above Owens valley. Streams cut deep valleys into the gentle western slope and deposited the resultant detritus onto the depressed western portion, creating the vast alluvial plains of the San Joaquin-Sacramento valley ("Great valley"). During the Pleistocene epoch alpine glaciers reshaped some valleys. creating the spectacular scenery of Yosemite valley and producing peaks. pinnacles and rock-rimmed lakes along the eastern crest. In a few high sheltered valleys, small glaciers still remain.

This massive. unbroken barrier lifts the prevailing winds moving eastward off the Pacific ocean. producing heavy precipitation. especially in winter. on the western slope (30–40 ft. of snowfall at 6.000 ft. in an average winter) and creating a desert eastward into Kevada. The range is a vast reservoir for water, supplying irrigation requirements for the Great valley and municipal requirements for several cities, notably San Francisco and Los Angeles.

The great differences in altitude produce marked contrasts in vegetation. On the west, the grasslands of the Great valley are succeeded upslope by a belt of oak woodland, replaced in turn by chaparral (drought-resistant dense brush), yellow pine forest. white fir—red fir forest, lodgepole pine forest, subalpine forest and culminating finally in alpine meadows and bare rock slopes above the timberline. On certain unglaciated interfluves amidst the yellow pine forests are groves of Sequoias (Sequoia *gigantea* "big tree"), world renowned for their great age and size. On the steep eastern slope the transition from forest to desert is abrupt. Some lumbering is carried on in the west-slope forests. The upper zones are grazed by sheep in summer and the foothills support cattle through the year.

Gold was discovered in 1848 in Sacramento valley gravels derived from the Sierra Nevada. Soon, thereafter, the bedrock source or "mother lode" was discovered on the western slope. After a wild period of mining booms and a longer period of steady production, mining activity gradually declined and the old mining towns became more important as tourist attractions than as mineral producers.

Tourists also visit the Sierra Nevada mountain recreation centres in great numbers in both summer and midwinter. Among the chief attractions are the three national parks—Yosemite, Sequoia and Kings Canyon (*qq.v*)—and several ski centres in the national parks, the Donner pass—Reno region and the Mammoth area on the eastern slope.

Donner pass (7.017 ft.). used by the Southern Pacific railroad and highway U.S. 40, is the most important transmontane route. connecting San Francisco with Reno, Nev. Farther south, the mountains constitute an almost impenetrable barrier to land transportation: from Tioga pass to Walker pass, a distance of 165 mi., no road crosses the range.

Aside from scattered recreation areas, lumber camps and small towns serving the transmontane transportation routes, the Sierra Nevada range is virtually devoid of permanent inhabitants. Much of it is included in the national parks and several national forests.

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SIEYÈS (Sē-ā-yās), **EMMANUEL-JOSEPH** (1748–1836), French abbé and statesman, one of the chief theorists of the revolutionary and Napoleonic era, born at Fréjus, S. France, on May 3, 1748. He was educated for the church at the Sorbonne; but while there he eagerly imbibed the teachings of Locke, Condillac, and other political thinkers, in preference to theology. Nevertheless he entered the church, and owing to his learning and subtlety advanced until he became vicar-general and chancellor of the diocese of Chartres. At the crisis of 1788, when Necker asked for opinions as to the constitution of the estates Sieyks wrote his celebrated pamphlet, "What is the Third Estate?" He thus begins his answer—"Everything. What has it been hitherto in the political order? Nothing. What does it desire? To be something." For this mot he is said to have been indebted to Chamfort. The pamphlet had a great vogue, and its author was elected as the last (the twentieth) of the deputies of Paris to the States General. He strongly advised the constitution of the Estates in one chamber as the National Assembly, but he opposed the abolition of tithes and the confiscation of church lands. Elected to the special committee on the constitution, he opposed the right of "absolute veto" for the king, which Mirabeau unsuccessfully supported. He had a considerable influence on the framing of the departmental system, but after the spring of 1790 his influence was eclipsed by men of more determined character. Only once was he elected to the post of fortnightly president of the Constituent Assembly. Excluded from the Legislative Assembly by Robespierre's self-denying ordinance, he reappeared in the third Kational Assembly, known as the Convention (September 1792–September 1795); but he effaced himself partly from disgust, partly from timidity. He abjured his faith at the time of the installation of the goddess of reason; and afterwards he characterized his conduct during the reign of terror in the ironical phrase, *J'ai vécu.* He voted for the death of Louis XVI., but not in the contemptuous terms La *mort* sans phrases sometimes ascribed to him.

In 1795 he went on a diplomatic mission to The Hague. He dissented from the constitution of 1795 (that of the Directory) in some important particulars, but without effect, and thereupon refused to serve as a Director of the Republic. In May 1798 he went as the plenipotentiary of France to the court of Berlin in order to try to induce Prussia to make common cause with France against the Second Coalition. His conduct was skilful, but he failed in his main object. He was elected a Director in place of Rewbell in May 1799. Already he had begun to intrigue for the overthrow of the Directory; he now set himself to sap the base of the constitution of 1795. With that aim he caused the revived Jacobin Club to be closed, and made overtures to General Joubert for a *coup d'état* in the future. The death of Joubert at the battle of Novi, and the return of Bonaparte from Egypt marred his schemes; but ultimately he came to an understanding with the young general. After the coup *d'état* of Brumaire, Sieyks produced the perfect constitution which he had long been planning, only to have it completely remodelled by Bonaparte. Sieyks soon retired from the post of provisional consul, which he accepted after Brumaire; he entered the senate, where he defended the arbitrary and illegal proceedings whereby Bonaparte rid himself of the leading Jacobins. During the empire he rarely emerged from his retirement, but at the time of the Bourbon restorations (1814 and 1815) he left France. After the July revolution (1830) he returned; he died at Paris on June 20, 1836. The thin, wire-drawn features of Sieyks were the index of his mind, which was keen-sighted but narrow, dry and essentially limited. His lack of character and wide sympathies was a misfortune for the National Assemblies which he might otherwise have guided with effect.

See A. Neton, *Sieyès* (1748–1836) *d'après documents inédits* (Paris, 1900); also the chief histories on the French Revolution and the Napoleonic empire. (J. H. Ro.; X.)

SPFAKA, the name of three species of large wooly lemurs (*q.v.*) of the genus Propifhecus, allied to the indri (*q.v.*), but distinguished by their long tails. Sifakas, found only in Madagascar, are variable in colouring, but always show a large amount of white. See PRIMATES.

SIGEBERT (d. 575), king of the Franks, was one of the four sons of Clotaire I. At the death of Clotaire in 561 the Frankish kingdom was divided among his sons, Sigebert's share comprising the Rhine and Meuse lands and the suzerainty over the Germanic tribes beyond the Rhine as far as the Elbe, together with Auvergne and part of Provence. At the death of his brother Charibert in 567 Sigebert obtained the cities of Tours and Poitiers, and it was he who elevated to the see Gregory of Tours (*q.v.*), the historian of the Franks. Sigebert married a royal princess, Brunhilda, daughter of Athanagild, the king of the Visigoths; the nuptials were celebrated with great pomp at Metz, the Italian poet Fortunatus composing the epithalamium. Shortly afterwards Sigebert's brother Chilperic I. married Brunhilda's sister, Galswintha; but the subsequent murder of this princess embroiled Austrasia and Neustria, and civil war broke out in 573. Sigebert appealed to the Germans of the right bank of the Rhine, who attacked the environs of Paris and Chartres and committed frightful ravages. He was entirely victorious, and pursued Chilperic as far as Tournai. But just when the great nobles of Neustria were raising Sigebert on the shield in the villa at Vitry, near Arras he was assassinated by two bravoes in the pay of Fredegond, Chilperic's new wife. At the beginning of his reign Sigebert had made war on the Avars, who had attacked his Germanic possessions, and he was for some time a prisoner in their hands.

See Gregory of Tours, *Historia Francorum*, book iv.; **Aug.** Thierry, *Récits* des *temps mérovingiens* (Brussels, 1840), and Aug. Digot, *His-*

toire du royaume d'Austrasie (1863). (C. PF)

SIGEBERT OF GEMBLOUX (*c.* 1030–1112), medieval chronicler. became in early life a monk in the Benedictine abbey of Gembloux. Later he was a teacher at Metz, and about 1070 he returned to Gembloux, where, occupied in teaching and writing, he lived until his death on Oct. 5, 1112. As an enemy of the papal pretensions he took part in the momentous contest between Pope Gregory VII and the emperor Henry IV; and he also wrote against Pope Paschal II. Sigebert's most important work is a *Chronographia,* or universal chronicle, covering the years 381–1111. which is published in vol. vi of the *Monumenta Germaniae historicae Scriptores,* with an introduction by L. C. Bethmann.

See S. Hirsch, *De vita et scriptis Sigiberti Gemblacensis* (1841); A. Molinier, *Les Sources de l'histoire de France,* tomes ii and v (1902–04); W. Wattenbach, *Deutschlands Geschichtsquellen,* Band ii (1894).

SIGER OF BRABANT (d. between 1281 and 1284), professor of philosophy at Paris and leader of heterodox Aristotelianism, was a native of the duchy of Brabant. From 1266 (when his name first appears) to 1276 he was prominent in the dissensions that troubled the faculty of arts in Paris. From his earliest years as a teacher he professed a disquieting Aristotelianism, without regard for orthodox Christian doctrine. His teaching was attacked by Bonaventura, the minister general of the Friars Minor, and by Thomas Aquinas, the head of the Dominican school. On Dec. 10, 1270, Étienne Tempier, bishop of Paris, condemned 13 errors taken from the teaching of Siger and his partisans. On Nov. 23, 1276, the inquisitor of France summoned Siger, Goswin of the Chapel and Bernier of Nivelles before his tribunal; they fled to Italy and probably appealed to the tribunal of the papal curia. On March 7. 1277, Tempier pronounced the condemnation of 219 propositions, aiming especially at the teaching of Siger and Boetius of Dacia, Siger was probably condemned to stay at the curia in the company of a cleric; he was stabbed at Orvieto, by his cleric, who had gone mad, and died under the pontificate of Martin IV, before Nov. 10, 1284. Dante (*Paradise,* x, 133–138) puts Siger in the Heaven of Light in the brilliant company of 12 illustrious souls who are glorified because of their fidelity to their own providential mission: Siger fought all his life for the autonomy of philosophy.

By the middle of the 20th century 14 certainly authentic works of Siger's and at least 6 probably authentic commentaries on Aristotle were known. The most important are: *Quaestiones in Metaphysicam; Impossibilia* (six exercises in sophistry): *Quaestiones de necessitate et contingentia causarum; Quaestiones in tertium de Anima;* and *Tractatus de animn intellectiva.*

Siger is an important representative of that school of radical Aristotelianism which arose in the faculty of arts at Paris when Latin translations of Greek and Arabic works had led to the discovery of philosophy by the masters there. Some of these masters, after 1260. inaugurated a purely rational teaching. without any concern with the exigencies of Christian faith; and Siger appears as the leader of this group. His capital source is Aristotle; secondary sources are Proclus and Avicenna (chiefly in metaphysics), Averroes (chiefly in psychology): Albert the Great and Thomas Aquinas. Siger's most typical doctrines are: the First Being is the immediate cause of a single creature. the first intelligence; all other creatures derive indirectly from God, by way of a progressive emanation; there is no real distinction between essence and existence in creatures; the created world is necessary and eternal, and every species of being (mankind, for instance) is eternal; there is only one intellectual soul for mankind and consequently one will; this unique soul is eternal. but the human individuals are not immortal (on the question of the soul. however. Siger's teaching was not consistent); human will is a passive potency moved by the intellect. Siger never accepted the theory of a double truth (one of reason and one of faith). To characterize his philosophy as "Latin Averroism" is inaccurate: his system must be called a radical or heterodox Aristotelianism.

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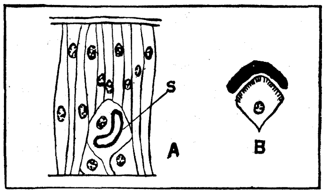
SIGHT, SENSE OF. Under the term "eyes" we include organs. or. in the simplest cases, groups of sensory cells, which are specially adapted for the perception of light. Nevertheless, sensitiveness to light can frequently be established for animals in nhich eyes are not demonstrable. We must assume, therefore, either that the whole surface of the skin is sensitive to light, or that single sensory cells are scattered in the skin ahich are very inconspicuous in their structure, and which are the bearers of this sense of light perception.

THE STRUCTURE OF THE EYES IN THE LOWER ANIMALS

Already in the Protozoa, however, true eyes are found. In Volvox and other Flagellates they consist of a lens, and, behind this, an accumulation of the plasma, which frequently is pigmented. The earthworm has isolated photo-sensitive cells, which may be distinguished by their structure; the simplest of the vertebrates *(Branchiostoma)* has numerous isolated photo-sensitive cells scattered over the whole of the dorsal nerve cord, each of which is half surrounded by a pigment cell (fig. 1).



AFTER HESSE

FIG. 1.—(A) SECTION THROUGH THE SKIN OF AN EARTHWORM. (S) PHOTO-SENSITIVE CELL. (B) PHOTO-SENSITIVE CELL WITH PIGMENT-CAP FROM BRANCHIOSTOMA

Eyes of the most simple kind originate through the concentration of a number of such photo-sensitive cells in a small space.

Eye-spots.—Eye-spots are found in Medusae, starfishes and some Annelid worms (fig. 2). The first step in the perfecting of this very primitive apparatus is the sinking of the eye-spot into a pit-like depression, thus forming an eye-cup (optic cup). This type already, perhaps, is adapted for the perception of the direction of light, and is of very general occurrence, being found in some worms, gastropods, bivalves, starfishes, Arthropods, etc. (fig. 3). This type of eye when it occurs in Arthropods is called an *ocellus,* and is more complicated, as the thin cuticle, which envelopes the whole of the body, becomes thickened over it, and forms a strongly arched, or occasionally, ball-shaped lens. At the same time division of labour takes place among the cells forming the eye-cup. The sides of this remain transparent, and secrete a kind of vitreous humour, only the cells situated at the back of the cup forming the retina (fig. 4a). In yet other cases two layers may be formed in the optic cup by a peculiar process of folding, which cannot be described here. A vitreous outer layer and an inner retinal layer can then be distinguished (fig. 4b). The open cup-shaped eye may become quite closed in, forming an optic vesicle, by the growing together of the outer margins (as in many Chaetopod worms, gasteropods and cuttlefishes). The interior of this optic vesicle is then filled by a jelly-like substance, the vitreous humour. The anterior portion of the vesicle is transparent, like the skin which grows over it; the inner half becomes the retina (fig. 5). This type of eye is found in its most perfect form in some worms (*Alciope*) and gasteropods (*Helix, Limax*) with the formation of a lens, which is free in the vitreous humour, and condenses the rays of light. The cuttlefish alone shows a further development. This is the highest of all invertebrate animals. In general, as well as in psychical, development, it ranks at least as high as fishes.

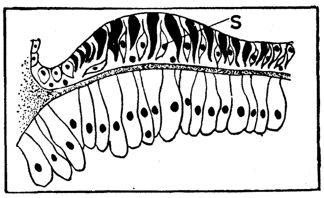


FIG. 2.—EYE-SPOT OF A MEDUSA: S RETINAL CELLS

The eye represented in fig. 6, presents a striking resemblance to that of a vertebrate. All the separate parts of the one are repeated in the other. The posterior chamber is the principal part; it is bounded at the back by the retina, and in front by the

iris. It is filled by a jelly—the vitreous humour.

The lens is spherical, as in fishes. It differs from the lens of a fish, however, in that it does not consist of cells; it is divided by a delicate skin which separates the anterior chamber of the eye from the posterior, half lying to the front, and half to the back.

The anterior chamber is closed by a transparent cornea, in front of which are movable eyelids. The power of accommodation is exactly the same as in the vertebrate eye. The cuttlefish can focus its sight either for near vision or for distant by means of particular muscles, which alter the length of the axis of the eye. It is hardly necessary to mention that the pupil in the iris can be expanded or contracted according to the strength of the light falling on it. In the structure of the retina, also, the eye of the cuttlefish is equivalent to those of vertebrates.

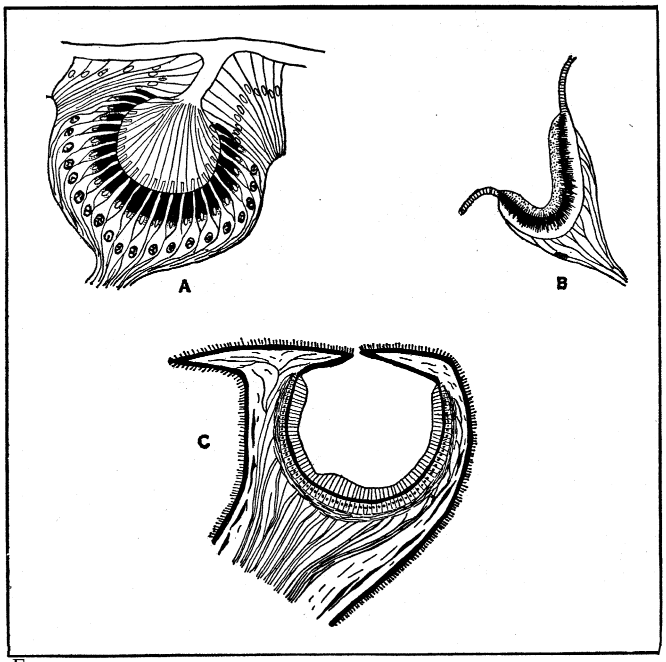


FIG. 3.—OPEN. CUP-SHAPED EYES OF (A) CHAETOPOD WORM (SYLLIS); (B) GASTROPOD, COMMON LIMPET (PATELIA); (C) CHAMBERED CEPHALOPOD (NAUTILUS)

It is made up of more than 100,000 elements per sq.mm., and thus is certainly adapted for the formation of a sharp image. Lastly, it may be mentioned, that in size also it is in no way inferior to the vertebrate eye. Eyes 37 cm. in diameter have been found in the giant cuttlefishes of the genus Architeuthis.

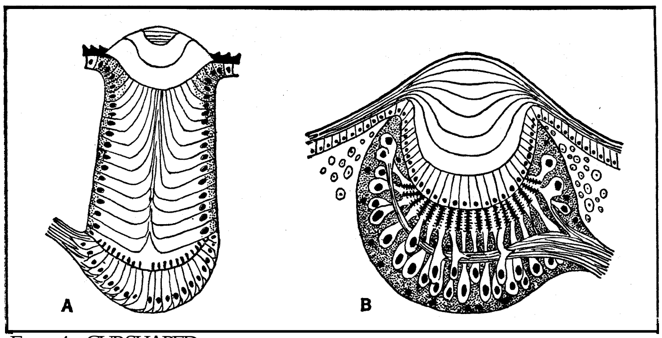


FIG. 4.—CUP-SHAPED EYES OF (A) THE LARVA OF A BEETLE (ACILUS); (B) A SPIDER (TEGENARIA)

The eyes of turbellarian worms and leeches have a somewhat different structure. In these animals, it is true, eye-cups are present, but they are not formed by the retinal cells themselves, but of pigment cells, which absorb the light, while the sensory cells penetrate into the interior of the cup (fig. 7).

Faceted **Eyes.**—We find quite a different type in the faceted eyes of insects and crustaceans. As the name implies, the eye may be seen to be formed of a great number of facets, usually square or hexagonal in shape, which in their regularity resemble closely those cut on a precious stone. Each facet corresponds to a single eye or ***ommatidium,*** which always takes the shape of an elongated cone. In each of these eyes, taken by itself, the following parts may be distinguished. The outermost part consists of a small, somewhat rounded, transparent lens. Under this is the crystalline cone, a conspicuous structure, usually gelatinous, which is quite transparent, and allows the rays of light to pass freely, and directs their path. If we examine the eye of a diurnal insect, we find that the inner extremity of the crystalline cone is adjacent to the cells which, collectively, correspond to our retina. Each ommatidium has only 6 or 7 of these cells. Among them they secrete a remarkable body, the rhabdom, which evidently represents a kind of transformer.

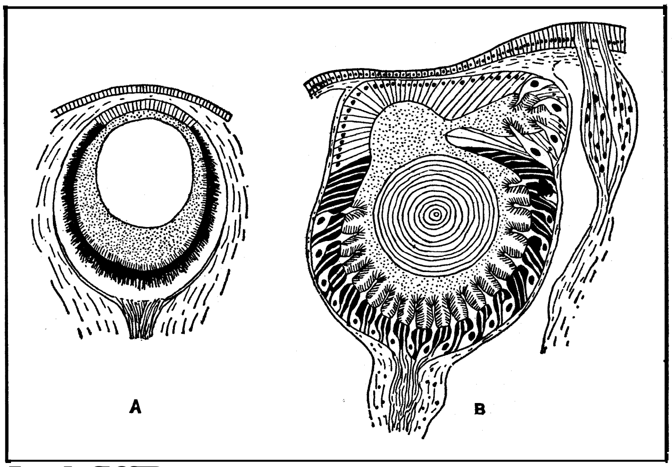


FIG. 5.—CLOSED, VESICULAR EYES OF (A) A MARINE GASTROPOD (MUREX); (B) A LAND GASTROPOD SLUG (LIMAX)

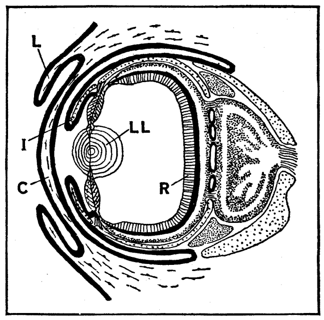
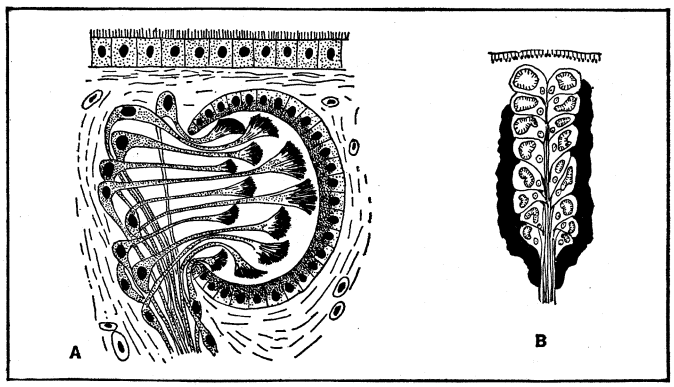


FIG 6.—EYE OF A CUTTLEFISH; L. LID; C. CORNEA; I. IRIS; LL. LENS; R. RETINA

The rays of light which enter the eye are focused on the rhabdom, and there are evidently brought into such a form of energy that they are available to the sensory cells. The nervous layer immediately adjoins the sensory cells. In diurnal insects each ommatidium is separated from its neighbour by a layer of pigment.

somewhat comprehensive conclusions may be drawn from the structure of the faceted eye as to its functional powers. It seems certain that each ommatidium functions separately. It projects the image of a point of light. The whole image seen thus by an insect is composed only of as many elements as the eye possesses facets. The number of these, however, is surprisingly small. Even those insects which have the best sight, such as dragonflies, have only about 60,000 ommatidia. With this we



AFTER HESSE

FIG. 7.—(A) EYE OF A TURBELLARIAN WORM (PLANARIA); (B) EYE OF A LEECH (HIRUDO)

must compare the fact that in the vertebrate eye a single sq.mm., which gives only an exceedingly small portion of the whole image, contains about 300,000–700,000 separate elements. It follows as a matter of course that only in a very slight degree is an insect

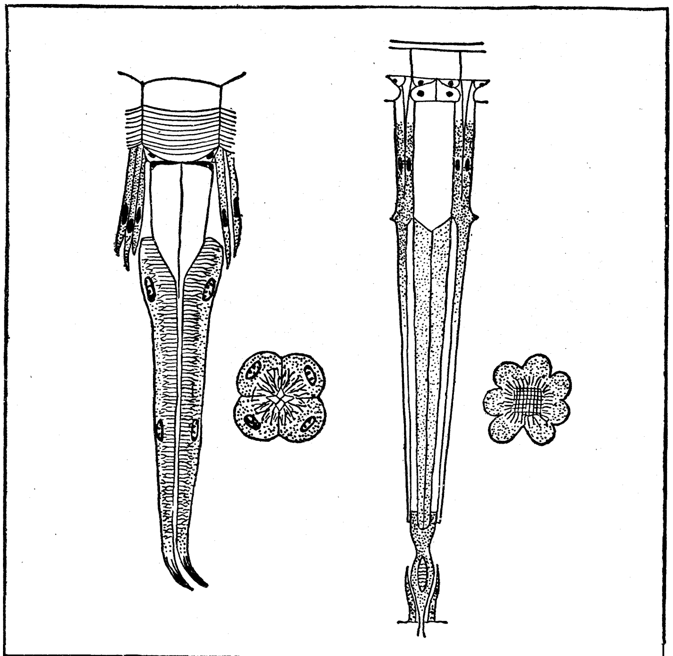
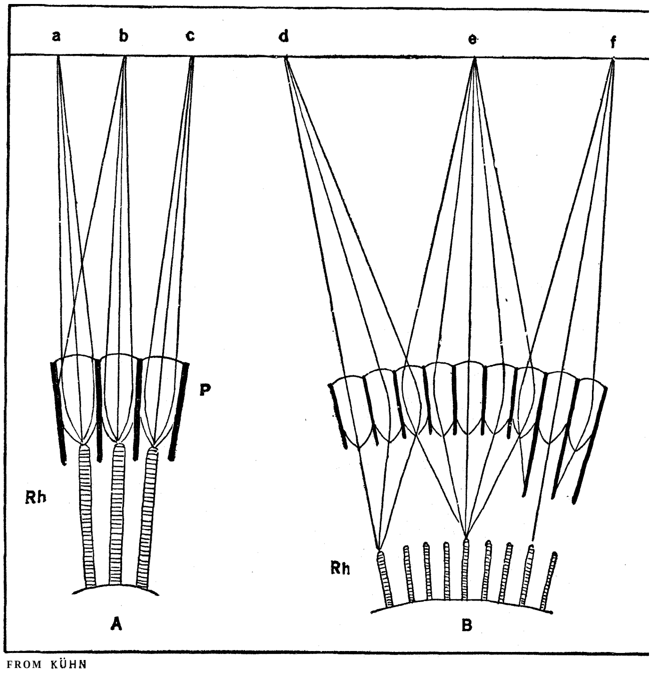


FIG. 8.— (LEFT) **OMMATIDIUM** FROM THE FACETED EYE OF AN INSECT (COCKROACH, **PERIPLANETA**) AND CROSS-SECTION THROUGH THE **RETINULA**. **(RIGHT) OMMATIDIUM** OF A CRUSTACEAN (CRAYFISH. ASTACUS), WITH CROSS-SECTION THROUGH THE **RETINULA**

able to distinguish form, as is borne out by the previously mentioned experiments. Most insects, which have only a few thousands or even hundreds of ommatidia, cannot do this at all. On the other hand, these eyes are eminently adapted for the perception of movement. When an insect the size of a fly passes

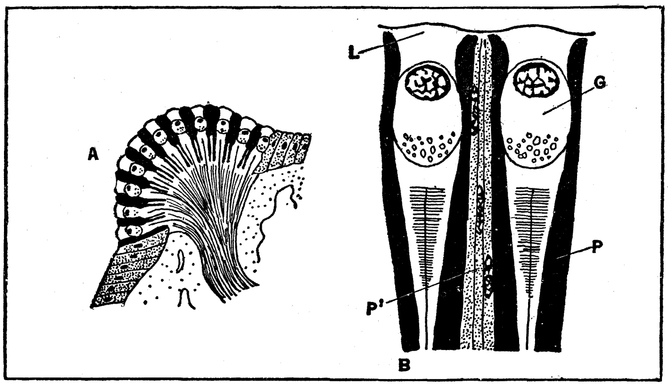


FROM KÜHN

FIG. 9.—PATH OF THE LIGHT-RAYS IN **A** FACETED EYE: (A) IN ONE GIVING AN APPOSITION-IMAGE. **(B)** IN ONE GIVING **A SUPERPOSITION-**IMAGE; P. PIGMENT; RH. RHABDON

in front of a dragonfly at a distance of about 2 metres, it is seen by the latter only as a black point, for it can be proved that, in this case, only one single ommatidium catches the image of the fly. In spite of this it is pursued, captured and eaten.

Eyes of **Nocturnal** Insects.—The eyes of nocturnal insects and of the mostly nocturnal crustaceans are constructed in a remarkably different manner from those of diurnal insects. As is to be expected, such an eye is constructed so as to admit a greater amount of light than that of a diurnal insect. This is attained by the ommatidia being no longer separated by pigment layers. In addition, the crystalline cone has, in such animals, other physical peculiarities. The physiologist Exner has proved this conclusively for the eyes of the glow-worm. He showed



AFTER (A) KUEPFER, **(B)** JACOB

FIG. 10.—FACETED EYE FROM THE MARGIN OF THE MANTLE OF THE BIVALVE MOLLUSC ARCA

(A) Transverse section through the edge of the mantle. **(B)** Two Ommatidia, more strongly magnified. L. Lens. G. Vitreous humour. P. Pigment coat of sensory cell. P' **Interstitial** pigment cells

that the light given out by a luminous point penetrates not only one ommatidium but many (fig. 9). After leaving the crystalline cone, however, the rays are refracted in such a way that, ultimately, they again become focused upon one point of the retina. Each rhabdom receives, therefore, a much greater amount of light than those in the eyes of diurnal insects. On account of the arrangement one upon the other of the points of light which come from the various crystalline cones, such eyes are described as giving "superposition images," while those of diurnal insects give "apposition images." It is of interest that crustaceans are able to use their eyes either for superposition or for apposition vision, according to their needs. This is attained by the movement of the pigment in the cells which separate the ommatidia.

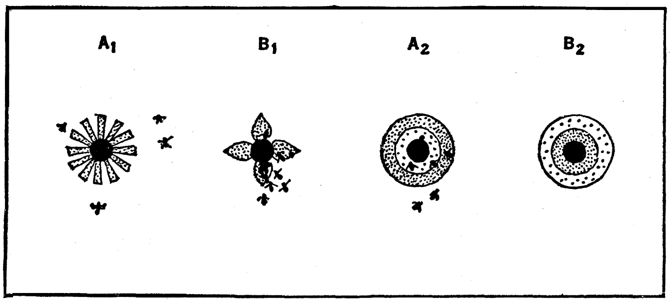


FIG. 11.— TRAINING HONEY-BEES TO DISTINGUISH FORMS

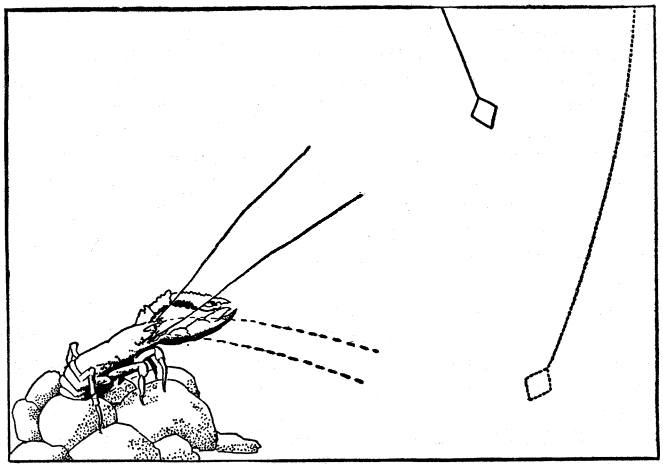
B_1 and A_1 are the boxes with forms to which the bee had been previously trained to come; A_1 and B_2 are other boxes

Faceted eyes are found in some bivalves (*Arca*) and Chaetopod worms, as well as in Arthropods, but serve, however, only for perception of movement (fig. 10).

THE FUNCTION OF THE EYE

To man the eye is by far the most important of all the sense organs. With the help of our eyes we recognise our fellow men, animals and plants, the things we use in daily life, in short all the world around us. He who studies the sight of animals is apt to make the mistake of supposing that their eyes function like ours.

Such perception of form as permits us, from the appearance of an object, to draw conclusions as to its other qualities, and thus to understand its nature, is only to be found in the highest animals, mammals, birds, and, perhaps, some reptiles. Even the frog does not recognise a motionless fly as desirable food, but is quite indifferent to it; it is, so to speak, "intellectually blind." This applies in a still greater degree to the invertebrate or lower animals. Of these, so far as is known at present, only bees and their relatives show a definite sense of form. Von Frisch demonstrated that bees can be trained to distinguish forms. Food was given them in a closed box, into which they were obliged



AFTER DOFLEIN

FIG 12 —GALATHEA SQUAMOSA, SHOWING REACTION TO OPTICAL PERCEPTION OF AN APPROACHING OBJECT, BY BENDING ANTENNAE DOWN

to crawl through a hole. Around this hole was glued the picture of a flower, while round a hole in another box, which was placed beside the first, but was empty, was gummed the picture of another flower. After food had been given thus for several days, the boxes, which could be distinguished only by the difference in the pictures of the flowers, were placed before the bees empty. A much greater number of visits was paid to the box which had contained food (*see* fig. 11). Bees, therefore, are able to distinguish between two flowers according to their shape. Similar experiments may be made also by using simple geometrical figures.

Perception of Movement. — As far as is known at present, none of the other lower animals are capable of such a performance. It is easy to guess for what purpose they use their eyes if we consider the behaviour of some mammals. The hare takes not the least notice of the sportsman standing motionless at the edge of the wood, but as soon as he makes the slightest movement, it takes to flight. It, therefore, exhibits in a marked degree the power of perception of movement. Spontaneous movement can take place only in living organisms. Since the animal heeds only the movement, and not the motionless form, it is able, in the simplest way, to distinguish between "living" and "lifeless."

The power of perceiving movement is very distributed. Schrader has made interesting experiments with falcons These intelligent birds, under normal conditions also, are able to distinguish motionless prey as such. If, however, the cerebrum is removed, they notice movement only. A falcon from which the cerebrum has been removed, pursues and strikes a living, active mouse just as skilfully as would a normal bird; as soon as the mouse is dead, however, it takes no more interest in it. In general, frogs and salamanders snap only at moving prey, and every angler knows that fishes act in the same way. Among the lower animals interesting observations have been made on insects, crustaceans and molluscs. The scallop, *Pecten jacobaeus,* has, on the edges of its mantle, a large number of eyes of complex structure. On account of the poor development of its brain, however, it is unable to distinguish its enemies by means of sight, and is able only to perceive movement. If another animal crawls slowly towards it, as soon as the scallop perceives the movement, it extends the long, thread-like tentacles, which are its olfactory organs By means of these it determines whether the approaching animal is friend or foe. If it be the former, the scallop quickly becomes quiet again; if the latter, it swims away hurriedly. A corresponding co-operation between eyes and feelers is often to be seen in decapod crustaceans. These animals react to a moving object by holding the antennae straight out towards it. (*See* fig. 12.) Uexkuell showed that the house-fly finds its mate by means of this perception of movement. If a small, black bead, about the size of a fly, is fastened to a thread, and drawn fairly rapidly through the air, the male flies immediately throw themselves upon it. If the surface of the bead be smeared with a sticky substance, it makes an ideal fly-trap. That dragonflies and other predatory insects only pursue moving prey need hardly be mentioned.

The most lowly animals which undoubtedly possess the power of perceiving movement are certain marine Chaetopod worms (*Branchiomma*). They live in tubes, constructed by themselves, from which only their heads project, which bear numerous, long tentacles. Each tentacle has at its extremity a compound eye. If one makes a rapid movement with the hand in front of the aquarium, every worm retreats into its tube with lightning rapidity. That this is a typical case of the visual perception of movement is proved by the fact that darkness or light, produced by the switching off or on of an electric lamp, without movement. makes no impression whatever upon the animals.

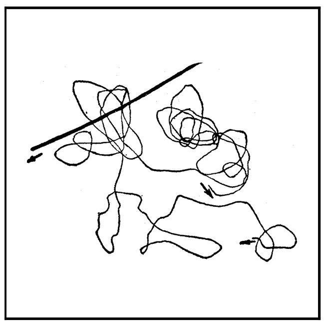
That the lower animals perceive and take heed of motionless objects is really only to be observed when they have to turn aside from their path on account of them. When an insect flies about in a forest it must not run the risk of colliding with every tree. This also applies to the deliberately moving gasteropods.

We can well observe in these slow-moving creatures how skilfully they avoid the obstacles which may be placed in their path.

This is also the case if we place between the animals and the obstacle a glass screen, which excludes all impressions of it other than visual ones. We do not know as yet how widespread this "avoiding reaction" is in the animal kingdom. On the other hand, visual perception of direction is almost universal. This power enables the animal to pursue an orderly path in a straight line. It hardly requires to be proved that it is a necessity of life for all freely-moving animals to crawl, fly or swim straight ahead. It suffices to remember that, without this power. an animal runs the risk of moving round and round in circles, in a quite aimless manner. Mephistopheles says in "Faust":—

> I tell you, the man who speculates,
> Is like a beast upon a barren heath,
> Led in a circle by an evil spirit,
> While just beyond are spreading, fresh, green fields.

We can conjure up this evil spirit in our experiments by conducting them in darkness. If we allow small insects to creep about in the dark on a piece of glass lightly smeared with soot, we can see from their tracks that they have crawled here and there, not indeed in circles, but in a totally aimless manner, without moving far from one place (*see* fig. 13). We can increase this restriction of movement by amputating one of the legs of the insect; it then frequently runs in a narrow spiral, always turning towards the same side. As soon as we admit light into the darkened chamber, however, matters are instantlv changed; the creature runs away from the light in a course straight as a line.



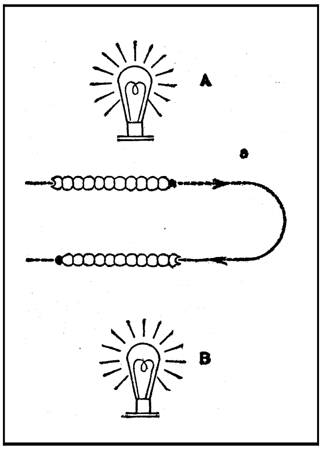
AFTER V. BUDDENBROCK

FIG. 13.—TRACK OF A BEETLE IN THE DARK (THIN LINE), AND IN THE LIGHT (THICKER LINE)

Visual Sense of Direction. — These experiments prove the existence of the visual perception of direction. This applies to human beings also. It has long been known that a man in desert or snow covered regions, or in dense brush, unable to use his sight for orientation, moves round in circles, and, after walking for hours, finds himself back at the point from which he started. The manner in which man and the higher animals orientate themselves in space by means of sight is generally known. Quite unconsciously they choose some prominent object, such as a tree, for which they aim; on approaching this they select as their goal another, more distant object, lying in the same direction.

The lower animals regulate their movements on a different principle. They shape their course in relation to the light.

This method of orientation is well illustrated by the following example. Xenophon frequently writes in his "Anabasis":—"We marched keeping the sun on our right." That is to say, we can in a quite unfamiliar region, travel in a straight course in a particular direction, if we take care that the rays of the sun and the line of march enclose a constant angle. What man does intelligently the lower animals accomplish by blind instinct.



AFTER V. BUDDENBROCK

FIG. 14.—THE MOVEMENTS OF A CATERPILLAR IN RELATION TO LIGHT

The particular motion with relation to the light may be demonstrated experimentally in two ways. A small candle is put on a table in a dark room, and the animal to be studied is placed about half a metre distant from the light. (Some small beetles or caterpillars are good subjects for this experiment.) The animal begins by running past the light, apparently without heeding it; if, however, we suddenly take up the light and place it on the other side of the animal, the latter turns in an angle of 180°, and continues its way in the opposite direction to that previously followed (fig. 14). This very pretty experiment does not succeed with all species. The following is simpler, and can be carried out with all sorts of insects, crustaceans, and gasteropods. The animal is placed on a table near the light, and left to its own devices; it may then be observed that, under the influence of the light which radiates outwards in a circle, the animal performs a circus-movement round the source of illumination. It moves, therefore, in such a way that the angle formed by the light rays and its path remains constant. In this instance the angle is roughly a right angle; the animal is able, however, to change it at will. For example, it may crawl in such a way that the light falls upon its eyes obliquely, from behind; it then moves in a spiral which gradually removes it from the light (see fig. 15).

The long known fact that nocturnal insects are attracted by a lighted lamp is connected with this particular type of movement.

Usually, on their nocturnal flights, they orientate themselves by the moon, the clouds, or other far distant sources of light. If, however, they come by chance within the influence of a near source of light, such as an electric arc-lamp, they are compelled to fly around the artificial light in circles or in spirals. Often enough they come thus into the immediate neighbourhood of the light, and are burnt.

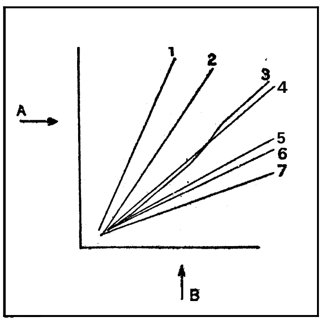
Visual perception of direction in animals may show itself in quite another way, namely, in what is called *phototaxis.*

The following example illustrates what is meant by this. If a bee is taken, and released in the middle of a room, it flies with absolute certainty towards the window, and, therefore, towards the light. Such an animal is called positively phototactic. The cockroach illustrates an opposite condition; it is negatively phototactic. It avoids the light, and when turned out of its hiding place, it will assuredly make for the dark.

That phototaxis is not always a constant character is shown by the bee. We cannot say off-hand "the bee is positively phototactic." It is so only under quite definite conditions; in very macy other circumstances it is not so. For example, when it returns from gathering honey, and flies into the dark hive, it is much rather to be described as negatively phototactic.

Sometimes it is easy to state the conditions under which an animal will become phototactic. The bee becomes positively phototactic if it is caught, and strives to free itself. In nature, where there are no glazed windows, brightness means the open air and the sky. A very clear example of phototaxis appearing only under certain conditions is furnished by the water scorpion (Nepa *cinerea*). This creature lives in shallow waters among the plants on the bottom. It is, however, an air-breather, and is obliged to ascend to the surface of the water from time to time, in order to inhale it. In this it is aided by positive phototaxis, which, in this case, co-operates with negative geotaxis. Since light only enters the water from above, the creature, which becomes phototactic only with lack of air, creeps up the water plants as much as possible in a vertical direction, until it reaches the surface. Scarcely, however, has it breathed in the fresh air, when phototaxis ceases, and the water scorpion is able to descend again into the deeper regions. As a final example, the water-flea, *Daphnia,* may be mentioned, in which we can produce phototaxis at wiil. We have only to introduce water containing carbon dioxide into a vessel in which there are Daphnia, to see at once that all the animals swim as quickly as possible towards the light. Here, however, we must again make it clear that, normally, the light enters from above. Daphnia live in stagnant waters, frequently very unclean, at the bottom of which poisonous carbon dioxide can be very easily formed through putrefactive processes. In this instance, phototaxis serves to protect the Daphnia from poisoning by carbon dioxide.

The Mechanism of Phototaxis.— While these matters are comparatively simple, the naturalists of the present day are as yet very divided in their opinions regarding the mechanism of phototaxis. There are various theories, of which we may, perhaps, go so far as to say that each is correct in some instances. The best known is the Theory of Tropisms (also called the Ray-Verworn Theory, or the Theory of Tropotaxis). It is founded on the fact that the majority of animals which are prototactic have bilateral symmetry. These all have a median plane dividing the body into two, absolutely identical halves. The entire animal is regarded as a small automaton. The light rays which fall on the eye are ccnverted into nervous energy, which is conducted to the brain. The latter transmits the stimulus to the limbs, which are under its control, and thus, according to this theory, the movements of the legs are, by a natural law, dependant on the strength of the illumination of the eyes. If the rays of light come from the front, they strike both eyes equally, and, therefore, the legs of each side move with equal force, and the animal runs straight forward. If, however, the light comes from one side, so that one eye is more strongly illuminated than the other, there is also a difference between the two sides in the working of the legs. The consequence must be that the animal turns until its median plane coincides with the direction of the light rays. When this is accomplished, it again runs in a straight line towards the light. This theory is so very striking in its great simplicity that, at first, it was received with much enthusiasm, particularly by everyone interested in Natural Philosophy.



AFTER MULLER

FIG. 15.—TRACK OF A NEGATIVELY PHOTOTACTIC WOODLOUSE UNDER THE INFLUENCE OF TWO BEAMS OF LIGHT AT RIGHT ANGLES (A & B)

With time, however, the opposition to this theory has been greatly increased, and there are many naturalists who have almost completely relinquished it. Frequently, the law which governs the movements of such animals is known by another name, namely the "Law of *Resultants.*" Thus, if we allow an animal to crawl into a field of light which is formed by two crossing beams, it is compelled to move according to the resultant. A fine example of this manner of reaction has been furnished by Frl. Müller, who worked with woodlice (see fig. 15). It appears that the animals under the influence of two equally strong beams of light, run exactly in the diagonal; if the beams are made to be of unequal strength the angle alters. It can be calculated in advance if we know the strength of both beams of light.

A second theory, which is in opposition to the theory of tropisms, asserts that the lower animals behave similarly to man and the higher animals. If a man walks towards a light, or let us say in a general way towards some optically perceptible point, first of all he fixes his eyes on the light, that is to say he moves them so that the light falls on the central point (*fovea centralis*); he then turns his head and body towards the light and goes straight forward. Kuehn has named this kind of reaction "telotaxis"; it is fundamentally opposed to tropotaxis, as will appear if we close one eye. A telotactically reacting animal is just as well able to direct its course when using only one eye as when using both; a tropotactically reacting animal, on the other hand, when it has only one eye is compelled continually to move round in circles. It is easy to convince oneself, on the basis of this alternative, that the majority of the more highly developed animals, such as insects or the higher groups of Crustacea, behave for the most part telotactically.

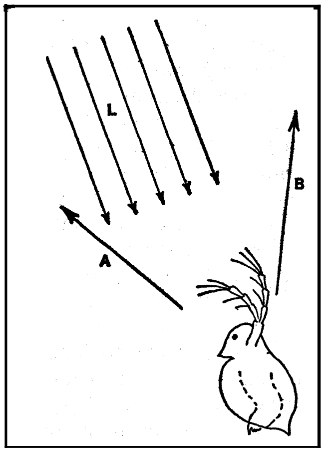
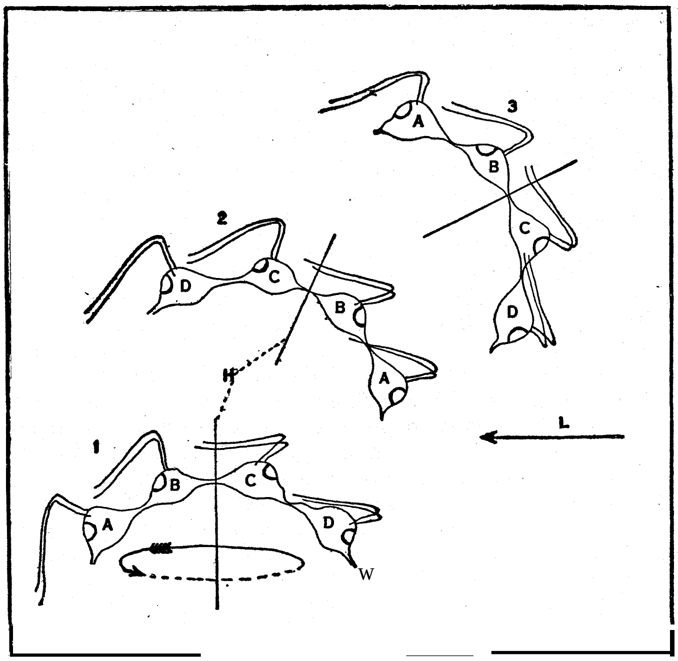


FIG. 16.— UPWARD MOVEMENT OF A POSITIVELY PHOTOTACTIC DAPHNIA, DIAGRAMMATIC

The numerous partial refutations which the theory of tropisms has undergone cannot be given in detail here. Only one particularly important argument can be mentioned. It used to be considered a proof of its validity that animals blind on one side constantly-run round in circles. If they are positively phototactic, they continualiy turn towards the side on which they can see; if they are negatively phototactic they turn towards the blind side. Now, in the first place, this certainly does not apply to all cases The majority of the higher insects learn very quickly to run straight when they have only one eye. Above all, Mast was able to prove that the animal does not move round in circles involuntarily, as the theory of tropisms would require, but that the animal voluntarily runs round thus, and moves its legs in such a manner as to attain this end. If some of the legs are amputated the remaining ones completely alter their movements, so that, in spite of the totally different locomotor conditions, the circus movement is still possible.

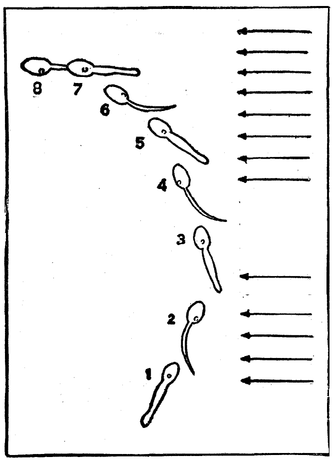
A second argument of general application is as follows:—The naturalist usually makes use of horizontal light in his experiments, which strikes the animal from one side. Only under these artificial conditions is it possible to turn about an axis which lies in the plane of symmetry of the body. Under natural conditions, on the contrary, the light, as far as aquatic animals are concerned, comes always from above. The Daphnia on becoming positively phototactic turns from its former position, not to right or left, but backwards. That it swims in the end towards the light, and not in the direction A or B is impossible to understand on the theory of tropisms (fig. 16).

Frequently, however, it is impossible to decide with certainty from such rough experiments the manner in which an animal orientates itself in relation to light, and a closer, more exact analysis is required. We are indebted to S. O. Mast for the best work on this subject. He showed that in many cases, neither tropotaxis nor telotaxis sufficed to account for the phenomena. As the first example we may mention briefly the researches of Mast on the orientation of the colonial Flagellate, Volvox. The colony is composed of about 20,000 individuals, which are arranged on the surface. Each zooid has two flagella, and an eyespot, provided with a lens. The colony has an anterior pole, which is always turned towards the front in swimming, and a longitudinal axis round which it rotates. If a light is placed to one side of a positively phototactic colony, it turns until the anterior pole is directed to the light, and then swims straight towards it. This gives the impression of being a clear case of tropotaxis, but Mast was able to prove that the zooids on the illuminated and on the shaded sides differ, not in the strength of the lashing of the flagella, but in the direction of the strokes, On the former side the flagella lash sideways, on the latter, straight out to the back (see fig. 17). It is apparent, therefore, that in this reaction we are dealing neither with a case of tropotaxis nor with one of telotaxis, but with a phenomenon *sui generis*. Very interesting are the orientation movements of asymmetrical animals, as for example one-eyed animals such as the Ascidian larvae also studied by Mast. These animals are negatively phototactic, and in s imming revolve about their longitudinal axis. When the light comes from one side, the eye, which is set in a pigmented cup, is alternately illuminated and in shadow with each revolution. Every time it is in shadow, the animal makes a stroke with its tail towards the ocular side; every time it is illuminated, it makes a stroke towards the abocular side (see fig. 18). In this way the larva quickly turns away from the light.



AFTER S. O. MAST

FIG. 17.— PHOTOTACTIC ORIENTATION OF A VOLVOX COLONY, SHOWING ONLY FOUR CELLS. L. THE DIRECTION OF LIGHT



AFTER S. O. MAST

FIG. 18.— REACTION OF THE NEGATIVELY PHOTOTACTIC, ASYMMETRICAL LARVA OF AMAROUCIUM

We find the least development of the sense of sight in those animals which are unable to perceive either images, movements, or direction, but can only distinguish light and darkness.

They react mostly to alterations in the light intensity to which they are accustomed. A very common phenomenon of this kind is the "shadow reflex." Many of the lower animals, particularly those which dwell in shells or shelters of some kind, into which they can withdraw, do so directly a shadow falls on them.

An animal particularly suitable for the demonstration of this reflex is the vineyard (Roman) snail, Helix *pomatia,* which has a wide distribution in Europe. If we cause a shadow to fall upon its head, it withdraws its horns very quickly, or completely retreats into its shell. Among marine animals may be mentioned the small sessile crustacean, *Balanus,* which, every time a shadow falls on it, withdraws its feet, which normally move in a constant rhythm. Further, many tubicolous worms react in a similar way, and many bivalves close their shells, if a shadow falls on them.

In short, the phenomenon is unusually widespread. The biological significance of this shadow reflex most certainly is that by this means the animal hides from danger, since the shadow may perhaps indicate the approach of some animal. This is, of course, a very poor expedient, since, in the first place, it fails to give protection from enemies which are in an opposite direction to the sun, and, in the second place, it causes the animal to withdraw unnecessarily thousands of times. Animals which do not possess any well-developed sense organs to give them certain warning of the approach of their enemies, are obliged, however, to help themselves even in this primitive manner.

The animals here mentioned, which respond to the slightest shadow, very frequently do not react in any way if we increase the degree of illumination. Other animals withdraw only in the latter circumstance, and are not disturbed by any shadows. Among these is the sand-dwelling *Mya arenaria,* which is found on the coasts of Europe and America. It lives in the sand at a depth of about 20 cm., and makes a shaft which leads upwards in a vertical direction, in which lies its tubular siphon, the organ by means of which it takes in food and oxygen. If this fleshy siphon were pushed so far out of the shaft that it stretched out into the water, fishes would immediately come and bite it off. The light reflex serves to prevent this; as soon as the siphon pushes out into the water, it is exposed to stronger light, and the reflex movement of withdrawal promptly takes place.

It is just these simple phenomena which are frequently of interest to the naturalist, since by their means we may easily understand the laws which govern the perceptual life of animals, and of mankind also. Weber's Law is very well known This states that a man is first sensitive to a new stimulus when it stands in a particular numerical ratio to that already present.

Thus, if originally light "L" prevails, an animal sensitive to shadow first withdraws when the light is shaded by about L/20. In this case the value of L is quite immaterial.

The table is compiled from the results of the author's experiments on *Balanus.* L_1 indicates the original light, L_2 the greatest amount of light which yet gives rise to the shadow reflex. L_1/L_2 is, as can be seen, roughly constant.

L_1	L_2	L_1/L_2
1,000	967	1·034
933	875	1·066
750	720	1·0415
500	480	1·0415
250	240	1·0415

From these experiments the fact of *Adaptation* may be proved as a logical inference. The sensitiveness of our eyes is considerably greater in weak light than in strong. The eye thus adapts itself completely to the light conditions present. Starting with an original intensity of 1,000 light units, *Balanus* first reacts when this is diminished by 33 units. With an original intensity of 250 units the animal first notices a diminution by 10 units. On pursuing the subject further, we find that with an original intensity of 25 units. diminution of this by only one unit is noticed by the animals. The eye, therefore, becomes more sensitive as darkness increases.

THE COLOUR-SENSE OF ANIMALS

Colours play such a large part in human life that the question whether animals also possess a sense of colour is of extreme interest to us. In speaking of the colour-sense of animals it behoves us to make it perfectly clear at the outset that it is quite impossible for us to study the sensations of animals. We cannot even say anything about the sensations experienced by our fellow men. On the other hand, we can decide objectively whether an animal is able to distinguish different colours.

The investigation of the colour-sense of animals has followed a remarkably zig-zag course. In the time of Darwin man, almost universally, was convinced that the lower organisms also possessed a sense of colour similar to his own. Later we went to the opposite extreme. Hess pronounced the definite opinion that all invertebrates and fishes were totally colour-blind, and that only the highest organisms, such as mammals, birds, reptiles and amphibians, were able to enjoy the colours of nature. This sweeping generalisation was contradicted, and so gave rise to a very active investigation of the whole subject. The result of these labours may be summarised thus:—very many of the lower animals, such as cuttlefishes, insects and the higher Crustacea, do indeed possess a sense of colour. Further, in cases in which it has not yet been proved to exist we hesitate to draw the conclusion that it is absent.

Experiments.—The methods by which we have sought to investigate the colour-sense in various animals are very numerous. All animals which possess a certain amount of intelligence can be trained to distinguish a particular colour. v. Frisch was the first to attempt this, with bees. It is just in dealing with these insects, for which the array of colours in flowers would seem to have been evolved, that this statement by Hess must give cause for reflection.

In order to understand the following it is necessary to consider more precisely the nature of coloured light. In this two factors are always to be distinguished, the brightness of the light, in physical terms, the intensity, and the colour of the light, or in physical terms its wave-length. In studying the colour-sense of animals we are concerned only with the question whether they are able to distinguish light of different wave-lengths, and we have to take the greatest care, therefore, that the reactions of the animals are not connected with differences in the intensity of the light. v. Frisch made use of the "chess-board" method. On a square board were fixed a large number of pieces of cardboard of all shades of grey, from the lightest white-grey to the darkest black-grey. Among these was placed a piece of cardboard of the colour on which the bees had been trained (blue). If the bees had no sense of colour, but distinguished between the different pieces of cardboard only by their degree of brightness, they would coniuse the blue with one or other of the greys, one of which would certainly be of the same tone. If, on the other hand, they had a true colour-sense, such confusion would not occur. The result of the experiment was in favour of the possession of such a sense by the bees. The trained bees, having been accustomed to find their food on a blue background, flew to the blue pieces of cardboard only, and paid no attention to any of the others.

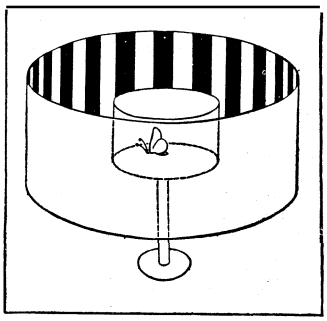
Since these fundamental researches were made by v. Frisch, the colour-sense of bees has been studied with much finer technique, particularly by Kuehn. Above all, we have learnt to train these insects to distinguish the pure colours of the spectrum. We are now able, therefore, to form a fairly precise estimation of the colour-sense of these insects. Bees perceive all wave-lengths between 650–313 $\mu\mu$. Within this range they distinguish four different colours. The first comprises wave-lengths from 650 to about 500 $\mu\mu$, and includes our red of shorter wave-length, and also yellow and green. Seemingly, all these appear to them as one colour. On the other hand, the red of longer wave-length, which we use in our photographic dark-rooms, bees do not distinguish at all; they confuse it with black. The second comprises wave-lengths from 500–480 $\mu\mu$ and corresponds to our blue-green, the third lies between 480 and 400 (our blue and violet). Lastly, bees perceive a fourth visual region in the ultra-violet, which is beyond our powers of sight.

It lies between 400–310 $\mu\mu$. Bees may therefore be trained to distinguish ultra-violet just as well as blue or yellow.

A sense of colour has been proved to exist also in Lepidoptera, dragonflies and flies; perhaps it is universal among insects

We have gone to work in quite a different manner to prove the existence of a colour-sense in Crustacea. Some of these possess the remarkable power of matching their colouration to that of the surface on which they live. On light backgrounds they are light, on dark ones they are dark. This is brought about by means of particular pigment cells (chromatophores) which are present everywhere beneath the transparent cuticle. The majority of species have several kinds of chromatophores of different colours. *Crangon,* the species which up to the present has been studied most, has white, yellow, red and black. Stimulation takes place through the eyes; blind crustaceans are no longer able to mimic their background. The light stimuli which reach the eye are communicated to the brain, and by this are transmitted to the pigment cells in a way which we do not yet understand more exactly. Koller was able to prove that the chromatophores which expand are always those which conform in colour to the background. On a grey ground the black cells expand, on a yellow ground, the yellow cells, and on a red ground the red cells. The intensity of the light plays as unimportant a part as in the case of bees.

With the simple inquiry whether a given animal is able to see or distinguish between colours the problem of the colour-sense of animals is by no means exhausted. It can be proved that every organism, including man himself, responds differently to light and its colours, according to the conditions under which it finds itself. According to Schlieper's investigations, in the optomotor reactions about to be described, all the animals studied hitherto act as if they were colour-blind, even those in which a sense of colour has been proved beyond all doubt, either by the "training method" or in some other way. The best-known instance of such a reaction occurring in everyday life is what is called "railroad nystagmus." If we watch a person opposite us in a railway carriage who is looking out of the window, we notice that his eyes do not remain still. They seek to follow the images of the rapidly passing landscape, and move in the direction opposite to that in which the train is going. They are directed forwards again in a particular rhythm. When studying animals we can represent the railway by a rotating cylinder, in the middle of which is placed the animal under observation. The inside of the rotating cylinder has vertical strips of paper stuck on it, of which half are coloured and half grey (fig. 19). Every animal must be studied in relation to a whole series of such cylinders, which differ from one another in the shades of grey, while the coloured strips are the same in all of them. The individual animals react differently to the rotation. Some move the head, some the feelers, some the eyes. In every species, however, a particular combination of grey and colour can be found to which no movement-reaction takes place. This means that, in this instance, the animal perceives no difference between the grey and the coloured strips; it sees a uniform grey, and is thus, in this experiment, certainly as blind to colours as in the previously described experiments it was aware of them. The reaction to the other "grey and coloured" combinations is only to the different degrees of brightness of the strips, not to perception of the colour contrast. The following little table may make this clear; it is taken from the results of experiments with the common white butterfly, *Pieris brassicae,* using the colour "blue." Grey 1 is the lightest, 12 is the darkest; the measured angle is that described by the feelers of the captive insect.



AFTER SCHLIEPER

FIG. 19.—OPTOMOTOR REACTION IN BUTTERFLIES AND MOTHS

Shades of grey	Angle
1	10–15°
3	5°
4 and 5	0°
6	3°
8	10–15°
10	15–20°
12	25°

From these results emerges the startling fact, which has not yet been explained, that the same animal reacts sometimes as if perceiving colours, at others as if colour-blind.

Another important result can be obtained by the methods used by Schlieper. By comparison with the grey papers, of known numerical degrees of brightness, we can calculate the relative brightness which different colours possess for the individual animals. We then reach the remarkable result that this value for the whole of the animal kingdom corresponds to that which prevails in totally colour-blind human beings. This had already been affirmed by Hess, but not sufficient heed was paid to it.

Relative Brightness-values of Hering's Coloured Papers for

	Ladybirds (*Coccinella*)	Bees	Shore crab (*Carcinus maenas*)	*Epinephelus justina*	Man (dark adapted)	Lizard (*Lacerta*)	Man (light adapted)
Green	62	69	64	64	65	64	74
Yellow	51	62	49	49	53	73	79
Blue	24	22	24	23	25	16	22
Red	8	14	11	10	9	57	31

(W. v. Bud.)

SIGHTS, GUN, are mechanical or optical devices that help the gunner aim. his weapon at a target. They range from simple iron sights for small arms weapons to complex "fire control systems" for long-range artillery. To understand their nature and use it is essential first to know something of the behaviour of projectiles during fight.

When a projectile is Ered from a gun, its flight path. or trajectory, forms a curve due to the action of the force of gravity and the resistance of the air. The force of gravity causes the trajectory to bend downward. If the projectile is rotating about its longitudinal axis, air resistance will cause it to drift to the right or left. depending upon the direction of rotation. These and other factors affecting the trajectory of a projectile are discussed quantitatively in the article BALLISTICS.

In view of these characteristics of the trajectory. it is obvious that the axis of a gun must be pointed above and to one side of the target to make the projectile hit that target. The process

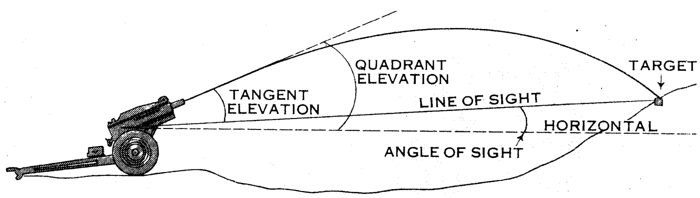


FIG. 1.— SIGHTING TERMS

of pointing a gun in the proper direction and at the desired angle of elevation is known as "laying" the gun.

The devices employed to determine the proper direction and elevation for laying the gun constitute the sight or fire control system

Terminology. — Indiscussing the principles of sighting, the following terms need to be clearly understood (*see* fig. 1):

Line of Sight —A straight line joining gun and target.

Angle of Sight.—The angle between the line of sight and the horizontal plane through the gun.

Elevation —The degree to which the axis of the gun is elevated above some line of reference. Quadrant elevation is the angle between the axis of the gun and the horizontal plane; tangent elevation, or superelrvation. is the angle between the axis of the gun and the line of sight

Rifles and Machine Guns.—The sights used for these types of weapons diifer very little throughout the world. They are based on the principle that two points in fixed relation to each other may be brought into line with a third point. A typical rifle sight consists of a fixed foresight near the muzzle and a rearsight that is movable in a vertical plane. as shown in fig. 2. Vertical movement is calibrated in range (yards or meters) and is constrained to follow a curve that compensates for lateral drift of the bullet.

A lateral adjustment is also provided to permit correction for the effect of wind.

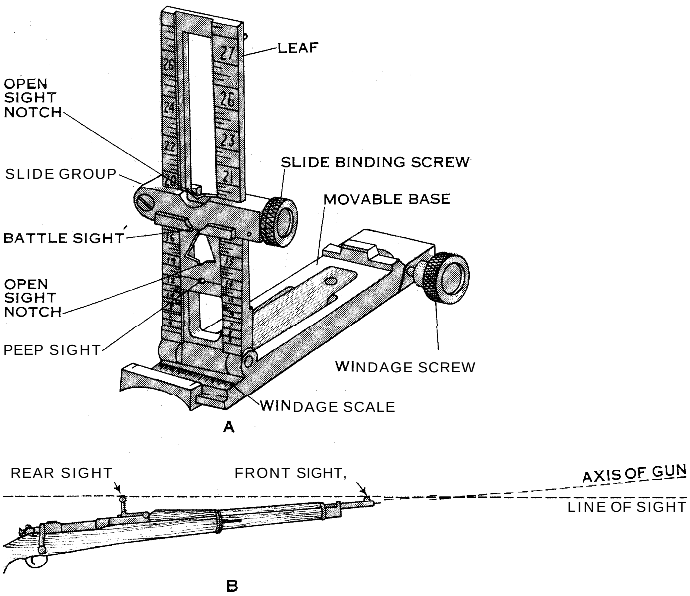


FIG. 2.— RIFLE AND MACHINE-GUN SIGHTS: (A) CLOSE-UP VIEW OF LEAF SIGHT; (B) ARRANGEMENT OF RIFLE SIGHTS

Field Artillery, Mortars and Free Rockets.—Before discussing the sighting systems of these weapons. it is necessary to understand the arrangement of the basic parts of a gun mount. The top carriage is that portion of a gun mount that rotates (traverses) about a vertical axis and forms the support for the tipping parts of the gun. Any component of the sighting system attached to the top carriage will move uith the gun in traverse. but will not move with it in elevation. The gun proper is usually mounted in a cradle attached to the top carriage by means of trunnions that form the horizontal axis about which the cradle and gun (tipping parts) rotate in elevation. The gun recoils in the cradle along the axis of the bore. Components of the sighting system attached to the cradle will move with the gun in both elevation and traverse. but will not move with the gun in recoil.

Since the elevating and traversing mechanisms are independent of each other. the laying of the gun can be simplified by having one member of the crew lay the gun in direction, and another lay it in elevation. It is. therefore, common practice to have the devices used for laying the gun in direction attached to the top carriage on one side (usually the left side) and the devices for laying in elevation attached to the cradle on the other side of the gun.

Mobile weapons are usually out of level (canted) due to irregularities in the ground and the axes of rotation are therefore not truly horizontal and vertical. When the gun is traversed under this condition, quadrant elevation will change and, conversely, when the gun is elevated the direction of fire will change. Sighting devices are so constructed that reference planes can be adjusted to the true vertical, hence laying accuracy is not impaired.

For protection from hostile fire, these weapons are usually emplaced in a position not visible to the enemy. Since the target can not be seen from the gun. laying in direction is accomplished by sighting on stakes set in the ground at a known direction from the gun. The horizontal angle between the gun axis and the aiming stake line required to hit the target is measured from accurate maps and corrected by ballistic computations. A panoramic telescope which permits sighting in any direction from the same eyepiece position is used to measure this horizontal angle. (See fig. 3.) The panoramic telescope is mounted on the cradle and the mount compensates for the out-of-level condition by leveling the telescope about a bar parallel to the gun axis. (See fig. 4.) This determines the vertical plane containing the gun and permits the panoramic telescope to accurately measure the direction of fire.

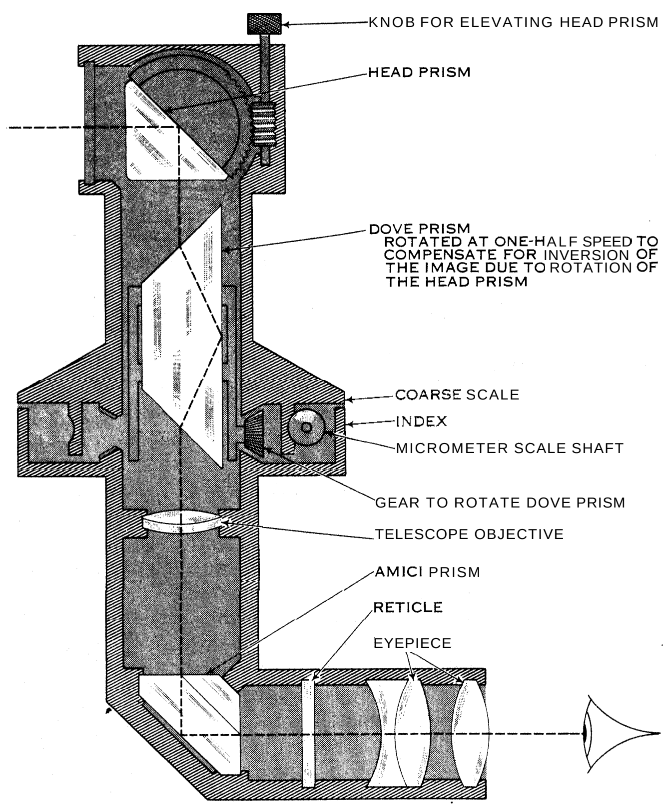


FIG. 3.— PANORAMIC TELESCOPE

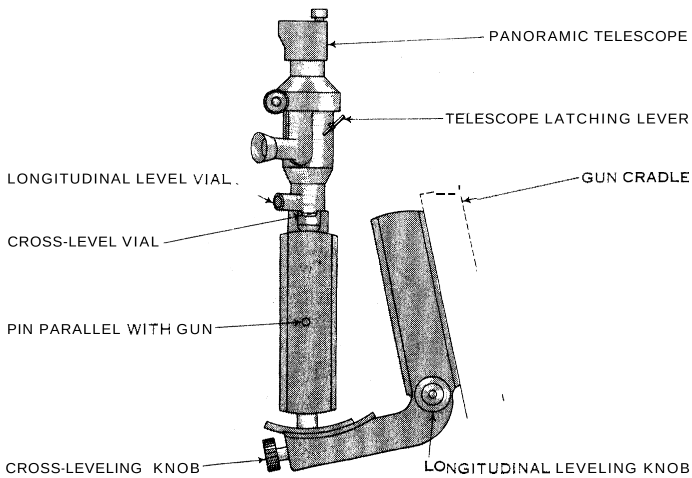


FIG. 4.— CANT COMPENSATING TELESCOPE MOUNT

Laying in elevation is accomplished by a device known as an elevation quadrant mounted on the cradle. The quadrant is also cross-leveled by rotation about a bar parallel to the gun axis so that elevation will be measured in the vertical plane. The precomputed quadrant elevation is set into the quadrant, offsetting a fore-and-aft spirit level. The gun is then elevated until the spirit level indicates that the gun has been elevated the desired amount. The elevation quadrant is sometimes incorporated into the compensating mount of the panoramic sight. Sights for mortars are usually so designed since laying of the mortar is performed by one man.

Antitank Guns and Recoilless Rifles.—As these weapons are employed at greater range than rifles or machine guns, they employ telescopic sights to increase the accuracy of fire. The telescopic sight contains a reticle with range markings (yards or metres) calibrated to the ammunition and offset at the longer ranges to compensate for drift. (See fig. 5.) The sight is mounted on the cradle (or directly on the recoilless rifle, which has no cradle) and in some cases provision is made for leveling the sight about an axis parallel to the gun to compensate for the error due to the gun being canted. In most cases the range of the target is estimated, but some guns are equipped with small-calibre spotting or ranging rifles to help determine the range. The spotting rifle is ballistically matched to the main gun. Both range and nindage

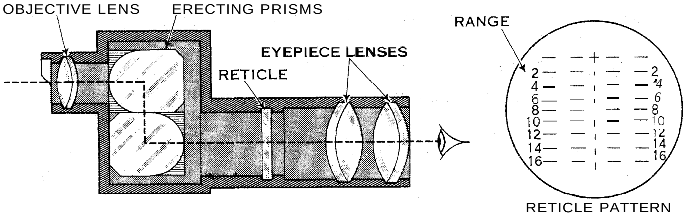


FIG. 5.— DIRECT FIRE TELESCOPIC SIGHT

corrections are determined by trial fire with the small gun until a target hit is obtained before firing the main gun.

Tank **Gunnery.**—High-power telescopic sights are always used for tank gunnery because direct hits are required on small targets at long range. The physical configuration of the vehicle often makes it impractical to use a simple telescope. An articulated telescope, one with a rotating joint parallel with the gun trunnion. is sometimes used to bring the eyepiece to the gunner and eliminate movement as the gun is elevated. Rlore frequently this problem is resolved by mounting a periscope in the turret roof and mechanically linking it to the gun to follow it in elevation. In some modern tanks: optical range finders (see RANGE FINDERS) are used to measure target range. Mechanical or electrical devices accurately compute the vertical and lateral corrections for each type of ammunition fired by the tank gun.

Naval Gunnery.——Modern naval guns are traversed and elevated by electronic and hydraulic servomechanisms. Direct laying by the gun crew is used only in emergencies. In normal practice. guns are sighted and the range of the target is determined either by radar or by optical means from director stations located high on the ship. The sighting data is electrically transmitted to a plotting room in the hull where mechanical or electronic computers generate the gun orders for electrical transmission to the turrets. A stable vertical gyroscope in the plotting room supplies data to the computer. usually called a range keeper, for conversion of director data into true horizontal and vertical tracking angles thus eliminating errors due to pitch and roll of the ship. The firing direction and quadrant elevation required to hit the target are computed by the range keeper with allowance for speed of both the firing ship and target. The laying angles are then converted, by data from the stable vertical gyroscope, into angles of turret elevation above deck plane and turret traverse in deck plane. The servomechanisms then keep the guns at the desired quadrant elevation and direction.

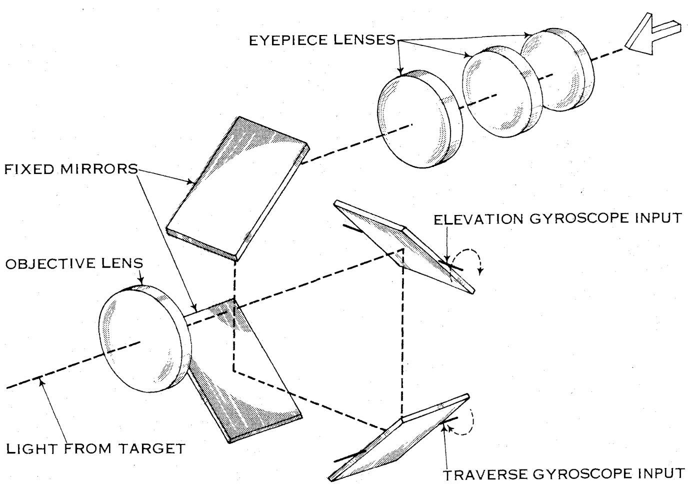


FIG. 6.— LEAD COMPUTING SIGHT

The guns are fired at any time, for ship motion does not disturb the lay of the guns.

See GUNNERY, NAVAL.

Antiaircraft Artillery.— Lowflying aircraft can be engaged successfully by antiaircraft artillery because the flight time of the shell is short. The high speed of jet aircraft makes it almost impossible to compute accurately the movement of the target during the time the projectile fired by an antiaircraft gun is in flight. The only effective weapons for use against high-flying aircraft are guided missiles or fighter planes.

Radar is used with antiaircraft artillery and missiles to measure the range to the target, but telescopic tracking in elevation and traverse usually gives greater accuracy than radar tracking, which is used only at long range or when visibility is poor. Electronic or mechanical computers are used to calculate the angle the gun must "lead" or be aimed ahead of the target. The gun is moved by electronic and hydraulic servomechanisms since the tracking rates are high.

Gyroscopes are used as the basic element in one type of lead-computing sight. Gyroscopic precession (see GYROSCOPE) is induced by the rotation of the sight while tracking the target in elevation and traverse. Precession is controlled by springs and weights designed to match the ballistics of the gun and adjusted as the target range changes. The amount the gyros precess against the restraining springs and weights is a measure of the required lead. This movement of the gyro is used to tilt mirrors in the sight (see fig. 6) which causes the target to appear ahead and above its true position; hence the gunner will track ahead by the appropriate amount.

Aircraft Gunnery.— Fighter aircraft carry rockets, machine guns or small-calibre cannon to engage both aerial and ground targets. Rigidly mounted guns are aimed by pointing the aircraft in the proper direction while approaching the target. Radar is used to measure the range to the target. A gyro lead-computing sight similar to that described above is used to compute the lead required to compensate for the motion of the firing aircraft and the target. (G. M. T.; W. T. AL.)

SIGIRI, the Lion's Rock, the ruin of a remarkable stronghold *i*° 59' N.. and 81° E.. 14 mi. N.E. of Dambulla, and about 17 mi. W. of Pulasti-pura, the now ruined ancient capital of Ceylon. There a solitary pillar of granite rock rises to a great height out of the plain. and the top actually overhangs the sides. On the summit of this pencil of rock there are five or six acres of ground; and on them. in A.D. 477, Kasyapa the Parricide built his palace, and thought to find an inaccessible refuge from his enemies. His father Dhatu Sena carried to completion, among other good works. an ambitious irrigation scheme—probably the greatest feat of engineering that had then been accomplished anywhere in the world. This was the celebrated Kala Wewa, or Black reservoir, more than 50 mi. in circumference.

SIGISMUND (1368–1437). Roman emperor and king of Hungary and Bohemia. was a son of the emperor Charles IV. He was born on Feb. 15. 1368. Having become margrave of Brandenburg on his father's death in 1378, he was educated at the Hungarian court from his eleventh to his sixteenth year. and was entirely devoted to his adopted country. Sigismund had been crowned king of Hungary on March 31. 1387, and having raised money by pledging Brandenburg to his cousin Jobst, margrave of Moravia, he was engaged for the next nine years in a ceaseless struggle for the possession of this unstable throne. (See HUNGARY.)

In 1396 Sigismund led the combined armies of Christendom against the Turks. who had taken advantage of the temporary helplessness of Hungary to extend their dominion to the banks of the Danube. This crusade. preached by Pope Boniface IX.. was very popular in Hungary. The nobles flocked in thousands to the royal standard, and were reinforced by volunteers from nearly every part of Europe, the most important contingent being that of the French led by John. duke of Nevers, son of Philip II., duke of Burgundy. After' capturing Widdin, he sat down before the fortress of Nicopolis, to retain which Sultan Bajazid raised the siege of Constantinople, and at the head of 140,000 men completely overthrew the Christian forces (Sept. 25–28, 1396). Deprived of his authority in Hungary, Sigismund then turned his attention to securing the succession in Germany and Bohemia, and was recognized by his childless step-brother Wenceslaus as vicar-general of the whole empire. But on the deposition of Wenceslaus (1400) Rupert III., elector palatine of the Rhine, was elected German king in his stead. Sigismund was involved in domestic difficulties out of which sprang a second war with Ladislaus of Naples; and on his return to Hungary in 1401 he was once imprisoned and twice deposed. This struggle in its turn led to a war with Venice, as Ladislaus before departing to his own land had sold the Dalmatian cities to the Venetians for 100,000 ducats. In 1401 Sigismund assisted a rising against Wenceslaus, during the course of which the German and Bohemian king was made a prisoner, and Sigismund ruled Bohemia for nineteen months. In 1410 the German king Rupert died, when Sigismund, ignoring his step-brother's title, was chosen German king, or king of the Romans, first by three of the electors on Sept. 20, 1410, and again after the death of his rival, Jobst of Moravia, on July 21, 1411; but his coronation was deferred until Nov. 8, 1414, when it took place at Aix-la-Chapelle.

During a visit to Italy the king had obtained from John XXIII. a promise that a council should be called to Constance in 1414. He took a leading part in the deliberations of this assembly, and during the sittings made a journey into France, England and Burgundy in a vain attempt to secure the abdication of the three rival popes. (See CONSTANCE, COUNCIL OF.) The complicity of Sigismund in the death of John Huss is a matter of controversy. He had granted him a safe-conduct and protested against his imprisonment; and it was during his absence that the reformer was burned. An alliance with England against France, and an attempt to secure peace in Germany by a league of the towns, which failed owing to the hostility of the princes, were the main secular proceedings of these years. In 1419 the death of Wenceslaus left Sigismund titular king of Bohemia, but he had to wait for seventeen years before the Czechs would acknowledge him. But although the two dignities of king of the Romans and king of Bohemia added considerably to his importance, and indeed made him the nominal head of Christendom, they financially embarrassed him. It was only as king of Hungary that he had succeeded in establishing his authority and in doing anything for the order and good government of the land. Entrusting the government of Bohemia to Sophia, the widow of Wenceslaus, he hastened into Hungary, but the Bohemians, who distrusted him as the betrayer of Huss, were soon in arms; and the flame was fanned when Sigismund declared his intention of prosecuting the war against heretics who were also communists. Three campaigns against the Hussites ended in disaster; the Turks were again attacking Hungary; and the king, unable to obtain support from the German princes, was powerless in Bohemia. His attempts at the diet of Nuremberg in 1422 to raise a mercenary army were foiled by the resistance of the towns; and in 1424 the electors, among whom was Sigismund's former ally, Frederick I. of Hohenzollern, margrave of Brandenburg, sought to strengthen their own authority at the expense of the king. Although the scheme failed, the danger to Germany from the Hussites led to fresh proposals, the result of which was that Sigismund was virtually deprived of the leadership of the war and the headship of Germany. In 1431 he went to Milan where on Nov. 25, he received the Lombard crown; after which he remained for some time at Siena, negotiating for his coronation as emperor and for the recognition of the Council of Basel by Pope Eugenius IV. He was crowned emperor at Rome on May 31, 1433, and after obtaining his demands from the pope returned to Bohemia, where he was recognized as king in 1436. though his power was little more than nominal. On Dec. 9, 1437 he died at Znaim.

Sigismund was one of the most far-seeing statesmen of his day, and steadily endeavoured to bring about the expulsion of the Turks from Europe by uniting Christendom against them. As king of Hungary he approved himself a born political reformer, and the military measures which he adopted in that country enabled the kingdom to hold its own against the Turks for nearly a hundred years. His sense of justice and honour was slight; but as regards the death of Huss he had to choose between condoning the act and allowing the council to break up without result.

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SIGISMUND I. (1467–1548), king of Poland, the fifth son of Casimir IV. and Elizabeth of Austria, was elected grand-duke of Lithuania on Oct. 21, 1505 and king of Poland on Jan. 8, 1506. He had served his apprenticeship in the art of government first as prince of Glogau and subsequently as governor of Silesia and margrave of Lusatia under his elder brother Wladislaus of Bohemia and Hungary. His little principality of Glogau soon became famous as a model state, in the prevailing anarchy of waning principalities, and as governor of Silesia he suppressed the robber knights with an iron hand, protected the law-abiding classes, and revived commerce. In Poland his first step was to recover control of the mint, and place it in the hands of capabie middle-class merchants and bankers, like Caspar Beer, Jan Thurzo, Jan Boner, the Betmans, who reformed the currency and opened out new ways for trade and commerce. In foreign affairs Sigismund was largely guided by the Laskis (Adam, Jan and Hieronymus), Jan Tarnowski and others, most of whom he selected himself. His first wife, whom he married in Feb. 1512, was Barbara Zapolya, daughter of Stephen Zapolya of Hungary. On Barbara's death three years later without male offspring, Sigismund (in April 1518) married the beautiful and wealthy Bona Sforza, a kinswoman of the emperor and granddaughter of the king of Aragon. who used her great financial and economic talents almost entirely for her own benefit, corrupted society, degraded the clergy, and became universally detested.

During the first twenty years of his reign, Sigismund was almost incessantly at war with Muscovy. The Tatars too, ravaged the border with a frequency which ultimately led to the establishment of the Cossacks. (See POLAND: History.) Protracted quarrels, again, with the grand-masters of the Teutonic Order, who were anxious to shake off Polish suzerainty led to a war in 1520–21, but were composed in 152j when the last grand-master professed Lutheranism and as first duke of Prussia did public homage to the Polish king in the market-place of Cracow.

Personally a devout Catholic, Sigismund was nevertheless too wise and just to permit the persecution of non-Catholics; and in Lithuania, where a fanatical Catholic minority of magnates dominated the senate, he resolutely upheld the rights of his Orthodox subjects, and protected the Jews.

After his 60th year there was a visible decline in Sigismund's energy and capacity. His gigantic strength and herculean build lent him the outward appearance of health and vigour, but during the last two-and-twenty years of his reign he apathetically resigned himself to the course of events. He died on April 1, 1548.

See August Sokolowski, *History of Poland* vol, ii. (1904), Zygmunt Celichowski, *Materials for the history of the reign of Sigismund the Old* (1900); Adolf Pawinski, *The youthful years of Sigismund the Old* (1893); Adam Darowski, *Bona Sforza* (1904).

SIGISMUND II. (1520–1572), king of Poland, was the only son of Sigismund I. (*q.v.*), whom he succeeded in 1548, and Bona Sforza. At his first diet (Oct. 31, 1548), he came into conflict with the *szlachta*, now becoming powerful, who, secretly supported by the Austrian court and the queen-mother, threatened to renounce their allegiance unless he repudiated his second wife, the beautiful Lithuanian Calvinist, Barbara Radziwill, daughter of the famous Black Radziwill. But his firm refusal produced a reaction, and at the second diet (1550) the *szlachta* was less turbulent. On the death of Barbara, under suspicious circumstances, five days after her coronation (Dec. 7, 1550) Sigismund made a purely political marriage with the Austrian archduchess Catherine, sister of his first wife Elizabeth, who had died young. Catherine proving childless, Sigismund, being the last male of the Jagiellos in the direct line, was anxious to have an heir, and the diet had undertaken to legitimize and acknowledge any fruit of his liaisons with Barbara Gizanka and Anne Zajanczkowska; but the Habsburgs, who coveted the throne, successfully opposed the wish of the Protestant party, that he should divorce Catherine and remarry. Actually he survived the queen's death (Feb 28, 1572) barely six months and died childless. Sigismund's reign was a period of internal turmoil and external expansion. He saw the invasion of Poland by the Reformation, the democratic upheaval which placed ail political power in the hands of the sslachta; the collapse of the ancient order of the Knights of the Sword in the north (which led to the acquisition of Livonia by the republic); and the consolidation of the Turkish power in the south. Sigismund's most striking and personal achievement was the union of Lublin, which made of Poland and Lithuania one body politic, and put an end to the jealousies and discords of centuries. (See POLAND: History.) He died at Knyszyne on July 6. 1572

SIGISMUND III. (1566–1632), king of Poland and Sweden, son of John III, king of Sweden, and Catherine Jagiellonika, sister of Sigismund II., king of Poland, thus uniting in his person the royal lines of Vasa and Jagiello Educated as a Catholic by his mother, he was on the death of Stephen Báthory elected king of Poland (Aug. 19, 15873 through the efforts of the Polish chancellor, Jan Zamoyski, and of his own aunt, Anne, queen-dowager of Poland. Sigismund promised to maintain a fleet in the Baltic, to fortify the eastern frontier against the Tatars, and not to visit Sweden without the consent of the Polish diet. The articles of Kalmar regulated the future relations betueen Poland and Sweden, when Sigismund should succeed his father as king of Sweden. The two kingdoms were to be perpetually allied. but each of them was to retain its own laws. Sweden was also to enjoy its religion subject to such changes as a general council might make. During Sigismund's absence from Sweden that realm was to be ruled by seven Swedes, six to be elected by the king and one by Duke Charles. his Protestant uncle. Sweden, moreover, was not to be administered from Poland. The Poles first wished the cession of Estonia to Poland, but eventually the territorial settlement was postponed; and Sigismund was duly crowned at Cracow on Dec. 27, 1587.

From the first Sigismund was out of sympathy with the majority of his subjects. As a man of education and refinement, he was unintelligible to the *szlachta,* who regarded all artists and poets as either mechanics or adventurers. His reserve was called stiffness and his calm, haughtiness. Even Zamoyski who had placed him on the throne complained that the king was possessed by a dumb devil. He lacked, moreover, the tact and bonhomie of the Jagiellos.

Sigismund's difficulties were also increased by his political views which he brought with him from Sweden, and which were diametrically opposed to those of the omnipotent chancellor. Yet, impracticable as it may have been. Sigismund's system of foreign policy as compared with Zamoyski's was at any rate, clear and definite. It aimed at a close alliance with the house of Austria, with the double object of drawing Sweden within its orbit and overaning the Porte by the conjunction of the two great Catholic powers of central Europe. A corollary to this system was the much needed reform of the Polish constitution. nithout which nothing beneficial was to be expected from any political combination. But his efforts foundered on the jealousy and suspicion of the magnates headed by the chancellor. The first 23 years of Sigismund's reign is the record of an almost constant struggle between Zamoyski and the king, in which the two opponents nere so evenly matched that they did little more than counter-poise each other. At the diet of 1590 Zamoyski successfully thwarted all the efforts of the Austrian party; whereupon the king. taking advantage of sudden vacancies among the chief offices of state, brought into power the Radziwills and other Lithuanian dignitaries, thereby for a time considerably curtailing the authority of the chancellor. In 1592 Sigismund married the Austrian archduchess Anne. and a reconciliation was patched up between the king and the chancellor to enable the former to secure possession of his Swedish throne vacant by the death of his father john III. He arrived at Stockholm on Sept. 30, 1593 and was crowned at Upsala on Feb. 19, 1594, after he had consented to the maintenance of the "pure evangelical religion" in Sweden. On July 14, 1594 he departed for Poland leaving Duke Charles and the senate io rule Sweden during his absence. Four years later (July 1598) Sigismund was forced to fight for his native crown by the usurpation of his uncle. aided by the Protestant party in Sweden. He landed unopposed at Kalmar.

After fruitless negotiations, Sigismund advanced with his army, but was defeated by the duke at Stangebro on Sept. 2j. He never saw Sweden again, but refused to abandon his claims; and this unfortunate obstinacy was to involve Poland in a whole series of unprofitable wars with Sweden.

In 1602 Sigismund wedded Constantia, the sister of his deceased first wife, an event which strengthened the hands of the Austrian party at court and still further depressed the chancellor. At the diet of 1605 Sigismund endeavoured to substitute a decision by a plurality of votes for unanimity in the diet. The opposition of Zamoyski nullified the effect of this salutary reform. His death, however, in the same year left his more ardent followers without a check. From 1606 to 1610 Poland was in an anarchical condition. On foreign affairs these disorders had a disastrous effect.

Poland was unable to take the opportunity of breaking the power of the tsars, which the collapse of Muscovy had shaken. At the outbreak of the Thirty Years' War Sigismund prudently leagued with the emperor against the Turks and the Protestants. Sigismund died very suddenly in his 66th year, leaving two sons, Wladislaus and John Casimir, who succeeded him in rotation.

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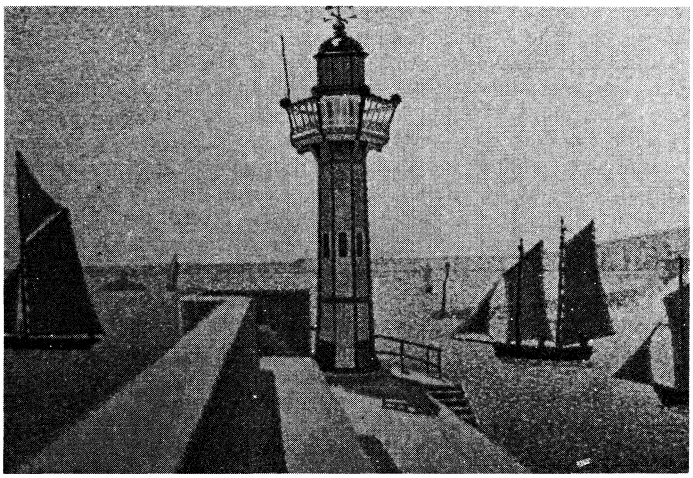
SIGNAC, PAUL (1863–1935), French painter, developer, with Georges Seurat, of the technique called Neoimpressionism, was born in Paris, Nov. 11, 1863. After youthful attempts to study architecture, he turned, at the age of 18, to painting. Through Armand Guillaumin, Signac became a convert to the tone division of impressionism, and he was represented by several landscapes at the exhibition of the Maison Dorée in 1886.

In 1884 Signac had helped found the Salon des Indépendants. There he met Seurat, whom he initiated into the broken-colour technique of Impressionism. The two went on to the method they called Pointillism or Neoimpressionism. They continued to divide their canvases into minute dabs of pure pigment, as had the Impressionists, but they adopted an exact, geometrical system of applying the dots instead of the somewhat intuitive application of the earlier masters. This technique was not unlike the mechanical process of printing photographic iilustrations in colour by means of halftones. Some critics denounced Signac's landscapes



BY COURTESY OF RIJKSMUSEUM KROLLER-MULLER, OTTERLO, THE NETHERLANDS

"PORTRIEUX" BY PAUL SIGNAC. IN THE RIJKSMUSEUM KRÖLLER-MÜLLER, *THE NETHERLANDS* as monotonous and mathematical rather than artistic, but others found that the optical mixture of detached colours separated by pure white created an admirable luminosity. In water colours Signac used the principle in a much freer manner. After 1886 Signac took part regularly in the annual Salon des Indépendants, to which he sent landscapes, seascapes and decorative panels. He traveled widely over Europe with Seurat and other painters, and in his later years painted many scenes of Paris, Viviers and other French cities.

Signac produced much critical writing and was the author of *De Delacroix au néo-impressionnisme* (1899) and *Jongkind* (1927). The former book is an exposition of Pointillism or Neoimpressionism as developed by Seurat and himself. Signac died in Paris on Aug. 15, 1935.

Paintings by Signac may be seen at the Museum of Modern Art and in the Frick collection in New York city; at the Musée National d'Art Moderne in Paris; and in many other public collections.

SIGNAL, a word common in slightly different forms to nearly all European languages, derived from Lat. *signum,* "a mark" or "sign," a means of transmitting information, according to some prearranged system or code, in cases where a direct verbal or written statement is unnecessary, undesirable or impracticable. For military signaling *see* SIGNAL COMMUNICATION; *see* also RAILWAY: *Communications and Signaling: Signals.*

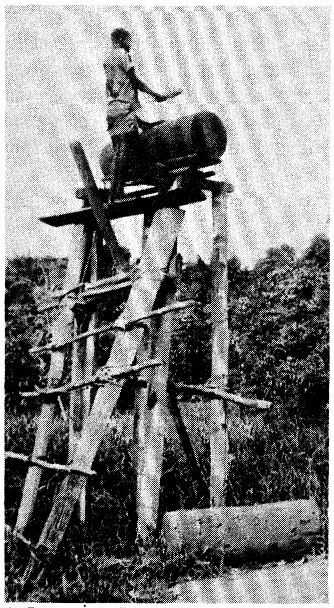
SIGNAL COMMUNICATION.. Signal communication or signaling has long played an important role in warfare. It serves to provide the means for transmitting information from reconnaissance and other units in contact with the enemy, and the means for exercising command by transmitting the orders and instructions of commanders to their subordinates. It comprises all means of transmitting messages, orders and reports both in the field and between all army headquarters and installations. In U.S. army usage, signal communication includes automatic transmission of data over military wire and radio circuits, between such electronic equipment as the computers and control systems employed in gun laying, in air navigation, in guided-missile control and in the various logistic and clerical activities of the military arms and services.

Signal communication in some armies includes such visual means as photography and television.

The history of the science can be divided into four phases: (1) the early period of origin and growth up to the invention of the electric telegraph and the Morse code of dots and dashes in the mid-19th century; (2) the advent of the telegraph, the telephone and wireless radio and their development up to World War I in 1914; (3) development during World War I and up to the beginning of World War II; and finally (4) the great expansion during and after World War II.

Early Development. — Some of the ancient writers! such as Polybius, make reference to the employment of various means of visual signaling. Before the end of the 18th century European armies used the visual telegraph system devised by Claude Chappe, employing semaphore towers or poles with movable arms. The Prussian army in 1833 assigned such visual telegraph duties to engineer troops. Messengers—still one of the valuable means of signal communications — were employed in war from ancient times. Alexander, Hannibal and Caesar each developed an elaborate system of relays by which messages were carried from one messenger post to another by mounted messengers traveling at top speed. They were thus able to maintain contact with their homelands during their far-flung campaigns and to transmit messages with surprising speed. Jenghiz Khan at the close of the 12th century not only emulated his military predecessors by establishing an extensive system of messenger posts from Europe to his Mongol capital but also utilized homing pigeons as messengers. As he advanced upon his conquests he established pigeon relay posts across Asia and most of Europe. He was thus able to utilize these messengers to transmit instructions to his capital for the governing of his distant dominions.

At the same time that these elementary methods of signal communication were being evolved on land, a comparable development was going on at sea. Early signaling betneen naval vessels was by prearranged messages transmitted by flags, lights or the movement of a sail. Codes were developed in the 16th century which depended upon the number and position of the flags or lights or on the number of cannon-shot discharges.



UNITED PRESS INTERNATIONAL

NATIVE DRUMMER OF THE CONGO RELAYING A MESSAGE IN THE JUNGLE COMMUNICATION BY DRUMS IS PRACTISED WIDELY IN AFRICA

In the 17th century, Adm. Sir William Penn (1621–70) and others developed regular codes for naval communication, and toward the close of the 18th century, Adm. Richard Kempenfelt developed a plan of flag signaling similar to that non in use. Later Sir Home Popham increased the effectiveness of ship-to-ship communication by improved methods of flag signaling

Advent of Electrical Signaling. — Despite the early pioneering efforts on land and sea the real development of signal communication in war did not come until after invention of the electric telegraph by Samuel F. B. Morse. In his successful demonstration of electric communication between Washington, D.C., and Baltimore, Md., in 1844, he provided a completely new means of rapid signal communication. The development of the Morse code of dots and dashes used with key and sounder was soon adapted to augment the various means of visual signaling. Vice-.\dm. Philip Colomb's flash signaling, adopted in the British navy in 1867, was an adaptation of the Morse code to lights. The first application of the telegraph in time of war was made by the British in the Crimea in 1854, but its capabilities were not well understood and it was not widely used. Three years later, in the India mutiny, the newly established telegraph, which was controlled by the British, was a deciding factor.

In the U.S. Civil War, wide use was made of the electric telegraph. In addition to its employment in spanning long distances under the civilian-manned military telegraph organization, mobile field service was provided in the Union army by wagon trains equipped with insulated wire and lightweight poles for the rapid laying of telegraph lines. Immediately before and during the Civil War visual signaling also received added impetus through the efforts of two British officers. Capt. Frank Bolton of the army and Capt. Colomb of the royal navy. and Maj. Albert Myer, signal officer of the U.S. army (*see* SIGNAL CORPS). The two former, working together, and Myer, working independently, arrived at the same end. They developed a system, applying the Morse code of dots and dashes. for spelling out messages by flags by day and lights or torches by night. Another development for light signaling placed a movable shutter. controlled by a key, in front of a strong light. An operator. opening and closing the shutter. could produce short and long flashes in accordance with the Morse code and this could spell out messages.

Simultaneously with U.S. and British developments in military telegraph. the Prussian and French armies also organized mobile telegraph trains. During the short, decisive Prussian campaign against Austria in 1866, field telegraph enabled Count Helmuth von Moltke. the Prussian commander, to exercise command over his distant armies. Soon afterward the British organized their first field telegraph trains in the royal engiceers. In the British Abyssinian campaign. 1867–68. Sir Robert Napier's forces made extensive use of Bolton and Colomb's new method of visual signaling and of the field telegraph. Success mas immediate and remarkable.

Another instrument was added to the techniques for visual signaling through the development of the heliograph. This instrument employed two adjustable mirrors so arranged that a beam of light from the sun could be reflected in any direction. The beam was interrupted by a key-operated shutter which permitted the formation of the dots and dashes of the Morse code. Where climatic conditions were favourable this instrument found much use. notably by the British army in India and the United States army in the southwestern U.S. Because consistency and regularity of sunshine were important, the heliograph was never widely adopted throughout the armies of continental Europe.

The invention of the telephone in 1876 was not followed immediately by its adoption and adaptation for military use. This was probably due to the fact that the compelling stimulation of war was not present and the added fact that the development of long-distance telephone communication required many years to accomplish. The telephone was used by the United States army in the Spanish-American \Tar. by the British in the South African War and by the Japanese in the Russo-Japanese War. This usage was not extensive and there was little material contribution to the development of voice telephony. Between the turn of the 20th century and the advent of World War I. military adaptation of the telephone did take place, but its period of major growth had not yet arrived.

Near the close of the 19th century, a new means of military signal con~municationmade its appearance — the wireless telegraph. or. as named in the United States and Canada — the radio. In 1894 Sir Oliver Lodge successfully demonstrated that the electromagnetic waves first discovered by Heinrich Hertz, and later studied by James C. Maxwell. could be guided and used for signaling. He was followed by Marconi. who developed but did not discover the use of these waves for signaling. The major powers throughout the world were quick to see the wonderful possibilities of this new agency for military and naval signaling. Its development was rapid and continuous and, by 1914, it was adopted and in extensive use by all the armies and navies of the world. It soon became apparent that wireless telegraphy was not an unmixed blessing to armies and navies, because it lacked secrecy and messages could be heard by the enemy as well as by friendly forces. This led to the development of extensive and complicated codes and ciphers as necessary adjuncts to military signaling. The struggle between the cryptographer and the cryptanalyst expanded greatly with the adoption of radio and continued to be a major factor affecting its military use. (See CRYPTOLOGY.)

From World War I to 1940. — The onset of World War I found the opposing armies equipped to a varying degree with modern means of signal con~municationbut with little appreciation of the enormous load that signal systems must carry to maintain control of the huge forces that were set in motion. The organization and efficiency of the armies varied greatly. At one end of the scale was Great Britain, with a small but highly developed signal service, and at the other end stood Russia, with a signal service inferior to that of the American Union army at the close of the Civil War. The fact that commanders could not control. co-ordinate and direct huge modern armies without efficient signal communication quickly became apparent to both the Allies and the Central Powers. The Germans, despite years of concentration on the Schlieffen plan, failed to provide adequately for communication between higher headquarters and the rapidly marching armies of the right wing driving through Belgium and northern France. This resulted in a lack of co-ordination between these armies which caused a miscarriage of the plan. a forced halt in the German advance and the subsequent withdrawal north of the Marne. On the Allied side. the debacle of the Russian forces in East Prussia — a crushing defeat at the hands of Gen. Paul von Hindenburg in the battle of Tannenberg — was largely due to an almost total lack of signal communication.

As the war progressed a growing appreciation prevailed of the need for improved electrical communications of much greater capacity for the larger units and of the need within regiments for electrical communications which had heretofore been regarded as unessential and impractical. Field telephones and switchboards were soon developed and those already in existence improved. An intricate system of telephone lines involving thousands of miles of wire soon appeared on each side. Pole lines with many cross-arms and circuits came into being in the rear of the opposing armies and buried cables and wires laid in trenches were installed in the elaborate trench systems to the forwardmost outposts. The main arteries running from the rear to the forward trenches mere crossed by lateral cable routes roughly parallel to the front. Thus there grew an immense gridwork of deep buried cables, particularly on the German side and in the British sectors of the Allied side with underground junction boxes and test points every few hundred yards. The French used deep buried cable to some extent but generally preferred to string their telephone lines on wooden supports set against the walls of deep open trenches. Thus electrical communication in the form of the telephone and direct-current telegraph gradually extended to the smaller units until front-line platoons were frequently kept in touch with their company headquarters through these mediums. At the beginning of the war most of the armies were using military telegraph instruments employing an alternating current at frequencies from 500 to 700 cycles per second These instruments could transmit well through the long and generally defective wire lines used in open warfare. However, when used in the trench systems in close proximity to the enemy it was found that their signals could be readily intercepted by using amplifiers associated with earth induction pickup devices A new type of telegraph instrument was soon developed nhich transmitted an interrupted direct current which could not be picked up by the listening devices then in use.

Despite efforts to protect the wire lines they mere frequently cut at critical times as the result of the intense artillery fires. This led all the belligerents to develop and use wireless (radio) as an alternate means of communication. Prewar wireless (radio) sets were too heavy and bulky to be taken into the trenches and they also required large and highly visible aerials. Radio engineers of the belligerent nations soon developed smaller and more portable wireless sets powered by storage batteries and using low inconspicuous aerials Although radio equipment came to be widely issued to the headquarters of all units to include battalions. the ease of enemy interception, the requirements for cryptographing or encoding messages and the inherent unreliability of these early nireless systems caused them to be regarded as strictly auxiliary to the wire system and reserved for emergency use when the wire lines nere cut. Visual signaling returned to the battlefield in World War I with the use of electric signal lamps. Pyrotechnics, rockets. Very pistols and flares had a wide use for transmitting prearranged signals. Messenger service came to be highly developed and motorcycle, bicycle and automotive messenger service was employed Homing pigeons nere extensively used as one-way messengers from front to rear and acquitted themselves extremely well. Dogs also were used as messengers and, in the German army, reached a high degree of efficiency.

A nen element in warfare, the airplane, introduced in World War I. immediately posed a problem in communication. During most of the war, communication between ground and air was difficult and elementary. The pilot had to land or to drop messages to make his reports. and he received instructions while in the air from strips of white and black cloth called "panels" laid out in an open field according to prearranged designs. Extensive development efforts were made to make practical the use of radio telegraph and telephone betneen the airplanes and ground headquarters. The closing stages of the war san many planes equipped with radio but the service nas never satisfactory or reliable and had little influence on military operations.

During World War I, wireless telegraph communication was extensively employed by the navies of the world and had a major influence on the character of naval warfare. High-powered shore and ship stations made possible wireless communication over long distances

World War I left a host of lessons to be studied by the army, naval and air force personnel of all of the nations. Important among these lessons was the need to improve mobility, fire power, communication and the effectiveness of air power. Advances in military communications after the war were greatly aided by the large increase in electronic and communication development for civilian purposes.

The growth of radio broadcasting following World War I brought into existence in most of the nations a greatly increased interest in communication engineering and the expansion of manufacturing facilities to exploit the new art. Carrier telephony on wire systems also made great advances in providing for several unconflicting conversations over the same wires. There was a rapid growth in long-distance telephone techniques and plant. The design of amplifiers for telephone repeaters made rapid progress.

One of the war lessons learned in most of the major nations was the compelling need for scientific research and development of equipment and techniques for military purposes. Although the amount of funds devoted to military development during the period from World War I to World War II n-as relatively small, the modest expenditures served to establish a bond between industry. science and the armed forces of the major nations.

Of great importance in radio communication was the pioneering by the amateurs and by industry and science in the use of very high frequencies. These developments opened up to the military the possibilities of portable short-range equipment for mobile and portable tactical use by armies, navies and air forces. Military work in these fields was carried out actively in Germany. Great Britain and the United States. As early as 1938 Germany had completed the design and manufacture of a complete line of military portable and mobile radio equipment for its army and air force.

The increased interest in scientific research and development on the part of the military brought about the birth of radar which was destined to become one of the major technological advances of World War 11.

Radar (*q.v.*), signifying radio detecting and ranging, was developed for long-range location and tracking of enemy aircraft and for antiaircraft fire direction. It used sharply beamed short pulses of radio energy which n-ere reflected back from the surfaces of aircraft in flight to give a visual signal indication on the face of a receiver oscilloscope. Using radar. it became possible to detect and locate enemy aircraft at distances of 100 to 150 mi.. which enabled the defending air force then to take off and intercept enemy bombers prior to reaching their targets. In Britain. radar became one of the major factors which enabled the British to meet and neutralize mass German bombing attacks during the battle of Britain. Although, strictly speaking. radar is not used for communication. it formed part of the complex communication systems required for antiaircraft warning and fire-control nets. The employment of radar in IFF systems (identification. friend or foe) to distinguish friendly aircraft from hostile on the oscilloscopes of search sets did in fact serve a communication function.

Between World Wars I and II the printing telegraph, commonly knon-n as the teleprinter or teletypewriter machine. came into civilian use and was incorporated in military wire-communication systems. Compared with the World War II period. military wire teleprinter networks n-ere not extensive. Prior to World War II military radioteleprinter circuits were nonexistent.

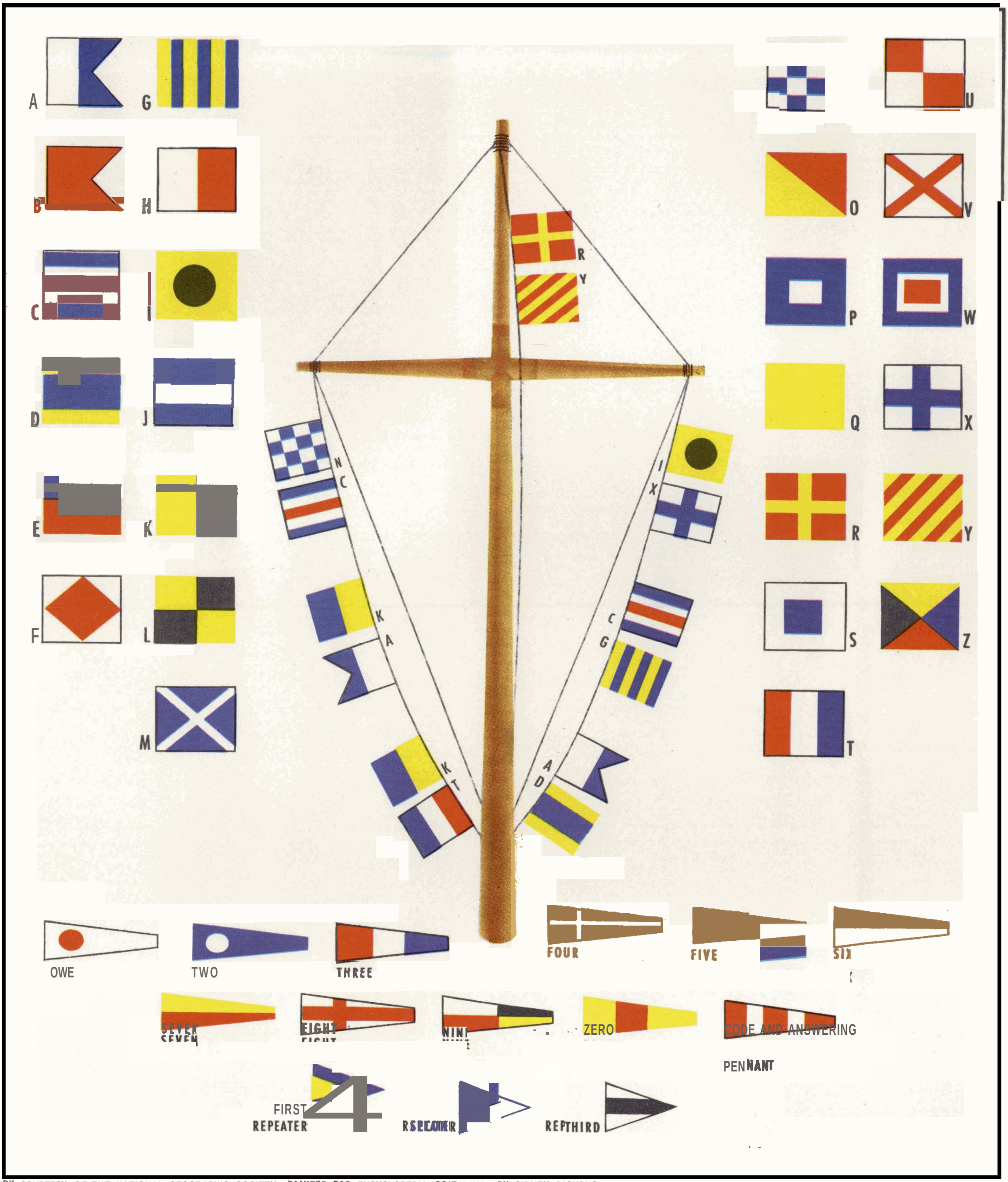
Another major communication advance which had its origin and early growth during the period between World Wars I and II was frequency modulated (FM) radio. Developed during the late 1920s and early 1930s by Edwin H. Armstrong, inventor and a major in the United States army signal corps during World War I. this new method of modulation offered heretofore unattainable reduction of the effect of ignition and other noises encountered in vehicular radio applications. It was first adapted for military use by the United States army. which, prior to World War II. had under development tank. vehicular and man-pack frequency modulated radio transmitters and receivers.

On the eve of World War II, all nations employed generally similar methods for military signaling. The messenger systems included foot, mounted, motorcycle, automobile, airplane. homing pigeon and the messenger dog. Visual agencies included flags. lights. panels for signaling airplanes and pyrotechnics. The electrical agencies embraced wire systems providing telephone and telegraph service. including the printing telegraph. Both radiotelephony and radiotelegraphy were in wide use, but radiotelephony had not as yet proved reliable and satisfactory for tactical military communication. The navies of the world entered World War II with highly developed radio-communication systems. both telegraph and telephone. and with development under way of radar and sonar (sound navigation and ranging) and many other electronic navigational aids. Blinker-light signaling was still employed. The use of telephone systems and loud-speaking voice amplifiers on naval vessels had also come into common use. Air forces employed wire and radio communication to link up their bases and landing fields and had developed modern air-borne long-range. medium-range and short-range radio equipment for air-to-ground and air-to-air communication.

World War II and After.—In the communication and electronics field. World War II was in one sense similar to World War I—the most extravagant prewar estimates of military. naval and air communication requirements soon proved to represent only a fraction of the actual demand. Requirements for all kinds of communication equipment and for improved quality and quantity of communications pyramided beyond the immediate capabilities of industry. Expansion of manufacturing facilities becaine vital, and the expansion of research and development activities in the communications-electronics field was unprecedented. The early German blitzkrieg, with tank and armoured formations. placed a new order of importance on reliable radio communication. The development of the air, infantry, artillery and armoured team created new requirements for split-second communication by radio between all members. Portable radio sets were provided as far down in the military echelons as the platoon. In every tank there n-as installed at least one radio and in some command tanks as many as three. In the field of wire communications multiconductor cables were provided. which could be rapidly reeled out and on which as many as four conversations could take place simultaneously through the use of carrier telephony. The Germans were the first to bring forth this type of military long-range cable and their example was promptly followed by both the British and the C.S. forces. High-powered mobile radio sets hecame common at division and regimental level. With these sets telegraph communication could be conducted at distances of more than 100 mi. with vehicles in normal motion on the road. Major telephone switchboards of much greater capacity were needed. These were developed. manuiactured and issued for use at all tactical headquarters to satisfy the need for the greatly increased number of telephone channels required to co-ordinate the movements of field units whose mobility and speed of movement capabilities had been expanded many times.

Radio relay. born of the necessity for mobility. became the outstanding communication development of World War II. Sets employing frequency modulation and carrier techniques were developed and used. as were also radio relay sets which used radar pulse transmission and reception techniques and multiplex time-division methods for obtaining many voice-channels from one radio carrier. Radio relay telephone and teletypenriter circuits spanned the English channel for the Normandy landing and later furnished important communication service for Gen. George S. Patton, Jr.. after his breakout from the Normandy peninsula.

The need for communication between the homelands and many far-flung theatres of war gave rise to the need for improved lone-range overseas communication systems. r\ system of radioteletypewriter relaying n-as devised. by n-hich a radioteletypewriter operator in Washington, London or other capitals could transmit directly by teleprinter to the commander in any theater of war. In addition. a system of torn-tape relay centres was established so that tributaries could forward messages through the major centres and retransmission could be effected in a minimum of time by transferring the perforated tape message from the receiving to the transmitting positions. In addition a system of holding teletypewriter conferences was developed. These conferences were called "telecon" and enabled a commander or his staff at each end to view on a screen the incoming teletypewriter messages as fast as the characters were received. Questions and answers could thus be passed rapidly hack and forth over the thousands of miles



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INTERNATIONAL CODE FLAGS AND PENNANTS

The two-letter signal RY flying from the masthead signifies "Crew have mutinied." The other two-letter groups on the halyards hoisted to the yardarm have the following meanings: NC—"I am in distress and require immediate assistance"; KA—"My vessel is very seriously damaged"; K1—"Have you a line-throwing apparatus?"; IX—"I have received serious damage in collision"; CG—"You should alight as near to me as possible"; AD—"I must abandon my vessel."

separating the Pentagon in Washington, D.C., for example, from SHAEF headquarters in Europe or Gen. Douglas MacArthur's headquarters in the far east.

During the latter years of the war, new and improved communication and electronic devices came forth from research and development in ever-increasing numbers. A new long-range electronic navigation device, known as loran. used for both naval vessels and aircraft was brought forth. Short-range navigational systems, called shoran, made their appearance. Combinations of radar and communications for the landing of aircraft in zero visibility were perfected. One such system was the GCA or ground controlled approach system. Combinations of radio direction-finding. radar and communications systems were developed and used for ground control of intercept aircraft—the system called GCI (ground controlled intercept). Radio-controlled guidance of falling bombs was brought forth to enable the operator in the bomber to direct the bomb to the target.

Electronic countermeasures made their appearance in the form of jamming transmitters to jam radio-communication channels and radar, navigation and other radio aids to military operation.

At the end of World War II the military forces of the Allied nations were called upon to occupy the territories of their former enemies. The Allied signal communications staffs were usually charged with responsibility for the supervision of military and civilian communication within the occupied areas.

The military services learned well from their wartime experiences the importance of scientific research and development in all fields including communications electronics. Advances were made toward increasing the communication capacity of wire and radio relay systems and toward improving electronic aids for navigation and for the detection of enemy forces. Measures to provide more comprehensive and more reliable communication and electronic equipment continued to be stressed in the armies, navies and air forces of the major powers. Further impetus to these developments came from the conflict in Korea. which reaffirmed the vital importance of signal communication in the co-ordinated and combined operations of air. ground and naval forces.

After mid-century, accordingly. military efforts in all the many facets of signal communication continued to intensify almost as extravagantly as during World War II. Two major additions in the U.S. army were television and electronic "brain" equipment. The latter. in many forms of digital and analogue computers and of such data-processing devices as punch-card machines, were applied increasingly to personnel record handling and to depot and supply operations interconnected over wide areas by signal-communication networks.

Television systems proved valuable training aids in military schools where mass instruction, especially in manual functions, was needed and where instructors were few. Such systems enabled a single instructor to teach many small classes simultaneously, each grouped before a receiver where they could watch demonstrations closely. Two-way communication systems permitted the instructor to call and question any student in any classroom and, inversely, enabled any student to put questions to the instructor. Portable television equipment in the field proved valuable for sending back to headquarters, by antenna radiation or coaxial cable. a picture of any scene of operations such as a river crossing. Equally valuable was a television camera in the hands of a forward scout or in a reconnaissance aircraft, whether piloted or remotely controlled. to scan enemy territory.

Thus signal communication, combining in itself the powers of photography, television, radar and other instruments using the electromagnetic radiation spectrum, moved into such new areas of military communications electronics as battle area surveillance and electronic warfare devices to interfere with, or jam, enemy transmitters. In the U.S. army, battle area surveillance activity radically augmented conventional reconnaissance methods. An electronically controlled target acquisition system. to discover enemy troops or transport on the ground or in the air. was being developed by the signal corps using optical, sonic. photographic, infrared and other sensory equipment. The aggregate of information gathered by these devices over a wide enemy front can be electronically assembled and displayed in the headquarters where the combat commander can quickly estimate the situation and make tactical decisions.

See Hanns Grosser, *Die Führungstruppe* (Berlin, 1944); T. B. Gravely, *The Second World War 1939–45: Signal Communications* (London, 1950); Dulany Terrett, *The Signal Corps: the Emergrncy* (Washington, D.C., 1956); G. R. Thompson et al., *The Signal Corps: the Test* (Washington, D.C., 1957). (G. I. Bk.; G. R. T.)

SIGNAL CORPS. Organizations of this or an equivalent title have existed in the armies of many nations since the creation of the first signal corps in the Union and Confederate armies of the C.S. Civil War.

United States.—The signal corps, U.S. army, dates from June 21, 1860, when congress authorized the post of signal officer, filled on June 27 by Maj. Albert J. Myer, assistant surgeon. who had won war department acceptance of a simple but effective method of flag signaling (wigwag). Obtaining officers on detail, he trained a number, some of whom later served with the Confederate army and helped establish the Confederate signal corps in 1862. The signal corps, U.S. army, under Myer and his officers in the Union cause was established on March 3. 1863.

The provision of signal communication and related tasks of observation brought the corps a variety of responsibilities, including weather reporting over army wire lines from 1870 until that responsibility was transferred to the weather bureau in 1891, observation balloons and early army aircraft and army photography. The signal corps made still and, later, motion pictures for many purposes, including military analysis and tactical reconnaissance; it produced and distributed all army training films. Responsibility for electrical communications (lost during the Civil War to the civilian military telegraph organization but recovered soon after) led to wire-line construction and operations to serve army posts and camps throughout the U.S. territorial west, and later to the provision of all communications in Alaska. The Alaska communication system, assigned to the signal corps in 1900, became the principal means by which civilians and government agencies in Alaska maintained rapid communication with the United States. Installed and operated by the signal corps! the system utilized submarine cable. overland pole lines and radio (more than 35 radio stations at mid-century).

Signal corps responsibility for army communications led to such electronic assignments as applications of radar and television. Army radar equipment was developed by the signal corps prior to World War II. Many types received wide use. especially in aircraft detection and in gun laying during that war. In 1946. using high-power radar designed at its laboratories at Fort Monmouth, N.J.. the signal corps succeeded in receiving radar reflections from the moon. Television closed-circuit systems for better training in army schools and field television for use in battle area surveillance were developed (*see* SIGNAL COMMUNICATION).

Signal corps research and development laboratories work upon a wide array of electronic aids, such as individual helmet radios for use in short-range communication with each soldier in combat, and theatre-wide area communication systems for the interconnection of headquarters by multiple routes. Such developments as these are necessary to provide the flexibility and universality needed for the command control of widely dispersed mobile forces in an atomic era.

In its global responsibility for the army command and administrative network the signal corps installs and operates increasingly dependable and automatically relayed high-capacity radio and wire circuits and teletypewriter conference systems the world over. In its equally world-wide depot and supply operations the signal corps seeks to speed service and reduce the amount of costly overseas stocking of equipment by making use of automatic data processing machines, which greatly facilitate the formerly slow paperwork involved in signal equipment requisitions and supply and replace the lengthy labours of clerical workers of the past.

Unlike the signal organizations of other armies, the U.S. army signal corps is responsible for the production and distribution of military communications equipment. Toward combat support, the signal corps mission includes the installation, operation and maintenance of communications within all commands down to and including the brigade. Communication within regiments and below has been generally handled since World War I by personnel of the several arms. But the equipment and techniques are usually those of the signal corps. Army doctrines and methods for signal communications are taught by the signal corps to selected personnel of the combat arms and technical services, the air forces, the navy and the marine corps.

Field units of the signal corps are organized into signal operations, construction and service battalions and into operations, construction, photographic, repair, depot and service companies. Signal battalions are organic units of infantry: air-borne and armoured divisions. Service companies and battalions are composed of teams. organized and equipped to perform one of the technical functions of the signal corps.

Other Countries. — In European armies the signal function, dating generally from the first military applications of the electrical telegraph in the mid-19th century. developed under engineer organizations. But the rapid multiplication of the means of signal communication. especially with the advent of radio early in the 20th century, took military signals from the engineers and established the function as a separate and independent organization. The commander usually serves on the general staff while directing also the many-sided operations of the signal communication system of a modern army. In Great Britain the director of signals in the war office became head of the British royal corps of signals. This corps. which took form in 1920 from the signal service of the royal engineers, provides communication facilities down to brigades and forward to infantry battalions and artillery battery headquarters. In France the signal service of the army was lodged, after World War I, with the engineers until mid-century when it separated as the *corps* des *transmissions.* The commander. directly responsible to the minister of national defense. is charged with the organization and operations of the corps, the training of signal personnel and the provision of technical advice on research and development and on supply requirements. In Germany signal troops served as a separate organization, the *Nachrichtentruppe,* after 1899.

Signal communications in the U.S.S.R. operated as a general staff function directly under the soviet war minister. Soviet signal troops serve under the ground forces along with the infantry. cavalry and engineers. In Japan the signal section, one of the technical services of the national safety forces of the country, is represented on the general staff by the chief of the signal section. A signal company serves each army division. performing functions similar to those in the U.S. army.

See R. F. H. Nalder. *The History of British Army Signals in the Second World War* (London. 1953) ; Dulany Terrett, *The Signal Corps: the Emergency* (Washington, D.C., 1956) ; G. R. Thompson *et al., The Signal Corps: the Test* (Washington, D.C., 1957). (G.R.T.)

SIGNATURE (through Fr. from Lat. *signatura, signare,* "to sign.!' *signum,* "mark," "token," "sign"), a distinguishing sign or mark. especially the name, or something representing the name. of a person used by him as affixed to a document or other writing to show that it has been written by him or made in accordance with his wishes or directions. In the early sense of something which "signifies" (*i.e.,* marks a condition, quality or meaning) the word was formerly also used widely, but now chiefly in technical applications.

In old medical theory, plants and minerals were supposed to be marked by some natural sign or symbol which indicated the particular medicinal use to which they could be put; thus, yellow flowers mere to be used for jaundice. the "scorpion-grass," the old name of the forget-me-not. was efficacious for the bite of the scorpion. Many superstitions were based on the human shape of the roots of the mandrake or mandragora. The bloodstone was taken to be a cure for hemorrhage. This theory was known as the "doctrine of signatures."

In printing or bookbinding the "signature" is a letter or numeral placed at the bottom of the first page of a section of a book, as an assistance to the bookbinder in folding and arranging the sections consecutively; hence it is used in connection with a sheet ready folded. In music it is the term applied to the signs affixed at the beginning of the stave showing the key or tonality and the time or rhythm.

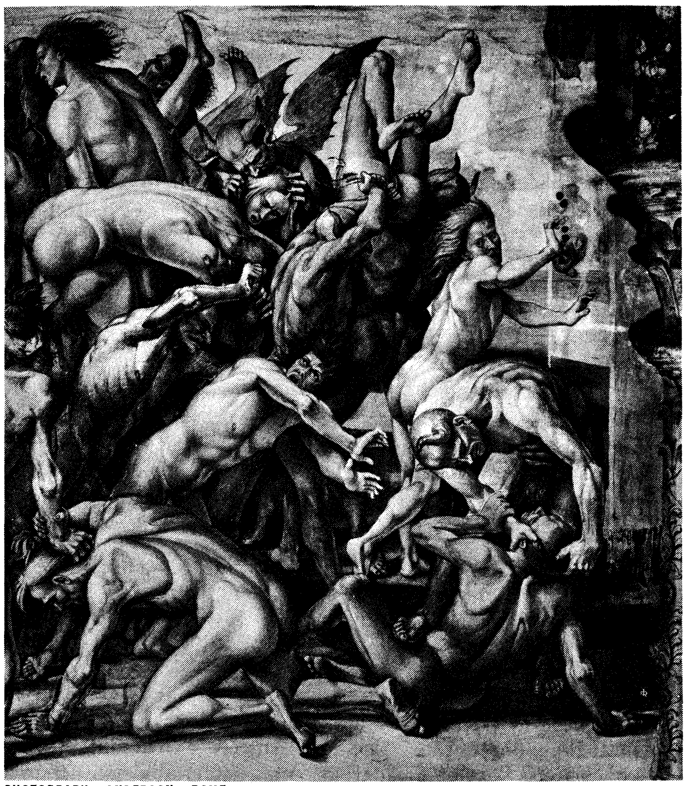
SIGN LANGUAGE. Speech as a mode of human communication is normally used between persons who are in visible contact. Therefore the gestures, facial expressions, bodily movements of the two parties are integral, even at times essential, elements in the communication. Thus "when the postural tensions and the spoken word contradict each other it is plain which should be given credence" (W. A. White, *Foundations* of *Psychiatry,* 1921, p. 79). There is therefore in all speech when the two parties are in visible contact an element of natural gesture. From this concept we arrive at the position that to speak with the hands is to think with the hands.

Organized sign language is found in many parts of the world. In Assam "the signs used depend on the genius and personality of the speaker, but the natural aptitude for their use is such that from one Naga to another their meaning is rarely obscure. Indeed, a dumb man has been known to make a long and detailed complaint of an assault in which nothing was missing except proper names, and even these were eventually identified by means of the dumb man's description of his assailant's dress and personal appearance" (J. H. Hutton, *Angami Sagas,* 1921, p. 291). Natural gestures form the basis of an extended system of sign language, as is evident in Australia. *See* DEAF AND HARD OF HEARIXG. TRAINING AND WELFARE OF.

See L. Lévy-Bruhl, *Les fonctions mentales dans les sociétés inférieures* 11910; trans. by L. A. Clare. *How Natives Think, 1926)* ; C. Wissler, *Man and Culture* (1923) ; W. B. Spencer and F. J. Gillen, *The Arunta,* 2 vol. (1927–28).

SIGNORELLI, LUCA (LCCA DA CORTONA, originally LUCA D'EGIDIO DI VENTURA DE' SIGNORELLI) (c. 1445/50–1523), Italian painter, the most powerful exponent of the nude before Michelangelo, was born in Cortona, Umbria, probably between 144j and 1450. He was first recorded as a painter in 1470, but it is very likely that he was a pupil of Piero della Francesca, along with Perugino. in the 1460s. The first certain surviving work by him is a fragmentary fresco. now in the museum at Città di Castello, which he finished in Nov. 1474. This shows a strong influence from Piero della Francesca. and the style is responsible for the attribution to Signorelli at this date of several other pictures, including the beautiful Madonna in Christ Church library, Oxford. His first signed work was a processional banner with a Madonna on one side and a Flagellation on the other; these are now in the Brera. Milan. as separate pictures. They still show links with the style of Piero, but the dominant influence is that of Florence, and especially that of the Pollaiuoli. which suggests that Signorelli visited Florence in the 1470s. The scientific naturalism represented by the Pollaiuoli now becomes the principal feature of Signorelli's style. In 1479 he was elected to the council of 18 in his native Cortona and for the rest of his life'he was active in politics.

About 1483 he went to Rome. for the "Testament of Moses" fresco in the Sistine chapel is unanimously attributed to him; yet his name does not occur in the only two documents — of 1481 and 1482—known to us. It is likely that his friend Perugino got him the commission to help complete the cycle. By this date his style was fixed and his interest in dramatic action and the expression of great muscular effort mark him as an essentially Florentine naturalist working outside Florence. The altarpiece for Perugia cathedral, of 1484, shows the same qualities. Between 1497 and 1398 he was at work on a fresco cycle of scenes from the life of St. Benedict in the monastery at Monteoliveto Maggiore, near Siena, but these are hardly more than a prelude to his masterpiece, the frescoes of the "End of the World" and the "Last Judgment" in the chapel of S. Brizio in Orvieto cathedral. A small part of the ceiling had been painted by Fra Angelico in the 1440s, and he had determined the subject by painting the "Christ in Judgment" over the altar. On April j, 1499, Signorelli was commissioned to complete the ceiling and it was not until April 27, 1500, that he received the more important commission to paint the walls. At this moment Italy was in turmoil. partly because of the incursions of the French armies and partly because of the preaching and death of Savonarola, who seemed to have predicted the French invasion as a judgment. The French had actually by-passed Orvieto on their way south, and the completion of the frescoes was therefore in the nature of a thanksgiving. It also explains the grim and terrible treatment of a subject well suited to Signorelli's genius. The large scenes on the walls represent the last days of the world, with the portents of doom followed by the appearance of Anti-christ and the false miracles worked by him before his final destruction. In the frescoes nearer to the altar we see the next stages, the "General Resurrection" and the "Last Judgment." "Heaven" and "Hell." The 'Judgment' itself is represented only by the small figure of Christ over the altar, painted by Angelico. Behind the altar are a Dantesque "Hell" (with the classical figure of Charon and the River Styx) and a part of the "Blessed in Heaven." Signorelli had little sense of colour, but here his greenish and



PHOTOGRAPH, ANDERSON, ROME

"THE CONDEMNED IN HELL," A DETAIL FROM ONE OF SIGNORELLI'S FRESCOES IN THE CHAPEL OF S. BRIZIO. ORVIETO, ITALY

purple devils add to the horror induced by the strained poses and the anatomical details in the resurrected and decayed bodies.

The Orvieto frescoes reach a level that he never again achieved, although he lived nearly 20 years after he received the final payment on Dec. 5, 1504. He was in Florence in 1508 on official business as prior of Cortona and he went to Rome at about this time, and again in 1513, but the new generation—Michelangelo and Raphael—had now won all the commissions and Signorelli returned to his less sophisticated Umbrian clientele. Most of his later works betray the hands of his numerous assistants, but among his better works are the altarpiece in the National gallery, London (1515), the "Deposition" (1515/16) in Sta. Croce. Umbertide. and the "Assumption" and "Immaculate Conception" begun in 1519 and 1521 (both in the Museo Diocesano, Cortona). One of his finest works, the "Pan" formerly in Berlin, was destroyed in World War II. He died in Cortona on Oct. 16. 1523.

See G. Vasari, *Lives* . . ., Eng. ed. by C. du G. de Vere, vol. iv (1913); L. Dussler, *Signorelli* (1927); M. Salmi, Luca *Signorelli* (1953)
(P. J. MY.)

SIGOURNEY, LYDIA HOWARD (née HUNTLEY) (1791–1865), U.S. author. whose numerous popular poems were characterized by sentimental morality, was born in Norwich, Conn., Sept. 1. 1791. After conducting schools in Norwich and Hartford, she was married, in 1819, to Charles Sigourney, a Hartford merchant. She contributed more than 2,000 articles to nearly 300 periodicals, and wrote 67 books and thousands of elegies, many of them distributed at the subjects' funerals. She died in Hartford, June 10, 1865. In 1866 her autobiography *Letters of Life,* appeared.

See Gordon S. Haight, *Mrs. Sigourney: the Sweet Singer of Hartford* (1930).

SIGSBEE, CHARLES DWIGHT (1845–1923), U.S naval officer, commander of the "Maine" at the time of her sinking in Havana harbour, was born in Albany, N.Y., Jan. 16, 1845, and graduated from the United States Naval academy in 1863. He served in the battle of Mobile bay and in both attacks on Ft. Fisher. After a deep-water survey of the Gulf of Mexico, he had other hydrographic experience before serving as hydrographer of the navy, 1893–97, in which office he made many improvements in surveying techniques. Taking command of the U.S.S. "Maine" on April 10, 1897, he survived her sinking on Feb. 15, 1898, and afterward commanded the U.S.S. "St. Paul." which defeated the Spanish cruiser "Isabella II" off San Juan on June 22, 1898. Sigsbee published two books. *Deep Sea Sounding and Dredging* (1880) and *The Maine, an Account of Her Destruction in Havana Harbour* (1899). He became a rear admiral on Aug. 11, 1903, and died July 19. 1923.
(J. B. HN.)

SIGURD: *see* SIEGFRIED.

SIGURÐSSON, JÓN (1811–1879), Icelandic statesman and man of letters, was born in the west of Iceland in 1811. He received an excellent education. In 1830 he was secretary to the bishop of Iceland, the learned Steingrimr Jónsson. In 1833 he went to Copenhagen to study Icelandic history and literature. His important works include: *Lögsögumannatal og Lögmanna à Islandi* ("Speakers of the Law and Law-men in Iceland"); the edition of *Landnáma* and other sagas in *Islendinga Sögur,* i–ii (Copenhagen, 1843–47); the large collection of Icelandic laws edited by him and Oddgeir Stephensen; and last but not least, the *Diplomatarium Islandicum,* which after his death was continued by others.

But although he was one of the greatest scholars Iceland has produced, he was still greater as a politician. The Danish rule had, during the centuries following the Reformation. gradually brought Iceland to the verge of economic ruin. Jón Sigurðsson began a hard struggle against the Danish government to obtain a reform. In 1854 the trade of Iceland was declared free to all nations. In 1840 the *althing* was re-established as an advisory, not as a legislative body. But when Denmark got a free constitution in 1848, which had no legal validity in Iceland. the island felt justified in demanding full home rule. To this the Danish government was vehemently opposed; it convoked an Icelandic national assembly in 1851, and brought before that body a bill granting Iceland small local liberties, but practically incorporating Iceland in Denmark. This bill was indignantly rejected and, instigated by Jón Sigurðsson, another was demanded of far more liberal tendencies. The Danish governor general then dissolved the assembly. but Jón Sigurðsson and all the members with him protested to the king against these unlawful proceedings. The struggle continued with great bitterness on both sides, but gradually the Danish government was forced to grant many important reforms. *(See* ICELAND. *History.)*

The grant of the constitution in 1874 was, in fact, the victory of Jón Sigurðsson, whose high personal qualities had rallied all the nation round him. He made Reykjavik not only the political, but the spiritual capital of Iceland by removing all the chief institutions of learning to that city; he was the soul of many literary and political societies and the chief editor of the *Ny Félagsrit,* which has done more than any other Icelandic periodical to promote the cause of civilization and progress in Iceland. Jón Sigurðsson lived the greater part of his life in Copenhagen, and died there in 1879; but his body, with that of his wife, Ingibjorg Einarsdóttir, whom he had married in 1845, and who survived him only a few days, was taken to Reykjavik and given a public funeral. On his monument is the inscription: "The beloved son of Iceland, her honour, sword and shield." (S. BL.; X.)

SIKANG, a former Chinese province, formed out of parts of western Szechwan and eastern Tibet, was given full provincial status on Jan. 1, 1939. When British India contested the Chinese sovereignty in Tibet, the Manchu government tried to retain control over the thirty-nine tribes, which had been under special jurisdiction of the Chinese commissioner at Lhasa, by creating a special district, Kham, out of their territory. This district remained contested between Tibet and China until the establishment of the larger province enclosing territory of Szechwan, which followed the restoration of full Chinese authority. The province was traversed by the southward courses of feeders of the Yangtze, the Mekong, Salween and Brahrnaputra rivers. The western border, which reached to within 125 mi. E. of Lhasa was uncertain, as the whole western part of the province was little explored. The eastern part of the province. organized from more than 50 former Szechwan counties, had rich mineral and forest resources and was not only geographically but in planning for economic development closely linked with the neighbouring Szechwan.

The capital of the province, Paan (Patang, Batang), is in a rich plain with several lamaseries on the route from Tatsienlu to Chamdo, a city of lamaseries and a commercial centre in the north, The population in 1953 was 3,381,064 with an area of 174,332 sq.mi.

In 1955 Sikang was absorbed into Szechwan province.

SIKELLANOS, ANGELOS (1884–1951), one of the leading modern Greek lyrical poets, was born on the island of Leukas. His first important work, the *Alnfroiskiotos* was published in 1909, and revealed his lyrical powers. It was followed by a group of outstanding lyrics. His next period was introduced by the philosophic poem *Prologos tes Zoes* ("Prologue to Life"; 1917) and includes the long works *Meter Theou* ("Mother of God") and *Pascha ton Hellenon* ("The Greek Easter"), culminating in the *Delphikos Logos* ("Delphic Ctterance"; 1927). The Greek tradition and the national historic and religious symbols are here given a mystic turn and a universal significance. In the 1930s and 1940s there appeared a second group of lyrics, which display the full power of Sikelianos' art. They express in rich and incisive language and with forceful imagery the poet's belief in the beauty and harmony of the world. The tragedies of Sikelianos (*Sibylla, Daedalus* in *Crete, Christ in Rome, The Death* of *Digenis* and *Asklepius,* which are introduced by the long dramatic poem *The Dithyramb of the Rose)* are more notable for their lyric than their dramatic qualities.

In his mature works Sikelianos is fulfilling in poetry the aspirations of the "demotic movement" of the 1880s, which sought to combine Greek tradition with western thought, and to introduce as a consciously literary language the idiom of the people. Although occasionally the power of his inspiration drives him to grandiloquence which blunts the poetic effect of his work, some of his finer lyrics are among the best in 20th-century western literature.

Sikelianos died at Athens, June 19, 1951.

See P. S. Sherrard, The *Marble* Threshing *Floor; a Study in Modern Greek Poetry* (1956). (CE. A. T.)

SIKHOTE-ALIN is a mountain range and region forming the southeastern part of the Soviet Pacific realm and adjoining the Sea of Japan and the Tatar strait. It lies east of the 700-mi.-long depression running from the Amur river mouth to the Bay of Peter the Great.

Topography.—Most of the region is occupied by the range comprising up to eight parallel chains of ridges running roughly north-northeast. The maximum elevations in the central ridges range from about 6.400 ft. at the Golez Komarov in the south, with gradually decreasing heights northward, to peaks about 4.300 ft. high in the north. Geologically. this is a folded range of mineraliferous metamorphic and sedimentary rocks of Paleozoic age, with frequent basalt extrusions and many tectonic faults. The whole block has been uplifted in the east and tilted down westward, so that the longer rivers run to the west and the short eastern rivers often tumble over falls and rapids down a steep slope to the Sea of Japan. The range appears high and rough from the sea, but from the central peaks the general aspect reveals a succession of round-domed peaks and a surprising over-all mild relief declining gradually toward the Ussuri river, which follows the depression at the western feet of the range. The Ussuri source in the extreme south of the range is only about 40 mi. from the coast near Vladivostok, and the water divide between the Ussuri and the short: south-running Sui-fen river is only about 600 ft. above sea level. Because of the trend of the main ridges parallel to the coast, the major part of the coast is relatively regular, with few bays and harbours. These are found chiefly at the south end of the range where the coast cuts across the parallel ridges almost at right angles.

Climate, Vegetation and Animal Life.—The Sikhote-Alin acts as a divide between the cool marine climate of the Sea of Japan region and the continental climate of the Xmur basin. The winter January isotherm of $-20°$ C. roughly follows the crestline of the range which separates the severely cold, dry Siberian air masses in winter from the humid, often fogbound seaward side of the range. In summer the temperature situation is reversed, with the Amur-Ussuri valley, as well as the southern end of the range, being much warmer than the drizzly eastern slopes. Precipitation in the Sikhote-Alin is as low as 23 in. annually in some parts of the lower western slopes and as high as 40 in. in the interior mountains. Because of the great summer monsoon concentrations of rainfall, destructive floods are common in the valleys. A rich virgin forest covers all except the highest altitudes and the settled lowlands and swamps. Nowhere is a permanent snow zone reached, although scrubby brushes and tundra mosses cover small areas of the peaks. Broad-leaved trees such as oak, birch, elm and linden intermixed with Korean pine and +Manchurian fir grow on the southern part of the mountains up to about 2.000 ft.; a transition to a coniferous zone of Okhotsk spruce follows in the higher altitudes of the south and continues down to sea level in the north. Although destructively cut in small areas of the settled valley slopes, the forests form one of the rich Sikhote-Alin resources still not systematically exploited in modern times. In the forests, especially in the south, roam a great variety of wild animal life, including the fearsome man-eating Manchurian tiger, the leopard, the Manchurian bear and the red wolf. Lesser furred animals are the sable, lemming, squirrel. marten and badger. Grass-eating game include the destructive wild boar, the Ussuri moose. wapiti, sika deer and musk deer. Bird life is abundant.

Political Divisions and Population.— Primorski *krai* (province) includes roughly the southeastern two-thirds of the physical region of the Sikhote-Alin. The northern region, including Sovetskaya Gavan, is part of Khabarovsk *krai.* This division accords with the economic hinterlands of Vladivostok and Khabarovsk, respectively, as well as with topographical considerations. The population is sparsely settled along both lower flanks of the Sikhote-Alin with increasing density toward the south and especially in the southwest end around Vladivostok. Along the east coast slopes, only Sovetskaya Gavan and Tetyukhe have significant populations. ranging up to 30,000 for the former and more than 50,000 for the latter in 1950. The southwest has such centres as Vladivostok, with about 265,000 people in 1956 (est.), and Voroshilov, with about 101,000. Lesser cities occur northward along the lower flanks of the range in the Ussuri-Lake Khanka depression. Ethnically, in the southern third of the region and in the lower flanks on each side of the range as far north as the Amur mouth in the west and to about the 47th parallel along the coast, the Great Russians predominate. There is local Ukrainian predominance south of Ol'ga, at Tetyukhe, Artem, the lowland east of Lake Khanka, the area around Bikin and the foothills between Khabarovsk and Vyazemskaya. The rest of the Sikhote-Alin to the north and in the centre is the realm of the few and scattered indigenous Tungusic tribes such as the Ude (Udet), the Orot and the Olt.

Natural Resources and Economic Development.— Relatively limited geological surveying revealed great mineral resources, including coal, iron, graphite, manganese, gold, tin, silver, lead and zinc, as well as raw materials for the glass and cement industries. The coastal waters are rich in fish and other marine products. Agriculture is chiefly important in the lower, valley grasslands of the southwest, although where level space permits in the terraces of the coastal hinterlands small farm settlements exist. The Eesources thus indicate that there are essential bases for a considerable measure of economic and industrial development in the Sikhote-Alin.

Land communications were poorly developed in the 1930s except along the western depression. The isolated east coast ports and settlements are visited by occasional steamships. Sovetskaya Gavan, connected with Khabarovsk by a railroad across the low part of the range, is the only harbour and port of consequence in the north. It is a lumber and fish-canning centre and docs some wooden shipbuilding. Fish canneries also are found at Nelma and at Tetyukhe which, however, is more important for its lead, zinc and silver mines and smelter at the end of a narrow-gauge railroad about 20 mi. inland from the port. Ol'ga bay in the southeast has an iron-mining town of several thousand people with a small agricultural hinterland. Suchan on the railway north of the port of Nakhodka mines coal for Vladivostok. Suchan is the most important Soviet Pacific port militarily and economically because of its long ice-free season and natural harbour. It is a large naval centre and has numerous industries, including large cold-storage plants and canneries for marine products, plywood plants and match factories. Northwest of it and part of the southwestern Sikhote-Alin industrial complex are Voroshilov with a beet-sugar plant, Lesozavodsk with a wood-tar factory and Spassk with large cement works. (H. J. Ws.)

SIKHS, a sect of dissenters from Brahmanical Hinduism. It originated in the Punjab, where most of the *Sikha,* "disciples," are still to be found. Although the fetters of Brahmanism have long been firmly riveted on India, attempts to loosen them date back to Buddhism (*see* BUDDHA AND BUDDHISM) and were renewed by many religious and social reformers from whom Sikhism borrowed ideas and even devotional hymns. Such were Jaidev, composer of the *Gita Govind* (translated by Edwin Arnold), who c. A.D. 1100 taught that Yoga (*q.v.*) was worthless in comparison with God's worship in thought, word and deed; Rāmānand, at the close of the 14th century, freed his followers from caste restrictions; a little later Kabir (b. 1398) denounced idolatry and ritualism. Nearly a century later, in 1469, was born Nānak, the first founder of Sikhism, contemporary with Luther. His name means "he who was born at the home of his mother's parents." and it lay at Talwandi, near Lahore. Of a Kshatri family (the Kshatriya had once been formidable spiritual rivals of the Brahmans) a curious, but hardly contemporary, Sikh account of his descent makes him a reincarnation of the king of the Videhas, Janaka the great patron of the Kshatrya *Upanishads*. The tradition may contain a grain of truth. As a young man he must have seen something of Sultan Sikandar Lodi's (1489–1517) measures against Hinduism.

Early **Period.**—Nānak's faith was sternly monotheistic. He taught the worthlessness of religious vestments: of ostentatious prayer and penance, pilgrimages and fanes. He declared that all men had a right to search for knowledge of God, irrespective of caste. He was a quietist, and though we have no authentic biography of him, we may conjecture that his life and doctrines did not expose him to persecution, and we hear nothing of any efforts to suppress his teaching. He was employed by a Muslim, and was married, leaving on his death in 1533 two sons, Sri Chand and Lakhmi Das, both Hindu names. Nānak, however, had designated as his successor in his spiritual mission the Guru-ship, another Kshatri, Lehna, who took the name of Angad. (Angada was a lesser legendary hero of the Epic age.) To Gurii Angad is due the inception of the *Granth* ("book") *Sahib* ("holy"), in which he embodied what he had learnt from Gurii Nānak, adding devotional reflections of his own. To mark the sacred character of the work, he is said to have invented Gurmukhi, the "Guru's tongue," the peculiar script of the Sikhs, by modifications of the Shārada alphabet. Dying in 1552, Angad in turn excluded his sons and designated the Kshatri Amār Dās as his successor. The reforms of this Gurii were important, including the separation of the Udisi order, founded by Ninak's own son Sri Chand, from the laity, denunciation of Sati, and the stressing of Ninak's attitude to caste by making all his Sikhs eat together. He also divided the country covered by his missioners into 22 sees. Dying in 1574, Amir Dās bestowed the Gurii-ship on his servant and son-in-law Jetha, under the name of Rim Dis.

To him is due the foundation of the golden temple built at Amritsar in 1579 on a site granted him by the emperor Akbar, whose policy aimed at welding all the creeds of India into one. Rām Dās taught no new doctrines but is still much revered. He died in 1581.

So far, the Gurus had aimed at continuing the Gurii-ship by designation, not at setting up a hereditary spiritual dynasty. But after Rām Dās the eastern tendency, so marked in Islam, to regard saintship as vested in a saint's physical descendants asserted itself. Still Rām Dās selected his third son, Arjan Dev (*Arjuna* was a legendary, semi-divine hero of the Epics; *Deva* was a title borne by an old Rajput dynasty of Jammii), to follow him as Gurii, though the Sikhs regarded Pirthi Chand as so entitled by right of primogeniture and the latter would probably have made good his claim to inherit the Guru-ship but for his exactions. Arjan was induced to insist on his right, though he had meekly surrendered his father's turban, the symbol of temporal rulership, to Pirthi Chand. He established a rude fiscal system appointing collectors of offerings. Gurii Arjan enlarged the *Granth,* half of which is due to him, and is said to have been arraigned before Akbar for setting up a new divinity, but the eclectic emperor naturally acquitted him. Arjan, however, made a fatal mistake in aiding Prince Khusrū, a rebel against his father Jahāngīr, with a modest sum of money. Possibly this act was dictated by a belief that Khusrū would continue Akbar's tolerant policy, but it may have been a forced loan.

Jahāngīr punished it with a fine of two lakhs of rupees, which Arjan was unable or unwilling to pay and so he was, it is said, tortured to death in 1606. To his son Har Govind, who succeeded him without contest he left a behest to maintain his throne by arms. Gurū Har Govind was installed with turban and necklace only but added an aigrette to the one and for the other substituted a sword-belt. The Guru-ship was now launched on a new adventure — the foundation of a militant sacred dynasty. The Guru founded the first Sikh stronghold, enlisted horse and foot, and encouraged his disciples to eat flesh to improve their physique.

After 12 years' imprisonment in the fortress of Gwalior, Har Govind obtained his freedom, probably by paying the fine imposed on Arjan. This imprisonment must have preceded his military activities. By them he was enabled to resist Shāh Jahān (1627–66) and claimed three victories over the imperial troops. But he died in 1645 in a remote valley of the lower Himalayas at Kiratpur on the upper Sutlej, which indicates that he had found it safer than Amritsar. Shāh Jahān, who had destroyed many Hindu temples, appears to have taken no special measures against the Sikhs. Har Govind's grandson, Har Rai, who succeeded him, was undoubtedly a supporter of the unfortunate Dārā Shikoh, who had the *Upanishads* partly done into Persian and professed mystical Siifi heresies. On that prince's execution in 1659 Har Rei was summoned to Delhi but sent his elder son Rām Rai instead, and on his death two years later Ram Rai was excluded from succeeding him as being a hostage or prisoner, his younger brother Har Kishen assuming the Guru-ship, though still a child. His death in 1664 left the direct line extinct and the inheritance reverted to Teg Bahādur, Har Govind's second son, but he was executed by Aurangzeb in 1675 for having refused to accept Islam. His prophecy that Europeans were coming from beyond the seas to destroy the Moghul empire became the Sikh battle-cry at the siege of Delhi in 1857.

Middle Period. — The tenth and last Guru was his son, Govind Rai, who took the affix *Singh,* "lion," in lieu of Rai and remodelled the Sikh organization which he renamed Khalsa, "pure." He made the Sikh initiation (*pahul*) a rite of admittance into a militant order. In that rite, with a two-edged dagger (*khanda*) sugar is stirred up in water, which the novice drinks and with which he is lustrated five times. He then utters the Sikh war-cry vowing adherence to the Sikhs' tenets. Thenceforth he must wear the five k's, the kes, unshorn hair, the kachh, drawers reaching only to the knee, the kara, iron bangle, the kirpan, sword (or khanda, small dagger) and khanga or hair comb. Of these the first four have soldierly uses, the long hair rolled round steel rings serving as a helmet and so on. But they have also a spiritual meaning, *e.g.,* the kachh symbolizing self restraint, the bangle obedience, and the comb purity of mind. The use of flesh and liquor is permitted as to a warrior, but tobacco as a narcotic is prohibited. Govind Singh also instituted the *karā parshād,* a kind of communion at which flour mixed with butter and sugar is eaten by all castes together.

Govind Singh waged an active defensive against the Moghul power but his levies were dispersed and his two sons put to death by the governor of Sirhind. On Aurangzeb's death, however, he aided Bahādur Shad, but in 1708 he was assassinated at Nander in the Deccan. Sonless and mistrustful of Banda Bairāgi, who claimed to be the eleventh Guru, Govind Singh declared the line of Guriis extinct and the Guru-ship vested in the Granth Sahib as God's representative on earth. Sikhism was thenceforth to be a militant theocracy, but it soon formed a mass of military bands under Sirdārs ("chiefs"). The earlier military organization of the Sikhs is obscure. Banda seems to have formed an almost regular army, but after gaining notable successes against the Moghuls, sacking Sirhind and compelling the allegiance of the Hindu hill-rajas who had generally refused to submit to the Gurus, he had to cede Amritsar to the true Singhs, the Tat Khālsa, elect of the elect, and was finally executed in 1716. His death left the Sikhs leaderless, but they were strong enough to extort grants of land from Farrukhsiar and formed two armies, a veteran and a younger. The latter comprised five companies, including the militant order of *shahīds,* which carried its forays in Rājpūtāna. On the Punjab, thus distracted, fell Nādir Shāh's invasion of 1738–39. Its last great Moghul governor, Adina Beg, recovered part of the province, but on his death in 1758 the Sikhs mastered the central and north-east Punjab. They now appear as better organized. Besides the Shahids, three new orders were formed with eight misls or confederacies. Under Jassa Singh (elected head of the Ahluwālia *misl; bādshā* ["monarch"], to his own followers, and by caste a potter on the earlier Sikh coins) there materialized as it were a cabinet of *gurūs,* the *gurū* matta "sacred council," convened by the Akalis or the *granthis* about 1762 at Amritsar. South of the Sutlej the reversion to kingship was accelerated when Ala Singh of Patiāla leased the province of Sirhind from Ahmad Shāh with the title of king (rājā) of kings, and the lessor's retreat from the Punjab left the Sikhs its masters from the Jamna to the Indus in 1767. But in 1808 Ranjit Singh suppressed the confederacy which bore the standard of the Khalsa; and the dissensions of the other *misls* enabled him, then merely the chief of the territorial confederacy, to absorb the rest, conquer Kashmir and Peshāwar, subdue the hill states and set up a hereditary monarchy, though he still minted Sikh coins and upheld Sikhism as the state religion. But he appointed Mohammedan *qāzīs* and muftis ("judges and law-officers"), and protected Muslim states like Maler Kotla and many institutions of that creed, which had befriended Sikhs from time to time.

Later Period.—The history of Sikhism in the 19th century belongs rather to the history of the Punjab (see INDIA, History), but the Sikh sub-sects and orders were mostly maintained. The differences with Hinduism tended, however, to be suppressed. Thus the Akalis lost ground, though the Kiikas remained staunch to their extremist tenets, with diminished numbers. Sects like the Sanwal-Shāhis, followers of a disciple of Guru Nānak, are all but confined to the south-west Punjab, while the Sewapanthis are still more restricted to the Sindh Sāgar Doāb. The Hindālīs forfeited their once influential position by throwing in their lot with Ahmad Shāh Abdali and are now known as Narinjani or worshippers of the Bright One (God). The Nirankāris, a modern sect, revived Nānak's teaching though they respect later Guriis also. The older orders became Sikh castes, like the Rāmgarhias, whose founder was a carpenter and which is now the Sikh carpenter caste; as the Sikh Kallāls or Nebs (potters) style themselves Ahluwālia. Every confederacy worked out its own destiny, tending to form hereditary chiefships and divide the villages it had occupied among its members as if they were private lands. To a certain extent the mutiny revived Sikhism by stimulating anti-Muslim feeling, and this recrudescence probably saved it from becoming a mere collection of more or less Hinduized sects in which the Nānak-panthis would have absorbed the Khālsa or sect of Gurii Govind Singh. But the revival was militarist rather than religious. The sectarian institutions decayed. Little was added to religious literature. In a sense the Granth became the Guru, receiving divine honours, for example at Conjeeveram, in the south, where it became the object of a fire sacrifice. The book of common prayer was the Panjgranthi, including five poems from the Granth, three of which have to be recited daily by the Khalsa Sikhs; yet Sikh ascetics used to make pilgrimages to Hindu temples. The Khalsa college at Amritsar was, however, founded, and there too the chief Khālsa Dīwān had his headquarters. It made grants to various schools, including some 30 for girls. Local societies, Singh Sabha, were established throughout the Punjab and even beyond it.

There was very little innovation in the religious sphere, but Sikhism was still alive awaiting a stimulus to arouse its latent power. This came to it from education, the general awakening of India, and the mal-administration of the sectarian shrines and temples.

Laity.—When Sikhism revived, all its divisions were equally resuscitated. A notable example of this was furnished by the Kiikas ("shouters"), who professed to be ethically strict followers of Govind Singh but observed such secrecy that they were debited with the degrading practices so often ascribed to such sects. The Kūka insignia, a high straight turban and a knotted necklace or rosary of wool, hint at an originally military asceticism and possibly at some connection with Banda Bairāgi, but their significance has never been disclosed. Supposed to be hostile to British rule, the Kiikas were certainly anti-Muslim, especially resenting the slaughter of kine, carefully planning the assassination of Mohammedan butchers and once organizing, in 1872, an armed rising which took the shape of a raid into the Muslim state of Maler Kotla. Owing to the drastic action of the district officer of Ludhiāna who executed over 100 mutineers by artillery the rising speedily collapsed, but severe as was the method of its suppression, it had undoubtedly excited the Sikh population and a less decisive one might in the end have resulted in more bloodshed. On the other hand the fanatical Akalis only revived as a body of harmless eccentrics practising their rites at Sikh gatherings, and not taken seriously by any other Sikh body. The Udāsi order became hardly distinguishable from a Hindu religious sect and was even regarded as Vaishnava.

The Nirmalas were not quite re-Hinduized but the general tendency of the Sikh laity was towards emergence into Brahmanism. Only the more ardent followers of Govind Singh preserved their distinctive tenets, dress, and protestant, anti-Brahmanical attitude. Thus ended the first phase of the Sikh revival. The second phase was greatly fostered if not initiated by the formstion of the Imperial Service troops. The Sikh recruits in the Phulkian states, south of the Sutlej, had often neglected to take the *pahul.* They were encouraged to do so by their British inspecting officers, and the military spirit of Sikhism was enhanced. With its revival came an awakened interest in other things. The Sikhs, even the stricter elements, had acquiesced in the decay of their religious institutions. In 1863 the British Government had by statute divested itself of all administrative control over religious endowments, but had provided no machinery to assume its functions. The SIKH orders had no written constitutions. Such an order as the Udāsi was in theory celibate. It proceeded to permit its members to marry, to found families of great respectability and influence, who were accepted as owners of the religious shrines and wealthy refectories, and administered them as private properties—on the Brahmanical model. But Brahmanism allows no lay interference with Brahman property.

Orders.—The humbler village fanes were equally appropriated by their incumbents, who naturally favoured the fatal principle **of** hereditary rights in them. The Kūka headship became a kind of dynasty. The Akalis alone retained celibacy, but even the Nirmalas failed to enforce it rigidly. But celibate or not, no order evolved any definite system of selecting its heads. The powers of the abbots, of the chapter and of the congregation were undefined. If, then, the glebe was alienated by a dissolute incumbent, or endowments mis-spent by incompetent abbots, the sole remedy for the laity was a suit in the courts, which begged the whole question of the layman's right to ask for relief by treating the priestly rights in the shrine as a matter of custom—of custom recently created by priestly malfeasance. Ignoring the fundamental doctrines of Sikhism in general and of its orders in particular, the courts proceeded to give legal recognition to the vested interests of the carnal heirs of spiritual offices in their benefices. This led to grave unrest among the Sikhs. Even the administration of the Khālsa college, founded under British auspices, had to be remodelled. The golden temple at Amritsar, being a purely religious foundation, was, however, beyond Government control. Internal dissensions made its problems difficult of solution. Its governing body had long been divided, one party permitting its walls to be adorned with Hindu mythological pictures, another condemning them as incompatible with Sikh monotheism. The Sikhs at a mass meeting accepted a provisional council, only in part nominated by Government, to draw up a scheme of management. But it failed to function. In 1920 the Mahātma Gandhi intervened, suggesting the appointment of the Shiromani Gurūdwāra Parbandhak committee for the management of shrines in general. This body proceeded at once to the high-handed seizure of places of worship, including the golden temple itself. It also reorganized the Akālis, recruiting them with lawless *jathas,* gangs of turbulent elements not all furnished by the Sikhs. It called on the Udāsi *mahant* or "abbot" of Gurū Nānak's birthplace, Nānkāna, to reform his institution. In defence of his property the Gurū enlisted Muslim mercenaries and so exacerbated Sikh feeling. A body of 130 Sikhs seized the sanctuary but were massacred to a man. Equally lawless seizures of shrines ensued. At Gurū kā Bāgh, the "Gurū's Garden," the Akālis captured the Gurūdwāra or fane of the Gurū, but the *mahant* held its house and lands. The committee took steps to seize some of the latter as appurtenant to the shrine, but the law was here successfully vindicated and no fewer than 5,000 Akalis arrested. In reprisal, the Akali order threw off a new and more militant offshoot in the Babbar ("lion") Akālis dedicated to the murder of village officials and others loyal to Government but in their isolation beyond its effectual protection. The tract between the Sutlej and Biās rivers was terrorized by Akāli and other lawless gangs, marked men being openly assassinated and property indiscriminately plundered Soldiery alone secured a semblance of order. Yet in 1923, when communal riots between Hindus and Muslims broke out at Amritsar the Akālis aided authority to maintain order. In 1924, however, the shrines committee espoused the cause of the misguided Maháràja of Nābha, who abdicated after levying private war on the sister Sikh state of Patiāla, and at Jaitoke a meeting of the new ruler's opponents had to be dispersed. The Akālis came to the rising, but their peaceful purpose was merely the perpetual recitation of the *Granth* for the restoration of the ex-Raja. Unfortunately they were reinforced by a huge mob which attacked the State forces. It was beaten off with a loss of 50 men, including 21 killed and only three or four Akālis fell. In 1925 the Sikh Gurūdwāra and Shrines bill became law. It set up legal machinery for the control of Sikh endowments, and if it is alleged to be unjust to the Sikh orders, it must be pleaded that the failure of those orders, even of the Udāsis, to organize their own self-discipline and protect the rights of the Sikh congregations made it a necessity The disruptions in the Udāsi order made it impossible to give legal embodiment to it or to anyone of its branches

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SIKH WARS, two Indian campaigns fought between the Sikhs and the British, which resulted in the conquest and annexation of the Punjab (see Punjab).

FIRST SIKH WAR (1845–46)

The first Sikh War, or Sutlej campaign, was brought about by the insubordination of the Sikh army, which after the death of Ranjit Singh became uncontrollable and on Dec. 11, 1845, crossed the Sutlej, and virtually declared war upon the British. The British authorities had foreseen the outbreak, and had massed sufficient troops at Ferozepore, Ludhiana and Umballa to protect the frontier, but not to offer provocation. So complete were the preparations for advance that on the 12th, the day after the Sikhs crossed the Sutlej, Sir Hugh Gough, the commander-in-chief, marched 16m. with the Umballa force to Rajpura; on the 13th the governor-general, Sir Henry Hardinge, declared war, and by the 18th the whole army had marched 150m. to Moodkee, in order to protect Ferozepore from the Sikh attack. The Sikh army is referred to for brevity as "the Sikhs," but it was composed of Sikhs, Punjabi Muslims and Hindus, as are the present Sikh regiments of the Indian army. Gurkha, Hindostani and Afghan mercenaries were also found in the ranks.

Wearied with their long march, the British troops were enjoying a rest, when the news came in that the Sikhs were advancing to battle at four o'clock in the afternoon. The British had some 10,000 men, and the Sikhs are estimated by some authorities as low as 10,000 infantry with 2,000 cavalry and 22 guns. The battle opened with an artillery duel, in which the British guns, though inferior in weight, soon silenced the enemy, the 3rd Light Dragoons delivered a brilliant charge, and the infantry drove the enemy from position after position with great slaughter and the loss of seventeen guns. The victory was complete, but the fall of night prevented it from being followed up, and caused some of the native regiments to fire into each other in the confusion.

Ferozeshah.—After the battle of Moodkee Hardinge volunteered to serve as second in command under Gough, a step which caused some confusion in the ensuing battle. At 4 A M. on Dec. 21 the British advanced from Moodkee to attack the Sikh entrenched camp under the command of Lal Singh at Ferozeshah, orders having been sent to Sir John Littler, in command at Ferozepore, to join the main British force. At 11 A.M. the British were in front of the Sikh position, but Littler though on his way had not yet arrived. Gough wished to attack while there was plenty of daylight; but Hardinge re-asserted his civil authority as governor-general, and forbade the attack until the junction with Littler was effected. The army then marched on to meet Littler and the battle did not begin until between 3.30 and 4 P.M. The engagement opened with an artillery duel, in which the British failed to gain the mastery over the Sikhs, owing to the light weight of the British ordnance. The infantry, therefore, advanced to the attack; but the Sikh muskets were as good as the British, and fighting behind entrenchments they were a most formidable foe. Littler's attack was repulsed, the 62nd Regiment losing heavily in officers and men, while the sepoys failed to support the European regiments. But the Moodkee force, undaunted, stormed and captured the entrenchment. though the different brigades and regiments lost position and became mixed up together in the darkness. The army then passed the night on the Sikh position, while the Sikhs prowled round keeping up an incessant fire. In the morning the British found that they had captured seventy-three pieces of cannon and were masters of the whole field; but at that moment a fresh Sikh army, under Tej Singh, came up to the assistance of the scattered forces of Lal Singh. The British were exhausted with their sleepless night, the native troops were shaken, and a determined attack by this fresh army might have won the day; but Tej Singh, after a half-hearted attack, uhich was repulsed, marched away, whether from cowardice, incapacity or treason. and left the British masters of the position.

Aliwal.—After the battle of Ferozeshah the Sikhs retired behind the Sutlej, but early in January they again raided across the river near Ludhiana, and Sir Harry Smith was detached to protect that city. On Jan. 21 he was approaching Ludhiana when he found the Sikhs under Runjoor Singh in an entrenched position flanking his line of march at Budhowal. He passed on without fighting a general action, but suffered considerable loss in men and baggage. After receiving reinforcements Sir Harry again advanced from Ludhiana and attacked the Sikhs at Aliwal on Jan. 28. An attack upon the Sikh left near the village of Aliwal gave him the key of the position, and a brilliant charge by the 16th Lancers, which broke the Sikh square, completed their demoralization. The Sikhs fled in confusion, losing sixty-seven guns, and by this battle were expelled from the south side of the Sutlej.

Sobraon. — Ever since Ferozeshah Gough had been waiting to receive reinforcements, and on Feb. 7, his siege train arrived, while on the follo ing day Sir Harry Smith's force returned to camp. On Feb. 10 Gough attacked the Sikhs, who occupied a strong entrenched position in a bend of the Sutlej. After two hours cannonading, the infantry attack commenced at 9 A.M. The advance of the first brigade was not immediately successful but the second brigade following on carried the entrenchments. The cavalry then charged down the Sikh lines from right to left and completed the victory. The Sikhs, with the river behind them, suffered terrible carnage, and are computed to have lost 10,000 men and 67 guns. The British losses throughout the campaign were considerably heavier than was usual in Indian warfare; but this was partly due to the fact that the Sikhs were the best natural fighters in India, and partly to the lack of energy of the Hindostani sepoys. After the battle of Sobraon the British advanced to Lahore, where the treaty of Lahore was signed on March 11.

SECOND SIKH WAR—PUNJAB CAMPAIGN 1848–49

For two years after the battle of Sobraon the Punjab remained a British protectorate, with Sir Henry Lawrence as resident; but the Sikhs were unconvinced of their military inferiority, the Rani Jindan and her ministers were constantly intriguing to recover their power, and a further trial of strength was inevitable. The outbreak came at Multan, where on April 20, 1848, the troops of the Dewan Mulraj broke out and attacked two British officers, Mr. Vans Agnew and Lieutenant Anderson, eventually murdering them. On hearing of the incident, Lieut. Herbert Edwardes, who was Lawrence's assistant in the Derajat, advanced upon Multan with a force of levies drawn from the Pathan tribes of the frontier; but he was not strong enough to do more than keep the enemy in check until Multan was invested by a Bombay column under General Whish. In the meantime Edwardes wished for an immediate British advance upon Multan; but Lord Gough, as he had now become, decided on a cold season campaign, on the ground that, if the Sikh government at Lahore joined in the rising, the British would require all their available strength to suppress it. Multan was invested on Aug. 18 by Whish in conjunction with the Sikh general Shere Singh; but during the course of the siege Shere Singh deserted and joined the rebels, thus turning the rising into a national war. The siege of Multan was temporarily abandoned, but was resumed in November, when Gough's main advance had begun. and Mulraj surrendered on Jan. 22. In the meantime Gough had collected his army and stores, and on Nov. 9, crossed the Sutlej.

Chillianwalla.—On Nov. 22 there was a cavalry skirmish at Ramnagar, in which General Cureton and Colonel Havelock were killed. For a month after this Gough remained inactive, waiting to be reinforced by Whish from Multan; but at last he decided to advance without Whish, and fought the battle of Chillianwalla on Jan. 13, 1849. Gough had intended to encamp for the night; but the Sikh guns openipg fire revealed the fact that their army had advanced out of its intrenchments, and Gough decided to seize the opportunity and attack at once. An hour's artillery duel showed that the Sikhs had the advantage both in position and guns, and the infantry advance commenced at three o'clock in the afternoon. The battle resulted in great loss to the European regiments, the 24th losing all its officers in a few minutes, while the total loss in killed and wounded amounted to 2,338; but when darkness fell the British were in possession of the whole of the Sikh line. Gough subsequently retired to the village of Chillianwalla, and the Sikhs returned and carried off their guns. After the battle Gough received an ovation from his troops, but his losses were thought excessive by the public in England and the directors of the East India Company, and Sir Charles Napier was appointed to supersede him. Before, however, the latter had time to reach India, the crowning victory of Gujrat had been fought and won.

Gujrat.—After the fall of Multan Whish marched to join Gough, and the junction of the two armies was effected on Feb. 18. In the meantime the Sikhs had withdrawn from their strong intrenchments at Russool, owing to want of provisions, and marched to Gujrat, which Gough considered a favourable position for attacking them. By a series of short marches he prepared the way for his "last and best battle." In this engagement, for the first time in either of the Sikh wars, the British had the superiority in artillery, in addition to a picked force of 24,000 men. The battle began on the morning of Feb. 21 with two and a half hours' artillery fire, which was overwhelmingly in favour of the British. At 11.30 A.M. Gough ordered a general advance covered by the artillery; and an hour and a half later the British were in possession of the town of Gujrat, of the Sikh camp and of the enemy's artillery and baggage, and the cavalry were in full pursuit on both flanks. In this battle the British only lost 96 killed and 700 wounded, while the Sikh loss was enormous, in addition to 67 guns. This decisive victory ended the war. On March 12, the Sikh leaders surrendered at discretion, and the Punjab was annexed to British India.

See Sir Charles Gough and A. D. Innes, *The Sikhs and the Sikh Wars* (1897); R. S. Rait, *Life and Campaigns of Viscount Gough* (1903).

SI KIANG: see HSI CHIANG.

SIKKIM, a princely state in the eastern Himalayas; a protectorate of India. Area 2.744 sq.mi. Capital. Gangtok. The country consists of part of the main chain of the Himalayas and of ranges projecting southward and gradually lessening in height.

On the west the Singalila range divides Sikkim from Nepal, the chief pass into which is Chiya Banjyany La (10.807 ft.). On the east the Chola range forms the boundary with Tibet. the chief passes being the Natu La (14.140 ft.) and Jelep La (14,890 ft.). Between these ranges the country is split up into mountain ridges and a succession of deep valleys, which in the south are only 1,000 ft. above sea level. The highest peaks are Kanchenjunga (28,168 ft.), Siniolchu or D2 (22,597 ft.), Kinchinjhau (22,700 ft.) and Chomo Yummo (22,403 ft.). The line of perpetual snow lies at about 17.000 ft. Between 12.000 and 15,000 ft. there are occasion~plateaus, with some small lakes, *e.g.*, at Changur, to which cattle are driven for grazing in the summer. Forests cover the mountain slopes from 9.000 to 12.000 ft. From 6.500 to 4,500 ft. the slopes have been brought under cultivation, crops of maize. millets and pulses being raised. At lower levels the slopes are terraced and rice is grown wherever irrigation is possible. Woolen cloth and cardamoms, oranges and apples are also produced, some fruit gardens being state maintained. The chief river is the Tista. which is formed by the confluence of the Lachen and Lachung in the north of Sikkim. The valleys drained by these two affluents are broader and more open than those in the south into which the steep sides of the mountains descend abruptly, forming narrow gorges.

Every variety of climate and vegetation, subtropical. temperate and arctic, is encountered. The rainfall is heavy, as the mountains are exposed to the moisture-laden monsoon winds blowing up from the Bay of Bengal, and averages 137 in. a year at Gangtok. The flora is exuberant and includes many species of rhododendron. Butterflies abound. Among mammals, the most interesting are the snow leopard, the cat-bear, the musk deer and two species of goat antelope.

The population numbers 137.725 (1951), of whom the majority are Nepalese. The other races are chiefly Bhotias of Tibetan extraction and Lepchas. The Lepchas, whose own name for themselves is Rongpa, *i.e.*, the people of the valleys or ravines, are believed to be the earliest inhabitants of Sikkim and to be of Indo-chinese origin. A peaceful simple people, they have been replaced at higher altitudes by the more industrious and pushing Nepalese, a hardy race of cultivators.

The Bhotias are mainly graziers, who make their homes at higher elevations.

Buddhism, the state religion, is professed by one-third of the inhabitants, chiefly the Bhotias and Lepchas, for most of the Nepalese are Hindus. There are a number of Buddhist monasteries picturesquely placed on the summits and shoulders of the hills. of which the most important is at Pemionchi. The Buddhism prevalent is oi the lamaistic type found in Tibet. There are no close clusters of houses that can be dignified with the name of village except around a few market places and in the Lachen and Lachung valleys.

History.—The ruling family is Tibetan and claims descent from one of the *gyalpos* or princelings of eastern Tibet. Their ancestors found their way to Lhasa and, in 1641, overcame the Lepcha chiefs of Sikkim. One of them established liis government and introduced Buddhist lamaism as a state religion. Till the end cf the 18th century Sikkim was practically a dependency of Tibet where its ruler was designated governor of Sikkim.

British relations with Sikkim began in 1816. when the Tarai or submontane portion of Sikkim {now in Darjeeling district), which had been occupied by the Nepalese, was restored to the raja by the treaty concluded at the end of the Nepalese War. In 1839 the site of Darjeeling was ceded to the British for use as a sanatorium. In 1849 the British resumed the whole of the Tarai and the outer hills, as punishment for repeated insults and injuries culminating in the imprisonment of Archihald Campbell, superintendent of Darjeeling, and Sir Joseph Hooker, when travelling in Sikkim. In 1861 a British force was required to impose a treaty defining good relations. The maharaja, however, refused to carry out his obligations and persisted in living in Tibet; his administration was neglected. his subjects oppressed and a force of Tibetan soldiers was allowed, and even encouraged. to build a fort in Sikkim territory. The government was forced in 1888 to send an expedition, which drove the Tibetans back over the Jelep pass. A convention was concluded with China in 1890, whereby the British protectorate over Sikkim was acknowledged and the boundary of the state defined; to this was added a supplemental agreement relating to trade and domestic matters, which was signed in 1893. A British political officer was appointed to assist the maharaja with a durbar or council composed of the chief civil officers and lamas. The maharaja refused to co-operate and tried to flee to Tibet through Nepal, where he mas stopped by the Nepalese and given over to the British. He then resided as a state prisoner near Kurseong in Darjeeling district and died in 1914 being succeeded by Tashi Namgyal.

When India attained independence in Aug. 1947 British paramountcy over Sikkim lapsed and under a standstill agreement the new dominion assumed control of the state's external affairs, communications and defense. In 1949 Maharaja Tashi Namgyal had to ask Indian help in restoring order: Indian troops were sent to Gangtok and an Indian civil servant was nominated as dewan or chief minister. A treaty of Dec. 5, 1950, formally provided for the protection of Sikkim by the Republic of India. In 1953 a state council of five elected and four nominated members was set up: two of the elected members assist the maharaja in the day-to-day administration of the state.

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SIKORSKY, IGOR IVAN (1889–), pioneer airplane designer and manufacturer. He was born in Kiev, Russia, May 25, 1889, and educated in Kiev, Petrograd and Paris. At an early age he turned his attention to aeronautics and in France and Germany studied the work of Blériot and Zeppelin (*qq.v.*). In 1909 he designed and built his first flying machine, a helicopter, but it was not successful and he turned to conventional fixed-wing airplanes. By 1911 he had produced five successful machines and become an accomplished pilot.

During the period 1913–17 Sikorsky designed. built and flew planes that were remarkable for their size and flying range. They were powered by four engines and were the precursors of the modern airiiners and large bombers.

In 1919 Sikorsky moved to the United States and became a citizen in 1928. He established an aircraft firm on Long Island that later became a division of United Aircraft corporation. His organization turned out a long series of land planes, seaplanes and amphibians that were used by the military services and commercial airlines.

In 1939, Sikorsky returned to his original interest in the helicopter, and produced the first successful direct-lift machine in the United States. He continued active development of this type until his retirement from United Aircraft corporation in May 1957. (S. P. J.)

SILAGE: *see* Ensilage.

SILAS, SAINT (*fl.* A.D. 50), early Christian prophet and missionary, was the companion of St. Paul (*q.v.*) on the second journey, when he took the place formerly held by Barnabas. The tour included southern Galatia, Troas, Philippi (where he was imprisoned). Thessalonike (Salonika) and Beroea. where Silas was left with Timothy, though he afterward rejoined Paul at Corinth.

He is in all probability the Silvanus (the abbreviation is similar to that of Prisca for Priscilla and Sopater for Sosipater) who is associated with Paul in the letters to the Thessalonians, mentioned again in II Cor. i. 19, and the bearer and amanuensis of I Peter (v, 12). It is possible, indeed. that he has an even closer connection with this letter, and some scholars are inclined to give him a prominent place among the writers of the New Testament. He was of Jewish birth and probably also a Roman citizen. St. Silas' feast day is July 13 in the west, July 30 in the east.

SILAY, a municipality of the province of Negros Occidental, Island of Negros, Philippine Islands, on the northwest coast, about 10 mi N. of Bacolod, the provincial capital. Pop. (1959 est.) 43,575.

SILCHESTER, a parish and village in Hampshire, England. 10 mi. S.W. of Reading. The parish contains the site of the Romano-British town of Calleva Atrebatum, excavated in 1864–78, 1890–1909, and 1938–39 (results published in *drchaeologia).* Soon after the Roman conquest Calleva became the cantonal capital of the Atrebates and the centre of a road system. The outer earthworks enclosed 230 ac.. the inner (about A.D. 160–170) 100 ac. The street plan divided Calleva into 37 *insulae* and there were a forum, basilica. public baths. several temples, a Christian church and an amphitheatre. (*See* Britain: *Roman.*) The main collection of antiquities from the site is in the Reading museum; the Calleva museum (opened 1951) illustrates the town's life. Pop. (1951) 421.

See G C Boon, *A New Guide to the Roman City Calleva Atrebatum at Silchester, Hampshire* (Reading, 1932).

SILENT TRADE: *see* Trade, Primitive.

SILENUS, in mythology, the son of Hermes (or Pan) and a nymph. The companion and nurse of Dionysus, he often appeared in art and in satyr plays in the god's train. He now and then emerged into cult, and a story. variously located in Asia Minor or Macedonia, showed King Midas as catching one (there were presumably many Silenuses, Silenoi, old satyrs) by making him drunk, and as being instructed by him on the woes of human life.

In art he generally appears as a little pot-bellied old man, with a snub nose and a bald head, riding on an ass and supported by satyrs; or he is depicted lying asleep on his mineskin, which he sometimes bestrides.

A more dignified type is the Vatican statue of Silenus carrying the infant Dionysus, and the marble group from the Villa Borghese in the Louvre.

SILESIA (Polish Slask, Czech Slezsko, German Schlesien). a region of central Europe, formerly a province of southwestern Poland.

The First Polish Period.—The name Silesia is derived according to German historians from that of the Silingae, a Vandal tribe; but this people migrated westward in the 3rd century, and by the 10th century the population of the country seems to have been exclusively Slavonic. The ownership of Silesia appears to have been disputed from early times between Poles and Czechs. In A.D. 1000 it was definitively attached ecclesiastically to Poland when a bishopric was founded in Wroclaw (Breslau) and attached to the Polish metropolitan see of Gniezno. The Bohemian dukes continued to claim political overlordship, but in 1054 the emperor Henry III, who had been called in to arbitrate, awarded the area to the Polish duke for payment by him to the Bohemians of an annual tribute.

King Boleslaw III of Poland established in his dominions the *senioratzcs* system under which every male member of the house of Piast received a portion of Polish territory. On his death in 1138 his eldest son, Wladyslaw, inherited Silesia with the *senioratus,* but was evicted from both by a younger brother. The emperor Frederick I restored Silesia to Wladyslaw's sons. It was then partitioned into the two duchies of Silesia (Slansco or Zlesia, later known as Lower, or northwestern Silesia) and Opole (Upper, or southeastern, Silesia), and as the Silesian Piasts proved extremely prolific, these were subdivided again in the course of following generations, until by the end of the 14th century there were no less than 18 Silesian principalities: Breslau (Wroclaw), Brieg (Brzeg). Glogau (Glogow), Jauer (Jawor), Liegnitz (Legnica), Miinsterberg (Ziembice), Oels (Olesnica), Schweidnitz (Swidnica) and Steinau (Scinawa) in Lower Silesia. and Beuthen (Bytom), Falkenberg (Niemodlin), Kosel (Kozle), Neisse (Nysa), Oppeln (Opole). Ratibor (Raciborz), Gross Strehlitz (Strzelce). Teschen (Cieszyn or Tesin) and Troppau (Opava) in Upper Silesia. All of these acknowledged a certain unity which was expressed in periodical meetings of the ruling princes, under the presidency of the senior Piast of the Silesian line.

In the meantime the ethnic composition of the population had been modified by the arrival of German settlers. The first of these coming from Flanders, arrived before the end of the 12th century, perhaps on the invitation of the Cistercian monks who played a large part in the development of the area. At the beginning of the 13th century, Henry the Bearded, duke of Silesia, colonized his principality extensively and systematically: he divided it into areas, in each of which he established a central town which he surrounded with a ring of villages with German settlers, mostly brought from western Germany. After the devastation of the country by the Tatar invasion of 1241, which although first checked at the battle of Liegnitz in Silesia, undid much of the early work, Henry's successors and his cousins resumed the work on the same system. Breslau was refounded as a German town, with Magdeburg law, and many other towns, similarly privileged, grew up. Even the countryside of Lower Silesia was then largely German. Forests were cleared, swamps drained and the land brought under cultivation. Both the mining and the weaving industries were developed and Breslau, which became a member of the Hanseatic league, and other towns became important trading centres, doing a large entrepdt trade between eastern and western Europe.

The Bohemian Period. — The petty Silesian princes often sought the help of the powerful kings of Bohemia against their own brothers and cousins, thus enabling those monarchs to revive their old claims to overlordship. In 1335 an arbitral award rendered by Charles Robert of Hungary assigned all Silesia to the Bohemian crown in return for the renunciation by the Bohemian king of his further claims to the Polish crown; this settlement was reaffirmed in 1338, 1356 and 1372. The change was, however, only one of overlordship; since the Piast princes remained hereditary rulers of their own principalities so long as their lines survived: only on the extinction of any line could the king of Bohemia take possession of the principality and assign it to a new *Landesfürst*. Although Bohemia was part of the empire, the Piast princes were left the status of *principes Poloniae.* (The Silesian princes became princes of the empire only under the emperor Rudolph II.)

Silesia belonged to the lands of the Bohemian crown, but not to Bohemia. On various occasions on which the will of its estates had to be consulted (chiefly on questions of succession) Silesia took a line different from Bohemia, although in practice usually identical with that of Moravia. In the Hussite disputes Silesia took the side of the emperor Sigismund against the Bohemian Hussites, whose aspirations it regarded as dangerous to the German national cause. It was in consequence heavily ravaged in the Hussite Wars of 1425–35, the German element suffering severely. Feeling in the country itself was divided, and when George of Podebrad ascended the throne of Bohemia in 1457, most of the Silesian princes recognized his suzerainty. The towns, however, led by Breslau, resisted, and because of this, the Hungarian king, Matthias Corvinus, was able to rule Silesia (with Moravia) from 1469 to 1490. Matthias introduced many reforms in Silesia, as in the rest of his dominions, establishing, *inter* nlia a regular diet, composed of representatives of the estates under the presidency of the prince-bishop of Breslau. On his death, Silesia reverted to the Bohemian crown, from whose weak holder, Vladislav, the estates exacted concessions which made them virtually independent.

The Habsburg **Period.**—On Dec. 5, 1526, the Silesian estates accepted without demur the succession of Ferdinand of Habsburg although the surviving Piast princes claimed that this could not affect their own rights, and one of them, Prince Ferdinand II of Liegnitz, concluded a *pactum mutuae successionis* of his own with the elector Joachim II of Brandenburg (1537). This had no immediate practical effect, and Silesia remained entirely under the Habsburgs, who progressively reduced its internal liberties, while tending to emphasize its independence of Bohemia.

The Reformation turned Silesia almost entirely Protestant, and consequently on the outbreak of the Thirty Years' War in 1618, it joined with Bohemia in its struggle against the Habsburgs. Like Bohemia, it suffered cruelly in the course of the long war, being repeatedly overrun by contending armies and plundered by lawless mercenary bands. Trade and industry were brought to a standstill and a high proportion of the population either lost their lives or emigrated. Even the physical damage was, houever, somewhat less severe than in Bohemia, and as a result of the intervention of Saxony, the Habsburgs were forced to renounce the complete enforcement of the Counter-Reformation in it. The peace of Westphalia (1648) provided that freedom of religion should prevail in parts of Silesia, and three Protestant churches were left to the population. At the peace of Altranstadt (1707) Charles XII of Sweden then forced Joseph I of Austria to restore to the Protestants 128 churches, with permission to build more. Silesia was again the most Protestant part of the emperor's Austrian dominions. Meanwhile it had been making an economic recovery which for some time was very slow: but the Austrian mercantilist reformers of the late 17th and early 18th centuries made the development of its mining and textile industries the cornerstone of their plans, and before long Silesia counted as the richest of all the Austrian provinces, while Breslau was now one of the largest and richest cities of the empire.

The Prussian Period. — It was chiefly its wealth that tempted Frederick II of Prussia to wrest it from Maria Theresa on her succession in 1740; his excuse was the old treaty of 1537, although his own great-grandfather had in 1686 renounced his claims under that treaty in return for the cession of the district of Swiebodzina (Schwiebus).

The wealth of Silesia caused Maria Theresa to resent and resist Frederick's aggression most bitterly: any concession, she declared, even the loss of the Netherlands, rather than cede one inch of Silesia. Under the treaty of Berlin of July 28, 1742, she was necertheless obliged to cede to Frederick all of Lower Silesia and Upper Silesia except the districts of Teschen, Troppau (Opava) and Jagerndorf (Krnov), and after the second Silesian War (1744–45) and the Seven Years' War (1756–63) had alike failed to reverse the decision of 1742, she reluctantly acquiesced in it The remnant of Austrian Silesia was united with Moravia until 1849, when it was made a separate crownland. Its history was purely provincial. Largely German as its wealthier classes were, they tended to take the anti-Czech side in politics. The Teschen area developed into one of the most important mining and industrial districts of the Austrian monarchy.

While Frederick's action in seizing the rest of Silesia had lacked any shadow of legal or moral justification, it had not been at all unwelcome to the German and Protestant Silesians, and it brought them many benefits. Frederick devoted much attention to his new acquisition, which was at first placed under a special *Landesminister.* The old estates were abolished, but a more efficient administration was introduced. Great attention was paid to the economic development. In 1807 the county of Glatz (Kladsko) was added to it, and the whole formally incorporated in Prussia as the Duchy of Silesia. In 181j this was further enlarged by the incorporation of Saxon Lusatia.

With the increasing importance of coal, in which Upper Silesia proved very rich, its economic development proceeded even more rapidly than beiore, until it became an industrial district second in Germany only to the Ruhr area. Lead and zinc, as well as coal and iron mere mined and utilized in factories on the spot. An important university was iounded in Breslau.

Lower Silesia was by this time purely German. In Upper Silesia, except for its western portions, the population was mixed. Most of the towns were almost entirely German, but many of the agricultural districts were Polish, and a fair proportion oi the miners and unskilled industrial workers were Poles, most oi them, indeed, nationally of a somewhat indeterminate type, speaking a dialect which was heavily interspersed with German words, and locally was described as *Wasserpolnisch.*

The Settlement of 1919–21.—In 1919 hoth Poles and Czechs laid claim to parts of Prussian Silesia, while conversely the Germans oi Austrian Silesia asked to be incorporated in Germany. Further, while the Czechs claimed the whole of Austrian Silesia, partly on grounds of historic right, Poland claimed Upper Silesia and part of Teschen Silesia as Polish by majority. Part of the district of Ratibor, with Hlucin, was transferred irom Germany to Czechoslovakia.

The Polish-Czech dispute was under consideration at the Paris peace conference when on Jan. 22, 1919, the Czechs iorcibly occupied Teschen. The powers ultimately on July 28, 1920, laid down a frontier which divided the area and the town itself. Czechoslovak Silesia was now incorporated in Moravia.

There remained the largest question of all: that between Germany and Poland. The Treaty of Versailles in its original iorm proposed to transfer the greater part of Upper Silesia (certain purely German districts being exempted) to Poland. In response to Germany's vigorous protests, this decision was modified, and article 88 of the final treaty provided that the population should declare by plebiscite whether it wished to belong to Germany or Poland. Pending the holding of the plebiscite, local authority in the plebiscite area (4,250 sq.mi.; pop., 1,942,000) was vested in an Inter-Allied commission, which arrived at Opole on Feb. 11, 1920. The troops at its disposal were too weak to keep impartial order even where they tried to do so, and there was serious fighting between Poles and Germans on several occasions, notably in Aug. 1920.

In the poll 706,820 votes were cast for Germany and 479,414 for Poland, practically all the towns voting for Germany. There was a Polish majority in the administrative districts of Rybnik, Pless (Pszczyna), Beuthen (Bytom), Kattowitz (Katowice), Tarnowitz (Tarnowskie Gory), Tost-Gleiwitz (Toszek-Gliwice) and Gross Strehlitz (Strzelce Opolskie).

The Inter-Allied commission proved unable to agree on the next step. The French wished to allot all southeastern Upper Silesia to the Poles, while the British and Italians wanted to leave the industrial district with the Germans. Protracted diplomatic negotiations led to no result. In May 1921 a rumour spread that the decision was going against Poland, whereupon the Polish plebiscite commissioner, Wojciech Korfanty, ordered an armed rising and took forcible possession of the area coveted by Poland. Much disorder occurred.

As the powers were still unable to agree on how the area should be partitioned, they eventually referred the problem to the council of the League of Nations, which on Oct. 12, 1921, awarded to Poland nearly three-quarters of the coal production and two-thirds of the steelworks.

The new frontier cut through a densely populated area which had grown up as an economic unit, and in order to guarantee economic continuity during the period of readjustment to the new conditions, the award recommended the conclusion of a convention establishing a special regime during that period. The convention was concluded on May 15, 1922. It fixed three transitional periods: one of six months, during which traffic across the frontier was almost free; another of three years (counting irom the date of the convention) when special, although smaller, concessions applied in each zone to the products of the other, while other concessions were to continue for 15 years, the total liietime oi the convention. These last included free importation into either country of the products of the coal mines of the other. During the whole 1; years railway and streetcar traffic operated under a special regime, all inhabitants regularly domiciled in either zone could obtain permits entitling them to cross the frontier without further formality, and the cultural and linguistic rights of minorities were guaranteed by most elaborate safeguards. A Mixed commission and an Arbitral tribunal had the duty of seeing these provisions (which in all occupied 606 articles, with a number of annexes) preserved.

The Mixed commission and the tribunal did their work extraordinarily well, but by the time the convention expired, Germany was out oi the League of Nations and Poland hostile to it. The convention was thereiore not renewed, the two countries announcing that they preferred to regulate their relationship bilaterally. The relationship was proioundly unhappy. since neither country was satisfied with the position: but the first changes in the frontier dispositions described above came at the expense of Czechoslovakia. As the result of the Munich conierence of Sept. 29, 1938, the greater part of Czech Silesia was ceded to Germany. Other portions went to Poland; during the months before Munich, Poland had again raised its never-forgotten claim on the Polish-inhabited parts of Czech Silesia. A few days aiter the Munich decision was announced, it occupied the areas claimed and secured the formal cession of them under an agreement signed on Nov. 1, 1938.

After World War 11.—After overrunning Poland in Sept. 1939 Germany reannexed Polish Upper Silesia. On Dec. 12, 1940, Silesia was once more divided into Lower Silesia (capital Breslau) and Upper Silesia (capital Kattowitz), the latter including parts of the Polish provinces of Kielce and Cracow. Much of the German war industry mas transferred there when the iactories of western Germany were put out of action by Allied bombing. Silesia was, however, itself overrun by the Russians at the end oi the war, and the Potsdam decision of Aug. 2, 1945, besides restoring the 1921 frontier, entrusted Poland with the administration of the whole oi German Silesia, Lower as well as Upper, as far as the Neisse (Nysa) river. The whole country was intensively Polonized, and its German inhabitants expelled. From June 1, 1950, Polish Silesia was divided in three provinces, Wroclaw, Opole and Katowice (Stalinogrod). Katowice included the Sosnowiec, Zawiercie and Czestochowa districts which beiore World War I1 had not been part of Silesia. The remnant of German Lower Silesia was incorporated in the land of Saxony. (C. A. M.)

SILHOUETTE, ÉTIENNE DE (1709–1767), controller-general of France. was born at Limoges on July 5, 1709. After travels in England. he established his reputation by his translations of Alexander Pope, Eliot Warburton and Henry Bolingbroke into French and by his writings on commerce and navigation. He then became, in succession, councilor to the *parlement* of Metz, chancellor to Louis, duke of Orléans, and royal commissioner to the Compagnie des Indes. On March 4. 1759, he mas made controller-general through the influence of the marquise de Pompadour. His reputed skill as a financier seemed to be confirmed by his immediate success in raising a loan of 72,000,000 livres, secured on the royal share of the excess profits of the farm of the indirect taxes. When. however. he announced his intention to restrict the expenditure of the royal household, to suspend for the duration of the war the exemption of municipal officeholders from the *taille,* to levy a third *vingtième* and to triple the poll tax on bachelors, opposition to his policy became general. These reforms were forced through against the resistance of the *parlements,* but the minister could not overcome the financiers' virtual boycott of his treasury operations and was compelled to resign on Nov. 23, 1759. Ridicule of him gave rise to the use of the term silhouette, first applied to a simplified design for men's pocketless clothing, in allusion to the sacrifices demanded by his fiscal exactions. He died on

Jan. 20, 1767, at Brie-sur-Marne. (A. GN.)

SILHOUETTE. The word silhouette commonly means a profile portrait cut out of black paper; but it is also used for any outline or sharp shadow of an object.

The earliest known pictorial art is that of paleolithic peoples, of several different eras, who made mural paintings and drawings in the limestone caves of France and Spain. Their art is distinguished by a brilliantly realistic representation that appears to have been first achieved by drawing the outline of the object's shadow, which was generally filled in with a flat colour. But representation by profile drawing persisted long after pictures and sculptures became conceptual rather than realistic (*e.g.*, the tomb paintings and relief sculpture of Egypt and the finely executed decorations on Greek and Etruscan pottery). The ancient Greeks knew how to draw the outline of a person's shadow cast by sunlight. Profile portraiture executed by using a candle or a lamp to throw the shadow on a wall or screen had become fairly common in Europe by the 17th century. Professional practitioners began to paint shadow portraits on any suitable material — plaster, wax, glass, vellum, paper — and to mount them, sometimes quite elaborately; and various mechanical devices were adopted to facilitate correct drawing. When paper became generally available the outline of the shadow was often cut out, and the cleverer practitioners learned to cut the portraits directly from life, besides making more elaborately composed pictures. In the 18th century the painted "shade" and the paper cut both became fashionable. After the coming of the daguerreotype and photography a few genuine artists, such as Phil May, sometimes made use of the painted shadow style in caricature; otherwise it can be said to have died out, except that the cut silhouette persisted.

The word silhouette was taken from the name of Étienne de Silhouette, the parsimonious finance minister of France in the middle of the 18th century, whose hobby was the cutting-out of paper portraits (the phrase "*à la Silhouette*," originally meant "on the cheap"). Silhouette's hobby was also that of later famous personages, including Johann von Goethe. Many connoisseur collectors in modern times look for both the painted and the cut silhouettes of the 18th and early 19th centuries, notably items by such artists as Francis Torond. A. Charles. John Miers, C. Rosenburg, Mrs. Brown, Auguste Edouart, T. Hamlet and Mrs. Beetham (nee Isabella Robinson).

In the middle of the 20th century there were still a few good silhouette cutters, but the underlying principles of the art lived then most vigorously in the cartoon film. (R. L. M.)

SILICA is a compound of the two most abundant elements of the earth's crust — oxygen and silicon — and it is the main constituent of more than 95% of the earth's rocks. Its resistance to change gives it special significance in the study of geology, and important applications in many chemical processes requiring a refractory (heat-resistant) substance. It occurs in a great variety of forms; the principal industrial sources are quartz sand and quartzite or sandstone rock.

Silica has the chemical formula SiO_2. By weight. it contains 46.75% of silicon and 53.25% of oxygen. It constitutes 59% of the mass of the solid crust of the earth, occurring both as free silica and in combination in the silicate minerals (*see* SILICON). The free silica found in rocks is almost universally crystalline quartz. Sea sand is quartz in the almost pure state.

Uses. — Buildings and roads consume the largest tonnage of silica, for sand is the ever-present constituent of portland cement concrete and lime mortar in construction work, and sandstone is one of the most permanent of building stones. The hardness of quartz becomes useful in the application of sand to the cutting, grinding and polishing of glass and stone, and in the consumption of a large tonnage of engine sand to prevent the slipping of driving wheels of a locomotive on a steel rail. The high melting point and low expansion coefficient of cristobalite make silica brick, usually manufactured from quartzite, one of the most useful of refractories, particularly in the steel industry. Another refractory use, consuming a large tonnage of sand, is in foundry molds. Low thermal conductivity adds to high melting point in making diatomaceous silica a popular refractory insulator for furnaces. Unusual insolubility in water and acids, together with negligible thermal expansion, gives vitreous silica a preferred place in chemical apparatus, both in the laboratory and in the plant.

As a chemical raw material, silica sand and rock enter into the manufacture of various products in which the silica, as such, largely disappears. to reappear in other combinations; these include glass. soluble silicates (water glass), ceramic products of various kinds, silicon carbide, ferrosilicon and silicones.

Pure silica is a chemical product as well as a raw material. When fused with an alkali. dissolved, precipitated. washed and partially dried, it is obtained in an amorphous. very finely divided form which has unusual absorptive properties for water vapour, gases and the minute impurities in certain liquids.

Principal Crystalline Forms. — Of the many forms of silica, the three principal crystalline forms are: quartz, tridymite and cristobalite. Quartz is the form that is stable, under atmospheric pressure. at all temperatures up to 867° C. Tridymite is the stable form from 867° C. to 1,470° C. Cristobalite is stable from 1,470° C. to its melting point at 1,723° C. (International Temperature Scale of 1948). The transformation of silica from one of these forms to another is sluggish, hence the two high-temperature forms can easily be preserved indefinitely at ordinary temperatures, while, conversely, quartz can be heated above 867" C. for hours or even for days and still remain either unchanged or only incompletely transformed into tridymite or cristobalite.

Three new crystalline forms of silica have been discovered since 1953: (1) coesite. which is stable only under high pressure and is the densest form of silica; (2) keatite, which is formed hydrothermally under high pressure and is possibly related to cristobalite in structure; and (3j a fibrous form not yet named by its discoverers, A. and A. Weiss, which is produced by the oxidation of silicon monoxide, SiO.

Each of the three principal forms exists in more than one polymorphous modification. depending upon the temperature. In contrast with the sluggish inversions mentioned above, these high- and low-temperature modifications are produced almost instantaneously when the inversion point is attained; only under very unusual circumstances is it possible to hold the high-temperature modification at a lower temperature than its normal range. These quick-changing modifications were formerly designated by Greek letters, such as alpha and beta. but because of confusion arising from differences in the convention as to which modification should be called alpha, it is clearer to refer to them by the words high and low, or upper and lower. They are so designated in the figure.

The high-low inversion of quartz is at 573° C. Tridymite has two such inversions, at 117° and 163° C. Cristobalite is peculiar among polymorphous substances in that its high-low inversion point changes through a range of temperature (200°–275° C.) according to the previous history of the cristobalite.

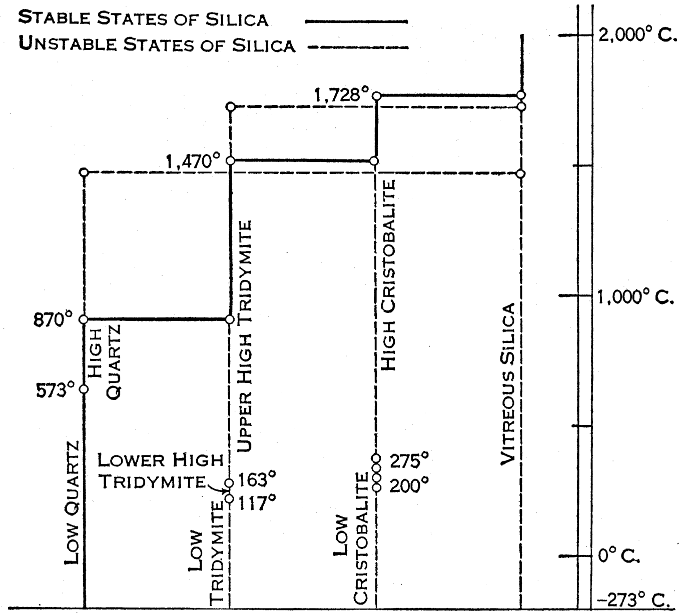
Imitating the sluggishness of the inversion between the principal crystalline forms. molten liquid silica when cooled below 1,723° C., crystallizes sluggishly and can therefore be easily cooled to an amorphous glass, called vitreous silica, fused quartz, or silica glass. (This property persists in the silicate glasses.) Vitreous silica is often incorrectly called quartz, but quartz is a crystalline substance of completely different properties. Upon long-continued heating at temperatures above 1,100° C. vitreous silica devitrifies slowly, usually with the production of white chalky cristobalite.

As the figure indicates, both quartz and tridymite can be melted at temperatures lower than the stable melting point of 1,723° C. but unless further heated to a temperature above 1,723° the fused silica so produced would gradually change over into cristobalite.

Silica is measurably volatile at temperatures above 1.600° C., but its vapour pressure is extremely small. The fluffy porous white deposits of silica often seen around electric furnaces usually are not due to direct distillation, but to reduction of SiO_2 by carbon monoxide and hydrogen to form volatile Si or SiO and gaseous SiH_4, which are subsequently reoxidized.

The Silica Minerals. — All of the three polymorphous crystalline forms mentioned above occur as natural minerals. and even the vitreous (glassy) form, though rare, has been found as a natural product. In combination with water in varying amounts up to about 12%, furthermore, silica occurs as the amorphous mineral opal. Finally, mixtures of hydrated and microcrystalline silica. over the whole range of possible proportions, occur in nature and can be grouped together as chalcedonic silica.

Cristobalite, the crystalline form stable at the highest temperature, always occurs as the low-temperature modification (see figure) but its external crystal form shows it to have grown



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STABLE AND UNSTABLE STATES OF SILICA

at a temperature above the inversion range of 200°–275° C. Tridymite, likewise. occurs as the low modification, but its habit of growth in twinned hexagonal plates shows that it formed above 163° C. Both of these minerals are instances of Ostwald's rule, which states that a form of low or intermediate stability has a better chance of groning than the form that is most stable under the prevailing conditions.

Natural vitreous silica is called lechatelierite. It is the material constituting the peculiar tubes often found in sand. known as fulgurites, and produced by the intense local heating due to a stroke of lightning. It occurs in the meteor crater of Arizona, again a product of sudden and intense heating. An unexplained occurrence of lechatelierite is the scattered fragments found over a considerable area in the Libyan desert.

The foregoing (cristobalite, tridymite, lechatelierite) are relatively rare minerals. In extreme contrast is quartz, the world's second most abundant mineral (feldspar being first). It has received many names, differentiated according to external form, colour and visual effects caused by inclusions. Clear, colourless, well-crystallized quartz is often called rock crystal, and it received local names like "Herkimer diamond." It exhibits several types of twinning (see QUARTZ) and is frequently found as a pseudomorph of other minerals. The clear varieties which are coloured uniformly by various impurities include amethyst (purple, violet); sapphire quartz (indigo, blue); blue quartz; citrine and false topaz (yellow); rose quartz (pink and rose-red); smoky quartz and cairngorm stone (yellow to brown); and morion (deep brown). Inclusions of gas bubbles give rise to milky quartz; of red hematite, to ferruginous quartz; of needles of rutile (TiO_2) or tourmaline, to sagenitic quartz; of fine fibres and streaks of various composition. to cat's-eye and tigereye.

Like euhedral and massive quartz, the chalcedonic silica minerals have received a variety of names based upon visual characteristics. Because of their microfibrous structure, they all show a waxy lustre on a natural or a fractured surface. If visually homogeneous, nearly colourless and translucent, the mineral is chalcedony. Translucent green makes it chrysoprase, or prase if leek-green. Bright green due to chlorite inclusions produces plasma.

Other translucent varieties are bloodstone and heliotrope (green with red or yellow spots), carnelian (red or yellowish-red), and sard (brown). When banded instead of visually homogeneous, the mineral is agate, of which onyx and sardonyx are subvarieties characterized by banding in planes rather than curving surfaces. The less-prized, because opaque. varieties of chalcedonic silica are jasper, which is usually red, yellow or brown, and may even be green and bluish gray; flint. which is gray to black with conchoidal fracture; and chert. likewise gray to black with splintery conchoidal fracture.

Hydrated, apparently amorphous silica is usually given the name opal, of which the varieties used for gem cutting are characterized by iridescent colours. Hyalite is the colourless and transparent form of opal. Although opal shows no evidence of crystallinity under the microscope, the X-ray reveals it to have, at least in part, the internal structure of cristobalite. An interesting structural form of opaline silica is the material called diatomite, which consists of microscopic skeletons of fresh-water diatoms. Sponge spicules are also essentially opaline silica. (See DIATOMACEOUS EARTH.)

Physical Properties. — The density of the principal forms at 0° C. is: quartz 2.651, tridymite 2.26, cristobalite 2.32, vitreous silica 2.203.

The thermal expansion of the crystalline forms is greatly influenced by the high-low inversions, in that the expansion coefficient becomes steadily greater as a polymorphous inversion point. like that of quartz at 573° C.. is approached At the inversion point there is a sudden increase of volume in going over to the high-temperature modification, after which there is relatively little change with further rise in temperature. High quartz actually contracts a little with rising temperature. Vitreous silica has an expansion coefficient which is near zero at all temperatures. This property gives it a special industrial value, for it can be suddenly heated, or chilled from a bright red heat (as by plunging in water) without breaking.

The specific heat of the forms at 0° C. is: quartz 0.1664, cristobalite 0.170, vitreous 0.1657. The curves of specific heat against temperature have the usual form, rising from zero at the absolute zero of temperature, interrupted by a discontinuity at the high-low inversions, and approaching a value of about 0.28 at the melting point.

The thermal conductivity of vitreous silica is uniformly low at all temperatures, about 0.003 cal. per square centimetre per second, per degree centigrade per centimetre at 0° C. Quartz, in contrast, while in a class with vitreous silica at ordinary temperature. rapidly increases in conductivity as the temperature falls and at the temperature of liquid hydrogen conducts as well as some metals.

The forms of silica are both hard and strong. Quartz is standard substance no. 7 in the Mohs' scale of hardness. A tensile strength as high as 160,000 lb. per square inch has been observed in drawn fibres of vitreous silica, and fibres that will carry 100,000 lb. per square inch are easily made. The vitreous form is singularly free from elastic anomalies and is therefore prized for various physical instruments.

The forms of silica are diamagnetic, with a mass susceptibility of about -0.5 per gram. They are poor conductors of electricity; the resistivity of vitreous silica at 20° C. is about 10^{19} ohms per square centimetre per centimetre which makes it popular as an electrical insulator. It is especially valuable in such service because. unlike common glasses and many other substances, it does not condense a conducting layer of moisture upon its surface. (For other electrical properties, see the article on QUARTZ.)

Both quartz and vitreous silica are colourless and transparent in visible light, and are unusually transparent to ultraviolet light. This property makes the vitreous form valuable in windows for transmission of whole sunlight. and in lamps for transmitting ultraviolet from the mercury arc. At nave lengths longer than visible light, on the other hand, though more transparent than other glasses to most of the infrared spectrum, silica reflects like a metal in the vicinity of wave length 9 μ, and has considerable reflecting power also near 13 and 23 μ.

The useful optical properties peculiar to crystalline quartz, particularly rotatory power, are discussed in the article QUARTZ.

Chemical **Behaviour.**—In the laboratory, crystalline and vitreous silica are virtually insoluble in pure water and dissolve very slightly in water solutions of the common mineral acids. Silica is attacked (etched). however, by dilute alkaline solutions and by concentrated phosphoric acid. and is rapidly dissolved by a solution of hydrofluoric acid (HF). The only halogen that attacks it is fluorine.

A homogeneous liquid containing only water and a few per cent of silica is easily obtained by acidifying the water solution of an alkaline silicate and dialyzing out the electrolytes. This liquid proves to be a hydrosol. containing silica units of large molecular weight, and not a true solution. Much experimental work was done on these sols in the hope of proving them to be silicic acids analogous to sulfuric and phosphoric acids, but without success. The sol can be concentrated to a stage where it becomes a rigid and elastic gel, corresponding to the natural mineral opal. The percentage of water in such gels is controlled by the temperature and by the water vapour pressure in contact with the gel, as well as by its previous chemical and physical history.

As the temperature rises. silica becomes measurably soluble in water, and dontinues to in'crease in solubility, if the pressure is increased, even above the critical temperature of water, 374° C., where surface tension disappears and gas and liquid become continuous in properties. At the critical end point of the solution, which is less than one degree higher than the critical temperature of water, and at the pressure corresponding to coexistence of quartz, liquid and vapour, quartz is soluble to the extent of 0.023% by weight. Its maximum solubility under these equilibrium conditions is 0.075%, at 332° C. Above the critical point, at higher pressures, a concentration of more than 0.3% has been attained. Vitreous silica attains an apparent equilibrium with water at about twice the concentration of quartz.

Silica in all forms reacts at temperatures above 1,000° C. with all metallic oxides, also with many salts when in the presence of air and moisture, to form crystalline or liquid silicates.

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(R. *B.* SN.)

SILICON is the second most abundant of the elements in the earth's crust, surpassed in quantity only by oxygen. It is found in measurable amount in practically every rock, in all natural waters, in the atmosphere (as siliceous dust), in many plants and in the skeletons, tissues and body fluids of some animals. Its presence in the sun and other stars is indicated by the spectroscope. It is never found in the free state, however, but always in combination—either with oxygen as silica (SiO_2), or with oxygen and aluminum, magnesium, calcium, sodium, potassium, iron and other elements in the numerous silicate materials which comprise rocks, soils and clays.

Prior to 1787 chemists had not differentiated silicon from its compound, silica, which they considered an element. In that year A. Lavoisier offered the speculation that silica was an oxide of an undiscovered element. In 1817 J. J. Berzelius found that the substance, free from oxygen, was present in cast iron; and six years later he established its existence as an element, although he was able to prepare it only in somewhat impure form. It was first obtained in reproducible crystalline form in 1854, when H. Sainte-Claire Deville crystallized it out of the alloy produced by electrolyzing a melt of mixed chlorides. The name silicon was derived from **silic-**, basal syllables of *silex,* Latin for "flint."

Silicon is chemical element no. 14 in the periodic system; symbol, Si. It is nonmetallic in character and has a chemical atomic weight of 28.09. Its isotopic composition, which has been found constant both in the earth's crust and in meteorites, is: Si^{28}, 92.28%; Si^{29}, 4.67%; Si^{30}, 3.05%. External electron arrangement: $1s^2\ 2s^2,\ 2p^6\ 3s^2,\ 3p^2$.

Forms.—Pure silicon crystallizes with isometric symmetry, and has the same structure as diamond. The distance between adjacent atoms is 2.3j A.

Amorphous silicon has been frequently described, especially by the earlier workers. Some of it was undoubtedly impure as a result of the method of preparation, and was mixed with silicides and silica. Even when fairly pure, the supposed amorphous element has been found to give the same X-ray pattern as the recognizably crystalline form.

Preparation and Physical Properties.—Silicon is best prepared by reaction of metals such as magnesium, aluminum and potassium with the halogen compounds of silicon. It can be purified by recrystallization from metallic solution, as in aluminum. the excess of solvent metal being removed with acid. Because of the difficulty of preparing the pure element, the recorded physical properties are not as reliable as those of more easily purified substances.

The physical properties of silicon are as follows:

Density (grams per cubic centimetre)	2.42
Coefficient of thermal expansion at 0° C.	7×10^{-6}
Melting point	1,420° C.
Boiling point	about 2,600° C.
Specific heat at 0° C., calories	0.174
Refractive index, $\lambda = 589\ m\mu$	4.24

Chemical **Behaviour** and Uses.—Silicon is attacked by oxygen and water vapour at a red heat and higher, but the coating of SiO_2 formed by the reaction protects the element. It is vigorously attacked by gaseous fluorine, chlorine and hydrofluoric acid. It is not acted upon by sulfuric acid, hydrochloric acid, nitric acid or aqueous ammonia at ordinary temperature. Many oxides are reduced by silicon at high temperatures with the formation of metal or silicide, and silica.

Silicon is used in industry principally as the alloy of iron and silicon called ferrosilicon. This may contain from 14% to 94% Si. It is used for deoxidizing common steels and for making special silicon steels.

Compounds.—Silicon stands next to carbon in the fourth group of the periodic system. By simple analogy, this fact leads to the expectation that silicon can form chain and ring compounds with hydrogen and the halides, as well as a complex system of hydrogen-oxygen compounds. This expectation is to some extent realized in the simpler chain formulas of silicon compounds, and even the names, suitably modified. of the carbon-hydrogen-oxygen compounds have been carried over into the silicon series. New compounds are constantly being added to the silicon series.

Silicon has four electrons in the outer or valence shell. These are capable of pairing with the valence electrons of other elements to give four covalent bonds. Silicon is therefore commonly classed as tetravalent. The electrons can also be transferred to the outer shell of a strongly electronegative element such as fluorine to form bonds of ionic type. The covalent bonds of silicon to oxygen are estimated to be about half ionic in character. In the compounds of carbon, on the other hand, ionic bonds are rare. Further, carbon never produces more than four covalent bonds, and in some compounds the number descends to three and two.

Another important factor in the formation of compounds besides the electron arrangement is the size of the atom, controlling the space available for close approach of other atoms. Silicon has a larger atom than carbon. The co-ordination number of the silicon atom in its compounds is in nearly all cases four. With some atoms, however, such as fluorine and (occasionally) oxygen, it can be six. It is never less than four in any known compound.

These differences in external atomic structure find expression in the following striking differences between the carbon and silicon compounds of similar formula: (1) The carbon compounds form self-contained independent molecules which maintain their separate existence even though vaporized, liquefied. dissolved and modified by substitution of atom for atom; the silicon compounds polymerize and pass over into solid crystalline or amorphous aggregates. or structures extending infinitely in one, two or three dimensions. (2) In a world where water is always present as vapour or liquid, the carbon-based molecules survive untouched, the silicon-based molecules hydrolyze and end as hydrated silica or as water-bearing micas and clay minerals. (3) The carbon series build up their complexities by conjunction of carbon atom to carbon atom, while the silicon series build up their complexities mainly through the intermediary of oxygen atoms. It is easy to see that. in a newly created world with prevailing temperatures of $-50°$ to $+100°$ C., carbon had within itself the possibility of an evolving life, while silicon was the possible parent mainly of cold rocks.

Hydrides.—Like carbon, silicon forms mith hydrogen a series of compounds containing a progressively smaller proportion of hydrogen. The first member is silane, SiH_4, and the series has been prepared as far as Si_6H_{14}. All can be made by action of an acid on a silicide. All are gases at atmospheric temperatures. There are no unsaturated hydrides corresponding to the ethylene, acetylene and benzene types of hydrocarbons.

Oxides.—There is evidence for the existence of a monoxide, SiO, but little information is available on its properties.

The dioxide. SiO_2, usually called silica, is one of the most extensively investigated and best-known of chemical substances. (See SILICA.)

Compounds With Hydrogen and Oxygen.—A number of such compounds, called by the generic name siloxanes. had been prepared and studied by mid-20th century, but they lack the stability and the variety of behaviour characteristic of the analogous organic acids, esters, etc.

Halogen Compounds.—Silicon tetrafluoride, SiF_4, is a gas formed by reaction of hydrofluoric acid, HF, on silica. It combines mith excess HF to form hydrogen silicofluoride, also called hydrofluosilicic acid or fluosilicic acid, H_2SiF_6, which is stable in water solution, giving the ion SiF_6^{--}. K_2SiF_6 is one of the few potassium salts that is difficultly soluble in water, making this acid useful in chemical analysis.

Silicon tetrachloride, $SiCl_4$, is a colourless liquid of boiling point 57° C. It reacts with water, either liquid or vapour, to form HCl and hydrated SiO_2. This reaction has been utilized, by including ammonia with the vapour, to produce a military protective dense white smoke consisting of particles of SiO_2 and NH_4Cl. As might be expected from the analogy with carbon, there are chlorides Si_2Cl_6, Si_3Cl_8 and others. Silicon tetrabromide is a colourless liquid boiling at 153° C. The tetraiodide is crystalline, melting at 121° C. and boiling at 290° C.

Numerous halogen derivatives of the silicon hydrides are possible, and many have been prepared and described. An example is silico-chloroform, $SiHCl_3$.

Carbide.—Silicon carbide. SiC, forms at electric furnace temperatures from reaction of carbon with silica. It exists in at least eight crystalline forms. It has become an important industrial abrasive and refractory, under trade names such as Carborundum and Crystolon. (See SILICON CARBIDE)

Organosilicon Compounds.—The introduction of silicon into carbon chains and rings—or, looked at from the other direction, the introduction of organic radicals into the simpler silicon compounds—opens an immense variety of possible structures, some hundreds of which have been prepared and described. None of these compounds has been identified as a natural product, though some may be taking part in the groath of silicon-bearing plant and animal tissues. Among the new compounds are the industrially important silicones (*q.v.*) which derive by polymerization from the general formula R_2SiO, in which R is an organic radical such as CH_3, C_6H_5 and the like. Another group of carbon-bearing compounds comprises the silicates, such as the industrially useful tetraethyl orthosilicate, $(C_2H_5)_4SiO_4$. The term organosilicon compound is restricted to those that contain at least one silicon-carbon bond.

Sulfide.—Silicon forms a colourless crystalline sulfide, SiS_2; its structure is that of an infinitely long chain of tetrahedra, SiS_4, which share opposite edges, the parallel chains themselves being held together by weak residual forces. It therefore differs from silicates of the chain type in that SiO_4 groups share corners but not edges (see below).

THE SILICATES

More than 95% of the earth's rocks contain silica as their principal component. Any such rock can be seen, either by direct inspection or by examination under the microscope, to be an aggregate of minerals, each homogeneous, usually crystalline, and usually transparent. In many rocks, one of these minerals is pure silica in the form of quartz. Most of the other rock minerals contain silica in combination; they are the silicate minerals.

Many of these minerals have been artificially duplicated, usually by high-temperature processes. New crystalline silicates, never found in nature. have also been produced by these same processes. Most of the silicates, both natural and artificial, are insoluble in water. A striking exception is the group of silicates of the alkali metals (lithium, sodium, potassium), which are obtainable as homogeneous water solutions containing silica in a wide range of proportions. These solutions can be concentrated to form glasses that still contain as much as 25% water. One such series, the sodium silicates. forms an important article of commerce, long known by the commercial name of water glass, no more commonly called silicate of soda.

By fusion with two or more oxides, commonly sodium oxide (Na_2O) and lime (CaO), both introduced as carbonate, silica forms the silicate glasses.

This extremely varied lot of substances, the silicate minerals, the synthetic silica compounds and the silicate glasses, are grouped by the chemist under the name silicates. As the name itself implies, the silicates were regarded throughout the 19th century and the first quarter of the 20th century as salts of certain silicic acids, in the same sense that sodium sulfate is a salt of sulfuric acid. The analogy was temporarily useful, even though it proved to be very difficult to produce a silicic acid resembling in any way the chemist's better-known acids. Pure silica proved to be extremely insoluble in pure water, and the homogeneous phases containing only silica and water, which are obtainable by various methods, were found to contain mostly colloidal or dispersed silica, with very little truly dissolved silica. The methods of organic chemistry failed completely to throw any light on the constitution of the silicates. and the field remained one for unrestrained speculation, uncheckable hypothesis and unproductive analogy.

The advent of the X-ray methods of studying the structure of crystalline and amorphous solids made possible a resumption of progress in the chemistry of the silicates. Systematic knowledge of silicate structure and constitution at mid-20th century was based largely on X-ray work particularly on the crystalline substances, the glasses and the clays. combined with the atomic-volume principle elucidated by V. M. Goldschmidt and others. It developed that the guiding unit is a group having the formula SiO_4. In all the silicates, as well as in pure silica, there are groups of four oxygen atoms arranged in space at the corners of a tetrahedron. There is usually a silicon atom at the centre of the tetrahedron, but it can be replaced here and there by aluminum (in most cases not to exceed one out of four silicon atoms), and rarely by beryllium. At the same time, an occasional tetrahedral corner will be found occupied not by an oxygen atom but by a fluorine atom or an OH pair (hydroxyl). The systematization of all the silicates is based upon the various ways in which it is possible to interconnect the silicon-oxygen tetrahedra. The chemically basic or electropositive elements, such as Li, Na, K, Mg Ca, Sr. Ba. Al (in part), Mn. Fe, fit into the openings between the tetrahedra in accordance with their atomic volume. The oxygen atom itself is larger than most of the silicate-forming atoms, which leads to the geometric possibility of fillable openings.

Silicate Structures.—Mineralogists and chemists are not in complete agreement as to the classification of the structures, but the main groupings are briefly characterized below, and some of the better-known examples are listed in parentheses. Some of the old names were still retained for lack of a more logical terminology.

Three-Dimensional Networks, or Silica Type.—All the tetrahedra share corners with other tetrahedra. The formulas contain the group SiO_2 or multiples thereof. The type includes silica itself; the feldspar group (orthoclase, plagioclase); the nephelite group; the cancrinite and sodalite groups in which certain electronegative units such as Cl, CO_3 and SO, are added to the structure; and the large zeolite family, with added molecules of H_2O as the principal structural characteristic.

Sheet Structures (Sometimes Called the *Disilicate* Type).—The tetrahedra are arranged in a plane, each being joined to other tetrahedra by three atoms in the plane. The type includes the aluminum disilicates (kaolin and other clay minerals); the nonaluminum member. talc; the analogous aluminum member, pyrophyllite; the chlorite family; and the micas (muscovite and biotite series).

Chain and Ring *Structures,* or *Metasilicate* Type.—These may be either chains or rings of tetrahedra, reminiscent in a way of the chain and ring structures of the chemistry of carbon. The chain structures, which are potentially infinite in length, include: single chain structures, containing SiO_3 or multiple thereof in the formula (pyroxene group, pyroxenoid family); double chains containing Si_4O_{11} in the formula (amphibole group); and other more complex chains. Ring structures include beryl and probably the tourmaline series.

Double Tetrahedral Structures, or *Pyrosilicate* Type.—Two tetrahedra share a single oxygen atom, giving formulas containing Si_2O_7. These silicates include the melilite group and the hemimorphite family.

Independent Tetrahedral Structures, or Orthosilicate *Type.*—There is no sharing of corners between tetrahedra, hence formulas contain the group SiO_4. The old formal derivation was from an imaginary silicic acid of the formula $Si(OH)_4$. These silicates include a varied assortment, such as the chrysolite group (olivine, forsterite, fayalite), garnet group and epidote group. Allied to these orthosilicates are some subsilicate minerals: in which not all the oxygen is in the independent tetrahedra (sillimanite, mullite).

Phase Equilibrium in *Silicate Systems.*—There is another approach to understanding the chemistry of the silicates which almost completely ignores the existence of atoms and proceeds on the thermodynamic basis of the Gibbs phase rule, determining experimentally the limits of stability of all the crystalline and liquid phases that can be produced synthetically. The work of the Geophysical laboratory of the Carnegie Institution of Washington, D.C., founded by A. L. Day in 1906, is the most extensive in this field. The method has the great advantage of proceeding from simple to complex systems and of covering the ground thoroughly as it goes, at least with respect to equilibriums readily attainable at high temperatures. It has the disadvantage of being faced with what might appear a numerically hopeless task. Hundreds and thousands of tests. short though they may be. are necessary for the complete survey of a system of three oxide components, and several such systems had been patiently completed by the 1950s, but no four-oxide system had been finished. Yet most silicate minerals contain at least five components and a great many contain ten. The total number of systems (unary, binary, ternary, etc.) that can be assembled from ten oxides is 1,023. Additional complications are: (1) the necessity, in systems containing the oxides of iron and manganese, of taking the metal and gaseous oxygen as the components. adding gaseous pressure as another variable; (2) the experimentally difficult problem of sealed high-pressure apparatus when water is one of the components. Nevertheless, the elucidation of the simpler systems had brought rich returns in such matters as the formulation of fundamental principles on the genesis of rocks, and the solving of industrial problems in ceramics.

Ten or more binary silicate systems are represented by reasonably satisfactory phase-equilibrium diagrams, together with six ternary systems (SiO_2 with the pairs Al_2O_3–CaO, Al_2O_3–MgO, CaO–MgO, CaO–K_2O, CaO–Na_2O, K_2O–Na_2O). Systems containing dissociable oxides are still fragmentary. Silicates of sodium and potassium with H_2O as a third component are fairly complete. Details will be found in articles on the individual metallic elements.

The Problem of Valence and Neutrality.— Implicit in both the atomic-structural approach and the phase-equilibrium approach to the study of the silicates is the chemist's basic assumption of the validity of Dalton's law of definite and multiple proportions. It is assumed, for instance, that the phases and the structures in a series of sodium aluminosilicates containing water can be correctly described in terms of the formulas SiO_2, Al_2O_3, Na_2O, and H_2O. But 20th-century chemistry. studying the metallic alloys and various inorganic systems containing solid solutions (*i.e.,* crystalline solutions), found that Dalton's rules are often only an approximation or a working limit, not an exact statement. In the system iron-oxygen, for example, there occurs one crystalline phase (wüstite) with a temperature range of stability from 560° to 1,424° C. and a range of composition from 23.10% to 25.60% oxygen, no point of which can be represented by a simple integral relation between the atoms; the composition FeO (22.27% oxygen) lies entirely outside the field and is nonexistent as a phase. The wüstite phase is a crystalline solution of oxygen in iron or iron in oxygen, whose composition depends upon the pressure and temperature. This relation will certainly carry over into the iron-bearing silicates.

Furthermore. it became apparent from study of the adsorptive and base-exchanging power of many substances that not only can there be ionization in liquid solutions but also in crystalline substances as well, with the possible production of structures into which ions and polar molecules can be introduced as a part of the systematic structure, to be released again under the proper chemical environment. The silicates with sheet structure include many such substances. (See ADSORPTION; VALENCE.)

Silicates in Industry.— The silicates are the foundation material for the widely various ceramic industries. In the United States the word ceramic is held to embrace not only industries based upon clay, which is the traditional usage, but any industry utilizing earthy raw materials (sand, clay, feldspar, magnesite) to manufacture a product with the help of a kiln or a furnace. The ceramic industries in the United States therefore include glass, vitreous enamels, portland cement and certain electric-furnace products (abrasives); as well as structural clay products (building brick, paving brick, tile), refractories, earthenware (pottery, sewer pipe) and whiteware (china. decorative porcelain, electrical porcelain). Soluble silicates have been mentioned above.

Another class of industrial silicates, the silicate slags, is closely allied to the metallurgical industries. In the production and refining of some metals. an active reagent is the nonmetallic liquid floating on the surface of the metal. collecting and removing the gangue of the ore and also reacting with constituents in the metal. The metallurgical slag produced in greatest tonnage is blast-furnace slag from the manufacture of crude iron. It consists essentially of silica. alumina and lime, with subordinate magnesia. Some of it is utilized as raw material for portland cement. Slag from the open-hearth furnace for making steel contains principaliy silica, lime and oxides of iron and manganese; in some localities it is high enough in phosphorus pentoxide to be utilized as fertilizer. Slags from the acid and basic Bessemer processes and from the smelting and refining of copper, lead and tin are siliceous in varying degree.

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(R. B. SN.)

SILICON CARBIDE (CARBORUNDUM). Silicon carbide is a crystalline compound of metallic silicon and nonmetallic carbon which is of great technical and industrial importance. It was discovered accidentally by Edward G. Xcheson in 1891 while he was experimenting with the use of electrical energy for the production of artificial diamonds. Acheson was heating a mixture of clay and coke in an iron bowl with an ordinary arc light carbon in an attempt to convert the carbon to diamond. and found some bright hexagonal crystals attached to the carbon electrode. He thought that he had prepared a new compound of the carbon and the alumina (aluminum oxide) of the clay. Because the natural form of fused alumina has the mineral name of corundum (*q.v.*), he called the new compound carborundum. This name was originally protected as a trade name but in many places became synonymous with silicon carbide. In 1893 Xcheson was granted a U.S. patent covering his invention. About the same time Henri Moissan produced a similar compound from a mixture of quartz and carbon. However, in a publication of 1903 Moissan ascribed the original discovery to Acheson.

The significance of the discovery was immediately realized by Acheson, for he found that the crystals approximated the hardness of the diamond. His early product was offered for the polishing of gems, and sold at a price comparable with natural diamond dust. The new compound was found,to be attainable with cheap raw materials and with good yields so that it soon became of industrial importance as a manufactured abrasive of wide application.

Properties. — Silicon carbide, which has the chemical formula SiC, crystallizes in the hexagonal system. Five crystalline-type habits in the hexagonal system were isolated and described in the technical literature. The ordinary commercial product has crystals up to $\frac{1}{2}$ in. average dimensions in the hexagonal plane and thicknesses of up to $\frac{1}{4}$ in. in the other dimension. The crystals are usually found closely interlocked into a massive porous structure, but occasionally fully developed crystals are formed in voids of the furnace ingots. These are the spectacular large, shiny crystals which are often exhibited as typical silicon carbide. Pure silicon carbide is clear with a slight green tinge. The index of refraction is very high, 2.648 for the ordinary ray and 2.691 for the extraordinary ray. A slight amount of impurity will change the colour from light green to blue, gray and black. Typical impurities in the crystal are aluminum, magnesium, calcium, graphite and free silicon, all of which change the colour to black when present in amounts up to 0.5%. The crystal begins to oxidize when heated in air at around 1,000° C., forming a film of silica over the surface. This film produces iridescent and attractive colours when the proper film thickness is developed.

Some natural silicon carbide was found in the Canyon Diablo meteorite and bears the mineralogical name Moissanite after Henri Moissan.

A low-temperature form of silicon carbide (β-SiC) was discovered and isolated in 1926 by H. Ott. It has the same chemical composition but crystallizes in the cubic system and has properties different from the industrial product. The ordinary hexagonal variety of crystal has a hardness on the Mohs' scale of scratch hardness just above fused alumina or corundum and considerably below the hardness of the diamond. In 1891 silicon carbide was the hardest synthetic material which had ever been made. The discovery of boron carbide in 1929 took this distinction from silicon carbide.

Other properties of silicon carbide, in addition to its hardness, served to develop a large commercial market for it. The crystals are mechanically strong, have high thermal conductivity and desirable fracture characteristics which make them extremely useful in grinding wheels and in abrasive paper and cloth products. The high thermal conductivity, taken with the resistance to fluxing, fusion or oxidation of the material, makes it valuable in the manufacture of high-temperature bricks and other refractory products such as muffles, tubes and saggers. Silicon carbide also has unique electrical properties, including a high negative temperature coefficient of resistance. In the cold, silicon carbide might be classed as an insulator; as it is heated up to higher temperatures it becomes more conductive, so that at 2,000° C. it is as conductive as graphite. This places it in the class of semiconductors which have many special uses.

Industrial Production. — The total production of silicon carbide in the United States and Canada in the years following World War II was about 60,000 tons annually. Of this amount, roughly 60% was used for abrasives and 40% for refractories and other special uses. The total synthetic abrasive production of all types for the same period was about 350,000 tons annually, so that it is apparent that while silicon carbide was still an important abrasive material, it no longer represented the chief abrasive manufactured with electric power. This distinction had passed to fused alumina or corundum, which finds its chief use in the cutting and grinding of steel and other high tensile strength products. Silicon carbide is used mostly for the shaping of low tensile strength materials such as cast iron, bronze, glass and marble.

The commercial manufacture of silicon carbide is accomplished in much the same way throughout the world from the two basic raw materials, glass sand (pure SiO_2) and high-grade coke (low-ash petroleum or pitch coke). Most of the world production is localized in the Niagara district of the United States and Canada where electric power from Niagara falls is available for the large requirement of electrical energy needed in the production. About 4 to 5 kw.hr. are consumed for the production of each pound of silicon carbide. The other large producing areas in the world are in Norway and in Czechoslovakia.

At mid-20th century the electric furnaces used for the production of commercial silicon carbide were similar throughout the industry and were much the same as the original furnace described by Acheson in his original patent. A typical furnace is a large brick box ranging in size from 20 to 50 ft. in length and from 10 to 20 ft. in width and 10 ft. deep. The refractory brick box serves only as a container to hold the crude mixture which consists of ten parts of glass sand and six parts of high-grade coke. Some variable amount of wood sawdust is added to the mixture to change its thermal conductivity and gas permeability characteristics. This loose granular mix is piled into the box until it is half full, and a trench is cut lengthwise in the loose mixture. This trench is filled with coarse metallurgical coke particles which are in contact with large carbon electrodes at each end of the box. This granular core is used ordinarily as a starting resistance to bring up the centre zone of the mixture to the reactive temperature which is from 2,000° to 2,600° C. Because of the long resistor and the many contacts between the carbon particles, a high voltage (up to 500 v.) is needed for starting the furnace, but as soon as some reaction takes place and a sheath of silicon carbide forms around the outside of the central resistor, the conductivity of the resistor is increased. This increase proceeds during the course of the run so that the voltage continually must be adjusted downward. As the current goes up to as high as 40,000 amp. the voltage must be adjusted down to a low of 75 v. Furnaces normally require from 1,000 to 3.000 kw. of power input to produce the abrasive efficiently. Expensive electrical equipment is necessary to control these large blocks of power through the required operating range. Production stops long before the central developing ingot of silicon carbide approaches the walls of the brick container because there is no known refractory which can stand the high temperatures involved in this furnace operation. The product is made in an envelope of itself. The chemical reactions liberate great volumes of carbon monoxide; in fact 1.4 tons of carbon monoxide is produced for every ton of silicon carbide recovered. This gas permeates the loose mix and burns on the outside of the furnace, aiding somewhat in the reduction of heat losses from the container.

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SILICONE, any one of a group of synthetic polymers (*see* POLYMERIZATION) composed of the elements silicon, carbon, hydrogen and oxygen. They are usually noted for ability to withstand comparatively high temperatures without decomposing.

Silicone polymers may take the form of oily liquids, resins or rubbery solids (elastomers), depending upon their chemical composition and the average size of the molecule. The commercial types of silicone resin and rubber are usually designed to have the greatest heat stability consistent with strength, adhesion and the other necessary physical properties, but some types are designed especially for fluidity or flexibility at very low temperatures or for some other special property such as solvent resistance. All types are quite inert chemically; they are indifferent to dilute acids and most reagents except strong alkalies and hydrofluoric acid, both of which are capable of destroying the basic structure of the polymer.

The name "silicone" was coined by F. S. Kipping of University college, Nottingham, Eng., to describe compounds of silicon which were analogous to the organic ketones (see KETONES). A silicone therefore designates a substance which has a composition corresponding to two organic groups or radicals bonded to a silicon atom which in turn is linked to oxygen; it might equally well be described as an organosilicon oxide. The analogy between silicones and ketones begins and ends with the empirical composition. however. for the two groups of compounds are very different structurally. The ketones have simple molecules corresponding to their elementary composition, whereas the silicones always have polymeric structures in which the unit of composition is repeated many times in a single molecule. A silicone polymer may therefore be pictured as a chain or network of alternate silicon and oxygen atoms bearing appropriate organic groups attached to the silicon atoms:

$$\begin{array}{ccccccc} & R & & R & & R & \\ & | & & | & & | & \\ - & Si & -O- & Si & -O- & Si & -O- \\ & | & & | & & | & \\ & R & & R & & R & \end{array}$$

The organic groups R modify what otherwise would be a purely inorganic siliccn oxide or silica glass, and provide the desired degree of flexibility. plasticity, or even fluidity. The kind of organic group and its size in relation to the silicon-oxygen framework thus has an important influence on the properties of the silicone polymer. In practice, the R groups are almost always methyl groups (CH_3-), but occasionally phenyl (C_6H_5-) or ethyl (C_2H_5-) groups.

Silicones usually are made by hydrolyzing the simpler organosilicon chlorides or ethers and condensing the products to polymeric form. The starting material is silica in the form of sand or quartzite, which by one of several methods is chemically combined with organic groups. In the Grignard method, silicon tetrachloride is prepared from the silica and is allowed to react with approximately two equivalents of organomagnesium chloride (Grignard reagent, *q.v.*) in an ether solvent to form a mixture of organosilicon chlorides from which the pure compounds are separated by distillation:

$$RMgCl + SiCl_4 = RSiCl_3 + MgCl_2$$
$$2RMgCl + SiCl_4 = R_2SiCl_2 + 2MgCl_2$$
$$3RMgCl + SiCl_4 = R_3SiCl + 3MgCl_2$$

In the direct method, elementary silicon is prepared by reduction of the silica and is caused to react directly with an organic chloride in the vapour phase and in the presence of a catalyst to form a mixture of organosilicon chlorides, from which the pure constituents again are distilled:

$$2RCl + Si = R_2SiCl_2, \text{ etc.}$$

In a third method, ethylene is absorbed by dichlorosilane made from silicon:

$$2HCl + Si = H_2SiCl_2$$
$$H_2SiCl_2 + 2C_2H_4 = (C_2H_5)_2SiCl_2$$

Pure organosilicon chlorides from any of these methods become the intermediates from which the silicone polymers are made.

Silicone resins are made by hydrolyzing a mixture of monosubstituted and disubstituted silicon chlorides, sometimes in a solvent. Reaction with the water replaces the chlorine nith hydroxyl groups, and the hydroxides intercondense to form a polymer:

$$R_2SiCl_2 + 2H_2O = R_2Si(OH)_2 + 2HCl$$

$$xR_2Si(OH)_2 = \left[\begin{array}{c} R \\ | \\ -Si-O- \\ | \\ R \end{array} \right]_x + xH_2O$$

Silicone resins prepared in this way usually are applied in the form of a solution or varnish. After the solution has been applied to the desired surface the solvent is evaporated and the resin is cured by heat, sometimes with the assistance of curing agents or catalysts. The final product has a molecular structure in which the chains of silicon and oxygen atoms are interconnected or cross-linked by extra atoms of oxygen on the monosubstituted silicon atoms, and is therefore comparatively insoluble and infusible. Such resins are useful as insulating and protective coatings, and some are serviceable at temperatures up to 600° C. for extended periods.

Silicone oils may be made by preparing linear polymers of dimethylsiloxane of a length corresponding to the desired viscosity and vapour pressure. In order to prevent further change of molecular weight through condensation, the chains are blocked by attaching unreactive groups to the ends. Such chain-blocked oils show little change of viscosity with temperature and so are useful at low temperatures as well as high. They do not oxidize or sludge as readily as do hydrocarbon oils, and they are suitable as dielectric media becsuse they have low electrical losses over a wide range of temperatures and frequencies.

Silicone elastomer is made by hydrolyzing pure dimethyldichlorosilane and extending the resulting linear polymers to very high molecular weight, so that the chains consist of thousands of dimethylsiloxane units. Such high polymers have elastic properties, and if they are milled with inorganic fillers and curing agents, the compounded material can be cured or vulcanized to a rubbery product.

Like silicone oil and resins, silicone rubber can be utilized at temperatures both above and below those permissible for the organic elastomers, both natural and synthetic.

Very thin films of silicone polymers also are formed *in situ* by reaction of the organosilicon chlorides with the adsorbed water on cellulose or glass, and the films so formed cause the surface to become highly water-repellent. Such a film is strongly bound and can be removed only by chemical action or by severe abrasion, but may readily be cleaned by alcohol or by solutions of wetting agents.

The process is useful wherever paper, cloth or glass is to be made water repellent.

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SILICON STEEL. Invented by Sir Robert Hadfield in 1889, this alloy led to the perfection of what is termed low hysteresis steel, used in the manufacture of electrical apparatus. The term hysteresis is applied to the tendency of magnetic materials to remain in any magnetic state which already exists. This leads to loss of energy when this state is changed. Silicon steel is superior to iron itself in magnetic qualities, and improves with use. Therefore it makes an ideal core for electrical transformers. Silicon steel is made by heating steel containing $2\frac{1}{2}\%$ to 4% of silicon to a temperature of about 1,000° C. It is then cooled, reheated to about 800° C. and cooled again. See STEELS, ALLOY.

SILICOSIS is a chronic, fibrotic disease of the lung produced by prolonged inhalation of silica (SiO_2) dust. Several pneumonoconioses, or dust diseases of the lung, produce recognizabie changes in roentgenograms, but only three—silicosis, asbestosis and beryliosis—cause clinical symptoms.

Silica is widely distributed in nature, being found in sand, sandstone, granite, quartz and other rocks. The disease is strictly occupational and occurs in persons engaged in such trades as mining, metal polishing, glassmaking, grinding and stonecutting.

Disease is seldom produced with less than a two-year exposure to air containing at least 6,000,000 particles of silica per cubic foot. Only particles less than ten microns in diameter can reach the periphery of the lung and those particles between one and three microns are the most injurious.

The action of silica is not merely mechanical but physiochemical. Early lung changes are discrete, fine. uniformly distributed nodulations which later progress to fibrotic masses that involve both the lung tissue and the draining lymph nodes.

The chief symptom of the disease is shortness of breath. Later cough, tightness across the chest and weakness develop. Diagnosis depends upon typical roentgenogram findings plus a history of prolonged exposure to silica dust. Secondary infections of the lung are a common complication. Tuberculosis occurs in about 75% of the cases. is often severe in character and is frequently fatal.

Treatment of silicosis is largely preventive since there is no cure for the established lung changes. Treatment of the complications, however. is frequently very beneficial. *See* also PNEUMONOCONIOSIS. (W. R. BY.)

SILISTRA, a town in Bulgaria on a low-lying peninsula projecting into the Danube, is 81 mi. below Ruschuk. Pop. (1956) 20,491. The town was formerly a fortress of great strength, occupying the northeast corner of the famous quadrilateral (Ruschuk, Silistra. Shumen, Varna), but its fortifications were demolished in accordance with the Berlin treaty (1878). The principal trade is in cereals and the town also contains sawmills. It is surrounded by fine vineyards, some 30 kinds of grapes being cultivated, and tobacco is grown.

Apiculture is extensively practised and there are large market gardens in the neighbourhood. A considerable area is still covered with forest, to which the region owes its name of Deli Orman ("the wild wood").

Silistra, the Durostorum of the Romans, was one of the most important towns of Moesia Inferior and was successively the headquarters of the legio I (Italica) and the legio XI (Claudia). It was defended by the Bulgarian tsar Simeon against the Magyars and Greeks in 893. Thereafter it came successively under the control of Russia (967), Byzantium (971) and Turkey (1388). Briefly in the possession of the Walachian prince Mircea, it passed finally to Turkey in 1416. In 1810 the town was surrendered to the Russians who destroyed its fortifications before withdrawing. In 1828–29 the Russians again captured the town and held it until 1836. During the campaign of 1854 it was successfully defended against the Russians, but after being invested again in 1877 it was evacuated by the Turks. Silistra was assigned to Bulgaria in 1878, to Rumania in 1913 and to Bulgaria again in 1940

SILIUS ITALICUS (in full TIBERIUS CATIUS ASCONIUS SILIUS ITALICUS) (25 or 26–101), Latin epic poet, was the author of a long epic entitled *Punica,* an account in hexameter verse of the second war of the Romans against the Carthaginians (218–201 B.C.). Silius was an advocate of distinction in his early years, but he soon took to the public service and was consul in A.D. 68 (the year of Nero's death). His life thereafter is described by the younger Pliny in one of his letters: "he won repute by his proconsulship of Asia, and obliterated by the praiseworthy use he made of his leisure the stain he had incurred through his former exertions" (presumably as an assistant of Nero). "In dignity and contentment, avoiding power and therefore hostility, he outlived the Flavian dynasty, keeping to a private station after his governorship of Asia."

Silius was a rich man and able to indulge his tastes as a patron of literature and the arts. He so venerated both Virgil and Cicero that he bought for himself Virgil's tomb at Naples (which he restored) and Cicero's estate at Tusculum. In later life he imitated both, the former in writing epic, the latter in discussing philosophy with his friends, such as the poet Martial, Epictetus, who thought well of him as a philosopher, and Cornutus, the Stoic, who dedicated to him a commentary on Virgil. The Stoicism of Silius is not as marked in his epic as that of Lucan in his, but it is discernible, as one might expect, in a story of long and embittered warfare; and it was clearly to be seen in his life. for at the age of 75 he discovered that he was suffering from an incurable disease and starved himself to death.

The *Punica,* the only uork he is known to have committed to writing, is the longest epic in Latin literature, comprising over 12,000 lines. It deals with the second only of the Punic wars, though the story of Regulus (*q.v.*) appears in it as a digression. Silius draws heavily on the historian Livy for his material. For the most part he sticks well to his story and conscientiously describes all the six great battles of the war. The "details of slaughter" (as his translator J. D. Duff puts it) are often repulsive and the catalogues of armies monotonous. It is very imitative of Virgil's *Aeneid* both in its form and in its mythology. The gods take part, for example, and Juno frustrates the Romans just as she does the Trojans in the *Aeneid.* It lacks the poetry and the drama of Virgil, and the metre is monotonous and the style sometimes repetitive. The epic has indeed been harshly judged by its critics and has been rarely edited since the 18th century, but Silius can tell a story well and in simple language, far purer than the overdecorated style of other Latin poets of the Silver Age; and his accounts of military matters (*e.g.,* of the operations of siege engines) often bear the stamp of experience. His characters are mostly rather wooden, but his Hannibal is drawn with some dramatic skill and steals the place of hero from Scipio. Of the minor characters the best drawn are Fabius Cunctator, an evident copy of Lucan's Cato, and Paullus, the consul killed at Cannae.

The last three books show signs, as well they might, of fatigue; but posterity should be grateful for about half a dozen beautiful pieces of verse, mostly in dramatic scenes of war.

The poem was discovered in a manuscript in 1416 or 1417; from this manuscript, now lost. all existing manuscripts are derived. There were two *editiones principes* (1471). Other editions are by D. Heinsius (1600); J. C. T. Ernesti (1791); L. Bauer. "Teubner Series" (1890); J. D. Duff, with Eng. trans., "Loeb Series," 2 vol. (1934).

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(AN. K.)

SILK AND SERICULTURE. Silk is a fibrous substance produced by many insects. principally in the form of a cocoon or covering within which the creatures are enclosed and protected during the period of their principal transformations; the webs and nests, etc., formed by spiders are also of silk. But the fibres used for manufacturing purposes are exclusively produced by the mulberry silk-moth of China, *Bombyx mori,* and a few other moths closely allied to that insect.

History.—The silk industry originated in China; and according to native records it has existed there from a very remote period. The empress, known as the lady of Si-ling, wife of a famous emperor, Huang-ti (2640 B.C.), encouraged the cultivation of the mulberry tree, the rearing of the worms and the reeling of silk. This empress is said to have devoted herself personally to the care of silkworms, and she is by the Chinese credited with the invention of the loom. A voluminous ancient literature testifies to the antiquity and the importance of Chinese sericulture, and to the attention bestowed on it by royal and noble families. The Chinese guarded the secrets of their valuable art with vigilant jealousy; and there is no doubt that many centuries passed before the culture spread beyond the country of its origin. Through Korea a knowledge of the silkworm and its produce reached Japan, but not before the early part of the 3rd century. One of the most ancient books of Japanese history, the *Nihongi,* states that towards A.D. 300 some Koreans were sent from Japan to China to engage competent people to teach the arts of weaving and preparing silk goods. They brought with them four Chinese girls, who instructed the court and the people in the art of plain and figured weaving; and to the honour of these pioneer silk weavers a temple was erected in the province of Settsu. Great efforts were made to encourage the industry, which from that period grew into one of national importance. At a period probably a little later knowledge of the working of silk travelled westward, and the cultivation of the silkworm was established in India. According to a tradition the eggs of the insect and the seed of the mulberry tree were carried to India by a Chinese princess concealed in the lining of her head-dress. The fact that sericulture was in India first established in the valley of the Brahmaputra and in the tract lying between that river and the Ganges renders it probable that it was introduced overland from the Chinese empire. References in Sanskrit literature indicate however that a silk industry existed in India at about 1000 or possibly 4000 B.C. From the Ganges valley the silkworm was slowly carried westward and spread in Khotan, Persia and Central Asia.

Most critics recognize in the obscure word *d'wreseq* or *d'mesheq*, Amos iii. 12, a name of silk corresponding to the Arabic *dimaks*, late Greek μέταξα, English damask, and also follow the ancients in understanding *meshi*, Ezek. xvi. 10, 13, of "silken gauze." But the first notice of the silkworm in Western literature occurs in Aristotle, *Hist. anim.* v. 19 (1;), 11 (6), where he speaks of "a great worm which has horns and so differs from others. At its first metamorphosis it produces a caterpillar, then a bombylius and lastly a chrysalis—all these changes taking place within six months. From this animal women separate and reel off the cocoons and afterwards spin them. It is said that this was first spun in the island of Cos by Pamphile, daughter of Plates." Aristotle's vague knowledge of the worm may have been derived from information acquired by the Greeks with Alexander the Great; but long before this time raw silk must have begun to be imported at Cos, where it was woven into a gauzy tissue. the famous *Coa vestis*, which revealed rather than clothed the form.

Towards the beginning of the Christian era raw silk began to form an important and costly item among the prized products of the East which came to Rome. Allusions to silk and its source became common in classical literature; but, although these references show familiarity with the material. they are singularly vague and inaccurate as to its source; even Pliny knew nothing more about the silkworm than could be learned from Aristotle's description. The silken textures which at first found their way to Rome were necessarily of enormous cost, and their use by men was deemed a piece of effeminate luxury. From an anecdote of Aurelian, who neither used silk himself nor would allow his wife to possess a single silken garment, we learn that silk was worth its weight in gold. Notwithstanding its price and the restraints otherwise put on the use of silk the trade grew. Under Justinian a monopoly of the trade and manufacture was reserved to the emperor, and looms, worked by women, were set up within the imperial palace at Constantinople. Justinian also endeavoured, through the Christian prince of Abyssinia, to divert the trade from the Persian route along which silk was then brought into the east of Europe. In this he failed, but two Persian monks who had long resided in China, and there learned the whole art and mystery of silkworm rearing, arrived at Constantinople and imparted their knowledge to the emperor. By him they were induced to return to China and attempt to bring to Europe the material necessary for the cultivation of silk, which they effected by concealing the eggs of the silkworm in a hollow cane. From the precious contents of that bamboo tube, brought to Constantinople about the year 550, were produced all the races and varieties of silkworm which stocked and supplied the Western world for more than twelve hundred years.

The silkworm took kindly to its Western home and flourished, and the silken textures of Byzantium became famous. At a later period the conquering Saracens obtained a mastery over the trade, and by them it was spread both east and west—the textures becoming meantime impressed with the patterns and colours peculiar to that people. They established the trade in the thriving towns of Asia Minor, and they planted it as far west as Sicily, as Sicilian silks of the 12th century with Saracenic patterns still testify. Ordericus Vitalis, who died in the first half of the 12th century, mentions that the bishop of St. Evroul, in Normandy, brought with him from Apulia in southern Italy several large pieces of silk, out of the finest of which four copes were made for his cathedral chanters. The cultivation and manufacture spread northwards to Florence, Milan, Genoa and Venice—all towns which became famous for silken textures in mediaeval times. In 1480 silk weaving was begun under Louis XI at Tours, and in 1520 Francis I brought from Milan silkworm eggs, which were reared in the Rhone valley. About the beginning of the 17th century Olivier de Serres and Laffémas, somewhat against the will of Sully, obtained royal edicts favouring the growth of mulberry plantations and the cultivation of silk; but it cannot be said that these industries were firmly established before Colbert in the 17th century encouraged the planting of the mulberry by premiums, and otherwise stimulated local efforts.

Into England silk manufacture was introduced during the reign of Henry VI; but the first serious impulse to manufactures of that class was due to the immigration in 1585 of a large body of skilled Flemish weavers who fled from the Low Countries in consequence of the struggle with Spain then devastating their land. Precisely one hundred years later religious troubles gave the most effective impetus to the silk-trade of England, when the revocation of the Edict of Nantes sent simultaneously to Switzerland, Germany and England a vast body of the most skilled artisans of France. who planted in these countries silk-weaving colonies which are to this day the principal rivals of the French manufacturers. The bulk of the French Protestant weavers settled at Spitalfields, London—an incorporation of silk workers having been there formed in 1629. James I used many efforts to encourage the planting of the mulberry and the rearing of silkworms both at home and in the colonies. Up to the year 1718 England depended on the thrown silks of Europe for manufacturing purposes, but in that year Lombe of Derby, disguised as a common workman, and obtaining entrance as such into one of the Italian throwing mills, made drawings of the machinery used for this process. On his return, subsidized by the government, he built. and worked, on the banks of the Derwent, the first English throwing mill. In 1825 a public company was formed and incorporated under the name of the British. Irish and Colonial Silk Company, with a capital of £1,000,000, principally with the view of introducing sericulture into Ireland. but it was a complete failure, and the rearing of the silkworm cannot be said ever to have become a branch of British industry.

In 1522 Cortes appointed officials to introduce sericulture into New Spain (Mexico), and mulberry trees were then planted and eggs were brought from Spain. The Mexican adventure is mentioned by Acosta, but all trace of the culture had died out before the end of the century. In 1609 James I attempted to reinstate the silkworm on the American continent, but his first effort failed through shipwreck. An effort made in 1619 obtained greater success, and, the materials being present, the Virginian settlers were strongly urged to devote attention to the profitable industry of silk cultivation. Sericulture was enjoined under penalties by statute; it was encouraged by bounties and rewards; and its prosecution was stimulated by rhapsodical rhymes like the following:

> Where Wormes and Food doe naturally abound
> A gallant Silken Trade must there be found.
> Virginia excels the World in both—
> Envie nor malice can gaine say this troth!

Written instructions were sent to the colonists on the care of the worms, raising of trees and even an ingenious scheme for the creation of silkworms, from the putrefaction of a young calf. This description is given in a booklet published at London in 1620 with the title *Observations to be Followed, For the Making of Fit Roomes to Keepe Silk-wormes in: and For the Best Manner of Planting of Mulberry Trees, to feed them.* It concludes with the following exhortation:

"Meane while. with all speed make these timely and necessary prouisions aforesaid, for the ground-worke of the busines, as to plant store of the best Mulbery trees, in a good aire, in proper soyle, & fit distance, & dig store of holes in the ground betimes for the preparing of the earth, the better to plant the trees in: prouide also faire and fit middle lodgings for the Silk-wormes: for this delicate creature, which clothes Princes, and payes his charges so bountifully, cannot indure to bee lodged in bare and beggerly roomes, but in those that be large, sweet, neat. wel ayred and lightsome. It is a thing well knowne, that a few Silk-wormes, fed at large, and ease. make farre more silke than a greater number, pent in narrow and ill-fauoured roomes. No ill smels must come neere them, they must be kept sweet, and oft perfumed; therefore hauing such store of sweetwoods in Virginia as you haue there, you shall do well to make their roomes and tables of those woods: sweet sents being a thing most agreeable to them. Bee carefull to doe things curiously and thorowly well for them at the first, for your more plentifull and certaine gaine after: considering the charge to you is all one: and a thing once wel done, they say, is twice done, which will thereby also bring you twice double profit, with long continuance."

In the prospectus of Law's great *Compagnie des Indes Occidentales* the cultivation of silk occupies a place among the glowing attractions which allured so many to disaster. Onward till the period of the War of Independence bounties and other rewards for the rearing of worms and silk filature continued to be offered; and when the war broke out Benjamin Franklin and others were engaged in establishing a filature at Philadelphia. With the resumption of peaceful enterprise, the stimulus of bounties was again applied—first by Connecticut in 1783; and such efforts have been continued sporadically down almost to the present day. Bounties were offered by the State of California in 1865–1866, but the State law was soon repealed, and an attempt to obtain State encouragement again in 1872 was defeated. About 1838 a speculative mania for the cultivation of silk developed itself with remarkable severity in America. It was caused principally through the representations of Samuel Whitmarsh as to the suitability of the South Sea island mulberry (*Morus multicaulis*) for feeding silkworms; and so intense was the excitement that. plants and crops of all kinds were displaced to make room for plantations of M. *multicaulis*. In Pennsylvania as much as $300,000 changed hands for plants in one week and frequently the young trees were sold two and three times over within a few days at ever advancing prices. Plants of a year's growth reached the ridiculous price of $1 each at the height of the fever, which, however: did not last long, for in 1839 the speculation collapsed; the famous *M. multicaulis* was found to be no golden tree, and the costly plantations were uprooted.

Spasmodic efforts continued through the years but the next peak of interest came about following the tremendous increase in the use of silk after the World War. Raw silk values rose rapidly achieving the high price in the United States, the chief market, of $21.00 a pound in 1919 as contrasted with $3.64 in 1914. A new wave of interest in sericulture spread around the world. In the United States, intensive efforts were made in California to produce larger cocoons than those in the Orient and more frequent crops of cocoons than might be possible in a less favourable climate. The cocoons were raised and were of superior grade—but again the problem of reeling them into raw silk, on a commercial basis, proved the stumbling block of competition with the Orient. Some attempt was made to ship cocoons to Japan, but the commerce was not sufficiently developed to be successful on a wide scale. Other attempts in the United States were instigated by a promoter who not only sang the praises of meeting world competition on raw silk but also promised his clients special profits from producing a silk filament pre-coloured by injection of dyestuffs into the silkworm. Louisiana. Florida and Canada were the scenes of greatest activity among the buyers of the mulberry trees and the rainbow-hued silkworms. Newspaper accounts implied that fortunes were to be made and that, with the exception of the dyers who would find themselves without an occupation, the entire public would be grateful to the promoter. A year later, the investors were seeking buyers for their cocoons. None were found, and once more sericulture in the United States proved to be impractical.

In Persia, the venture assumed another role, that of acting as a substitute for the Persian poppy crop. The anti-narcotic division of the League of Kations pinned their hopes on the mulberry tree as a means of reducing the world output of opium. Persia, as one of the ancient homes of the silk industry, would have a natural aptitude for sericulture, it was thought, and the assistance of American silk manufacturers was sought in buying reeling machinery and employing skilled workers from France and Italy to teach the modern methods of raising and reeling silk. The Americans were already engaged in other fields and did not participate, but the industry was started. However. as in so many other cases, Persia found that producing the silk was only half the problem; the other half was the marketing of it. In 1939, Persian Government representatives presented to New York fabric dealers samples of plain and printed fabrics made in the factories of Iran (Persia) with the hope that the makers could share in the great dress market of the world but the exhibit, the type of fabrics and their styling, as well as the limited amount being made, did not result in any great show of interest on the part of potential buyers.

During this period, the American manufacturers returned to China, the original source of silk, and still the source of some of the strongest and best silk grown. The difficulty was the lack of modern methods of preparation for the user, the fabric manufacturer and the lack of standardization in the grades and quantities produced. To demonstrate the meaning of the modern requirements: the American silk industry subscribed a large sum of money to initiate the study of sericulture in three of the missionary colleges in China. Buildings were erected, land bought for mulberry orchards, modern laboratory equipment installed and courses of study established in the methods of raising and feeding worms so as to avoid disease and the consequent imperfect silk filament! in the proper sizing of the silk thread by efficient reeling, in the making of the size and type of skein required by high-speed modern looms, and in the conditioning and testing of the silk to determine its grade for the purchaser. It was thought by the Americans that the Chinese would be sufficiently interested to carry on the work when it had been demonstrated that the American market could be more equally shared with the Japanese if the methods were adopted. The Chinese, however, had found that they could sell their silk made in the accustomed manner to the European buyers who did not require the same high standard of efficiency as the Americans due to their less pressing high-wage problem and the use of older, slower looms. After a few years, the campaign was discontinued not only because of the results but also of the increasing domestic upheavals in China itself which resulted in disruption of many of the relationships so necessary to successful prosecution of the enterprise.

India was another experimental field. The Indian Government, especially at Mysore, evinced much interest in the educational work done by the Americans in providing the proper grade and adequate quantity of raw silk for the United States market. Similarly ambitious were officials in the Black sea area of Russia, in Greece, Spain and even South Africa but the American market continued to look mainly to China and Japan for its supplies and by 1936, United States Department of Commerce report on foreign commerce and navigation omits all mention of any of the smaller countries.

Raw silk can be profitably produced where there is not only low cost labour but labour working at low wages for long hours at a high degree of efficiency under modern conditions of factory organization, as evidenced in the success of the Japanese in capturing and maintaining the lion's share of the world markets.

The Silkworm.—The mulberry-feeding moth, *Bombyx mori*, which is the principal source of silk, belongs to the *Bombycidae*, a family of *Lepidoptera* in which are embraced some of the largest and most handsome moths. *B. mori* is itself an inconspicuous moth. of an ashy white colour, with a body in the case of the male not $\frac{1}{2}$in. in length. the female being a little longer and stouter. Its wings are short and weak; the fore pair are falcate, and the hind pair do not reach to the end of the body. The larva which is hairless. is of an ashy grey or cream colour, attains to a length of from 3 to $3\frac{1}{2}$in., and is slender in comparison with many of its allies. The second thoracic ring is humped, and there is a spine-like horn or protuberance at the tail. The common silkworm produces only one generation during the year where the seasons are defined: *e.g.*, Europe and the Near East; in Japan, the largest silk-producing country of the world, the race of silkworm is bivoltine, *i.e.*, reproduction takes place twice annually, while in parts of India and China reproduction is almost continuous and the races cultivated are called multivoltine; but the quality of the silk is in inverse ratio to the number of hatchings. The silkworm's natural food is the foliage of mulberry trees.

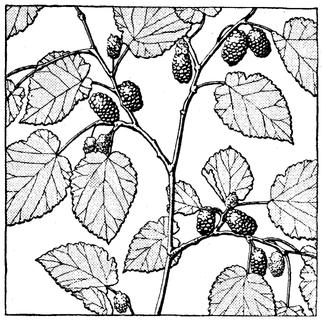
The silk glands or vessels consist of two long thick-walled sacs running along the sides of the body, which open by a common orifice—the spinneret or seripositor—on the under lip of the larva. As the larva approaches maturity these vessels become gorged with a clear viscous fluid, which, upon being exposed to the air immediately hardens to a solid mass. Advantage is taken of this peculiarity to prepare from fully developed larvae silkworm gut used for casting lines in rod-fishing. and for numerous other purposes where lightness, tenacity, flexibility and strength are essential. The larvae are killed and hardened by steeping some hours in strong acetic acid; the silk glands are then separated from the bodies, and the viscous fluid drawn out to the condition of a fine uniform line, which is stretched between pins at the extremity of a board. The board is then exposed to the sunlight till the lines dry and harden into the condition of gut. The preparation of gut is, however, merely an unimportant collateral manufacture. When the larva is fully mature, and ready to change into the pupa condition, it proceeds to spin its cocoon, in which operation it ejects from both glands simultaneously a continuous and reelable thread of 800 to 1,200yd. in length, moving its head around in regular order continuously for three days or thereabouts. The thread so ejected forms the cocoon, and consists of filaments seriposited from two separate glands. Two other glands, named after their discoverer the glands of Filippi, secrete a glutinous or resinous substance, which is believed to serve the double purpose of helping the thin viscous threads through the spinneret and causing the two filaments to adhere when brought into contact with the atmosphere.

Under the microscope cocoon silk presents the appearance of a somewhat flattened combination of twp filaments placed side by side, being on an average $\frac{1}{1,200}$ in. in thickness. The cocoons are white or yellow in colour, oviform in shape, and often with a constriction in the middle. According to race, etc.. they vary considerably in size and weight, but on an average they measure from an inch to an inch and a half in length. and from half an inch to an inch in diameter. They form hard, firm and compact shells with some straggling flossy filaments on the exterior, and the interior layers arc so closely and densely agglutinated as to constitute a parchment-like mass which resists all attempts at unwinding. The whole cocoon with its enclosed pupa weighs from 1 j grains for the smaller races to about 50 grains for the breeds which spin large cocoons. From 10 to 12 days after the completion of the cocoon the enclosed insect is ready to escape; it moistens one end of its self-made prison, thereby enabling itself to push aside the fibres and make an opening by which the perfect moth comes forth. The sexes almost immediately couple; the female in from four to six days lays her eggs, numbering 500 and upwards; and, with that the life cycle of the moth being complete, both sexes soon die.

SERICULTURE

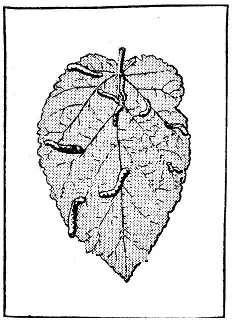
The art of sericulture concerns itself with the rearing of silkworms under artificial or domesticated conditions: their feeding, the formation of cocoons, the securing of these before they are injured and pierced by the moths, and the maturing of a sufficient number of moths to supply eggs for the cultivation of the following year. The first essential is a stock of mulberry trees adequate to feed the worms in their larval stage. The leaves preferred in Europe are those of the white-fruited mulberry, *Morus alba,* but there are numerous other species which appear to be equally suitable. The soil in which the mulberry grows: and the age and condition of the trees, are important factors in the success of silkworm cultivation; and it has been too often proved that the mulberry will grow in situations where, from the nature of the leaf the trees put forth and from other circumstances, silkworms cannot be profitably reared. An elevated position with dry, friable, well-drained soil produces the best quality of leaves. Throughout the East the species of mulberry cultivated are numerous, but, as these trees have been grown for special purposes at least for three thousand years, they show the complex variations peculiar to most cultivated plants.

Incubation and Rearing of Worms. — The eggs of the silkworm, called "silk-seed" (Fr. *graines*), are hatched out at the period when the mulberry buds are breaking into leaf. The hatching is natural where the climate is uniformly hot, but in countries where the silkworm has been introduced. artificial heat has to be applied to thr eggs. In many parts this is done by the primitive fashion of imparting to the seed the necessary heat by contact with the human body, but this gives an irregular and unduly protracted hatching. Simple incubators are now in use which make incubation regular, and the eggs all hatch out tonether, which is a great advantage from the point of view of economical feeding later on. The eggs are very minute — ahout 100 weighing a grain; and a vast number of hatched worms may at first be kept in a small space; but as the worms grow and require more and more leaves, the caterpillars require quickly increasing and ample space. The seed is distributed in perforated boxes to rearers, as it requires air all through the period of preservation until the worms are hatched. The boxes are opened and the seed is evenly spread on trays which are placed into the incubator; the lamp of the incubator is lit and the temperature is brought to 6j° F. This is gradually increased daily by about 2° until it reaches 77°, at which temperature hatching takes place. The trays are withdrawn from the incubator and perforated paper or open-mesh gauze is spread over the minute worms; mulberry leaves, now young and very tender. are finely chopped and spread over the paper or gauze; the little norms wriggle up through the holes and begin feeding The temperature of the room in which they are placed should be maintained at 77°. In more progressive countries. a special rearing house (Fr *magnanerie*) is allocated to the rearing of silkuorms; it may he used for other purposes during the remainder of the year provided it is swept clean, disinfected and lime-washed ready for the reception of the worms. In more backward places. the dwelling of the peasant rearer is utilized, but the same scrupulous disinfection and cleanliness should be observed, though this is often neglected with unfortunate effects on the worms and the rearer The place set apart for rearing should be well ventilated but not necessarily well lit indeed, it should be capable of shading the worms from the direct rays of the sun, which are detrimental to them.



BY COURTESY OF THE CORTICELLI SILK CO.
FIG I. — MULBERRY LEAVES, THE FAVOURITE FOOD OF SILKWORMS

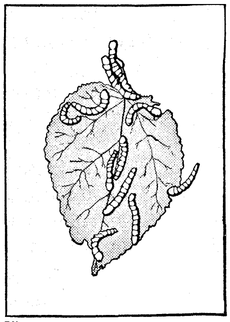
Though there are many methods of keeping the worms during feeding, the best is probably to erect shelves about three feet wide in the centre of the room so that there is a walking space between them and the walls all round and gangways intersecting them These shelves are constructed by means of light scantling from the floor to the ceiling with crozs-pieces at intervals of two feet, the lowest being two feet above the floor. Over the frame-nork thus created is laid large-mesh wire netting which, in this way, provides a series of shelves each two feet high Paper is spread over the wire and the norms are placed on this; the worms increase in size with astonishing rapidity and they are given more and more space in conformity with their growth. No less remarkable is their groning voracity. After three or four days they are sufficiently grown to be able to consume whole young leaves, and from this time onwards their powers of consumption run parallel with the maturity of the mulberry. The feeding lasts about 42 days, but during that time the norm passes through four periods of sleep lasting 24 hours each; some races have only three periods of sleep. but these are rare During this sleeping period the skin of the worm cracks and when the creature wakes up it is able to shed the old skin and continue with the new one. The importance of the regularity of hatching out now becomes apparent. The worms hatched out on the same day all sleep at the same time, and during the sleep do not require nourishment If, however, the hatching out is irregular, sleeping and active hungry worms are mixed up, with the risk either of a waste of mulberry



BY COURTESY OF THE CORTICELLI SILK CO.
FIG 2. — SILKWORMS SIX AND TEN DAYS OLD FEEDING ON A MULBERRY LEAF

leaf or of malnutrition of the active worms. Worms will not touch faded leaves; the latter must be green but very slightly wilted. The sleeping periods occur on the sixth, twelfth, eighteenth and twenty-sixth day after hatching. After the fourth sleep, the worms start their great and final feed. lasting for ten days during which period they consume about twenty times their own weight of leaves.

Laurent de l'Arbousset showed in 1905 that 1 oz. of seed of 30 grams producing 30,000 to 35,000 silkworms (30,000 may be depended upon to reach the cocoon stage) will give a harvest of 130 to 140lb. fresh cocoons and ultimate yield of about 12lb. raw silk properly reeled. The amount of nourishment required for this rearing is as follows:—hatching to first moult, about 9lb. of leaves of tender growth, equal to 40 to 45lb. ripe leaves; first to second moult, 24lb., representing 100lb. ripe leaves; second to third moult, 80lb., representing 240lb. ripe leaves; third to fourth moult, 236lb., representing 472lb. ripe leaves; fourth moult to mounting, 1,430lb., representing 1,540lb. ripe leaves, totalling to about one ton of ripe leaves for a complete rearing. The growth of the worms during their larval stage is stated by Count Dandolo to be as follows: the small, black, newly hatched worm weighs about one-hundredth of a grain, and is about one-twelfth of an inch long; when it has reached its full growth, the large white worm weighs about ten grains, and is more than three inches long. Or, in tabular form:

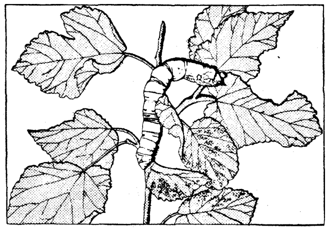


BY COURTESY OF THE CORTICELLI SILK CO.
FIG. 3.— WORMS ABOUT 18 DAYS OLD

	Weight per 100	Size in Lines
Worms newly hatched. . . .	1 gr.	1
After 1st moult	15 „	4
„ 2nd „	94 „	6
„ 3rd „	400 „	12
„ 4th „	1,628 „	20
Greatest weight and size . . .	9,500 „	40

The **Cocoons.**—The worms show that they are ready to spin their cocoons by raising the forepart of the body and waving it slowly from side to side. Provision is now made for the structure on which they can spin. This consists of "bushes" of scrub-oak or other many-branched shrub which are placed vertically in the centre of the shelves on which the worms have hitherto spent their lives. Obedient to the dictates of nature, the worms, now replete with glutinous fibre, mount up into the bushes and proceed to spin the cocoons around themselves. If they are overcrowded there is the danger of two worms combining to spin one cocoon; this latter is practically useless for making silk as the combined threads are inextricably mixed up and the cocoon is incapable of being. reeled into fine silk. After eight days, the bushes are removed from the shelves and the cocoons are picked off them. The importance of an even incubation is again demonstrated here, for if the hatch-out were irregular some worms would be ready to spin before others and the rearer would run the risk of taking down the bushes before all the worms had completed their spinning, resulting in some cocoons of inferior quality. On the other hand, the rearer dare not wait more than eight days, otherwise the chrysalis would complete its transformation and change into a moth which, in emerging from the cocoon, would cut through the silk fibres and destroy it for reeling purposes and thus render it practically valueless.

With the exception of those selected for reproduction of eggs, the cocoons are now treated so as to preserve them intact for reeling. The chrysalis must be killed without damage to the cocoon. The worm spins the cocoon with one continuous thread in a manner forming the figure 8, therefore the cutting of the cocoon at one end to allow the moth to escape means the cutting of the one continuous thread into many thousands of short ones and naturally makes it impossible to unwind ("reeling silk" is only another way of saying "unwinding cocoons"). The method adopted for killing the chrysalides is that of suffocation. Leaving cocoons exposed to the hot sun will suffocate the chrysalides, but it also hardens the gum in the thread, making unwinding difficult and wasteful, and withdraws to a certain extent the colour from yellow cocoons. Another method is suffocation by steam. The cocoons are placed in shallow drawers in a cupboard which is constructed over a common washing copper. The bottoms of the drawers are constructed so as to allow of steam percolating through them. A fire is lit below the cauldron, which is filled with water, and steam is generated. The cocoons remain in the steam from eight to ten minutes and the chrysalis is suffocated. The cocoons are then spread lightly on canvas beds. sheltered from the sun, but where air can circulate freely. They remain on the beds from six weeks to two months, during which time they require to be turned over twice daily to prevent heating and the dead chrysalis gradually dries up without becoming putrid. In this method there is the risk of either keeping the cocoons in the steam too long and damaging the fibre, rendering the thread brittle, or not keeping them long enough so that the chrysalis, which has marvellous powers of recovery, will complete its metamorphosis and the moth will cut through after all. The safest and most practical method is suffocation by hot air. *Séchoirs,* or dryers, are constructed to take a large quantity of cocoons at one charge, and air is fanned through a steam-coiled chamber rendering it about 200° F. The hot air circulates by means of channels through the chambers containing the cocoons, and the chrysalis is suffocated and all moisture in it dried up in one process of twelve hours' duration. The cocoons are put into sacks and stored without fear of deterioration. Exposure to air and wind. which also means exposure to dust and dirt, is unnecessary, and the colour of the silk when the cocoons are reeled is richer. while the water used in the reeling keeps clean.

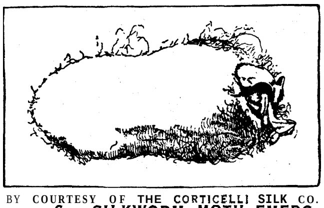


BY COURTESY OF THE CORTICELLI SILK CO.
FIG. 4.— A SILKWORM. ALMOST FULL GROWN, FEEDING

Selection of Eggs for Reproduction.—The promiscuous production of eggs for the following crop by the rearers is strongly to be discouraged and in many countries it is absolutely prohibited, because of the great risk of propagating diseases to which the silkworm is prone. Reproduction, if a virile and healthy race of worm is to be preserved, must be under the supervision of experts. These experts choose rearers who are known to be extremely adept at cocoon-raising and give them specially selected eggs, each separate laying of nhich has been microscopically examined for the presence of disease. These eggs are known as "cellular seed." The experts pay periodical visits to the *magnanerie* during the rearing to examine the condition of the worms and take away any of doubtful appearance for microscopic examination. If the rearing is entirely successful and no trace of disease is found, the cocoons are taken to the "seed station," where they are examined. Ill-formed or imperfect cocoons are sent to be stifled and the selected ones are threaded together into long ropes and suspended from the ceiling to within a foot of the floor. In due course the moths emerge from the cocoons, mating takes place and the female is placed in a small linen bag, about 2in. square, which has been washed and disinfected; the mouth is tied up and these bags are strung together and suspended from the ceiling of another room. The female lays its eggs in the bag and dies. The males, after two or three matings, are destroyed. This part of the process is carried on until the cocoon crop is at an end. The ratio of reproduction is about 250 to 1, so the seed stations require about 1,000lb. of cocoons for seed for a crop of 25,000lb. of cocoons the next season.

BY COURTESY OF THE CORTICELLI SILK CO.
FIG. 5.—A SILKWORM MOTH EMERGING FROM ITS COCOON (FRONT VIEW)

As soon as the mating is over, work is begun on the microscoping of the seed which has been laid. In the case of selection for cellular seed, each bag is emptied of its contents, the seed is washed in water to free it from the remains of the dead female and a few seeds are crushed and placed on a slide for examination. If the microscope tells no tale of disease, that particular laying is passed. If traces of disease are found, the bag and its contents are burned. In the case of seed not to be used for reproduction but only to be distributed for producing cocoons for silk, called industrial seed, each rearing is kept separate and the contents of all the bags of one rearing are emptied out together. This heap of seed is washed as before, is well mixed and half a dozen samples are taken, crushed and examined as before. If disease is detected, further samples are taken to determine the extent of it. If not more than 5% of disease is apparent, the rearing passes; if more, it is entirely destroyed. In this way all the eggs are gradually cleared through the microscoping room, a further washing takes place and, after the seed is dry, it is done up in small gauze bags in weights of 1 oz., $\frac{1}{2}$ oz. and $\frac{1}{4}$ oz. These, in turn, are placed in perforated cardbcard boxes and are ready for distribution to rearers the following season, the cellular seed being kept separate for selected rearers for a further cycle of reproduction.



BY COURTESY OF THE CORTICELLI SILK CO.
FIG. 6.—SILKWORM MOTH EMERGING FROM ITS COCOON (SIDE VIEW)

The expert's task is not finished with the production of sound and healthy seed. He is also concerned with the cross-breeding of different varieties with a view to a higher yield of silk in the cocoons for reeling, to creating hardier races for different conditions of climate, to improving the cocoons of one part of the world by crossing the moths with those from another — an endless succession of problems for the propagation of sericulture in general.

DISEASES

That the silkworm is subject to many serious diseases is only to be expected of a creature which for upwards of 4,000 years has been propagated under purely artificial conditions, and these most frequently of a very insanitary nature, and where not the healthy life of the insect, but the amount of silk it could be made to yield, was the object of the cultivator. Among the most fatal and disastrous of these diseases with which the cultivator had long to grappie was "muscardine," a malady due to the development of a fungus, Botrytis *bassiana,* in the body of the caterpillar. The disease is peculiarly contagious and infectious, owing to the development of the fungus through the skin, whence spores are freed, which, coming in contact with healthy caterpillars, fasten on them and germinate inwards, giving off corpuscles within the body of the insect. Muscardine, however, has not been epidemic for many years.

The Pebrine Epidemic. — About the year 1853 anxious attention began to be given in France to the ravages of a disease among silkworms. This disease, which at a later period became known as *pebrine*—a name given to it by De Quatrefages, one of its many investigators — had first been noticed in France at Cavaillon in the valley of the Durance near Avignon. Pebrine manifests itself by dark spots in the skin of the larvae; the eggs do not hatch out, or hatch imperfectly; the worms are weak, stunted and unequal in growth, languid in movement, fastidious in feeding; many perish before coming to maturity; if they spin a cocoon it is soft and loose, and moths when developed are feeble and inactive. When sufficient vitality remains to produce a second generation it shows in increased intensity the feebleness of the preceding. The disease is thus hereditary, but in addition it is virulently infectious and contagious. From 1850 onwards French cultivators were compelled, in order to keep up their silk supply, to import graine from uninfected districts. The area of infection increased rapidly, and with that the demand for healthy graine correspondingly expanded, while the supply had to be drawn from increasingly remote and contracted regions. Partly supported by imported eggs. the production of silk in France was maintained. and in 1853 reached its maximum of 26,000,000 kilos of cocoons. valued at 117,000,000 francs. From that period, notwithstanding the importation at great cost of foreign graine, reaching in some years to 60,000 kilos, the production of silk fell off with startling rapidity: in 1856 it was not more than 7,500,000 kilos of cocoons; in 1861 and 1862 it fell as low as 5,800,000 kilos; and in 1865 it touched its lowest weight of about 4,000,000 kilos. In 1867 De Quatrefages estimated the loss suffered by France in the 13 years following 1853, from decreased production of silk and price paid to foreign cultivators for graine, to be not less than one milliard of francs. In the case of Italy, where the disease showed itself later but even more disastrously, affecting a much more extended industry, the loss in 10 years De Quatrefages stated at two milliards. A loss of £120,000,000 sterling within 13 years, falling on a limited area, and on one class within these two countries, constituted indeed a calamity on a national scale, calling for national effort to contend with its devastating action. The malady, moreover, spread eastward, and, although it was found to be less fatal in Oriental countries than in Europe, the sources of healthy graine became fewer and fewer, till only Japan was left as an uninfected source of European graine supply.

A scourge which so seriously menaced the very existence of the silkworm in the world necessarily attracted a great amount of attention. As early as 1849 Guérin Méneville observed in the blood of diseased silkworms certain vibratory corpuscles, but neither did he nor the Italian Filippi, who studied them later, connect them distinctly with the disease. The corpuscles were first accurately described by Cornalia, whence they are spoken of as the corpuscles of Cornalia. The French Academy charged De Quatrefages, Decaisne and Péligot with the study of the disease, and they issued two elaborate reports—*Études sur* les maladies *actuelles* des vers a soie (1859) and *Nouvelles Recherches sur* les maladies *actuelles* des vers *à* soie (1860); but the suggestions they were able to offer had not the effect of stopping the march of the disease. In 1865 Pasteur undertook a government commission for the investigation of the malady. Attention had been previously directed to the corpuscles of Cornalia. and it had been found. not only that they occurred in the blood, but that they gorged the whole tissues of the insect, and their presence in the eggs themselves could be microscopically demonstrated. Pasteur established (1) that the corpuscles are the special characteristic of the disease, and that these invariably manifest themselves, if not in earlier stages, then in the mature moths; (2) that the corpuscles are parasites, and not only the sign but the cause of the disease; and (3) that the disease manifests itself by heredity, by contagion with diseased worms, and by the eating of leaves on which corpuscles are spread. In this connection he established the very important practical conclusion that worms which contract the disease during their own life-cycle retain sufficient vitality to feed, develop and spin their cocoon, although the next generation is invariably infected and shows the disease in its most virulent and fatal form. This fact. however, enabled the cultivator to know with assurance whether the worms on which he bestowed his labour would yield him a harvest of silk. He had only to examine the bodies of the moths yielding his graine: if they were free from disease then a crop was sure; if they were infected the education would assuredly fail.

Pasteur brought out the fact that the malady had existed from remote periods and in many unsuspected localities. He found corpuscles in Japanese cocoons and in many specimens which had been preserved for lengthened periods in public collections. Thus he came to the conclusion that the malady had been inherent in many successive generations of the silkworm, and that the epidemic condition was only an exaggeration of a normal state brought about by the method of cultivation and production of graine pursued. The cure proposed by Pasteur was simply to take care that the stock whence graine was obtained should be healthy, and the offspring would then be healthy also. Small educations reared apart from the ordinary magnanerie, for the production of graine alone, were recommended. At intervals of five days after spinning their cocoons specimens were to be opened and the chrysalides examined microscopically for corpuscles. Should none have appeared till towards the period of transformation and escape of the moths, the eggs subsequently hatched out might be depended on to yield a fair crop of silk; should the moths prove perfectly free from corpuscles after depositing their eggs the next generation would certainly live well through the larval stage. For special treatment towards the regeneration of an infected race, the most robust worms were to be selected, and the moths issuing from the cocoons were to be coupled in numbered cells, where the female was to be confined till she deposited her eggs. The bodies of both male and female were to be examined for corpuscles, and the eggs of those found absolutely free from taint were preserved for similar "cellular" treatment in the following year. By this laborious and painstaking method it has been found possible to re-establish a healthy stock of valuable races from previously highly infected breeds. The rearing of worms in small educations under special supervision has been found to be a most effective means of combating pebrine. In the same way the rearing of worms for graine in the open air, and under natural conditions as far as possible, has proved equally valuable towards the development of a hardy, vigorous and untainted stock. The open-air education was originally proposed by Chavannes of Lausanne, and largely carried out in the canton of Vaud by Roland, who reared his worms on mulberry trees enclosed within "manchons" or cages of wire gauze and canvas. The insects appeared quickly to revert to natural conditions; the moths brought out in open air were strongly marked, lively and active, and eggs left on the trees stood the severity of the winter well, and hatched out successfully in the following season. Roland's experience demonstrated that not cold but heat is the agent which saps the constitution of the silkworm and makes it a ready prey to disease.

Other **Diseases.**—*Grasserie* is another form of disease incidental to the silkworm. It often appears before or after the first moult, but it is only after the fourth that it appears in a more developed form. The worm attacked presents the following symptoms: the skin is distended as if swollen, is rather thin and shiny, and the body of the worm seems to have increased, that is, it suffers from fatness, or is *engraissé*, hence its name. The disease is characterized by the decomposition of the blood; in fact it is really a form of dropsy. The blood loses its transparency and becomes milky, its volume increases so that the skin cannot hold it, and it escapes through the pores. This disease is more accidental than contagious and rarely takes very dangerous proportions. If the attack comes on a short time before maturity, the worms are able to spin a cocoon of a feeble character, but worms with this disease never change into chrysalides, but always die in the cocoon before transformation can take place. The causes which produce it are not well known, but it is generally attributable to currents of cold and damp air, to the use of wet leaves in feeding, and to sudden changes of temperature.

Another cause of serious loss to the rearers is occasioned by *flacherie,* a disease well known from the earliest times. Pasteur showed that the origin of the disease proceeded from microscopic organisms called ferments and vitrios. One has only to ferment a certain quantity of mulberry leaves, chop them up and squeeze them, and so obtain a liquid, to find in it millions of ferments and vitrios. It invariably occurs during the most active period of feeding, three or four days after the fourth moult up to the rising, and generally appears after a meal of coarse leaves, obtained from mulberries pruned the same year and growing in damp soil. It can also occur from the feeding of damp leaves, *e.g.,* leaves wetted by rain, to the worms or from leaves too freshly plucked and not allowed to wilt slightly. *Flacherie* is an intestinal disease of the cholera species and therefore contagious. The definite course is not occasioned so much from the ferments which exist in the leaves themselves, but from an arrest of the digestive process which allows the rapid multiplication of the former in the Intestines. Good ventilation is indispensable to allow the worm to give out by transpiration the great quantity of water that it absorbs with the leaf. If this exhalation is stopped or lessened the digestion in its turn is also stopped, the leaf remains longer than usual in the intestines, the microbes multiply, invading the whole body, and this brings about sudden death. The true remedies consist in the avoidance of the fermentation of the leaves by careless gathering, transport or packing, in proper hygienic care in ventilation and in maintaining a proper degree of dryness in the atmosphere in rainy weather, and in the use of quicklime to facilitate the transpiration of the silkworms.

WILD SILKS

The ravages of pebrine and other diseases had the effect of attracting prominent attention to the numerous other insects, allies of the mulberry silkworm, which spin serviceable cocoons. It had been previously pointed out by Captain Hutton, who devoted great attention to the silk question as it affects the East Indies, that at least six species of *Bombyx,* differing from *B. mori,* but also mulberry-feeding, are more or less domesticated in India. These include B. *textor,* the boropooloo of Bengal, a large species having one generation yearly and producing a soft flossy cocoon; the Chinese monthly worm, *B. sinensis,* having several generations, and making a small cocoon; and the Madrasi worm of Bengal (B. *croesi),* the Dassee or Desi worm of Bengal (*B. fortunatus)* and *B. arracanensis,* the Burmese worm—all of which yield several generations in the year and form reelable cocoons. Besides these there are many other mulberry-feeding *Bombycidae* in the East, principally belonging to the genera *Theophila* and *Ocinara,* the cocoons of which have not attracted cultivators. The moths yielding wild silks which have obtained most attention belong to the extensive and handsome family *Saturniidae.* The most important of the species at present (1940) is the Chinese tussur or tasar worm, *Antheraea pernyi,* which is an oak-feeding species, native of Mongolia, from which is derived the greater part of the so-called tussur silk imported into Europe. Closely allied to this is the Indian tussur moth, *Antheraea mylitta,* found throughout the whole of India feeding on the bher tree, *Zizyphus jujuba,* and also on many other plants. It yields a large compact cocoon of a silvery grey colour, which Sir Thomas Wardle of Leek, who devoted a great amount of attention to the wild-silk question, succeeded in reeling Next in promising qualities is the muga or moonga worm of Assam, *Antheraea assama,* a species to some extent domesticated in its native country.

The yama-mai worm of Japan, *Antheraea (Samia) yama-mai,* an oak-feeder, is a race of considerable importance in Japan, where it was said to be jealously guarded against foreigners. Its eggs were. first sent to Europe by Duchêne du Bellecourt, French consul-general in Japan in 1861; but early in March following they hatched out, when no leaves on which the larvae would feed were to be found. In April a single worm got oak-buds, on which it throve, and ultimately spun a cocoon whence a female moth issued, from which Guérin Méneville named and described the species. A further supply of eggs was secretly obtained by a Dutch physician Pompe van Meedervoort in 1863, and, as it was now known that the worm was an oak-feeder, and would thrive on the leaves of European oaks, great results were anticipated from the cultivation of the yama-mai. These expectations, however, for various reasons, have been disappointed. The moths hatch out at a period when oak leaves are not ready for their feeding, and the silk is by no means of a quality to compare with that of the common mulberry worm. The mezankoorie moth of the Assamese, *Antheraea mezankooria,* yields a valuable cocoon, as does also the Atlas moth, *Attacus atlas,* which has an omnivorous larva found throughout India, Ceylon, Burma, China and Java. The Cynthia moth, *Attacus cynthia,* is domesticated as a source of silk in certain provinces of China, where it feeds on the *Ailanthus glandulosa.* The eria or arrindi moth of Bengal and Assam, *Attacus ricini,* which feeds on the castor-oil plant, yields seven generations yearly, forming loose flossy orange-red and sometimes white cocoons. The ailanthus silkworm of Europe is a hybrid between *A. cynthia* and *A. ricini,* first obtained by Guérin Méneville, and now spread through many silk-growing regions. These are only a few of the moths from which silks of various usefulness can be produced; but none cf these presents qualities, saving perhaps cheapness alone, which can put them in competition with common silk.

A wild silk which has entered the market since the beginning of the 20th century is Anaphe. It-is found in West and East Africa. The worms combine to make large nests of cocoons with a strong outer protecting covering, tough as parchment. A peculiar and unpleasant quality of this species is the presence of hairs of a somewhat poisonous nature which bring out a rash on the skin when the nests are handled. Chemical treatment before handling has'eliminated this trouble, but progress with the utilization of this silk is slow. It first began to attract attention in Germany in 1913 but its experimental stage was held up until 1920. At first, the outer cover was thrown away and the internal cocoons were treated, but it has since been found that the outer cover is the more valuable and the internal cocoons hardly worth the trouble of working. Natives use the nests for the manufacture of their blankets but its economic usefulness in Europe has still to be proved. The systematic planting of the bush on which the Xnaphe worm feeds would also be indicated if there is to be a constant and cheaper supply of this material.

PHYSICAL AND CHEMICAL PROPERTIES OF SILK

Common cocoons *(Bombyx mori)* enclosing chrysalides weigh each from 0·4 to 2 grams, *i.e.,* there are from 300 to 600 to the pound, for small breeds. and 270 to 300 for large breeds. About one-sixth of this weight is silk and of that one-half can be reeled, the remainder which cannot be reeled consisting of surface floss or blaze and the husk of the chrysalis. It is therefore difficult to estimate the total length of thread produced by the silkworm or even that of the portion reeled. which varies in length and thickness according to the condition and robustness of the cocoon and may be joo metres in some breeds and in others 900 to 1,200 metres. It has been estimated that one pound of raw silk requires from 2,100 to 3.000 cocoons. Under favourable conditions 11 kilograms of fresh cocoons may give 1 kilogram of raw silk for commerce and about the same quantity of waste silk for spinning. The thread is usually thicker and stronger towards the middle of the reeled portion than at the extremities. The mean diameter of the cocoon thread or bave which is composed of two filaments of different specimens of mulberry silk was found at the Lyons laboratory to vary from 0·00180 to 0·0033cm.; the bave of wild silks from 0.0030 to 0·0070 centimetre. The denier or weight in grams of 9,000 metres of the bave of mulberry silk varies from 1.8 to 3.8. and that of the bave of the Anthers (wild silks) from 3 to 8 deniers.

The raw silk fibre *(see* FIBRES) consists essentially of two cores of *fibroin* cemented together and covered with *sericin* or silk albumen, besides small quantities of waxy and colouring matters. The ultimate filaments of fibroin, which constitute about 70 to 80% of drv. raw mulberry silk have in bulk, after removal of the gum, the characteristic soft white appearance and pearly lustre of pure silk. Under the microscope the filaments appear smooth and rod-like and. when examined by polarized light, show the colours given by doubly refracting substances; their cross-section is roughly triangular (maximum diameter, 0.0023 to 0·0014cm.; minimum diameter, 0·0018 to 0·0009cm.). The filaments have great tensile strength (3 to 5×10^9 dynes per sq.cm.) extending considerably before breaking, and show true elastic effects under limited stresses (Young's modulus, 0.4 to $0{\cdot}8 \times 10^{11}$ and rigidity, 0.2×10^{11} dynes per sq.cm. under ordinary conditions). In fact, silk is said to have almost the equivalent tensile strength of iron wire; that of the wire being 90,000lb. per sq.in. and that of silk 64,000. Its elasticity is also a remarkable characteristic. An elasticity of 20% means that the silk fibre can be stretched one-fifth of its original length and when released will return to its natural state. To the two properties of tensile strength and elasticity silk owes much of its excellence as a textile material, especially in the making of women's hosiery. The density of silk fibres is about 1·3, refractive index 1·5, and specific heat 0·3 calories per gram. The low electrical conductivity of fibroin. utilized in the employment of silk for electrical insulation, may cause a troublesome electrical excitation of the fibres during manufacturing processes in a dry atmosphere. Its thermal conductivity also is low. Under ordinary atmospheric conditions fibroin contains about 11% of its dry weight of hygroscopic moisture which may be removed by heating it at 105° C. It is insoluble but swells slightly in water, alcohol, benzene and other organic liquids.

Fibroin is an amphoteric colloid and belongs to the chemical class of proteins; the formula $C_{15}H_{23}N_5O_6$ sometimes assigned to it should be taken to be no more than an approximate expression of its elementary composition. The X-ray method of examination indicates the possible presence in fibroin of a crystalline constituent, and there is some chemical evidence that fibroin is chemically heterogenous. It dissolves in the cold in concentrated solutions of the mineral acids or of the caustic alkalies, and in an ammoniacal solution of copper oxide; from all these solutions it may be reprecipitated in a more or less altered form when the solution is neutralized. but, owing to more far-reaching changes, not after long standing. When heated, fibroin melts and burns giving a smell of burned feathers which serves to distinguish it from the vegetable fibres. including artificial silk. It may be distinguished from wool by its microscopical appearance and by chemical tests. The ultimate filaments of the wild silks are thicker and more ribbon-shaped than those of mulberry silk and exhibit longitudinal striations along which the filaments tend to split into fibrillae under any mechanical or chemical action; the fibroin of the wild silks possesses properties similar to those of mulberry fibroin but is more resistant to chemical action. Sericin, also a protein, is more active chemically than fibroin: from which it may be separated by the solvent action of hot water. best under pressure, or of acid or alkaline solutions. Its hot aqueous solution gelatinizes on cooling. Its elementary composition is similar to that of fibroin but it contains more oxygen; like fibroin it may be chemically heterogenous. The colouring matter of yellow silk is probably *carotene* or a related substance.

Silk has great power of absorption. Its brilliant colours are due to a greater capacity of absorption toward colouring matters in general than perhaps any other fibre. It also absorbs dyestuffs at much lower temperatures than does wool. So great are its powers of absorption that its weight can be increased as much as 30% in moisture without any change in appearance. In order to prevent fraud by shipping raw silk to which moisture was added by the seller to secure a greater return on the poundage sold. an international standard of 11% was established many years ago as the permissible limit of "regain" in moisture over the dry weight.

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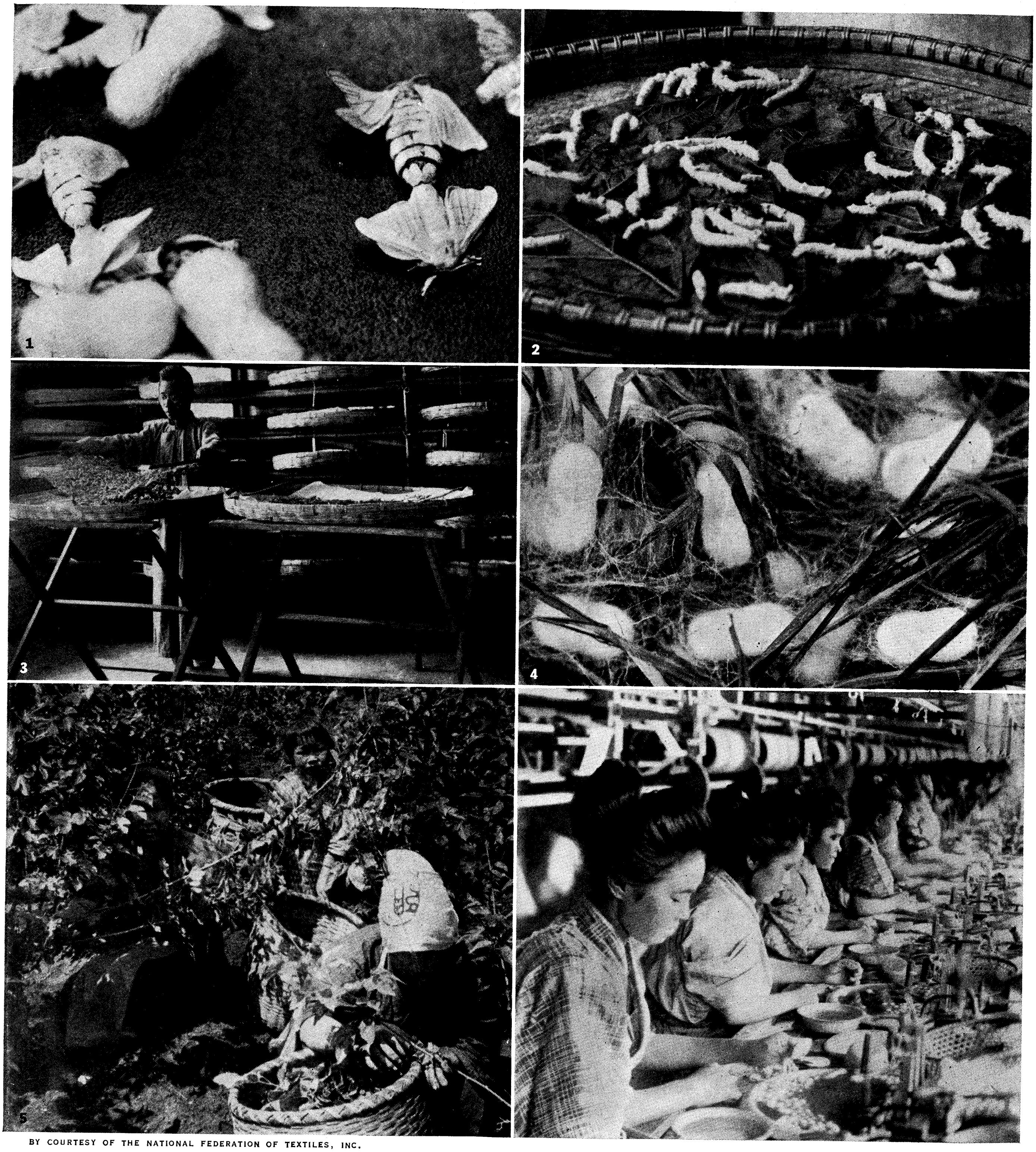
(N. BR.; F. WA.; W. S. DE.; I. L. BL.)

SILK MANUFACTURE. In discussing silk manufacture, it is necessary to distinguish between the preparation of the silk cocoons (the process called reeling) and the manufacture of productz made from the threads after reeling. Both are referred to as silk manufacture although the term popularly refers to the fabricated product. rather than to the thread or yarn, which is termed raw silk. Another exception is the waste or by-product of the cocoons which is shipped to the silk manufacturing countries for spinning into a special yarn termed spun silk. The process used resembles cotton or wool spinning methods rather than silk reeling. Raw silk is the commonest used form for industrial yarns.

Filature or **Reeling.**—When the cocoons have been gathered and the enclosed chrysalides stifled. they are sorted for reeling. Doubles (cocoon. made by two worms in conjunction). pierced cocoons and any from other causes rendered unreelable are put aside for spun silk. The object of reeling is to bring together the filaments from tno or more (generally five or six. but sometimes up to 20) cocoons, and to form them into the one continuous. uniform and regular strand (finer than human hair) which constitute.: the commercial raw silk. To do this, the natural gum of the cocoons which holds the filaments together is softened by boiling 10 to 12 min. The ends of the filaments are caught. and unnound and laid



CULTURE OF SILKWORMS

1. Breeding of the male and female silk moths
2. Full-grown silkworms feeding on mulberry leaves
3. Cleaning the feeding trays. Student at the University of Nanking using net type of lining on feeding tray, thus saving time and labour
4. Close-up view of silkworms spinning cocoons. The outside fibre Is removed and used as waste silk
5. Gathering mulberry leaves in a Japanese orchard. Only the tenderest and freshest leaves can be used
6. Modern silk reeling in a Japanese filature. The cocoons are placed in basins of hot water and the silk thread is wound up over the heads of the workers onto the reel in back of them. Size of the thread varies with the number of cocoon filaments run at ore time

together, so as to form a simple uniform rounded strand of ram silk. This extremely delicate reeling process is particularly suited to female labour. The establishment in which it is done is called a filature. and may contain 20 to 300 reeling basins.

A six-filament silk thread is scarcely visible. and yet can easily stand most strains imposed by the manufacturing process. A good silk stretches about one-third of its own length before breaking. During the reeling process. of course. breaks do occur continually, so the reeler must watch carefully and as soon as a break is detected supply a reserve thread which is kept ready. A break of one filament in a thread of six will be rectified by a first-class reeler within half a yard of thread. An unheeded break means a thin spot in the completed thread and shows as a ring or uneven shading in hosiery or fabric.

When the skeins of silk are removed from the reels. they are twisted and packed into small bundles called books. These books or hundles are packed to form a bale weighing about 133 lbs.

Silk Waste.—The term silk waste includes all kinds of unwindable raw silk which is unsuited to the throwing process. Before the introduction of machinery for spinning silk waste. the refuse from reeling and silk winding was nearly all destroyed as being useless. The exception was that which could be hand-combed and spun by means of the distaff and spinning wheel, a method which is still practised by some of the peasantry in India and other eastern countries.

Waste silk is supplied principally by the following sources: (1) The silkworm, when commencing to spin, emits a lustreless and uneven thread which is unreelable. (2) The extreme outside and inside layers of each cocoon are put aside as waste. (3) Pierced cocoons (those from which the moth has emerged). (4) During the reeling process the silk often breaks; and both in finding a true and reelable thread, and in joining the ends, there is unavoidable waste.

This waste silk, packed in bales of various sizes and weights, is a much-tangled mass of all lengths of fibre mixed with much foreign matter, such as ends of straws. twigs. leaves. worms and chrysalides. It is straightened out as fibres, with the aid of machinery, then joined to become the thread known as spun silk.

There are two distinct kinds of spun silk—one called schappe containing as much as 20% of the original silk gum "sericin" and the other spun silk which is entirely free of the gum.

The combings left after the processing of the spun silk fibres are called noils. They are used in spinning short fibres.

Growth of Industry and Uses of Spun Silk.—Spun silk is pure silk just as much as raw silk. Before the introduction of synthetic fibres such as nylon, the yarn was used widely for sewing thread. elastic webbing, lace, plush and for novelty yarns in combination with wool and rayon for use in men's clothing fabrics, upholstery materials, etc. During World War I millions of yards of cartridge bag cloth were woven of spun silk. Until the development of nylon and similar fibres only pure silk proved satisfactory for the bags, as it was necessary to have complete destruction occur when the gun was fired to avoid a backfire from burning ash when the next charge was inserted. To a large extent, rayon and spun rayon supplanted spun silk yarns in the making of plushes and velvets and by the latter 1950s there was only a limited market for the yarn.

Throwing.—Raw silk, being too fine and delicate for ordinary use. as received from the reeling machine undergoes a series of operations called throwing, the object of which is to twist and double it into more substantial yarn. It is as raw silk that the thread is shipped to the principal textile manufacturing countries—the United States. France, England and Italy.

The word throwing originated with the old Anglo-Saxon term *thrawan*, meaning "to twist." The man engaged in such work is known as a throwster and the product is termed thrown silk.

In the United States, throwing is a service performed chiefly by the commission throwster—one who will prepare for a fixed price per pound the raw silk sent him by the owner. Some throwsters buy the raw silk direct from the importers, throw it and sell the thrown silk to manufacturers of fabrics or hosiery. The silk is shipped on spools or cones, the latter for the hosiery trade. It also may be shipped as skeins. and prior to mid-20th century. silk fabrics were woven only from dyed yarn skeins. The development of crepe fabrics following World War I changed this practice, crepe yarns being dyed after woven into fabric. This can he understood by taking a tightly twisted piece of thread and attempting to make it lie straight. The resulting snarl demonstrates the necessity of winding crepe threads directly onto a spool or bobbin and waiting until the thread is woven into a fabric before it is dyed. This dyeing process is termed piece dye.

It is in the throwing process that raw silk shows itself different from other textiles. The thread. one continuous strand, does not need the combing and preparation required by the shorter fibres of cotton and wool. The only refining needed before weaving is that of producing different effects in the finished fabric by twisting the silk thread to varying degrees. In weaving some fabrics, no throwing is required.

In the crepes, however. silks are thrown and the types produced are organzine. crepe, tram and singles. Crepe is customarily spoken of as a separate type although technically it is organzine with a higher number of turns per inch: 40 to 80. Organzine is the result of doubling two or more threads, previously twisted as single threads and twisting them in the opposite direction 8 or 10 turns to the inch. This type of yarn is used chiefly for the warp or lengthwise thread. Tram, on the other hand, is used for the filling or crosswise thread and begins with the raw silk thread without doubling. Two or more threads are twisted together with a few turns per inch. Singles are the raw silk threads both twisted and untwisted. When twisted hard (hard twist). the yarn is used for making chiffons and other sheer fabrics.

Throwing, considered the least skilled operation in the manufacture of silk, employs chiefly women workers and is done in areas where a plentiful supply of relatively unskilled labour is available and power is cheap.

Raw silk is shipped to the throwing mill in the original bales. The bales are opened and the skeins are checked as to weight and quality and tagged with the name of the owner. The next step is soaking the skeins overnight in warm, oily (usually olive oil) soapsuds, to soften the natural gum. This done, the skeins are removed. dried and placed on reels or swifts. Then comes the winding process; that is, the silk is wound off the reels onto spools or bobbins about four or five inches long. The bobbins are wound with a rapid reciprocating motion, so as to lay the fibre in diagonal lines. In crepe weaves. the filling is made from alternating twists of hard-twist tram. The crepe effect is achieved by the contrary pull of the two tightly twisted threads. The weaver must know the direction in which the threads have been twisted—left or right. For easier identification, the throwster tints the threads a colour designated by his customer for the left and the right. These colours are known as fugitive tints as they must completely disappear in the boiling-off of the woven fabric before dyeing. If skeins are ordered, each is carefully divided into small sections by interlacing cotton threads to prevent tangling of the yarn in handling. Bobbins or cones are packed carefully and shipped in boxes or cases. Most thrown silk is shipped in this way rather than in skeins.

Weaving.—Silk looms are the same as those for other textiles; plain, box and Jacquard. In general, the plain looms weave the flat fabrics such as taffetas, linings, etc.; the box looms make the crepes and novelties; and the Jacquard loom is the intricate mechanism that weaves elaborate designs for damask, brocade and lamé. Silk looms have many contrivances to give smoothness to the weaving and regulate the tension on the fine threads. Ends and rough spots that would be relatively unimportant in cotton or wool weaving had to be eliminated in the silk weaving. For many years, the use of the hand loom in silk weaving was considered necessary.

This prejudice for the hand-made article was not unique to the silk industry however. It was paralleled in many other fields. Machine-made silks have resulted in a greater degree of perfection and lower cost, which in turn created an increased demand.

The weaves most closely identified with silk are taffeta, satin. chiffon and crepe. In the U.S., public acceptance of these weaves as synonymous with silk resulted in rulings by the Federal Trade commission that, regardless of the fact that originally the words were descriptive of a method of weaving or construction of weave. their use on anything but silk products must be accompanied by a qualifying description of the fibres substituted for silk. Technically, the words are applied to fabrics of any fibres as long as they are made in the method designated as taffeta. satin, etc.

Taffetas are the basic plain weaves. and comprised most of the silks of past generations. Satins were next in popularity. because the high lustre of silk was especially adaptable to the method of weaving that brings the filling thread on the surface of the material rather than the simple in-and-out movement of the taffeta. Crepes are woven either as the taffeta plain weave or in the satin effect. In many cases weaves are combined. Chiffons are transparent. thin. ephemeral: the origin of the name is a description—French. "rag". Following World War II crepe fabrics. because of the skilled labour required in handling the crepe yarns and by reason of style change, largely were replaced by a type of taffeta weave made of rough, coarser-sized ran. silk thread. simulating the oriental products known as Shantung, pongee and habutai. These fabrics. with their plain in-and-out weave, did not require throwing nor the smooth perfection needed for the finer crepes, satins. etc. Hahutai, originally a native Japanese iabric. was the most used silk fabric in the period after 1945 and was exported by Japan especially to the United States in large quantities for use in scarfs and other types of women's clothing. It was also exported unfinished. then printed. dyed and otherwise reprocessed in the importing countries, for clothing and shower curtains, umbrellas. raincoats, etc. Hahutai is also referred to (incorrectly) as momme silk because the commonly used Japanese designation of the weight of a fabric is its momme weight. Momme weight represents the weight in pounds of roo yd. of the fabric in the gray. One momme cloth equals 1.042 sq.yd. weighing .1323 oz.. or 1.00 sq.yd. weighing .1270 oz.. or 1.00 sq.yd. weighing .0079 lbs.. or 100.0 sq.yd. weighing .795 lbs.

Silk when woven from the undyed thread is referred to as raw goods or greige goods. The latter term comes from the term *grès* meaning "gum" and refers to the natural gum or coating of albuminous matter which is part of the filament spun from the cocoon and which is still a part of the thread before dyeing. The woven greige fabric has a lustreless, stiff and harsh appearance which would be unacceptable for most practical uses. One exception is bolting cloth. a unique type of silk fabric used primarily by millers in preparing fine flour. Coarser sizes are used in the process known as screen printing. Another use is as a filter for women's powder compacts. Originally, bolting cloth was made on hand looms in the cellars of mountain homes in the St. Gall and Appenzell sections of Switzerland where the humid air helped to keep the fine threads in place during the weaving operation. Although this remained true of some of the finer grades, there was a growing development in the manufacture of the fabric on power looms in the United States and France after 1940. Synthetic fibres (principally nylon) as well as silk. have been used for bolting cloth.

Other silk fabrics. when woven as raw goods, must be degummed or scoured before they are dyed and finished. These fabrics are termed piece dyed to differentiate from the yarn dyed which are dyed in the thread. In general all crepe fabrics and satins are piece dyed; taffetas may be either yarn or piece dyed. The process leaves a white. soft. flimsy fabric that has a pleasant touch but would be undesirable for general use in clothing. The degumming process is done as part of the dyeing and finishing operation and the process is also called boiling-off. The resultant liquid is a valuable adjunct in the dye bath as it contains a large amount of the natural sericin—it is known as boil-off liquor.

Degumming or Scouring Process.—Silk is usually boiled off in a solution of 30% of its own weight of neutral soap dissolved in sufficient pure water to give a 1% solution. If degummed in skeins. the hanks of ran silk hung on a wooden rod are immersed in this solution which is maintained at a temperature just below the boiling point. the hanks being turned around to expose all parts equally to the solvent action of the hot solution. If woven in the gum. the fabrics are immersed in the same type of solution. The temperature is about 95° C. After one hour the silk is removed and the water extracted before a second bath with half the quantity of soap. It is finally rinsed and dried in a hydroextractor. The amount of gum to be boiled off determines the strength of the soap solutions. but care has to be exercised not to overdo the scouring, whereby loss of strength. substance and lustre would result. The perfect scouring of silks removes from 20% to 27% of their weight, according to the character of the silk and the amount of soap or oil used in the working. Scouring renders all common silks. whether white or yellow in the raw, a brilliant pearly white. with a delicate soft, flossy texture. since the fibres which were agglutinated in reeling. being degummed. are separated from each other and show their individual tenuity in the yarn. Silks to be finished white are at this point bleached.

Knitting.—Silk is knitted into fabric and hosiery. Silk hosiery, from the time of Queen Elizabeth I of England. has typified a desirable luxury. but after World War I silk hosiery for women became a necessity coincident with the everyday use of silk fabrics for outer clothing and underwear. The strength of the silk fibre permitted the knitting of extremely thin or sheer fabric. where the shorter. weaker fibres such as cotton could produce only a heavy. thick iabric. Silk hosiery since 1941, has been largely supplanted by nylon but silk is still used to some extent in knitted silk fabrics commonly referred to as warp knitted (or glove silk) in which parallel yarns are arranged in two tiers on the knitting machine. There are two types of warp knitted silks—tricot and Milanese. Tricot, the more important, is characterized by fine vertical wales on the iace and crosswise ribs on the back. Its construction permits the making of designs such as stripes. Milanese is a fabric in which the threads are interknitted at every course in which the threads run diagonally. A fine rib on the face and a faint diagonal or diamond effect on the hack are characteristic. These fabrics are run resistant, but will develop holes where the thread breaks.

Dyeing, Printing and Finishing.—Silk has a special affinity for dyestuffs and finishing materials, and the handling of the fibre either as yarn or fabric has been the pride of dyers throughout the ages. In mediaeval Europe Florence. It.. was noted for its dyed silks. In France, the patronage of Louis XIV developed many new ways of dyeing silks and in 1630 reference was made in a French publication to the metallic weighting of silk. The finishing of silk fabrics to give them smoothness. lustre. stiffness and rustle was the subject of constant experimentation by the workmen of Italy. France and England. When the silk industry became established in the United States, many of the artisans from Europe brought their guild and family trade secrets with them. Although many formulas have been published for dyeing and finishing preparations. every dyer treasures his own method of handling silk. And that pride of individual artisanship still continues.

The process of weighting is primarily suitable for silk. but weighting of other fibres. notably rayon. has been attempted. Silk for centuries has been treated with sugar, salts of tin and lead; and iron to increase its weight and give the flimsy. soft pure silk the body and close texture that women for the past three centuries have always associated with "good" silk. To determine by laboratory research the effect of weighting on the silk fibre. groups both in the United States and in Europe compared weighted and unweighted samples and measured the tensile strength of silk fabrics periodically to learn to what degree the fabrics had lost strength. Contrary to the general impression. the amount of weighting did not of itself determine the tensile strength of silks. The manner in which the threads were woven. the ingredients used in weighting and the method followed in the weighting process were equally if not more significant.

These tests emphasized the mystery that surrounds the physical reaction of silk as it absorbs the minerals without outward change of appearance. Silk can absorb the liquids in its weighting bath to 300% oi its original u-eight without any noticeable change in its outward appearance. The solution does not coat the fibre, but is absorbed by it and is not removable except by laboratory treatment. For hundreds of years. the objective of the dyer was to develop his process to give the desired appearance to any fabric he handled. Rut weighting, or rather poor weighting, brought about a demand for satisfactory wear in fabrics as well as aesthetic appeal. Some fabrics were only usable nith heavy weighting. such as fabrics used in facing men's dress clothes. Contrarily, unweighted fabrics were found to be more popular for underwear.

The unweighted fabric is termed pure dye although the words are sometimes misunderstood by the layman. They have no reference to the quality of the dyestuffs but are probably a distortion of an expression intended to describe a finish as "pure dyestuff," *i.e.*, nothing but dyestuff, although the origin is not clearly established. The U.S. government edict, in 1938, demanded that where any weighting was present in the fabric, the percentage of weighting in proportion to the silk fibre content in the finished fabric must be so stated. Similar regulations were put into effect in France.

The process of weighting begins with the degummed fabric, which is placed in the weighting solution bath for several hours. It is then removed, washed and dried. Additional baths of this kind may be given and each time the threads gain weight. The length of time for the bath and the formula for the contents of the bath are, after many hundreds of years, still dependent largely on the skill and knowledge of the individual workman. After a further treatment of special solutions. the silk is dyed. During this process. one of the valuable adjuncts is the sericin or boil-off liquor which was saved aiter the degumming process. The gum solution gives added weight of a natural kind. The gum content of the silk is a cause of dissension as to the basis of expressing the amount of weighting in a fabric. The European method is based on "par weight" (the weight of the silk before degummingj. The European silk manufacturer considers that he may add weighting to the degummed silk up to the original weight. without technically weighting the silk. The percentage of weighting would be figured from the par weight not the degummed weight. The actual amount of weighting or foreign matter in the fabric would, therefore, be more than stated. In the United States, government regulations require that the percentage of weighting be expressed as the proportion of metallic weighting to the amount of actual silk fibre in the finished fabric: with no notice made of the original weight.

Printing of silk fabrics is done by the same general methods followed in other textiles. The most popular method is the roller printing done by engraved copper rollers, similar to book or magazine printing. Each colour in the design is a separate roller and in referring to designs, reference to the number of rollers is synonymous with the number of colours. Designs for roller printing run from one to four colours and can be application or discharge. In the first. the design is applied to the cloth; in the second. the design is made by chemically removing the background colour.

Screen printing is used for the prints of more than four colours and also for achieving a hand-printed effect that is in demand in more expensive printed iabrics. Instead of a roller for each colour. there is a screen for each colour. The process is slower than roller printing and is frequently used where a fewer number of yards of a given design is required.

Screen printing is especially preferred for silk fabrics. More brilliant colour effects are achieved and there is wider latitude in the type of design used. The chief advantage lies in the reduction of risk inherent in merchandising an article of fleeting style value such as printed fabrics. Roller printing requires the investment not only of the engraving and printing, but the minimum amount accepted by the printer for imprinting is 1.000 yd. Of that amount, at least half or all of it may be sold at less than cost if the design of the fabric does not gain buyer acceptance. In screen printing, as few as 10 yd. may be printed at one time.

To give the dyed and printed silk smoothness, dull lustre and suppleness. and to provide protection against certain characteristics of wear, such as creasing, perspiration, water-spotting. etc., the finishing of silk is an additional art in preparing the fabric for the market. The materials used include starches, dextrin, glue, gelatin, sulphonated oils, mineral oils, glycerine. resin and various organic chemical compounds used as softeners and penetrants. Not the least of these are perfumes or essential oils used at the final stage for eradicating any unpleasant odours remaining from the other materials. In addition to the oils and gums. the finishing treatment includes stretching. gassing, moiréing and framing. Fabrics must be made uniformly wide, wrinkles removed and fuzz burned off the surface. The natural strength and elasticity of silk provides ample opportunity for manipulation in producing desired effects.

Packaging. — Silk fabrics are prepared for the market as pieces of about 80 yd. each. They are rolled full width on paper tubes of about 2-in. diameter or folded in half of the width and reeled on flat cardboard reels about 14 × 24 in. The fabrics are carefully wrapped in tissue paper and a light cardboard outside wrapper.

(I. L. BL.)

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SILK SCREEN PRINTING. Screen stencil printing is the modern form of what is probably the oldest of all printing processes. It is the logical development of the principle used by the Chinese and Japanese: who long ago learned to make very intricate stencils by gluing the cut design to a web of hair! thus making it possible to use isoiated elements which could not otherwise be held in place.

The screen stencil ordinarily used consists of bolting silk stretched over a wooden frame. On this silk is the design to be stencilled. This design may be produced by simply painting the areas which are to remain white with some substance, such as gum or shellac, which will make the silk impervious to the ink used. The stencil is placed in contact with the surface to be decorated and a puddle of ink is scraped from one end to the other by means of a rubber squeegee. This forces the ink, which resembles ordinary house paint, through the open areas of the stencil and it adheres to the surface beneath. The stencil is then lifted from the decorated surface and the ink allowed to dry, after which another colour may be applied from another stencil: and so on.

For special purposes. wire gauze or cotton fabrics may be substituted for the bolting silk, and a great number of ingenious methods have been devised for putting the design on the screen. Fine detail in the pattern generally makes it advisable to make the stencil photographically, by impregnating the screen with a light-sensitive material, such as dichromated glue or albumin, and exposing it to light under a tracing of the pattern. The image is developed by washing with water. which removes the coating from the open areas where it has not been light-hardened. Simple designs are often made by cementing patterns cut from paper. celluloid or metal, to the screen, a common method being to cut the design from shellac-coated paper and fasten it to the cloth by passing a hot iron over the two in contact.

As compared with other printing processes, screen stencil printing has the advantage of requiring relatively cheap equipment and little preliminary work. It is very economical for short runs of suitable subjects, and is widely used for show cards, posters, charts. etc. It permits printing on almost any surface: so it is used for decorating paper, cloth, glass. wood, celluloid, rubber, metal, linoleum and oilcloth. The inks used are usually oil paints, but may be water colours. dyes or lacquers, so that the process may be used to produce any effect from the most delicate of pastel shades to glossy, weatherproof colours. so heavy that they stand out in visible relief. Areas of relatively great size are easily stencilled: frames 50 by 60 in. are frequently used for textile printing. Finally, as the object to be decorated need not be limited in thickness or even perfectly flat. the process is much used for printing on objects such as toys, novelties, and machinery which could not be run through a printing press.

The limitations of the process lie in the fact that it is not suitable for reproducing subjects with fine detail and delicate gradations of tone, such as photographs for process colour work. It is unsuitable for reproducing very long runs because it is a relatively slow printing process and because the stencils are of limited durability.

SILL, ANNA PECK (1816–1889), U.S. educator, a pioneer in women's education in the United States who sought to bring the education of girls to the level of that for men, was born Aug. 9, 1816, at Burlington, N.Y. After attending the district school, she began to teach at a school near Albion, N.Y., and in 1837 entered Miss Phipps' Union seminary, where she shortly became a member of the faculty. There she remained until 1843, when she established a seminary for girls at Warsaw, N.Y.

After three years Miss Sill abandoned this project and went to teach at Cary Collegiate institute, Oakfield, N.Y. She was invited to Rockford, Ill., in 1849 to open a girls' seminary and was made principal of the school (Rockford Female seminary) in 1852. Thereafter she spent much of her time raising funds for the young institution. It expanded gradually until in 1887 it began to confer collegiate degrees. The name was changed to Rockford college in 1892.

Miss Sill had retired in 1884, but she remained with the institution as principal emerita and taught occasional classes. She died in Rockford on June 18, 1889.

SILL, EDWARD ROWLAND (1841–1887), U.S. author and educator, was born at Windsor, Conn., April 29, 1841. Although slight, Sill's poetry is notable for its reflection of the temper of his age: religious doubt, restlessness and the hopes of humanitarian idealism.

Orphaned in 1853, Sill lived with relatives at Cuyahoga Falls, O., and at Honesdale, Pa. He studied at Phillips Exeter academy and, although he found its academic formalism and Puritan atmosphere uncongenial, graduated at Yale in 1861. He then drifted through various jobs in California and made abortive attempts to study medicine and law. Returning to the east in 1866, he entered Harvard divinity school, but soon found himself restless in the confines of dogma and turned to newspaper work in New York which he also soon abandoned. He finally settled on teaching as his permanent career and was, successively, high-school principal and school superintendent in Cuyahoga Falls (1869–71), teacher and principal at Oakland, Calif., high school (1871–74) and teacher of English at the University of California (1874–82). Upon his resignation he returned to Ohio and devoted himself to writing, contributing frequently to the *Atlantic Monthly* and other periodicals.

Sill died in Cleveland, O., Feb. 27, 1887.

The Hermitage and Other Poems (1868) and *The Venus of Milo and Other Poems* (1883) were published in his lifetime. *The Prose of Edward Rowland Sill* (1900) and *The Poems* (1902) were collected posthumously.

See W. B. Parker, *Edward Rowland Sill: His Life and Work* (1915).

SILL (O. Eng. *syl,* Mid. E. *sylle, sille;* the word appears in Icel. *syll, svill,* Swed. *syll,* and Dan. *syld,* and in German, as *Schwelle;* Skeat refers to the Teutonic root *swal-*, "swell," the word meaning the rise or swell formed by a beam at a threshold; the Lat. *solea,* from which comes Fr. *seuil,* gives Eng. "sole," also sometimes used for "sill"), the horizontal base of a door or window frame. A technical distinction is made between the inner or wooden base of the window frame and the stone base on which it rests—the latter being called the sill of the window, and the former that of its frame. This term is not restricted to the bases of apertures; the lower horizontal part of a framed partition is called its sill. The term is sometimes incorrectly written "cill."

SILL. In geology, a tabular body of igneous rock formed by intrusion of magma (molten rock) along a structural break (bedding or foliation) in the earth. The tabular form and parallelism with surrounding structure are the diagnostic features. To many geologists there is another essential; injection must have occurred along relatively flat-lying breaks. The magma, therefore, displaced the adjacent rock vertically by lifting the roof. This mechanism is quite different from that involved in the formation of steep intrusive sheets (most dikes). In the latter, magma entered passively as the walls of the steep fractures were spread apart by horizontal movements.

It is believed that, as the injected magma comes into contact with the cooler adjacent rock, it becomes chilled and rapidly solidified to form a thin, dense selvage or layer along the sill roof and floor. Somewhat slower cooling of the more internal portions of the sill result in coarser textures. Margins of many sills show a streaked and banded appearance, believed to have been produced by liquid flow along the smooth sill roof and floor. Large crystals commonly show parallel arrangement of their long dimensions near sill boundaries. These are believed to have formed early and to have been turned into the lines and layers of flow parallel to sill contacts.

Some sills, after congealation, have been split open and injected by fresh magma. Such bodies are called multiple sills if the successive injections were of one kind of magma, and composite sills if different kinds of magma were involved.

Sills may range up to several thousand feet in thickness and may extend across country for hundreds of miles. They are commonly associated with dikes and larger intrusive bodies *(see* BATHOLITH; LACCOLITH; GEOLOGY). Most described sills are composed of diabase or dolerite and closely related rocks. Granitic, rhyolitic, dioritic, and andesitic sills are locally abundant; and the rocks comprising them commonly belong to the class known as porphyries *(see* PORPHYRY).

Some thick sills, such as the Palisades sill in New Jersey, furnish striking evidence that an essentially homogenous magma became differentiated during consolidation and yielded a diverse, layered series of rocks. In general, such sills show a dense chill zone at the top and bottom; and heavy rocks, near the base, grade upward to somewhat lighter rocks near the top. It seems clear that early developed heavy crystals (olivine and pyroxene) settled in the slowly congealing magma, whereas lighter minerals (feldspar) may have remained more or less stationary or possibly were buoyed upward.

The rocks immediately in contact with sills commonly appear to have been profoundly changed. This phenomenon, known as contact metamorphism, is believed to have been brought about largely by the heat of the intrusive magma. In the case of large sills, the metamorphic zone may extend a few hundred feet from the intrusive margin. Sedimentary rocks may show a baked or indurated and bleached appearance in contact with a sill roof or floor. Shale, for example, has commonly been reconstituted to a tough. brittle rock called hornfels, in which many new minerals (cordierite, feldspar, garnet, pyroxene, etc.) have formed. Blocks and fragments of the adjacent rock, accidentally caught up in the intrusive mass, may also show these metamorphic effects *(see* also METAMORPHISM).

See M. P. Billings, *Structural Geology* (1954); R. A. Daly, *Igneous Rocks and the Depths of the Earth* (1933). (C. A. CN.)

SILLANI, TOMASO (1888–), Italian author, was born March 25, 1888. at Otricoli. He contributed poetry and articles on political questions to Italian and foreign newspapers. One of the founders of the Pro-Italian Dalmatia association, he was active in supporting Italian claims to Adriatic and colonial expansion. Sillani founded (1918) and later directed the review *Rassegna Italiana.* Among his works are *Le Pastorali* (verse, 1912), *Il Perugino* (1914), *L'Alsazia e la Lorena* (1914), *La Dalmazia monumentale* (in collaboration with others, 1917), *Capisaldi* (2 vol., 1918), *La Libia in 20 anni di occupazione italiana* (1932), *La Vittoria dello spirito* (1925), *L'Italia e l'Oriente Medio ed Estremo* (1935), *Scritti sul Risorgimento di H. Nelson Gay* (1937).

In 1945 Sillani became founder and director of the Italian Study-Centre for International Reconciliation.

SILLANPÄÄ, FRANS EEMIL (1888–), Finnish author, was born in 1888, the son of a Finnish farmer. He began to write at an early age, studying in particular the lives of peasants in western Finland.

At first his novels were known only in Scandinavia, where they enjoyed a great popularity, but later they were translated into several European languages. The best known of the novels is *The Maid Silja.* Other of his publications include *Hurskas Kurjuus* ("Meek Heritage"), *Miehen tie* ("A Man's Way") and *Nuorena Nukkunut* ("Fallen Asleep While Young"). In 1939 he received the Nobel prize in literature. In December of that year, two weeks after Russia had begun the invasion of Finland. Sillanpaa crossed the Snedish border aith his seven children on his way to Stockholm to receive the award.

In addition to his novels of peasant life, he has published several collections of short stories and essays.

SILLERY, CHARLES ALEXIS BRULART, MARQUIS OF (Count of Genlis) (1737–1793). French soldier and politician, was born at Paris in 1737. In his youth he sailed for the West Indies for military sen-ice, but left his regiment to join the navy. He saw active service at sea in the Seven Tears' War (1756–63) and was captured by the English. Upon his release in 1762 he returned to France. married the countess of Genlis and became the confidential adviser of the duke of Chartres. In 1789 he became deputy to the states-general at Versailles and later to the National Convention, where he threw in his lot with the Girondists (*q.v.*). When the latter fell. Sillery was included in the proscription of May 1793. He was condemned to death and guillotined Oct. 31, 1793, at Paris.

SILLERY, CHARLES DOYNE (1807–1837), Irish poet, was born at Athlone, Ire., on March 2, 1807. His father was an Irish army officer.

After serving as a midshipman on a voyage to the far east, Sillery left the navy and in 1828 went to Edinburgh, Scot., where he died on May 16, 1837. His works include *Vallery, or the Citadel of the Lake*, 2 vol. (Edinburgh. 1829); *Eldred of Erin* (Edinburgh, 1833); *The Royal Marines and Other Poems* (London, 1833); and *The Exiles of Chamouni* (1834).

Religious books include *A Discourse on the Sufferings of Our Saviour* (1833); *An Essay on the Creation of the Universe* (1833); and *The Man of Sorrows*, which was published after his death.

SILLERY, NICOLAS BRULART DE (1544–1624), French diplomat and statesman, was born in 1544 at Sillery. In 1573 he became councillor at the parliament of Paris,.and in 1589 he was named ambassador to Switzerland, being appointed again to the latter post in 1593. In 1598 he negotiated for France the treaty of Vervins, which terminated the "war of deliverance from Spain."

He rose rapidly in the esteem of Henry IV, whose divorce from Marguerite de Valois, sister of Charles IX, Sillery had arranged in Rome. Henry named him chancellor of Navarre in 1605 and chancellor of France two years later. After Henry's assassination in 1610, he was kept in office by Marie de' Medici (whose marriage to Henry had also been negotiated by Sillery), but he lost influence and retired to the town of his birth, where he died in 1624.

SILEIMAN, BENJAMIN (1779–1864), U.S. chemist and geologist, was born on August 8, 1779, at Trumbull (then called North Stratford), Conn. Entering Yale college in 1792, he graduated in 1796, became tutor in 1799 and in 1802 was appointed professor of chemistry and mineralogy, a position which he retained till 1853, when by his own desire he retired as professor emeritus. Not only was he a popular and successful teacher of chemistry, mineralogy and geology in the college for half a century, but he also did much to improve and extend its educational resources, especially in regard to its mineralogical collections, the Trumbull Gallery of Pictures, the Medical institution and the Sheffield Scientific school.

Outside Yale he was well known as one of the few men who could hold the attention of a popular audience with a scientific lecture, and on account of his clear and interesting style, as well as of the unwonted splendour of his illustrative experiments, his services were in great request not only in the northern and eastern states but also in those of the south.

His original investigations were neither numerous nor important, and his name is best known to scientific men as the founder, and from 1818 to 1838 the sole editor, of the *American Jozirnal of Science and* Arts — often called *Silliman's Journal*—one of the foremost American scientific serials. In 1810 he published *A Journal of Travels in England, Holland and Scotland,* in which he described a visit to Europe undertaken in 1805 in preparation for the duties of his chair. He paid a second visit in 1851, of which he also issued an account, and among his other publications were *Elements of Chemistry* (1830), and editions of W. Henry's *Chemistry* with notes (1808), and of R. Bakewell's *Geology* (1827). He died at New Haven on Nov. 24. 1864.

His son, BENJAMIN SILLIMAN (1816–1885), chemist and mineralogist, was born at New Haven on Dec. 4, 1816. After graduating at Yale in 1837 he became assistant to his father, and in 1847 was appointed professor in the school of applied chemistry, which was largely due to his efforts and formed the nucleus of the subsequent Sheffield Scientific school. In 1849 he was appointed professor of medical chemistry and toxicology in the Medical college at Louisville, Ky., but relinquished that office in 1854 to succeed his father in the chair of chemistry at Yale. The duties of this professorship. so far as they related to the Academic college, he gave up in 1870, but he retained his connection with the Medical college till his death, which happened at New Haven on Jan. 14, 1885.

Much of his time, especially during the last 20 years of his life, was absorbed in making examinations of mines and preparing expert reports on technical processes of chemical manufacture; but he was also able to do a certain amount of original work, publishing papers on the chemistry of various minerals, on meteorites, on photography with the electric arc, the illuminating powers of gas. etc. A course of lectures given by him on agricultural chemistry in the winter of 1845–46 at New Orleans, La., is believed to have been the first of its kind in the United States.

In 1846 he published *First Principles of Chemistry* and in 1858 *First Principles of Physics or Natural Philosophy,* both of which had a large circulation. In 1853 he edited a large quarto illustrated volume, *The World of Science, Art and Industry,* which was followed in 1854 by *The Progress of Science and Mechanism.* In 1874, when the 100th anniversary of Joseph Priestley's preparation of oxygen was celebrated as the "Centennial of Chemistry" at Northumberland, Pa., where Priestley died, he delivered an historical address on "American Contributions to Chemistry," which contains a full list, with their works: of American chemists up to that date. From 1838 to 1845 he was associated with his father in the editorship of the *American Journal of Science,* and from 1845 to the end of his life his name appeared on the title page as one of the editors in chief.

SILLIMANITE, an aluminum sillicate mineral that. like the closely related aluminum silicates andalusite and kyanite (*q.v.*), may be used to form mullite, an important refractory material (*see* also MULLITE). It crystallizes in the orthorhombic system and has the composition $Al_2O_3.SiO_2$. It occurs in metamorphic rocks as long slender crystals and as rosettes. The hardness range is from 6 to 7 and specific gravity from 3.23 to 3.24. Its colour ranges from brown to gray to olive-green. In the laboratory it may be synthesized over a limited range of temperatures and pressures and is presumably so formed in nature. At pressures under approximately 3.000 atm.. in the temperature region of 600°-900° C., the stable phase of essentially the same composition is the mineral mullite. Sillimanite occurs at pressures from 3.000 to 12,000 atm. Above these pressures the mineral kyanite appears. At temperatures below approximately 600° C. the polymorph of sillimanite, andalusite. appears. It is an important geological mineral and serves both as an indicator of temperature and pressure of environment in which rocks containing it were formed. It is present in metamorphosed kaolin rich sediments. It was named after Benjamin Silliman (*q.v.*). (G. C. KY.)

SILLS, MILTON (1882–1930), U.S. actor, was born on Sept. 15, 1882, in Chicago, Ill. His parents, William Henry and Josephine Antoinette (Troost) Sills named him Milton George Gustavus, but he dropped his second and third names.

Graduated from The University of Chicago in 1903, he became a fellow in philosophy at the university, After his first appearance on the professional stage in a melodrama at New Palestine, O., in 1906, he toured the middle west. He played in Donald Robertson's Art theatre, Chicago, 1907–08, and later went to New York city, playing the leading man in *This Woman and This Man,* 1909. He also appeared in *A Happy Marriage,* by Clyde Fitch and managed by Charles Frohman. *The Servant in the House, The Fighting Hope, Diplomacy, The Governor's Lady, Mother, The Rack, The Law of the Land,* and *Just Married.*

In 1914 he appeared in the motion picture *The Pit,* based on a novel by Frank Norris. He had leading roles in *Behold My Wife, The Great Moment, Adam's Rib, The Barker, Burning Daylight, The Sea Hawk, Hard Boiled Haggerty, Paradise* and other motion pictures. He also was part author of *Men of Steel,* in which he appeared.

Sills was married to Gladys Edith Wynne of London, Eng., from whom he was divorced in 1925, and on Oct. 12, 1926, he was married to Doris Margaret Kenyon, an actress.

Sills died in Santa Monica, Calif., on Sept. 15, 1930.

SILO: *see* ENSILAGE.

SILONE, IGNAZIO (pseudonym of SECONDO TRANQUILLI) (1900–), Italian author whose novels reflect his belief in the need for social reform, was born at Pescina dei Marsi, Xbruzzi, on May 1, 1900. One of the founders of the Italian Communist party, he left the party in 1930 while in exile in Switzerland. Returning to Italy in 1944, he continued to influence Italian socialism, although without holding any important political office.

Silone's first novel. *Fontamara* (1930; Eng, trans., 1934), is a poignant description of poverty and Fascist oppression in an Abruzzi village. Its peasant hero. who struggles for freedom but dies in prison, believes that political and social regeneration will be accomplished by a Communist revolution. The hero of *Pane e vino* (1937; Eng. trans.! *Bread and Wine,* 1937) and *Il Seme sotto la Neve* (1940; Eng. trans., *The Seed Beneath the Snow,* 1943) has turned from Communism to a Christian belief in universal brotherhood.

In *Una Manciata* di *More* (1952; Eng. trans.! *A Handful of Blackberries,* 1954) Silone denounces Communism though still urging social reform and the development of the south of Italy, which is also the subject of *Il segreto di Luca* (1956).

See bibliography in *Fiera letteraria* (Aug. 14, 1955); an essay by Edmund Wilson in the *New Yorker* (Sept. 8, 1955). (F. DI.)

SILOTI, ALEKSANDR (ILYICH) (1863–1945). Russian-born pianist and conductor. who was a follower of Liszt. was born on Oct. 10. 1863. near Kharkov. He studied at Moscow under N. Rubinstein and Tchaikovsky. and from 1883 to 1886 at Weimar under Liszt, later founding the Liszt society at Leipzig. He first appeared as a pianist at Moscow in 1880, taught at the Moscow conservatory in 1887. and between 1890 and 1900 toured Europe and the United States. In 1901 he conducted the Moscow Philharmonic orchestra and subsequently divided his activities between conducting and piano playing. He published his reminiscences of Liszt in 1911.

Siloti settled in England in 1919. and in the United States in 1922, and from 1924 to 1942 taught at the Juilliard school of music. He died in New York on Dec. 8. 1945.

SILURES. These were a powerful and warlike tribe in ancient Britain. occupying approximately the counties of Monmouth. Brecon and Glamorgan. They made a fierce resistance to the Roman conquest about A.D. 48. but a legionary fortress (Isca Silurum, Caerleon) was planted in their midst and by A.D. 78 they were overcome.

Their town Venta Silurum (Caerwent, 6 mi. W. of Chepstow) became romanized. Its massive Roman walls survive, and excavations have revealed a town hall and market square. a temple, baths, amphitheatre. etc.

SILURIAN SYSTEM. This article is divided into several broad sections and subsections dealing with the Silurian system and period of geologic time. In addition to the cross references to related material given under the various headings of this article, for general background information *see* GEOLOGY: *Historical Geology;* PALAEOBOTANY; PALAEONTOLOGY. For additional information on the iorms of life referred to see separate articles on these iorms. as ECHINODERMA; FISHES; etc. *See* also Index references under "Silurian System" in vol. 24.

Following are the main divisions of this article:

I. The Silurian System and Period
  1. Physical Events and Features
  2. Climate and General Ecology
  3. Facies, Biogeography and Migration Routes
II. Silurian Life
  1. Characteristics and Evolution
  2. Invertebrates and Associated Fossils
  3. Fishes, Land Plants and Associated Fossils
III. Regional Summary
  1. Great Britain
  2. European Continent
  3. U.S.S.R.
  4. Asia
  5. Australia
  6. South America
  7. North Africa
  8. North America

I. THE SILURIAN SYSTEM AND PERIOD

Rocks of the Silurian system are those that were formed during the Silurian period. which is roughly the interval from 320,000,000 to 350,000,000 years ago. a middle division of the Paleozoic era (*q.v.*), as indicated on the accompanying geologic time chart. Many European geologists outside of England and the U.S.S.R. also include under the term Silurian the older rocks and the earlier time more generally called Ordovician. To them the Silurian as

Geologic Time Chart

System and Period	Series and Epoch	Distinctive Records of Life	1,000 Years
		CENOZOIC ERA	
Quaternary	Recent	Modern man	11
	Pleistocene	Early man	1,000
Tertiary	Pliocene	Large carnivores	
	Miocene	Whales, apes, grazing forms	
	Oligocene	Large browsing mammals	
	Eocene	Rise of flowering plants	
	Paleocene	First placental mammals	70,000
		MESOZOIC ERA	
Cretaceous		Extinction of dinosaurs	130,000
Jurassic		Dinosaurs' zenith, primitive birds, first small mammals	160,000
Triassic		Appearance of dinosaurs	200,000
		PALEOZOIC ERA	
Permian		Reptiles developed, conifers abundant	235,000
Carboniferous			
Upper (Pennsylvanian)		First reptiles, coal forests	260,000
Lower (Mississippian)		Sharks abundant	285,000
Devonian		Amphibians appeared, fishes abundant	320,000
Silurian		Earliest land plants and animals	350,000
Ordovician		First primitive fishes	400,000
Cambrian		Marine invertebrates	500,000
		PRE-CAMBRIAN TIME	
		Few fossils	3,500,000–4,000,000

here defined is Upper (or Late) Silurian or Gotlandian.

Rocks of the Silurian system have yielded about 10% of U.S. iron, 20% of its salt and a little oil and gas. They also serve, especially where mainly limestone and dolumite, as host for many metallic mineral deposits, including important gold and tin ores in eastern Australia. And they are exploited industrially for cement. agricultural lime and building stone.

Silurian volcanoes dumped thousands of cubic miles of debris into linear subsiding zones and basins in eastern Australia and other regions, announcing related mountain building of this age. Contemporaneous deposits provide the earliest reasonably varied occurrences of fishes and land plants. Although both originated tens of millions of years before. neither is widely recorded until Devonian time. An aberrant vertebrate relative, *Monograptus,* the last surviving bladelike graptolite (*q.v.*), burst into a flowering of short-lived species whose flexible external skeletons are used to divide the Silurian marine deposits of the world into time-equivalent zones. Archaic reef-building corals and the brachiopods advanced less speedily but over broader fronts. The evidence of all these creatures, and the sediments, is interpreted to signify mild climates; not markedly zoned latitudinally, but with local, long-lasting. Late Silurian arid regions.

The responses of Silurian rocks to local conditions of erosion and weathering account for many of the world's distinctive landscapes. Undercutting of weak sedimentary layers beneath massive hliddle Silurian dolomites at the outlet of Lake Erie created and maintains Niagara falls. The picturesque glade country of Tennessee consists of isolated grassy areas on infertile shales surrounded by wooded areas on more calcareous shales or limestones of Middle Silurian Age. Beautiful Wenlock Edge in Shropshire is an east-dipping Middle Silurian limestone ridge, and much of Wales and the Lake district of England is underlain by Silurian rocks. The Swedish island of Gotland is the type site of the Gotlandian; picturesque Visby, its capital and ancient Hanseatic harbour, is built around a Silurian reef limestone.

Rocks are identified as Silurian (or a specific part of it) from comparison of their contained fossils with those of the type marine sequence in south Wales and Shropshire, or on relationship to or correlation with other rocks so dated. By definition, therefore, the Silurian includes all deposits formed during the same time as those in the type sequence, regardless of origin, location, or local relationships. The principal Silurian subdivisions for selected regions are outlined in the accompanying correlation table, emphasizing marine sequences as the basic local standards.

The Silurian is an enduring monument to British persistence. The Roman emperor Tiberius Claudius vowed (c. A.D. 43) to exterminate even the name of the warlike Silures of areas now in the Welsh borderland for their stubborn resistance under Caractacus (Caradoc). Beaten and dispersed by Julius Frontinus for Vespasian (A.D. 78), they were, in fact, almost forgotten until 1835, when Scotsman Sir Roderick Impey Murchison (*q.v.*), an old soldier himself, delighted in naming his new rock system for them. In his epochal The Silurian System (1839), Murchison reflects how:

In ancient days
The Roman legions and great Cesar found
Our fathers no mean foes, and Cressy plains
And Agincourt, deep tinged with blood, confess
What the Silures' vigour withstood
Could do in rigid fight.

He and his British successors have done a job worthy of their ancestors in unraveling the complicated rock succession of the type Silurian, subdividing it and establishing its graptolitic and shelly faunas as independent world-wide standards for correlation. In most of the rest of the world. however, the Silurian is one of the most neglected and thus most poorly known sequences—ironic contrast to the wide attention given to the lower part of Murchison's original Silurian, the Ordovician, which was not split off as an independent system until 1879.

1. Physical Events and Features.—Mountain-building deformation older than the oldest local Silurian deposits is indicated by Silurian overlap across folded Ordovician rocks in the Acadian region of east central North America (Taconic folding or orogeny) and eastern Australia (Benambian orogeny). Similar relationships indicate later deformation between Silurian and overlying Devonian in Australia (Bowning orogeny), in northwestern Europe (Caledonian orogeny) and apparently in the western U.S. Thus it is frequently said that the Silurian began and ended with important, if local, compressive movements of the earth's crust. Strong evidences of volcanism throughout the Silurian of eastern Australia, the Pacific border of North America and the Acadian region, however, and the thick sequences of coarse detrital sediments in Australia, south Scotland and the eastern Appalachian trough seem to imply continued crustal instability in the borderlands. As a consequence of such events, some seaways that were well defined during Ordovician time were strongly modified or abandoned in the Silurian, and new directions of marine invasion were found.

2. Climate and General Ecology.—Widespread reef formation by Silurian corals and stromatoporoids (hydrozoan relatives) couples with the evidence for high calcium metabolism furnished by laterally equivalent limestones and dolomites to imply extensive warm shallow seas in present continental areas and little latitudinal or seasonal temperature variation. Interference of mountainous tracts with prevailing winds, or other special meteorologic circumstances, created local arid conditions in the middle latitudes such as those under nhich the Silurian salt and gypsum deposits of New York state and the Michigan basin originated. If deposits which some interpret as glacial in southeastern Alaska, British Columbia and northern Norway prove to be both glacial and Silurian they would suggest mountains high enough to support valley glaciers.

Principal ecologic variations were presumably connected with physical and chemical changes due to increasing depth at sea or altitude on land. or special geographic configuration.

3. Facies, Biogeography and Migration Routes.—As those of all other geologic ages, Silurian rocks formed under differing local physical or chemical conditions, or with different sources of supply and biologic migration routes, take on a characteristic stamp, or facies, which may tell a great deal about their origin and ecology. Facies variations of rocks and accompanying fossil assemblages may be lateral (in space), vertical (in time) or both. Similar sedimentary facies that do not differ drastically in age, and some that do. are likely to contain similar fossils; and different facies of the same age ordinarily contain different assemblages of fossils. (See also FOSSIL.)

The stratigraphic correlation of unusual facies is worked out from field relations to deposits of known age. or is based on ubiquitous fossils of restricted time span. Species of graptolites, so characteristic of Silurian as well as Ordovician beds. have proved especially useful in indicating the probable contemporaneity of contrasting sedimentary facies. They are, in fact, such generally excellent index fossils, that they are logically interpreted as animals which actually floated at the surface of the water all or much of their lives instead of living somewhere below the surface like most planktonic species or floating only temporarily like the larval stages of so many aquatic organisms. This would explain their being buried, not only with the open-sea sediments of their normal living environment, but also in many different shallow water deposits, together with bottom-living shelly fossils. In eastern Australia, for example. species of *Monograptus* establish the Silurian age and particular stratigraphic level of the important early land plant *Baragwanathia* and associated paleobotanical remains.

Classification of Silurian biotal facies (faunas and floras) shows that they follow sedimentary facies that appear to be related to distance from land, depth of water and nature and amount of detritus brought to the sedimentary site. The usual Silurian deposits and faunas (plants are not numerically important) are divisible into three principal facies of marine sediments: (1) graptolitic shale and flaggy sandstone; (2) detrital limestone and calcareous shale with shelly faunas; (3) carbonate rocks (limestone and dolomite) with mainly coral and stromatoporoid faunas. To these three primary facies types must be added evaporite sequences (salt and gypsum) with highly restricted planktonic faunas in shaly interbeds, slabby argillaceous limestones that in part seem to represent special conditions of tide-flat sedimentation, Late Silurian continental (nonmarine) deposits with plants and fishes and the volcanic facies, which commonly grades to or alternates with graptolitic shale. The three principal facies are found in most regions with thick and extensive Silurian sections; the others represent special local conditions.

The wide dispersal of similar Silurian faunal facies implies good communication channels. Highly generalized possible connections at times of maximum marine expansion are suggested by the distribution map. The distinctive limestone and dolomite sequences of the western U.S. are very exceptional. They represent an extreme development of the carbonate facies, characterized by predominance of dolomite, with a sparse but widely distributed fauna of corals and large, thick-shelled pentameroid brachiopods. Thin graptolitic shales have been found only locally. The sea in which these deposits formed may have connected with the eastern North American seaways at its south end, although proof of this is lacking.

II. SILURIAN LIFE

1. Characteristics and Evolution.—The record of Silurian invertebrate life shows essentially an elaboration of Ordovician lineages (see ORDOVICIAN SYSTEM). It has. however, novel and distinctive features of its own, such as expansion of the corals and echinoderms, and a general substitution of the dominant groups of brachiopods. And it differs from the Devonian record in the types of corals and brachiopods present, the continued importance of graptolites and many less striking features. These differences, of course, are due partly to accidents of preservation and vagaries of collecting and recording.

Silurian plants and fishes are the oldest preserved, except for isolated occurrences of fish fragments in the Middle and Upper Ordovician of the North American Rocky mountains and Cambrian plants reported from eastern Siberia. Estonia and north India. This distribution pattern is apparently attributable to the rarity of preserved pre-Silurian terrestrial deposits.

The characteristics and evolution of Silurian or any other fossil

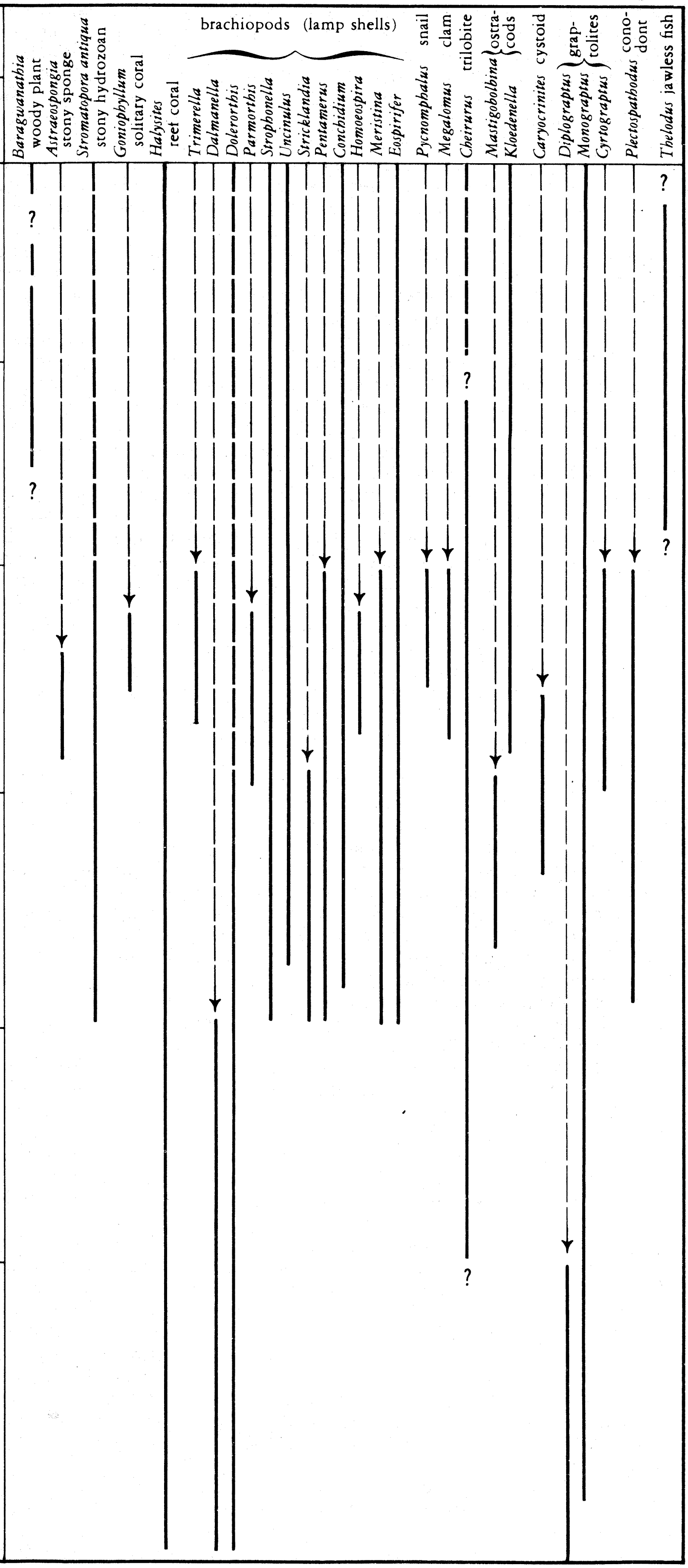
SILURIAN SYSTEM

Correlation table showing general Silurian subdivisions, local rock sequences and ranges of representative genera

Series	Stage	North America: South Central Canada	North America: Nevada	North America: New York state	North America: Northern Nova Scotia	Britain: Lake district	Britain: S.E. Wales and Shropshire	Gotland	Bohemian massif	U.S.S.R.: Eastern Urals	U.S.S.R.: Altai mts.
Upper Silurian	Ludlovian (Salopian)		? Lone Mountain dolomite	Rondout limestone Cobleskill dolomite Salina shales with salt beds	Stonehouse limestone	Kirkby Moor flags Bannisdale slates Coniston grits Upper Coniston flags	Upper Ludlow shale and sandstone Aymestry limestone Lower Ludlow shales and flags	*Ascoceras* limestone Ostracod limestone *Sphaerocodium* limestone *Dayia* limestone	*Monograptus hercynicus* limestones and shales (f_1) Crinoidal limestone and shales Brachiopod limestones and shales Cephalopod sandstones (e_2) *Monograptus dubius* shales and limestones	*Atrypa marginalis* limestones *Conchidium* limestones *Brooksina* strata limestones and shales	Reef limestones and shales
Middle Silurian	Wenlockian (Salopian)	Attawapiskat limestone Ekwan River limestone		Guelph dolomite Lockport dolomite Rochester shale	Moydart limestone McAdam limestone	Lower Coniston flags	Wenlock limestones and shales Wenlock shales and flags Woolhope limestones and shales	? Marlsand limestone	$e_{1\gamma}$ *Monograptus priodon* shales and limestones	Bobrovka limestones, shales and sandstones Tura limestones	?
	Upper Llandoverian (Valentian)	?	Roberts Mountain limestone and dolomite	Irondequoit limestone Williamson shale Wolcott limestone Sodus shale Reynales limestone Maplewood shale	Ross Brook shale		Upper Llandovery shales and lesser sandstone	? *Stricklandinia* marl	$e_{1\beta}$ (e_1)		
Lower Silurian	Lower Llandoverian (Valentian)	Severn River limestone Port Nelson dolomite		Thorold sandstone Grimsby sandstone Cabot Head shale Whirlpool sandstone ? Upper Queenston ?	Beechhill sandstone and limestone ?	Stockdale graptolitic shales	Middle Llandovery shales Lower Llandovery shales and sandstones	*Arachnophyllum* shale	*Diplograptus* shales $e_{1\alpha}$	Shales and sandstones (partly graptolitic) ?	Shales and limestones with *Halysites* and graptolites ?

Correlation table showing general Silurian subdivisions, local rock sequences and ranges of representative genera (Continued)

Southwest China: East and central Yunnan	East Australia: Melbourne district	East Australia: Yass district	South America	North Africa: Central Morocco
Miao-kao limestones and shales with ostracods and fish	Lower Yering sandstones, shales and conglom-erates		Widely present but undivided	Shales and limestones
		Upper Hume shales, sandstones and conglom-erates		Shales with *Monograptus nilssoni*
Apparently missing	Melbourne graptolitic sandstones and shales	Lower Hume shales and limestones Laidlaw tuffs and grits Yass sandstones, shales and limestones		Shales with *Monograptus riccartonensis*
Mien-tien shales, sandstones and limestones with *Monograptus* and *Climaco-graptus*	Keilor graptolitic shales, sandstones and conglom-erates	Douro tuffs		Shales with *Monograptus spiralis* and *turriculatus*
		Bango limestones, shales and tuffs with *Halysites*		Shales with *Monograptus regularis*
		Hawkins tuffs		Shales with *Monograptus* and *Climaco-graptus*



life are of interest not only from an aesthetic and scholarly point of view, but also because they provide the only practicable means of consistently telling fossil time. Radiogenic methods of absolute age determination do not yet suffice for general dating or correlation of the Paleozoic rocks. even though a very few apparently reliable dates are used to set. approximately, the hands of the paleontological clock in terms of years.

From the fossils also can be deduced much of the history, ecology and geography of ancient times, always in connection with the characteristics and positions of the rocks themselves. Ecologic deductions, for instance, are greatly aided by the tracks, trails and burrows made by different organisms. Indeed these are almost the only traces of life in some deposits, such as the Silurian of the eastern Appalachian trough.

2. Invertebrates and Associated Fossils.—In the Silurian, as with other fossiliferous rocks, the invertebrate and noncellular (or unicellular) organisms are the true indices of time, on the basis of which nearly all meaningful stratigraphic correlation with the standard marine sequence is founded. The form sequence of the monograptid graptolites illustrates well how such correlation may be accomplished either by relating stage of evolution to time or by the empirical knowledge of the ranges of specific morphologic types. Correlation, or paleoecological analysis. in practice, however, is usually made by analysis of the total biotal characteristics of the problem sample, considered in relation to lithology and sequence of the enclosing sediments. Ranges of selected index genera at the right side of the correlation table illustrate how Silurian fossiliferous sediments can be dated, using apparent terminal ranges of a variety of fossils.

The graptolites. despite their suggested close alliance to the vertebrates, are at best invertebrate chordates, and, in this sense, the most conspicuous and distinctive Silurian invertebrates. The monograptids are the evolutionary culmination of the simple sawbladelike forms of graptolites and appear to be exclusively Silurian—no Ordovician or Devonian report has ever been unequivocally substantiated.

Moreover, only a few species of two genera (Diplograptus and *Climacograptus*) of their Ordovician ancestors carried over into the Silurian. and these only into the lower part. The Silurian graptolite assemblage thus consists almost entirely of *Monograptus*, of short-lived derivative genera from it or older forms, and of occasional reticulate colonies such as persisted into the Devonian. The apparent time subdivision of Silurian rocks is based largely on short-ranged species of *Monograptus*—18 of the 26 graptolite zones in the type Silurian sequence are so characterized, and many of the same species floated around the world.

Corals and stromatoporoids are subordinate to the graptolites as Silurian time indicators but far ahead of them in range of evolutionary diversification. Compound corals particularly flourished, including the tabulates, which now reached their greatest expansion, and fasciculate tetracorals which did not attain their acme until the Devonian. Horn corals of simple types were more abundant and more complicated than Ordovician, less so than Devonian relatives. Stromatoporoids had also to await the Devonian for their climax, and no Silurian or other common Paleozoic coelenterate is anything like its modern relatives. Presumably however, they did have the same alternation of sessile and free-floating generations as typifies the living representatives of the phylum, which would account for wide distribution of identical species in favourable environments. Unlike the graptolites, which apparently could drift even after death, they are not found far from their place of life except as a result of unusual events.

Bryozoa are still about as common as they were in the Ordovician. with a slight dwindling of stony types and an increase of the more delicately ornamented tniglike cryptostomes. Locally they made small mounds at the bottom of the Silurian seas, as represented by the ball reefs of the Rochester shale in western New York state.

Among Silurian brachiopods, the globular, short-hinged and commonly large pentameroids were the most distinctive forms. Short-hinged spire-bearing brachiopods were essentially new, alhough there are common Ordovician forms. The wide-hinged spiriferoids began the expansion that was to flower in Devonian and Lower Carboniferous time.

The pelecypods continued to expand slowly from Ordovician beginnings, and the prosobranch gastropods became important fossils, in continuance of a long, progressive expansion to modem times. Among the cephalopods, ammonoid progenitors appeared and nautiloids dwindled. Some distinctive Ordovician groups of nautiloids were missing completely (*e.g.*, Endoceratida) and others died out during the Silurian (*e.g.*, Ascoceratida). As if to emphasize their decline, no important new nautiloid groups appeared.

Among the arthropods, trilobites continued their slow decline from a Cambrian maximum, and ostracods and merostomes both expanded slightly. Among the latter, eurypterids became much more common, while the aglaspids were missing; but xiphosurans ancestral to living *Limulus* are recorded. Ostracods are locally abundant and useful Silurian index arthropods. Trilobites, despite their general decline, showed an expansion of bizarre spiny types, perhaps as an adaptation to floating or camouflage, forced by increasing competition for the nutrient-rich bottom niches or predation. Allied developments may have caused the eurypterids to enter fresh water in later Silurian time, from which, according to one theory, they eventually chased the fishes. It is an old law of life that each time new or better offensive or competitive equipment or tactics are evolved compensation is made, or the hunted or competitive inferior perishes or takes exile.

Crinoids were the most successful Silurian echinoderms, enjoying their greatest recorded expansion of numbers and kinds. Unlike their commoner living relatives, these lilies of the sea were stalked forms; if they were equally colourful their colonies were the showy marine gardens of Silurian time. Cystoids were also common, and, although much more primitive, were similar in living habits and appearance to the crinoids. Other echinoderms were not important.

Noncellular invertebrates, or the Protista (Protophyta and Protozoa), are abundant in some Silurian deposits. Chitinous and agglutinated Foraminifera have been described from North America, the Baltic and England, and Radiolaria are occasionally reported, but little is known in detail of these Silurian records.

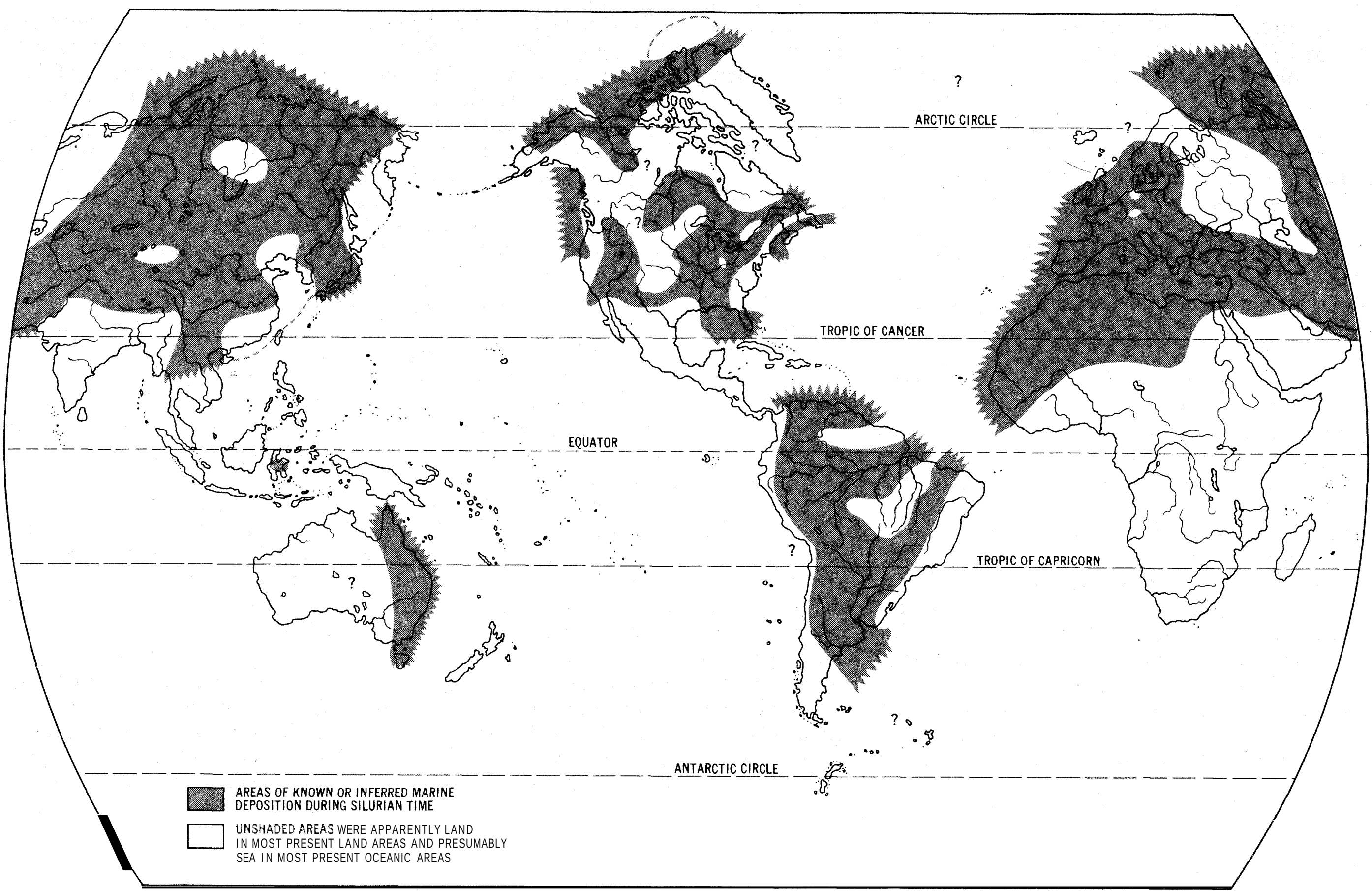
An important group of Silurian problematica is the Chitinozoa, consisting of minute, black, chitinous, vase-shaped to club- or ball-shaped organisms. Revelation of such tiny creatures or parts of creatures by chemical treatment of apparently unfossiliferous rocks sometimes permits the correlation of deposits whose position cannot be closely established by other methods.

3. Fishes, Land Plants and Associated Fossils.—Silurian occurrences of fish and plant fossils are more numerous and complete than in older rocks. They are, however, mostly, though not entirely, restricted to the upper part of the system and the fossils are not demonstrably more advanced than their predecessors. Conversely, they are greatly surpassed in number and variety by Devonian records. In the Late Silurian. in fact, the arthropods appeared to be making more headway than the vertebrates in colonizing the lands. The arachnids were represented by the scorpionid *Paleophonus*, from the Upper Silurian of both sides of the Atlantic. Millipedes are reported to occur in association with eurypterids (water-dwelling scorpionlike creatures) in Wales. Neither scorpion nor millipede was surely air breathing, but both were at least evolving in that direction. In the estuarine to questionably marine or fresh water deposits, where the early fishes are most commonly found, is also an abundance of eurypterid remains. Indeed the Silurian and Devonian saw the climax of this group, which comprised the greatest arthropod predators of all time, perhaps including principal foes of the early fishes, and possible ancestors of the arachnids.

The simple, externally armoured, mainly backboneless earliest fishes and the primitive early plant assemblages are discussed in a separate article on the Devonian system (*q.v.*).

III. REGIONAL SUMMARY

The distribution map shows where Silurian marine deposits of different ages might have been laid down on the present Iand areas. Naturally a map for any instant of the 30,000,000 years or so of



DISTRIBUTION OF SILURIAN SEAS AND LANDS

Silurian time would look very different from this highly generalized scheme, particularly if the Paleozoic geology of the ocean basins were known. Silurian nonmarine deposits and plutonic rocks are not well enough known to consider on a composite map of this scale. This map and the correlation table together give a general view of Silurian stratigraphy and paleogeography that supplements the condensed discussion of outcrop regions below.

1. Great Britain. — Silurian sediments of the type region in Wales and western England, and extending into southern Scotland, were deposited in a northeast-southwest trending subsiding area (the Caledonian geosyncline) and bordering shelf seas to the east. The basin or geosynclinal facies is characterized by graptolite-bearing slates and shales, flaggy and shaly silt stones. sandstones and mixed coarse detritus about 5,000 to 10,000 m. thick. This facies is typically developed in the Lake district of northwestern England. The shelf facies consists of shales (including mudstones), limestones and silt stones with a shelly fauna and a maximum thickness of perhaps 1.000 m. in typical development. It thins eastward to disappear toward the inferred Silurian seashore. Complete gradation in sedimentary facies, thickness and fauna occurs from shelf to basin along the margins of the subsiding trough, with some persistent zones of graptolitic shale that correlate between facies and record the history of down warping. The type area of south Wales and the Welsh borderland is happily intermediate between extreme developments of either shelf or basin facies. Northward, to the south of Scotland. the sediments suggest approach toward the northwest side of the geosyncline.

At many places in the Welsh borderland the oldest Silurian deposits in Britain are separated from underlying rocks by unconformity or abrupt upward reduction of volcanic components. Preceding crustal movements, of which the profuse Ordovician volcanicity is one indication. may have brought the southeastern part of the British subsiding area generally above water in the waning stages of the Ordovician. Subsidence. with sharply waning volcanism, was almost immediately renewed, however, and continued intermittently to near the end of the Silurian or beyond. Onset of the Caledonian orogeny forever reversed the process and made mountains where the sea had been, from Wales to Scandinavia.

Subdivisions of the British sequence are shown on the correlation table. The oldest interval, the Llandoverian (or Valentian, or May Hill), saw the sharpest distinctions between basin graptolitic shale facies and calcareous and in part sandy shelf facies. This distinction was less marked in the Wenlockian or middle division. when the importance of the calcareous facies was increased by growth of coral-stromatoporoid reefs and colonies on the shelf and spread of shelly fossils into the graptolitic shales. In Ludlovian or Upper Silurian time the distinction became progressively less marked. It finally disappeared in the last half of the Ludlovian (Aymestry) along with general faunal impoverishment and disappearance of the graptolites from Britain.

2. European Continent. — The same Caledonian depression in and along which were deposited the Silurian sediments of Britain, continued northeastward to Scandinavia, with a bordering shelf sea that locally extended as far eastward as Estonia. Best-known Scandinavian sequences are in southern Norway, southern Sweden and Gotland. That of south Sweden (Skåne) is a somewhat deformed but essentially complete basin succession of graptolitic shales with limestone interbeds increasing toward the top. This grades northwestward to the fine-textured and richly fossiliferous, but also structurally disturbed, intermediate to platform facies of limestones and shales north of Oslo. Southeastward it goes into the thin, calcareous. relatively flat lying shelf-facies of Gotland and Estonia. The Caledonian trough of pre-Silurian time thus seems now to have shifted its axis to the east and to have become a broad but not very deep embayment bulging northeastward into but not across Scandinavia. Later Caledonian deformation from a northwest direction folded the Norwegian sequence and that of south Sweden but did not noticeably affect Gotland or the eastern Baltic.

The Silurian section of Gotland, important because it comprises the type Gotlandian (synonym of Silurian as here used) is a thin but richly fossiliferous succession of limestones and calcareous shales. Many of the hills of Gotland are coral-stromatoporoid reefs, marvelously exposed for study. Despite its importance and fine shelly faunas, agreement has not been reached as to names, limits, or number of subdivisions for the Gotlandian section.

Between the Baltic and Brittany, the Silurian is represented by poorly developed and little understood shales, sandstones and limestones, commonly strongly metamorphosed and discontinuous. Only eastward in the Harz and Thiiringer uplifts does the section improve, with Bohemian aspects. The Armorican massif itself (Brittany) displays a basinal Silurian facies—500 m. or so of graptolitic black shales, with sandstone at the base.

In the Bohemian (or Czechoslovakian) massif around Prague is the famous Silurian sequence of Joachim Barrande and J. Perner; somewhat deformed by Caledonian as well as by later movements. This is prevailingly of graptolitic shales with at first inconspicuous limestone bands. The calcareous fraction increases toward the top until the whole sequence goes over to gray and black limestones, with both bedded and reef facies. Total thickness is somewhat under zoo m. A thin sandstone with land plants near the top is followed by shale and limestone with the last known uniaxial graptolites. This sequence represents a large span of Silurian time during which sediments presumably accumulated in a relatively shallow or slowly subsiding basin which connected through Brittany to the Caledonian seas. It also spilled over through the Montagne Noire of south central France and had connections to Elba, Sardinia, Spain, the eastern Bavarian Alps and the Balkans, where Silurian rocks generally resemble those of central Czechoslovakia.

3. **U.S.S.R.**—The so-called Tethyan seaway connected through the present site of the Alps, Mediterranean and the northern middle east to the Gralian trough and Siberia during parts of Silurian time. It left about 400 m. of richly fossiliferous marine Wenlockian and Ludlovian calcareous shales and limestones in Podolia, southwest Ukraine (formerly southeast Poland). The beds dip slightly westward along the walls of deeply entrenched streams beneath a cover of younger deposits, to disappear under Downtonian (basal Devonian) marine deposits and the Old Red Sandstone.

The north-south trending Uralian subsiding belt lay on the eastern side of the north European heartland and extended beyond Spitzbergen presumably to the north of Greenland and the northern islands of the Canadian Arctic archipelago. It developed independently, and its Wenlockian and Ludlovian shelly fauna is more like that of southeastern Alaska and northern California than to anything else well known. Presumably there was a direct connection across central Siberia and the Aleutian area at this time. Graptoliies occur in Llandoverian shales and sandstones of the Urals. The Silurian of the Altai mountains of south central Siberia consists of shales and limestones with grsptolites and corals, at places reefy.

4. Asia.—Limestones and sandstones with corals, brachiopods and graptolites are known from Spiti and Kashmir at the north of the Indian continent, and in the Shan states of Burma, where graptolites establish Early and Middle Silurian age. Total thickness may not exceed 300 m.

Connections are from the Tethyan or Mediterranean area to southwest China, where (in east and central Yunnan) there are about 1,000 m. of fossiliferous shales, sandstones and limestones of Llandoverian and Ludlovian age. Llandoverian deposits, in fact, occur widely in western and central China, but the Ludlovian is known only in the southwest, and the Wenlockian nowhere at all. The record in north China is obscure.

The Kitakami mountains of north Japan (north Honshu) reveal 200 to 300 m. of Middle and Upper Silurian limestones and slates, with corals and stromatoporoids in the limestones and radiolarians in slates near the series boundary. Silurian is also reported from central Honshu and the islands of Shikoku and Kyushu.

In Celebes is a Silurian outpost between Yunnan and eastern Australia, identified by the coral Halysites.

5. Australia.—The known Silurian of Australia is limited to the eastern coast and Tasmania. A thick (3,000 m.) conglomerate in the centre (Macdonnell ranges) has been tentatively referred to the Silurian for obscure reasons. but no fossils are known from it. Known Silurian sections consist dominantly of coarse clastic and volcanic deposits. Interbedded with these locally are graptolitic shales and limestones or calcareous shales with a shelly fauna. Northeast of Melbourne are 8,000 m. of clastic beds that may represent the whole of the Silurian. In the Yass district of New South Wales the section is only about 1,000 m. thick, but is famed for the rich and beautifully preserved fossils of its Yass beds and lower Hume limestones and shales.

Silurian crustal unrest, indicated by prolonged and widespread volcanic activity. culminated with compressive movements and deep-seated igneous intrusions locally termed the Bowning orogeny, and considered a phase of the more inclusive Caledonian orogeny. When the Devonian seas reinvaded eastern Australia their deposits frequently came to rest on the folded and erosionally truncated edges of Silurian rocks.

6. South America.—A compilation of South American paleogeographic data by Kenneth Caster shows broad invasion of that continent by the Silurian seas. The details, however, are little known and difficult to interpret, because Silurian was lumped with Ordovician in the reconnaissance studies that so long characterized South American geological exploration. Between South America and Antarctica, detrital and volcanic deposits at the base of the Cumberland bay series of South Georgia Island are questionably referred to the Silurian on doubtful fossil evidence.

7. North Africa.—Silurian deposits throughout north Africa are prevailingly in the basin facies. They imply a broad, open, but not very rapidly subsiding sea that connected freely with the Tethyan (Mediterranean) and north European seaways. In central Morocco the entire succession, save the top fraction, consists of graptolitic shales with characteristic species of most of the British stages. Altogether it is about 1,000 to 1,500 m. thick. This facies continues not only through the Great Atlas, where an axis of subsidence might be expected, but also southward, to the middle of the Sahara shield.

8. North America.—The Silurian rocks of North America are mainly the deposits of warm platform seas, which deepened in the eastern U.S. to form the Appalachian trough. Detrital sediments originating in eastern borderlands were largely restricted to this trough, and some (with fishes and eurypterids) along its eastern side may be nonmarine or very near shore. Leaving aside the Acadian deposits, with their European affinities, the gross form of the Appalachian succession is that of a wedge of sandstones, shales, carbonate rocks and some conglomerates from 300 to 2,000 m. thick—like a giant composite delta. By contrast, equivalent strata on the west side of the trough and the east flank of the Cincinnati arch are greatly reduced and are here already within the interior platform seas. Prevailing aridity over and adjacent to the Late Silurian seas from western New York state to southern Michigan led to the accumulation of commercial deposits of gypsum and salt in arms of the sea or intermittently connected salt basins. These evaporites are interbedded with green and red shales and grade eastward to coarser and partly red detritus. During parts of the Middle Silurian unusual (and uncertain) conditions led to deposition of the famous hematitic Clinton iron ores from New York to Alabama. The iron replaces formerly calcareous shell fragments and is deposited between them in stratigraphically limited zones of varying thickness. Graptolitic shales are also found in some of the Appalachian trough deposits, although not as common as in the good basin developments of Europe and north Africa.

Little mud or sand entered the Silurian seas west of the Cincinnati arch, and the sediments there were thin, almost entirely calcareous, and locally include reefs. Thus, sequences of limestone generally less than 300 m. thick are prevalent in the Mississippi valley. Limestone is also a common rock of the Silurian in central Canada, southwest of Hudson bay and in the Acadian region at the eastern apex of the continent; for instance, in eastern Quebec (Chaleur bay), northern Nova Scotia (Arisaig) and Anticosti Island. The interior limestones grade to dolomites in the shallower parts of the ancient seas, especially in the Great Lakes region.

The Silurian has restricted development in the eastern Great Plains and the subsurface of north central Texas, but richly fossiliferous limestones and shales are exposed in the Arbuckle mountains of southern Oklahoma.

Development in the Cordilleran region is almost restricted to the U.S., with an arm along the Mexican border to west Texas. There it is preponderantly dolomite, with limestone and shale subordinate and with identifiable fossils only locally. In the Eureka district of central Nevada the section is as much as 1,400 m. thick. The Pacific border deposits of California and Alaska are coarse, impure, detrital and volcanic sediments with occasional fossiliferous limestone lenses and with Siberian and Uralian faunal affinities. Those of the North American arctic seem to be mainly calcareous, dolomitic or shaly.

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(P. E. Cd.)

SIEVA, ANTONIO JOSE DA (1705–1739), Portuguese dramatist, was born at Rio de Janeiro. Brazil, but went to Portugal with his parents at the age of eight. The parents belonged to a French family which had emigrated to escape the Inquisition. António was sent to study at Coimbra, and, while still a student. was arrested with his mother. Both were tortured, but António abjured his errors, and his mother figured as a penitent in an auto-da-f6. He completed his studies and joined his father in practice as an advocate at Lisbon. He married a cousin whose parents had been burned by the Inquisition, while she also had been exiled for her religion. On Oct. 5, 1739, husband and wife were imprisoned for "judaizing." having been denounced by the Inquisition. On Oct. 18 António was strangled, and his body burned in an auto-da-f6; on that same day one of his popular operettas was given at a Lisbon theatre.

His dramatic works, which were produced at the Bairro Alto theatre between 1733 and 1738, include the following comedies, all played by marionettes — D. Quixote (1733), *Esopaida* (1734), *Os Encantos* de Medea (1735), *Amphitrião* (May 1736), Labyrinth de Creta (November 1736), *Guerras* do Alecrim e *Mangerona* (carnival of 1737), As *Variedades* de Proteo (May 1737) and *Precipicio* de Faetonte (1735). Slight as these sketches are, they show considerable dramatic talent and an Aristophanic wit. The characters are well drawn and the dialogue full of comic strength, the scenes knit together and the plot skilfully worked out. Moreover Silva possessed a knowledge of stagecraft, and, if he had lived, he might have emancipated the drama in Portugal from its dependence on foreign writers; but the triple licence of the Palace, the Ordinary and the Inquisition, which a play required, crippled spontaneity and freedom. Even so, he showed some boldness in exposing types of the prevailing charlatanism and follies, though his liberty of speech is far less than that of Gil Vicente (*q.v.*). His comedies give a truthful and interesting picture of 18th century society, especially his best comedy, the Alecrim e *Mangerona,* in which he treats of the *fidalgo* pobre, a type fixed by Gil Vicente and Francisco Manoel de Mello (see MELO, FRANCISCO MANUEL DE).

BIBLIOGRAPHY.—His plays were published in the first two volumes of a collection entitled *Theatro comico portuguez,* which went through at least five editions in the 18th century, while the *Alecrim e Mangerona* appeared separately in some seven editions This comedy and the *D. Quixote* have been reprinted in a critical edition with a life of Silva by Dr. Mendes dos Remedios (1905). Ferdinand Denis, in his *Chejs-d'oeuvre du théâtre portugais* (pp. 365–496, 1823), prints liberal extracts, with a French translation, from the *Vida de D. Quixote.*

See Dr. Theophilo Braga, *Historia do theatro portuguez; a baixa comedia e a opera* (1871); F. Wolf, *Dom Antonio Jose' da Silva* (1860); Ernest David, *Les Opéras du juij Antonio Jose' da Silva, 1705–1739* (1880); Oliveira Lima, *Aspectos de litteratura colonial Braeileira* (1896); *Jewish Encyclopedia,* vol, xi. p. 341; G. A. Kohnt, "Bibliography of Works relating to Antonio José da Silva and Bibliography of Don Antonio's Compositions" in the *Publ. Am. Jew. Hist. Soc.* No. 4, p. 181; idem, "Martyrs of the Inquisition in South America," ib. p. 135; M. Grunwald, "José da Silva" in *Monatsschrift* (1880), xxix. p. 241.

SILVANUS (Lat. silva, wood), a deity or spirit of the woodland bordering on clearings. Thus he is partly wild and partly civilized, and reflects the experience of the earliest settlers in Italy; hence his later identification with foreign deities felt to be not wholly hostile. Accordingly Horace writes of the "horridi dumeta Silvani" (Odes, iii. 29) but he also calls him "tutor finium" (Epod., ii. 22) and Virgil "arvorum pecorisque deus" (Aen. viii. 600). A writer on land measurement (Script. *gromatici,* i. 302) tells us that each holding had three Silvani — domesticus (of the holding itself), agrestis (of the wilder pasture-land) and *orientalis* (of the boundaries). Although much worshipped, he never made his way into the towns, but is almost the only Roman deity who from first to last retained the same perfectly intelligible rustic character. His double nature as deity of woodland and cultivated land is seen well in the artistic representations of him; he carries a young tree in one hand, a pruning-hook in the other.

See Wissowa, *Gesammelte Abhandlungen* (1904, p. 78 foll.).

SILVER, a metal known from very early times, has long been used in the manufacture of articles of value such as coins, ornaments and jewelry because of its comparative scarcity, brilliant white colour and resistance to atmospheric oxidation. Apart from these uses, silver has a number of applications. most of which depend on its high thermal or electrical conductivity and corrosion resistance. Silver which has been hardened by elements such as copper or gold is used in electrical contacts. In electronic engineering conductors are sometimes coated with silver for radio-frequency currents. where the skin effect is important.

Silver apparatus is used to a limited extent in the chemical engineering industry, for example. in the manufacture of certain medicinal chemicals, in processing foodstuffs and beverages and in handling organic acids such as citric and lactic acids. Silver functions as a mild oxidation catalyst in the vapour phase oxidation of certain organic compounds such as the lower aliphatic alcohols.

The silvering of glass mirrors is an old-established industry and depends on the action of a chemical reducing agent such as invert sugar, Rochelle salt or formaldehyde on an ammoniacal silver solution. It is also possible to produce mirrors by evaporating silver on to a surface from an electrically heated filament in high vacuum. (See also Uses, below.)

Silver is uidely dispersed and sometimes occurs native, usually associated with copper and gold. The chief minerals are argentite (silver glance), Ag_2S, and chlorargyrite (horn silver), AgCl. There are also a number of complex sulfidic minerals such as stephanite (Ag_5SbS_4) and proustite (Ag_3AsS_3). Silver minerals are found with the ores of certain base metals, especially those of zinc, lead, copper and nickel, and considerable amounts are also derived from gold-silver ores.

Silver is present in sea water, though the concentration is minute and there appears to be no prospect of its economical recovery.

Physical Properties. — Silver, to which the symbol Ag is given, has an atomic number of 47 and an atomic weight of 107.88. The natural isotopes are Ag^{107} and Ag^{109} which are roughly equally abundant. Its chief radioactive isotopes are Ag^{108} (half life, 225 days), Ag^{110} (half life, 24 seconds) and Ag^{111} (half life, 7.5 days). The pure metal melts at 960.5° C. and boils at about z,000° C. In the molten state it dissolves oxygen (at the melting point about 20 vol. aye dissolved per volume of molten silver at one atmosphere pressure of oxygen). Most of this is evolved on solidification, a phenomenon which is known as the splitting of silver.

The metal has a face-centred cubic lattice (a = 4.0778 Å). The density is 10.49 at 15° C. but hard-drawn wire has a slightly lower value.

Silver is the most malleable and ductile of all metals except gold; one gram of pure metal can be drawn into a wire more than a mile long and it can be beaten into leaves of less than 0.00025 mm. thickness. The pure annealed metal has a Vickers pyramid hardness of 26: it is harder than gold but softer than copper. Pure silver is too soft for use as a coinage metal or in the manufacture of jewelry, and for these purposes it is generally alloyed with a small percentage of copper, which has no appreciable effect on its colour.

Silver has an excellent thermal conductivity. Taking it as 100 the relative values for other metals are:

Ag	Cu	Au	Zn	Sn	Fe	Pt	Pb	Bi
100	73.6	53.2	19.0	14.5	11.6	8.4	8.1	1.8

The electrical conductivity of silver is also slightly superior to that of copper. The resistivity at 20° C. is 1.59 microhm-cm. but this value is appreciably increased by cold working. The optical reflectivity of the freshly polished metal is about 98% for infrared light and 95% in the visible region of the spectrum. It decreases very rapidly in the ultraviolet below 3,500 Å and is only 10% at 3,200 A.

Chemical Properties.——Silver is more electropositive than copper but less so than gold. The standard electrode potential is − 0.7978 v. at 25° C. The metal does not react with moist or dry oxygen but is oxidized superficially by moist ozone. It is quickly tarnished by sulfur at room temperature and a surface film of silver sulfide is formed. A similar effect is obtained with hydrogen sulfide in presence of air or oxygen or with materials, such as vulcanized rubber, which can give free sulfur. Solutions of sulfides also blacken silver.

Fluorine, chlorine, bromine and iodine all react with silver at elevated temperatures but attack on the solid tends to be limited by protective halide films. Aqueous hydrofluoric acid and fluoride solutions do not attack silver appreciably but hydrochloric. hydrobromic and hydriodic acid react superficially. Silver dissolves readily in either strong or dilute nitric acid, forming silver nitrate ($AgNO_3$) and nitric oxide. Hot strong sulfuric acid dissolves the metal and forms silver sulfate (Ag_2SO_4) and sulfur dioxide. When the acid strength is less than 60% there is no action up to the boiling temperature except in presence of oxidizing substances.

In the absence of air fused alkali hydroxides have no action. It is also unaffected by fused alkali carbonates or cyanides though aqueous cyanide solutions in presence of oxygen form the argentocyanide ion.

Colloidal Silver. — In addition to the highly reactive forms of silver, sometimes called molecular silver, which are obtained as finely divided powders by precipitating the metal from its solutions with a reducing agent, or by reducing silver chloride with a metal such as iron or zinc in an acid solution, true colloids are readily obtained. Reducing agents commonly used in preparing colloidal silver are: formaldehyde, hydrazine salts and salts such as tartrates or citrates. Protective colloids are sometimes added. In addition good silver colloids are obtained by passing an arc between pure silver electrodes under water. The colour of the colloids may vary from lilac to red and is largely conditioned by the particle size. Red and yellow solutions contain the smallest and blue solutions the largest particles. Colloidal silver exhibits reducing properties and, in common with some other colloids, is able to catalyse the decomposition of hydrogen peroxide.

Chemically *Pure* Silver. — Silver of the highest purity is of special interest to the chemist because it was made and used in all the classical work on the determination of atomic weights. A procedure used by T. W. Richards and H. Wells in 1905 may still be quoted, though various other methods are now available. Silver nitrate is recrystallized, precipitated by hydrochloric acid and the resulting chloride thoroughly washed, and reduced to metal with pure invert sugar and caustic soda. The reduced silver is fused in a block of lime in the reducing flame of a blowpipe. The product is further purified electrolytically and again melted in a lime boat in an atmosphere of hydrogen. Silver of at least 99.999% has been obtained.

Compounds of Silver. — In the majority of silver compounds the element has a valence of one. These so-called argentous compounds include such familiar substances as silver chloride, bromide, iodide and nitrate. A few argentic compounds are known in which the element has a valence of two (see below).

Silver oxide (Ag_2O) is prepared as a dark brown precipitate by adding an excess of sodium hydroxide solution to a solution of silver nitrate. It is appreciably soluble in water (0.02 g. per litre at 25° C.) and this solution has an alkaline reaction and behaves as if it contained silver hydroxide. It will precipitate many insoluble metal hydroxides from solutions of their salts and absorbs carbon dioxide from the atmosphere to form silver carbonate. The oxide loses oxygen slowly at 250° C. and is rapidly decomposed to silver and oxygen at 350° C. In its reactions it behaves as a moderately strong oxidizing agent. The oxide dissolves in aqueous ammonia, probably forming the complex $[Ag.2NH_3]OH$. The solution, on exposure to air, forms a black precipitate of fulminating silver, which is dangerously explosive. Its composition is uncertain, but it may contain either the nitride Ag_3N, or the amide $AgNH_2$.

Halogen *Compounds*.—The halides of univalent silver, the most useful compounds of silver, are all well-known and stable compounds. Silver fluoride (AgF) differs from the chloride, bromide and iodide in that it is readily soluble in water (180 g. of AgF in 100 g. of water at 25° C.). It is obtained by dissolving silver carbonate in hydrofiuoric acid and evaporating the solution in vacuum. It forms several hydrates. The fluoride has a rock salt structure, in which it resembles silver chloride and bromide but differs from the iodide. The melting point is 435° C.: the fused salt decomposes slightly and contains a little free silver. A silver subfluoride with the formula Ag_2F is formed by the interaction of silver fiuoride and metallic silver at 50° C.–90° C., or in the cathodic reduction of silver fluoride. It is a solid with a bronze colour and a curious crystal lattice in which pairs of layers of silver ions alternate with single layers of fluoride ions. It is thus, in a sense, intermediate between a metal (silver) and an ionic crystal (silver fluoride), which is in keeping with the high electrical conductivity of the solid. Decomposition into silver and silver fluoride occurs above 100° C. or when the solid reacts with water.

Silver chloride (AgCl) is prepared by the addition of hydrochloric acid or a soluble chloride to a solution of a silver salt (*e.g.*, silver nitrate). It is formed as a curdy white precipitate which coagulates on heating or shaking. The salt may also be prepared by direct union of the elements as, for example, when chlorine is passed through molten silver. It melts at 455° C. It is found in nature as the mineral horn silver. The solubility in water at 25° C. is 1.91 mg. per litre. It is, however, much more soluble in concentrated hydrochloric acid and the solution is believed to contain the acid $HAgCl_2$. Silver chloride is also dissolved by solutions of soluble chlorides, the solubility being greater the greater the concentration of the dissolved salt. It is changed to silver sulfate by boiling with concentrated sulfuric acid and dissolves readily in dilute aqueous ammonia. The solution, which contains the complex cation $[Ag(NH_3)_2]^+$ yields silver chloride again on acidification with nitric acid. Silver chloride is soluble in alkali cyanide solutions and the solutions contain the complex anion $[Ag(CN)_2]^-$. On the addition of sodium thiosulfate solution to silver chloride, a solution is obtained which contains the complex anion $[Ag(S_2O_3)_2]^{3-}$. Silver bromide and iodide dissolve similarly and the formation of this complex is the reaction which occurs in the fixing of the emulsion of a photographic plate or film after first developing and washing it. The fixing removes all unchanged silver halide and so makes the emulsion insensitive to light. Silver chloride forms the compound $AgCl.3NH_3$ when it is treated with gaseous ammonia below 20° C. All the ammonia is driven off at 65° C. but there are several other ammoniates which are stable in the intermediate temperature range.

Silver bromide is found in nature as the mineral bromargyrite. It is formed by the action of bromine on silver or, as a curdy pale yellow precipitate, when hydrobromic acid or a soluble bromide is added to a solution of a silver salt. It melts at 434° C. The solubility in water is less than that of silver chloride (0.11 mg. per litre at 21° C.). It is only sparingly soluble in dilute ammonia solution, the solubility being less than that of silver chloride but greater than that of silver iodide. This difference may be used as a means of distinguishing between the three halides. The reactions of silver bromide with aqueous solutions of alkali cyanide and thiosulfate are similar to those of silver chloride. Ammoniates are also formed with gaseous ammonia.

Silver iodide is found native in the mineral iodoargyrite. It is prepared by methods exactly analogous to those for silver chloride and bromide, and is a yellow solid, which melts at 552° C. There are three crystalline modifications. which have wurtzite. zinc blende and cubic lattices respectively. The last of these is stable above 147° C. The solubility in water at 25° C. is only 0.0025 mg. per litre. The salt is soluble in a strong solution of potassium iodide. Other reactions are very similar to those of silver chloride and bromide.

When silver chloride, bromide or iodide is exposed to light the colour changes from white or yellow to pink. violet and finally to black. In this process halogen is lost and, with prolonged and intense irradiation, weight losses of up to about 10% may be recorded. It is not yet certain what is formed but it is thought to be either silver or a silver subhalide or both. When the silver halides are used in photography very much smaller exposures than those referred to above are involved; indeed they are such that no visible change occurs in the halide grains. Only when the emulsion is subsequently developed *i.e.,* submitted to the action of a chemical reducing agent, are those grains which have been exposed to light blackened because of the production of metallic silver (see PHOTOGRAPHY).

Other Compounds of Univalent Silver.—Silver nitrate ($AgNO_3$) is the chief silver compound which is of technical importance. It is made in large quantities by dissolving silver in nitric acid of density 1.25–1.30. It crystallizes in transparent plates which melt at 212° C, and can be cast. The solubility at 20° C. is 222 g. per 100 g. of water. It is moderately soluble in methyl and ethyl alcohols and, to a smaller extent. in various other organic solvents. When heated at about 320° C. silver nitrate loses oxygen and forms silver nitrite. At a red heat silver is formed.

The chief use of silver nitrate is as an intermediate in the preparation of silver halides for incorporation in photographic emulsions. When used for this purpose the technical salt must first be purified. In analytical chemistry aqueous solutions of silver nitrate are used in the volumetric determination of halides, cyanides and thiocyanates. as well as for the detection of reducing agents and of the cations of various acids which form insoluble silver salts. Silver nitrate has a causticizing action on the skin and produces a blackening because of the formation of silver. Cast sticks of silver nitrate are used in pharmacy under the name lunar caustic. A similar blackening is produced when the salt is in contact with other types of organic matter and, in aqueous solution, it has been used for marking linen. The free nitric acid tends, however, to destroy the fabric and it is preferable to use the silver salts of weaker organic acids.

Silver sulfide (Ag_2S) is found native in the mineral silver glance or argentite. It is also found associated with the sulfides of other metals (*e.g.,* with lead sulfide). The metal has a great affinity for sulfur and the sulfide may be made by the direct union of the elements or by the action of hydrogen sulfide on a solution of a silver salt. It is a black-brown solid which is insoluble in cold dilute mineral acids, though it dissolves in hot dilute nitric acid and also in alkali cyanide solutions.

Silver sulfate (Ag_2SO_4) is produced when the metal is dissolved in hot sulfuric acid, or by adding dilute sulfuric acid to a fairly strong solution of silver nitrate. It forms white rhombic prisms which are isomorphous with anhydrous sodium sulfate and are only sparingly soluble in water. The salt dissolves in aqueous ammonia, the solution yielding the complex salt $[Ag(NH_3)_2]_2SO_4$.

Silver selenide (Ag_2Se) is made by heating silver powder with selenium. It is a black crystalline material and a. semiconductor. Silver telluride (Ag_2Te) resembles the selenide and is prepared by a similar method. Both selenium and tellurium may occur with silver minerals and, if they find their way into the metal as trace impurities, they have a deleterious effect on its mechanical properties as well as on its usefulness as a catalyst.

Silver cyanide is obtained as a curdy white precipitate when a soluble cyanide is added to a silver salt solution. It is soluble in excess of cyanide solution and forms the complex anion $[Ag(CN)_2]^-$. This is important in electroplating. a process in which the object to be plated is made the cathode, the anode being a sheet of pure silver. The electrolyte is. as a rule, a solution containing the complex $K[Ag(CN)_2]$, the anion of which is dissociated to a slight extent into silver cations and cyanide anions. On electrolysis the former are deposited on the cathode to be plated and the latter react with the anode, causing fresh silver to pass into solution as the complex and so replenish the bath. Silver thiocyanate (AgCNS) is a very insoluble salt which is also insoluble in nitric acid. It is precipitated by the addition of ammonium thiocyanate solution to a silver nitrate solution. Silver azide (Ag_3N) is formed as a white precipitate when sodium azide is added to silver nitrate solution. It resembles silver chloride in many of its reactions, but is very explosive in the dry state and has been used as a detonator.

In addition to the silver salts already mentioned there are numerous others, among which are the phosphates, arsenates and chromates. which are insoluble and are used in testing qualitatively for the presence of these acid radicals in solution. The silver salts of many organic acids have been prepared and are of interest in that they yield silver when they are ignited in air and so may be used in determining the equivalent weight of the acid.

Silver also yields a large number of co-ordination compounds. A few of the more important, such as the complex cyanide and thiosulfate, have already been mentioned. In certain of these compounds the stability of the cation is increased by co-ordination. Thus, for example, co-ordination of the silver ion with ethylenethiocarbamide (etu) yields the complex chloride and bromide $[Ag(etu)_3]Cl$ and $[Ag(etu)_3]Br$, neither of which is darkened by light.

Bivalent Silver.—One of the few simple compounds of bivalent silver is argentic fluoride (AgF_2) which is a dark brown solid formed when fluorine reacts with argentous fluoride. It melts at 690° C. and is a ponerful oxidizing agent and also a good fluorinating agent. The other halides of bivalent silver are unknown. Anodic oxidation of silver or, alternatively, oxidation of an aqueous solution of silver nitrate with a persulfate gives a black compound of the empirical formula AgO which is very probably an oxide of bivalent silver.

There is some indication that anodic oxidation of silver may give a higher oxide, possibly Ag_2O_3. The stability of the argentic ion is much increased by co-ordination with various ligands. Thus, for example, although argentic persulfate is unknown, co-ordination of the metal with pyridine enables the relatively stable compound $[Ag(pyr)_4]S_2O_8$ to be prepared. It is isomorphous with the corresponding cupric compound. Other co-ordinating molecules which give similar products are o-phenanthroline and dipyridyl.

Alloys. — Silver alloys with most metals but few of the products have any practical value. Alloys with copper are harder, tougher and more fusible than silver and are used for coinage and jewelry. The proportion of silver in these alloys is stated in terms of fineness, which means parts of silver per 1,000 of the alloy. Sterling silver contains 92.5% of silver and 7.5% of another metal, usually copper; *i.e.*, has a fineness of 925. Gold and silver form a continuous series of solid solutions. Various alloys of gold. silver and copper are used in the jewelry trade and in dentistry. There are also several minor uses for these alloys (*e.g.*, in the manufacture of electrical contacts and for hard solders). Silver-zinc alloys are important because they form readily and provide the basis of the Parkes process for desilverizing lead. In dentistry a silver amalgam is used which is a mixture of mercury with a silver-tin alloy. It sets in the tooth cavity by the interaction of the components to form a ternary system of which mercury is a component. There are, however, other types of dental alloy. Lead and silver form a simple eutectic at 304° C. (2.5% silver).

There is also an important group of silver-bearing alloys which is used in soldering and brazing. Among these are various alloys based on the silver-copper-zinc and the silver-copper-phosphorus systems.

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METALLURGY, MINING AND PRODUCTION, USES

History. — Early Roman records show that before the use of *argentum*, from which the chemical symbol Ag was derived, the word "Luna" and a crescent moon symbol were used for silver. The actual use of silver dates far back into antiquity; however, it is believed that gold and copper were the first metals to be worked by man. Silver ornaments and decorations have been found in the royal tombs dating back as far as 4000 B.C. In the Code of Menes, who is supposed to have reigned in Egypt about 3500 B.C., it was decreed that "one part of gold is equal to two and one-half parts of silver in value." This may have been the first gold standard. By 800 B.C. it is probable that both gold and silver were used as money in all countries between the Indus and the Nile. The Romans probably advanced the art and science of the metallurgy of silver further than any other race up to their time. The Romans had several large and important silver workings, using perhaps the first fire metallurgy (pyrometallurgy) to produce silver metal and then converting the metal into priceless silver ornaments.

According to Pliny in his *Historia naturalis*, "the ore was washed and sieved five times, fused with lead and then cupelled for pure silver." Cupellation is the process of oxidizing the lead to lead oxide, which is quite volatile at high temperatures. Several centuries later it was found that certain ores of gold and silver could be amalgamated by grinding in the presence of iron or copper salts, water and mercury. This method finally evolved into the Patio process. In the latter part of the 19th century, the cyanidation process was developed for the treatment of gold and silver ores. From about 1850 up to the middle of the 20th century approximately 70% of the world production of silver was derived as a by-product in the smelting and refining of copper, lead and zinc ores.

Occurrence. — Silver is widely distributed in nature, but the total amount present in the lithosphere (the solid part of the earth) and hydrosphere (the liquid part) is quite small when compared with other metals. For every 10,000,000 parts of iron, there are about 2 parts of silver found in the lithosphere. About 90% of the silver mined in the 20th century occurred in the native condition, either finely disseminated in other minerals, which is by far the most important, or as free silver. The term native silver means an alloy of silver and some other metals; gold is generally one of the metals. Free silver is native silver in a rather coarse form. Practically all sulfides of lead, copper and zinc contain some silver, and in general if the three different metal sulfides occur in the same ore: the largest per cent of the silver will be found in the lead sulfide (galena). These are called argentiferous ores. Argentiferous ores may contain amounts of silver from a trace to several thousand troy ounces per avoirdupois ton or about 10%. Ores containing silver mined from 1900 to 1955 averaged from about 3 to 30 oz. per ton. (See MINING, METAL.)

Unlike gold, silver tends to form many natural occurring minerals. Some of the most important silver minerals are: cerargyrite (silver chloride) and sylvanite (gold, silver telluride). This group, called secondary minerals? is generally found near the surface of the earth's crust. Another group is generally found deep in the earth's crust and includes argentite (silver sulfide), polybasite (silver antimony sulfide), proustite (silver arsenic sulfide), pyrargyrite (silver antimony sulfide), tetrahedrite (copper antimony sulfide) and tennantite (copper arsenic sulfide). In tetrahedrite and tennantite, part of the copper is usually replaced with silver. Pyrargyrite and proustite, because of their colour, are called ruby silver minerals, while tetrahedrite and tennantite, for the same reason, are called gray copper minerals.

Metallurgy. — Several methods are employed for the extraction of silver, or gold and silver from the ores. However, it must be realized that the majority of ores that contain silver also contain the base metals lead or copper or zinc or any combination of these three metals and are treated metallurgically mainly for the three. The silver they contain is removed as a by-product. Under certain economic conditions it may be more profitable to send such ores to a lead or copper smelter.

The amalgamation process consists of treating ores containing free silver and cerargyrite with water and mercury. The silver amalgams with the mercury and the cerargyrite reacts with the mercury to liberate silver, which amalgamates with the excess mercury. The amalgam is separated from the waste rock and then distilled in retorts. The mercury is condensed for further use and the silver is cast into bullion bars.

The cyanidation process is used mainly on ores in which gold is the main valuable constituent and silver a by-product. However, a large amount of the ore mined in blexico contains only silver as the main valuable constituent and is treated by the cyanidation process. In the cyanidation process the ore is generally pulverized and then leached with a basic dilute sodium cyanide water solution. The silver reacts with the sodium cyanide to form a water-soluble sodium silver cyanide. The resulting mixture is then filtered and the solids discarded. The solution containing the soluble silver is treated with metallic zinc dust, which causes the silver to precipitate from the solution. The metallic silver is filtered off, melted and cast into bullion bars.

Refining of crude silver bullion or gold-silver bullion may be carried out by a number of methods, the method used depending to a large extent on the purity and the amount of bullion to be refined. For bullions containing a large amount of impurities it may require smelting in a small furnace with lead oxide and other materials to form a slag (which can be sent to a lead smelter) and the lead bullion, which contains most of the gold and silver. The lead bullion is then cupeled. The resulting alloy, mainly gold and silver, is called doré. The high-purity doré can then be treated in the same manner as high-purity bullion obtained from cyanidation. The most important methods of treating high-purity gold and silver bullions are electrolysis and parting. In electrolysis the gold and silver bullions and dorés are used for the anode (positive pole). Silver and the more basic impurities are dissolved in a dilute nitrate water solution at the anode; gold remains unattacked and falls off the anode to the bottom of the electrolysis cell as the silver goes into solution. Pure silver is deposited at the cathode (negative pole), which is made of a thin sheet of pure silver. The resulting cathode silver is melted and cast into bars.

Parting, or wet method, is generally applicable to doré or very high-purity gold and silver bullion in which the silver to gold ratio must be higher than two parts of silver to one part of gold. If the ratio is not two to one or better, then silver must be added and the resulting alloy remelted. The doré or gold and silver bullion is placed into a bath of hot concentrated sulfuric or strong nitric acid and the silver is allowed to dissolve. The silver forms water-soluble sulfates or nitrates. The residue is filtered off and treated for its gold content. The clear solution containing the silver is treated with ferrous sulfate or copper or iron to precipitate the silver. The resulting precipitate is filtered off, washed, dried and melted down with flux to give a product that averages 99.5% silver or 995 fine of silver.

Uses.—Monetary use generally claims approximately 40% of the silver mined each year. This use to a large extent takes the form of stockpiling in government hoards. In the U.S. the largest part of the silver bars are stockpiled at West Point, N.Y. The U.S. silver dollar since 1834, the date of the last gold standard established by England, contains 0.773 + troy ounces of silver. The remaining part of the dollar is 10% copper. This 0.773 + oz. of silver in a U.S. dollar is based upon the ratio of 16 to 1; *i.e.,* when the gold standard was set in 1834, it required 16 oz. of silver to be equal in value to 1 oz. of gold. In 1834 the price fixed for gold was $20.67 + per ounce. At 16 to 1 ratio the value of silver is $1.292 +. Therefore, if a U.S. silver dollar contains 0.773 + oz. and the price of silver is $1.292 +, then the silver in a silver dollar is worth approximately $1; however, the price of silver was not fixed as in the case of gold but allowed to fluctuate on the world market as supply and demand dictated. The lowest yearly world price for silver after 1834 was $0.282 + per ounce in 1932 and the highest was $1.346 in 1934. This means that in 1932 the silver in a U.S. silver dollar was worth approximately $0.218 + and in 1834 approximately $1.041 +. The average yearly world market price for silver from 1834 to the mid-1950s was about $0.92 + per ounce. In 1933, to help restore prosperity the U.S. government fixed the price for newly mined silver in the U.S. at $0.646 + per ounce.

The average yearly world market price for silver in 1933 was $0.349 + per ounce. In 1934 the U.S. went off the gold standard established in 1834 and fixed the price of gold at $35 per ounce, but did not revaluate the silver coinage standard. In 1946 the U.S. government raised the price for domestic mined silver to $0.905 per ounce.

Use of the metal for silverware, ornaments, jewelry and other products consumes about 35% of all the silver mined in the world. An average teaspoon marked sterling (not less than 92.5% silver) will contain about 1 oz. of silver. Jewelry silver is an alloy containing 80% silver and 20% copper. Gold dental alloys contain about 75% gold, 10% silver, 10% copper and the remaining palladium, platinum and zinc. Dental amalgams are alloys of silver, tin and mercury. Yellow gold used in jewelry is composed of 53% gold, 25% silver and 22% copper (see Alloys, above).

The photography industry consumes about 15% of the silver mined in the world each year for making film and photographic plates. In this industry silver is used in the form of halides, such as silver bromide. Prior to World War II, manufacturers of airplanes and diesel locomotives began to use pure silver as a bearing material; such bearings have a seizure resistance of 1 compared with about 3 for babbit. After restriction on silver use was removed at the end of World War II, nearly all aircraft and diesel locomotives were equipped with pure silver main bearings. Each main bearing on a diesel locomotive will contain approximately 6 oz. of silver.

During World War II the U.S. government loaned nearly 1,000,000,000 oz. of silver to war plants for temporary nonconsumption uses, such as conductors of electricity. Silver has a relative electrical conductivity of 100 compared to about 95 for copper. Silver and its alloys are used extensively in the electrical industry, mainly because of its resistance to oxidation, for switches and contact points where arcing and wear is a problem. Silver coatings applied to ceramics, glass and mica are finding wide use in electronic devices. Electrical circuits, particularly for portable radios, may be made by stamping or printing a given electrical circuit on panels with silver ink. This modern method of making intricate electrical circuits has greatly reduced the consumption of metal conductors and labour required for soldering wire joints. Silver solders or silver brazing alloys have rather a low melting point and make strong joints that have high resistance to corrosion.

The catalytic properties of silver and its salts are used extensively to influence chemical reactions of ammonia for making fertilizers and other oxidation chemical reactions. Silver foil and plates are used for replacement of missing bone fragments because of its germicidal properties (see also *Medicinal* Uses, below). Certain silver compounds have fungicidal properties; a weak silver nitrate solution can be used to disinfect certain plants.

(S. L. S.)

Medicinal Uses.—Apart from silver nitrate, much of the silver which is used in medicine is in the colloidal form in association with proteins. The chief uses of silver compounds are as antiseptics, astringents and caustics. Silver ions in water have a germicidal action, even at very low concentration, and this has been utilized to a limited extept in water sterilization.

Applied externally, silver nitrate has a limited caustic action, destroying the superficial tissues and separating the part acted on as a slough. It may be employed to destroy warts. In granular lids and various forms of ophthalmia, solutions of silver nitrate are employed.

The nitrate is both astringent and stimulating as well as bactericidal and solutions of it have been used to paint indolent ulcers and in chronic pharyngitis or laryngitis.

External or internal medicinal administration of silver, except in large doses, causes no harmful systemic effects but continued exposure may produce a chronic form of silver poisoning which is known as argyria and in cases of which silver is deposited in the tissues. The most marked symptom is the dark slate-blue colour of the lips, cheeks, gums and, later, of the skin.

In large doses silver nitrate is a poison, causing violent abdominal pains, vomiting and diarrhea, with the development of gastroenteritis. The treatment consists in the use of solutions of common salt, followed by copious drafts of milk or white of egg and water, or soap in water, in order to dilute the poison and thus protect the mucous membranes of the esophagus and stomach.

(H. J. Es.)

Production.—Since about 1900, Mexico has been the leading producer of silver in the world, producing about 30%. The U.S. is second, producing about 25%, and Canada is third, producing about 15%.

The leading silver producing state in Mexico is Hidalgo, in which the world's largest silver mine, the Real de Monte y Pachuca, is located. In the U.S. Idaho leads; and in Canada, the province of British Columbia.

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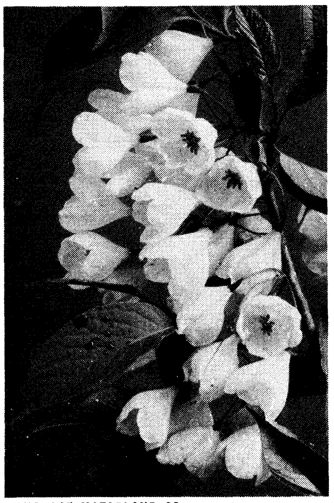

J. HORACE MCFARLAND CO.
LEAVES AND BLOSSOMS OF SILVER BELL (HALESIA CAROLINA)

SILVER BELL or SNOWDROP TREE, common names for three or four species of trees or large shrubs belonging to the genus Halesia of the storax family that are native to the southeastern United States. They produce rather large bright green, generally oblong and short-stalked leaves and showy white, slender-stalked, drooping bell-shaped flowers, appearing before or with the leaves and followed by light-brown winged fruits.

H. *carolina*, which reaches a height of 40 ft., is hardy as far north as Massachusetts, while H. diptera, usually a smaller plant but with larger flowers, is hardy to Philadelphia, Pa. H. *monti-*

cola, considered by some botanists as a variety of *H. carolina*, found in the mountains of North Carolina to Alabama, is the largest of all species, sometimes reaching a height of 90 ft. *H. carolina* and *H. diptera* can be cultivated rather easily in their natural range. (J. M. BL.)

SILVERBERRY (*Elaeagnus argentea*), a North American shrub of the oleaster family (Blaeagnaceae), found from Quebec to Hudson bay and British Columbia, south to Minnesota and Utah. It grows from 6 to 12 ft. high, with silvery-scurfy leaves and numerous fragrant flowers, pale yellow within and silvery without, borne in the leaf axils, and round-ovoid, olivelike silvery fruit, with a mealy edible fleshy portion enclosing a grooved nut.

SILVER CITY, a famous ghost town of Owyhee county in southwestern Idaho. U.S., was founded March 10, 1863, and quickly displaced adjacent Ruby City as the centre of the Owyhee mines. Exceptionally rich silver lodes in nearby War Eagle and Florida mountains took years to develop but were the subject of great excitement and bitter rivalry for control. The Poorman mine. although entangled in litigation. publicized the district particularly well; silver crystals from it won a special gold medal at the Paris exposition of 1866. In 1868 armed conflict among claim owners forced the governor to dispatch troops from Fort Boise to restore order. An important mining industry with a strong labour union movement had developed prior to financial collapse of the silver market accompanying the failure of the Bank of California on Aug. 26, 1875; by then Silver City had Idaho's earliest daily newspaper—the *Owyhee* Daily *Avalanche*—and sufficient stability to survive the economic panic. More efficient mining technology. extensive British investment and improved railway transportation near that remote mountain district (elevation over 6,000 ft.) brought a long revival after 1886. The gradual decline of mining activity led to loss of population and, in 1935, of the county seat. Silver City's peak population had been several thousand; in the 1960s it was less than 50. It can be reached by road from Nampa (44 mi.. part paved) or by gravel road (about 20 mi.) from the highway between Boise and Reno. Nev. There are a number of other ghost towns in the county. *See* also IDAHO: *History*. (M. D. B.)

SILVER CITY, a city of southwestern New Mexico. U.S., the seat of Grant county, is a mining and cattle centre located in the foothills on the southern edge of the Gila National forest, about 160 mi. N.W. of El Paso, Tex. The town dates from 1870. the date silver was discovered on the outskirts of Silver City; it was incorporated in 1878. Although the silver mines have been exhausted, other mining is still important in the area. The Chino Mines division of Kennecott Copper corporation at nearby Santa Rita is the district's largest industry and is one of the nation's largest open-pit copper mines. The combination of mining and ranching gives Silver City and its surrounding towns a western frontier atmosphere even in modern times. New Mexico Western college, a state-supported institution established in 1893, is located there.

The climate is cool in the summer but fairly mild during the winter. despite the altitude of approximately 6.000 ft. The nearby Gila forest provides recreation for the area and is the site of the Gila Cliff Dwellings National monument, established in 1907, an unspoiled relic of vanished Indian tribes. The city has a council-manager form of government in effect since 1957. For comparative population figures *see* table in NEW MEXICO: *Population*. (R. P. SA.)

SILVERFISH, a small active wingless insect, so called from the silvery glitter of the scales covering the body. It is less than half an inch long and is found in damp corners or among books and papers in houses. Although accredited with destroying paper and linen, it probably feeds only on farinaceous or saccharine substances. Scientifically it is *Lepisma saccharina* and belongs to the order Thysanura, subclass Apterygota (*q.v.*).

SILVERIUS, SAINT. pope from 536 to 537, was a legitimate son of Pope Hormisdas. born before his father entered the priesthood. He was consecrated successor to Agapetus I on June 8, 536, having been pressed on the Roman clergy by the Gothic king Theodahad. Six months afterward (Dec. 9) he was one of those who admitted Belisarius into the city.

Silverius opposed the restoration of the patriarch Anthimus, whom Agapetus had deposed, and thus brought upon himself the hatred of Theodora, who desired to see Vigilius made pope. He was deposed by Belisarius in March 537 on a charge of treasonable correspondence with the Goths, degraded to the rank of monk and sent to Lycia. Justinian, who entertained his complaint, sent him back to Rome, but Vigilius was ultimately able to banish his rival to Palmarola, where he died, probably about Dec. 537.

SILVERSMITHS' AND GOLDSMITHS' WORK. Personal ornaments, utensils, vases. decorative objects. etc.. made of silver or gold, with their various alloys, are known as silversmiths' and goldsmiths' work.

(*See* also EGYPT: *History: Ancient Civilization and Culture;* INDIAN ART; ROMAN ART; BYZANTINE ART; METALWORK, DECORATIVE,; IRONWORK; JEWELLERY.)

EGYPTIAN TO ROMAN

Gold, silver and their natural or artificial mixture called electrum or white gold, were worked in ancient Greece and Italy for personal ornaments, for vessels: arrows and weapons: for coinage, and for inlaid and plated decoration of baser metals.

Aegean lands were rich in precious metals. The largest of the Trojan treasures, the so-called Treasure of Priam, is a representative collection of jewels and plate. The gold ornaments were packed in a large silver cup. They consist of elaborate diadems or pectorals. bracelets. earrings or hair-rings and beads. The Trojan vases have bold and simple forms, mostly without ornament: but some are lightly fluted. Many are wrought from single sheets of metal. The characteristic handle is a heavy rolled loop soldered or rivetted to the body. Some silver flasks with inverted cup-covers have small shoulder-studs pierced vertically for hanging. Bases are sometimes round or pointed, sometimes fitted with separate collars. An odd shape in gold is an oval bowl or cup with a broad lip at each end and two large roll-handles in the middle. A plain spouted bowl of usual early Helladic shape in the Louvre is the typical specimen of goldsmith's work from pre-Mycenaean Greece. Silver seems to have been more plentiful in the Cyclades, but only a fen simple vessels, headbands, pins and rings survive.

Minoan and Mycenaean.—A profusion of gold jewellery was found in early Minoan burials at Mochlos, three silver dagger-blades come from a communal tomb at Kumasa, and silver seals and ornaments of the same age are not uncommon. An elegant silver cup from Gournia belongs to the next epoch (Middle Minoan I., *c.* 2000 B.C.). Minoan plate and jewellery are amply represented in the wealth of the mainland tombs at Mycenae and Vaphio.

The vases from Mycenae are made indifferently of silver, gold and bronze; but gold is generally reserved for drinking-cups, small phials and boxes; silver is used for jugs as well. Much of the funeral furniture is gold. It has been thought that the small gold discs, which Schliemann found in prodigious quantities (700 in one grave), were nailed on wooden coffins, but they may have been sewn on clothes. They are impressed with geometrical designs based on circular and spiral figures: stars and rosettes and natural forms such as leaves, butterflies and octopods. Models of shrines and other amulets are also made of gold. A splendid piece of plate is a silver counterpart of the black steatite libation-vase from Knossos in the form of a bull's head. with gold horns. a gold rosette on the forehead. gold-plated muzzle, ears and eyes. The gold is not laid on the silver, but on inserted copper strips. The gold cups from Mycenae are plain curved or carinated forms related to the silverware and pottery of Troy, and embossed conical vessels of the Minoan tradition. Some plain pieces have handles ending in animals' heads. The embossed ornament consists of vertical and horizontal bands of rosettes and spiral coils, floral, foliate, marine and animal figures.

Cretan and mainland tombs have produced many examples of weapons adorned with gold. Modest ornaments are gold caps on the rivets joining hilt and blade, but the whole hilt is often cased in gold. An example from Mycenae has a cylindrical grip of openwork gold flowers with lapis-lazuli in their petals and crystal filling between them; the guard is formed by similarly inlaid dragons. The most splendid Mycenaean blades are bronze inlaid with gold, electrum, silver and niello. Here again the work is done on inserted copper plates. This kind of flat inlay seems to have been originally Egyptian. It occurs on daggers from the tomb of Queen Aah-Hotep, which are contemporary with the Mycenaean (c. 1600 B.C.), and it is significant that two of the Mycenae designs have Egyptian subjects, though their style is purely Minoan. These are the scenes of cats hunting ducks among papyrus-clumps beside a river in which fish are swimming. Another blade bears Minoan warriors fighting lions, and lions chasing deer. A dagger from Thera has inlaid axe-heads; one from Argos, dolphins; and fragments from the Vaphio tomb show men swimming among flying-fish. These are masterpieces of Minoan craftsmailship; in the long decadence of the Mycenaean age there seems to have been no invention, and later pieces of goldsmith's work repeat conventional forms and ornaments.

Greek and Etruscan. — The period of transition from the Bronze to the Iron Age, when Aegean external relations were violently interrupted, was not favourable either to wealth or art, and the only considerable pieces of plate that have come from Greece are the embossed and engraved silver bowls made by Phoenicians. Most of them bear elaborate pictorial designs of Egyptian or Assyrian character, and are evidently foreign to Greece; but some simpler types, decorated with rows of animals in relief or wrought in the shape of conventional flower-bowls, can hardly be distinguished from the first Hellenic products. Early Greek work is rare. A severe and elegant silver bowl in the Metropolitan Museum, New York, represents the flower-type in its finest style. It is cast and chased, and probably belongs to the 5th century B C. Other pieces of the same age are simply moulded, and no special kind of decoration seems to have been developed for work in precious metals.

Silver vases and toilet instruments have been found beside the commoner bronze in Etruscan tombs. A chased powder-box of the 4th century is in the Metropolitan Museum, New York. The bronze reliefs of the archaic chariot in the same collection have their opulent counterparts in some hammered silver and electrum fragments in London, Munich and Perugia. The electrum details are attached with rivets.

Roman. — About the 4th century B.C. there was revived the fashion of ornamenting silver vessels with relief, and this type of work, elaborated in the Hellenistic age and particularly at Antioch and Alexandria, remained the usual mode of decoration until the end of the Roman empire. Various fabrics of moulded pottery correspond to the successive styles of metalware. A silver vase in the British Museum, bearing a frieze of chariots between floral bands, is nearly a reflex of an earthenware Calene bowl (3rd century B.C.) in the same collection. Pliny names Greek silversmiths whose work was valued highly at Rome, and laments the disappearance of the art in his own day. He must refer only to its quality, for Roman silverware has been abundantly preserved. Many rich hoards in modern collections were buried by design during the calamitous last centuries of the ancient world, and the most sumptuous, the Boscoreale treasure, was accidentally saved by the same volcanic catastrophe that destroyed Herculaneum and killed Pliny. This treasure (108 pieces) is mostly in the Louvre. A hardly inferior hoard (70 pieces) found at Hildesheim and now in the museum of Berlin, also belongs to the early empire. The acquisition and appreciation of silver plate was a sort of cult at Rome. Technical names for various kinds of reliefs were in common use (emblemata, *sigilla, crustae*), weights were recorded and compared and ostentatiously exaggerated. Large quantities of bullion came to Rome with the spoils of Greece and Asia in the 2nd century B.C., and Pliny says that even in republican times there were more than 150 silver dishes in the city of a hundredweight apiece. The Emperor Claudius had a slave who possessed a five-hundredweight dish. Weights of vessels are often marked on their bases.

Cups and jugs of Augustan style are usually covered with ornament in high relief. The subjects are very diverse: historical, mythological and mystic scenes, formal and naturalistic designs of flowers and foliage, graceful studies of animals and birds. Others have conventional fluting, petals or gadroons, Bacchic instruments and masks, embossed or engraved wreaths, gilt or inlaid with niello. Silver and niello inlay was commonly applied to bronze plates. A singular type of silver bowl (*patera clipeata*) has a central ornament in high relief or even in the round: portrait-busts are not uncommon in this place. In course of time the ornament was restricted, and later Roman plate is largely plain with narrow border-friezes, small central medallions, and handles embossed in low relief. One of the very few gold pieces that survive, a shallow bowl found at Rennes and now in the Bibliothèque Nationale of Paris, is exceedingly elaborate. It measures 25 centimetres across and weighs 1,315 grammes. The central medallion and its surrounding frieze contain scenes of a bibulous contest between Bacchus and Hercules; between these and the edge is a row of 16 gold coins each framed in a foliate wreath. The coins range from Hadrian to Caracalla. In the same collection are several examples of very large silver plates (*clipei* or *missoria*), in which the whole field is embossed with mythological or historical subjects. The largest (called the shield of Scipio) is 72 centimetres in diameter and weighs 10,300 grammes. Another bears the name of Gelimer, king of the Vandals and Alans (6th century). The "shield of Theodosius" at Madrid shows the emperor, seated between Valentinian and Arcadius among his guards, with an allegorical group in the exergue. The persistence of classical and even pagan subjects in early Christian work is well illustrated by the silver and gilt casket of Projecta, the centrepiece of the Esquiline treasure in the British Museum. It was a wedding-present; some of its many panels contain incidents in the marriage ceremony, others have groups of Venus and her attendants, and the lid bears the pious exhortation: *Secunde et Proiecta vivatis in Christo.*

Jewellery.—There is not the same break between prehistoric and classical jewellery as between other gold and silverwork and arts in general. It is true that certain types of ornament went out of fashion at various times and places, but the ancient jeweller's craft seems to have been rather cosmopolitan, and designs of common articles, earrings, bracelets and necklaces, were universal and persistent. The outstanding feature of ancient jewellery is its large display of figured surface, generally resulting in a tinsel fabric. The earliest specimens of Aegean jewels come from opposite ends of that region, Troy and Crete, and are contemporary (c. 2500 B.C.). The Trojan are the more elaborate but the elements are the same in both: thin wire in linked and plaited chains and coils, thin foil in petals and rosettes. The largest Trojan diadem or pectoral is made of 90 gold chains fringed with tiny scales and supporting foil-pendants. The simplest earrings are swelling hoops, simple or multiple or enriched with transverse bands. They are identical with archaic Greek types 2,000 years later. A more elaborate earring is a horizontal half-cylinder made of wire or plate with rosettes along its front upper edge and pendent discs below. This also reappears in the archaic period as the basket-earring of Etruria, doubtless an Ionian importation. Pinheads and bracelets are decorated with applied rosettes and spiral coils, and the pins are crowned with rows of little jugs. A plaited wire bracelet at Troy is reflected in a foil bracelet stamped with the same pattern at Mochlos in Crete.

This Early Minoan group contains many flower-headed pins, related on the one side to Trojan decorative rosettes, on the other to Sumerian hair ornaments. Granulation occurs on Trojan earrings, and was doubtless used at the same time in Crete, but very little jewellery has been found there, and earrings are scantily represented even in the wealth of the Mycenae shaft-graves. The swelling hoop was Mycenaean, and often had a pendent globule-cluster, which was ultimately enlarged into the semblance of a bull's head with granulated muzzle and coiled wire ears. The shaft-grave jewels are mostly diadems and hairpins, bracelets and pectorals, bead-necklaces and pendants, signet and finger-rings and plaques for decorating clothes. Thin plates cut and embossed in animal and floral forms served for all these ornaments. They are very seldom cast or wrought. Stone inlay is rare, but stone beads are often mounted in gold, and enamel is not uncommon. European and oriental (Phoenician) elements are combined in a treasure from Aegina, now in the British Museum, which belongs to the very end of the Mycenaean age, c. 1000 B.C. Its designs are mainly stylized openwork figures fringed with small pendants.

In the following period diadems, bracelets and earrings were decorated by the old processes of stamping, granulation and enamelling in the new Geometric style. Archaic Greek and Italian jewellery (700–500 B.C.) was almost wholly oriental in design, Egyptian and Assyrian models of Phoenician introduction being reinforced by rich Ionian and Lydian wares. New forms in Greece and Etruria were the coiled bracelets and earrings ending in heads of lions and bulls, pomegranate, lotus and palmette pendants, winged figures of sphinxes and sirens and masks of satyrs. But the technique was unchanged. Embossed plates are the basis of the work, stamped with separate punches or hammered into dies, and finished singly or joined back to back around a plsster core. Granulation was brought to an amazing fineness, particularly in Etruria. Patterns were precisely drawn in a field of minute grains, which were fused into globules and soldered to their background in one operation. In Greek 5th century work granulation is displaced by filigree, and enamel reappears. The style of this and the next century aims at elegance and delicacy. Necklaces consist of pendent flowers and tassels in a trellis of finely plaited ropes; flower-petals are variegated with enamel. Hoops of earrings are masked with filigreed rosettes and discs, and support elaborate pendants. Victories, Cupids and doves were favoured here by Hellenistic sentiment, and a strange but quite popular Graeco-Roman type was made with pendent vases. A change of fashion at this time, doubtless under oriental influence, introduced large coloured stones, at first garnets, in the centres of designs, and the new decorative principle became dominant in Roman jewellery. The stones are cut in simple shapes and grouped in rows by colour, blue, red, green, sapphire, garnet, plasma, with pearl borders. They are usually plain, but sometimes engraved as cameos or intaglios. In the closing period, from the 3rd century A.D., gold coins of contemporary and earlier emperors were also set like gems, and the goldsmith's skill was mainly exercised upon the borders and backgrounds. These bear arcaded patterns in chased relief and open-work, a bold and heavy style which, with colour-decoration, ousted the classical figure-work, and gave its character to the jewellery of mediaeval Europe.

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EUROPEAN

During the first six centuries there existed two principal sources of production of early Christian silver vessels: the Hellenistic and the Persian. The designs consisted often of figure compositions. Antioch was an important centre for goldsmiths' work after the 4th century, and here was made, in the 4th or 5th century, the "Antioch" chalice, now privately owned in New York City. From the 10th century, church vessels, especially chalices, became more sumptuous and were occasionally enriched with enamel and gems. Among extant early silver is the Esquiline treasure, Hellenistic in character, and the Lampsacus treasure, both in the British Museum; and the sacred treasure of Luxor, 5th to 6th centuries, now at Cairo. In the Metropolitan Museum at New York is the 6th century treasure from Cyprus, probably part of the same "find" as the objects at Nicosia and in the British Museum.

Byzantine silver of the 6th century is often marked with stamps in the manner of modern plate. St. Mark's in Venice contains many precious examples of Byzantine goldsmiths' work, including the famous *pala* d'oro, fashioned in Constantinople in 976, and enlarged and modified later by Venetian and other goldsmiths. The monasteries of Mt. Athos are rich in early vessels.

Early goldsmiths' work of a sacred character comprises the 6th century gold cross of Justin II. and Sophia, in Sf. Peter's, Rome; three great altar-frontals; (a) that executed before 835 in S. Ambrogio, Milan; (b) that in Aix-la-Chapelle cathedral; (c, 1000); and (c) that in the Cluny museum, Paris. To these may be added the Codex *Aureus,* and the ciborium of the Emperor Arnoulf, both at Munich. Early figures of the Virgin are two of the 11th century (with later additions) in Essen cathedral and another by a goldsmith of Hildesheim. The celebrated treatise of c. 1100 by the monk Theophilus, of Essen, is of extraordinary interest in the history of metal working.

A highly-skilled school of metal workers and enamellers was established in the 12th and early 13th centuries on the Meuse, chief of whom was Nicholas of Verdun. By his pupil or follower, Hugo d'Oignies, are three authenticated works, including his masterpiece, the shrine of St. Eleutherius (1247) in Tournai cathedral (see *Burlington Magazine,* xxxv.; xxxix.). By Siegfroid, pupil of Nicholas of Verdun, is a superb chalice of c. 1230, in Borgå church, Finland. Of the same school was Godefroid de Claire, goldsmith and enameller, of Huy.

English ecclesiastical work suffered incredible destruction at the Reformation. Of the few English silver chalices one of the earliest is that of the 13th century in the British Museum. Patens are more common. Important works are William of Wykeham's crozier at Oxford, and a censer and incense boat of c. 1350 in the Victoria and Albert Museum.

The early examples of ecclesiastical work in France include the Gourdon gold chalice and paten of the 7th century; a 9th century casket and a 10th century statuette of St. Foy, at Conques; the cross of Laon, in the Louvre (c. 1200); an early 13th century ciborium in Sens cathedral; a cross of the same century in Amiens cathedral; the Virgin of the abbey of Roncevaux, 14th century; and the Virgin in the Louvre (1339).

The churches of Italy abound in sacred vessels, especially from the 14th century, the early works including the 12th century altar-frontal at Città di Castello; and the chalice of 1290 by Duccio of Siena. Famous among reliquaries is the bust of St. Agatha at Catania, by Giovanni Bartolo, of Siena (1376). But more celebrated is the great reliquary of Orvieto, containing the blood-stained corporal of the Bolsena miracle, by Ugolino da Siena (c. 1338). Crosses include that of S. Giovanni, Florence, 1459, important for its influence upon others. Two great altar-frontals are in the cathedral of Pistoia and in S. Giovanni at Florence. Upon the latter were employed several famous artists—Antonio Pollaiuolo, Michelozzo, Verrocchio and others. The Abruzzi's greatest goldsmith, Nicola da Guardiagreli, designed the altar-frontal of Teramo (1433–48). An example of the combination of niello, enamel and silver, is the celebrated pax by Maso Finiguerra at Florence (1452). The most celebrated work of Valerio Belli (1468–1546), carver of crystal and medallist, is the crystal casket of 1532 in the Pitti palace, Florence. Caradosso, famous as a goldsmith and medallist, was the maker of a gem-set golden tiara for Julius II., known from an old coloured drawing in the British Museum, with a drawing of the gold morse executed by Cellini for Clement VII.

The early goldsmiths' work of Spain was of considerable importance. The Cross of the Angels, made in Asturias in the time of Alfonso II., and the Cross of Victory (908), both at Oviedo, are well-known. Chalices and other sacred vessels of unsurpassed richness were made in the Gothic and Renaissance periods. Under the sway of three members of the Arfe family in the 16th century several cathedrals were enriched with costly custodias (monstrances), great tower-like structures peculiar to Spain.

Early chalices were of two types with or without two handles; both lasted until the 13th century, when the two-handled form would seem to have been no longer made. The goldsmiths of the Merovingian period (420–751) were highly skilled and produced great quantities of jewellery and plate. The Carolingian period (768–814) brought a new style into the West. It used figure subjects in relief and foliated ornament, adopted from the Christian East through Italy.

Spoons are among the earliest things in silver. The Romans and Anglo-Saxons had their spoons. The earliest extant English spoon is probably the celebrated anointing spoon of the late 12th or early 13th century, which was, however, re-fashioned in 1660. Early English spoons include the "Apostle" spoon, popular for 200 years from about 1450. Original sets of 13 are extremely rare, the first being dated 1536–37, and was acquired by the late J. Pierpont Morgan. Next in popularity was the seal-top spoon, made between *c.* 1510 and 1670. From about 1670 spoons in England became more common, and the patterns were copied by American silversmiths. Continental spoons are usually more ornate and are of many patterns from the 17th century. A typical German object in silver (and occasionally of gold) is a spoon, fork and toothpick combined, of the 16th and 17th centuries.

Forks of silver are rare until the 18th century. The earliest known English fork is dated 1632–33.

English Work.—In the early centuries, after the invasion of Britain, Anglo-Saxon ornamentation passed through three stages, in the use first of spiral decoration, secondly of animal ornament, and thirdly of animal ornament combined with the conventional interlacing patterns of Anglo-Saxon and Irish art, introduced in the 6th century, probably from the eastern Mediterranean. The art of the Kentish goldsmiths was particularly skilled, especially in the reign of Ethelbert (560–616). Notable examples are the famous Alfred jewel and the silver-gilt cup from Halton moor (British Museum). The beautiful Ormside bowl of copper and silver, 8th century, is also said to be Anglo-Saxon (York Museum).

Celtic craftsmen possessed an aptitude for borrowing ideas and implanting their own individuality upon them. Evidence of their skill in metal working is to be seen in their personal ornaments. The Celtic goldsmiths of Ireland in Christian times borrowed designs from the Anglo-Saxon craftsmen of Kent, but soon surpassed their Kentish masters in technical accomplishment, as may be observed in two masterpieces; the Ardagh chalice and the Tara brooch (9th and 10th centuries).

Not a vestige remains of the silver made in England during the Norman occupation. There is ample evidence of the superior merits of the English arts and crafts in mediaeval and Tudor times. The most common of English drinking vessels from *c.* 1200 to the 16th century was the mazer bowl. Two historic examples of drinking horns of the 14th century are at Oxford and Cambridge. Two unique English vessels are the Studley bowl, late 14th century, in the Victoria and Albert Museum, and the enamelled silver cup (1350–75) of the corporation of King's Lynn. England is still rich in cups, tankards and drinking vessels from the 16th century. Great standing salts were regarded with veneration, particularly in the reign of Elizabeth, when the decoration of plate was markedly under German influence. In the 16th century came the sumptuous rosewater ewers and basins.

The restoration of .Charles II. in 1660 was followed by the introduction of larger and more costly vessels and by ornate decoration. Soon after 1685 the French Huguenot refugees who fled to England after the revocation of the Edict of Nantes revolutionized the decoration of English plate. Much of the early 18th century English silver is distinguished for its austere simplicity and solidity. Louis XIV. ornament was also popular, and the influence of the French rococo was strong. In the comfortable 18th century many kinds of domestic vessels were introduced or became common. The influence of Robert Adam, architect and designer, is apparent in silver between 1770 and 1790, while a little later the classical spirit was conspicuous in the silver designed by John Flaxman, the sculptor, and others. Plate of English style was made at Dublin from the 17th century, and Scottish goldsmiths wrought excellent plate from the 16th century. Silver was made in the Channel Islands in the 17th century and probably earlier.

A gild of London goldsmiths existed as early as 1180, and in 1327 it was regularly incorporated. The mark of the leopard's head (lion's face) is first mentioned in 1300, followed in 1363 by the maker's mark. In 1478 and 1544 the date-letter and lion passant respectively were introduced. Between 1697 and 1719, the figure of Britannia and the lion's head erased were in use. From 1784 the sovereign's head was marked; it was discontinued in 1890. Silver was assayed in mediaeval and later times at Norwich, York, Chester, Newcastle and Exeter. The present assay offices are London, Chester, Birmingham and Sheffield.

France.—The development of the craft in France may be followed in some measure after the death of Louis XIV., though vast quantities of silver work were melted at the Revolution. Little remains of the work of Thomas Germain, a talented 18th century goldsmith, but several notable pieces by his son, François Thomas Germain, notably at Lisbon, have survived. For the more important of these the student must, however, repair to the old imperial and royal collections at Leningrad and Lisbon, which are unequalled in France itself.

The former contains notable objects by masters of the 18th century, by Claude Ballin the younger; François Thomas Germain; Paul Charvel and Louis Lenhendrick; Robert Joseph Auguste, a prolific goldsmith; Antoine Boullier; Edmé Pierre Balzac; and Claude Augustus Aubry. Two celebrated goldsmiths of the First Empire, Biennais and Odiot, are represented by notable specimens. Henri Auguste, a talented Paris goldsmith, fled to Jamaica and died there in 1816.

The écuelle is peculiar to France and became a common vessel in the 18th century. One delightful phase of French goldsmiths' work must be mentioned, namely, the exquisite gold and enamelled boxes of the 18th century.

One of the few surviving examples of early secular plate is the gold and enamelled cup (1380) of the kings of France, in the British museum, which is decorated with scenes from the life of St. Agnes, and is unparalleled elsewhere. The cup has undergone subsequent alterations in England and Spain.

One other important early French vessel is the covered beaker, made about the year 1462, now at Oriel college, Oxford. Of the few pieces of secular plate of the 16th century are the massive plain ewers with their dishes, the pair of cups and a wine bottle, all dating from 1581–82, from the chapel of the order of St. Esprit, and now in the Louvre. Here also are the unique and magnificent enamelled gold shield and morion of Charles IX of France (1560–74). The beautiful sardonyx and gold ewer in the old Imperial collection at Vienna, sent as a gift with Cellini's golden salt, from Charles IX to Ferdinand of Tirol, is believed to have been executed in Paris, as was the gold mounted sardonyx cup showing similar details, in the Louvre.

Italy.—Italy has great wealth in ecclesiastical goldsmiths' work but in secular silver it is singularly poor, many precious objects having been converted into bullion. One authentic work by Benvenuto Cellini alone can be mentioned: the celebrated gold salt at Vienna. French designs, especially Louis XVI styles, penetrated here as elsewhere, as in the "Turin" service at Leningrad and in the work of L. Valadini, of Rome.

Germany.—Domestic silver in Germany earlier than the second half of the 15th century is rare. In the prosperous cities of Augsburg and Nuernberg in the 16th century, the output of silver work was enormous. German Renaissance work is marked by exuberance of ornamental detail; much of it has been attributed to Italian goldsmiths, especially Benvenuto Cellini. One of the most precious German things of the period, attributed to Cellini, is the gold and enamelled Rospiglioso cup in the Altman collection in the Metropolitan museum, New York. The six members of the Jamnitzer family were prominent at Nuernberg between about 1535 and 1625.

English ornament of the Elizabethan and Jacobean periods was markedly influenced by German work. Every collection of German plate contains a preponderance of drinking vessels. A few cups of about 1590–1620 were made as "masterpieces," before admission to the gilds. Certain exclusively German cups are the giant cup (Riesenpokal), the double cups, the *Jungfrauenbecher* and the little ships. Other popular cups are those decorated with a large boss or lobe (buckeln), and the pineapple cup (*ananaspokal*), which was copied in London, in the reign of James I. The common gourd-shaped cup was also introduced into England. Certain fantastic cups were fashioned like birds and animals, figures and globes. Many are fitted with clockwork mechanism for propulsion along the table. Tankards were common from the 16th to the 18th century. The Baroque taste was strong, as was the rococo. Designs were executed for silversmiths by Albrecht Altdorfer (c. 1480–1538); Peter Flötner, whose *Kunstbuch* was published in 1549; Virgil Solis (1514–62); Hans Brosamer (fl. 1520–54); Bernard Zan ($. 1580–81); Hans Sibmacher (fl. 1555–95); Georg Wechter; and Paul Flindt; and the anonymous designers of the late 16th century.

Spain.—The early silversmiths' work of Spain shows many outside influences. In the second half of the 15th century artists came from Lombardy and South Germany and introduced new features in decoration. Spain is now singularly poor in early domestic silver. Some ornate shallow dishes were common in Spain and Portugal in the 16th century. For about 50 years from 1590, a small and characteristic ewer was made, mostly at Toledo. A common decoration of silver of the early 17th century are little enamelled plaques. Filigree work was popular in the 17th century. The Baroque taste prevailed in Spain and Portugal, as did the later French decoration. A notable atelier was founded in Madrid in 1778 by D. Antonio Martinez, who favoured severe classical designs.

Portugal.—In the reign of Emanuel I. (1495–1521) Portuguese work was infected by the national style in architecture, called Arte *Manuelina.* Of this style is the celebrated early 16th century gold and enamelled monstrance of Belem (in the National Museum at Lisbon), by the Lisbon goldsmith, Gil Vicente, from a design by Garcia de Rezende. Some 16th century silver and some 17th century basins are very elaborate. The influence of French decoration of the 18th century, superimposed on the national taste in decoration, is marked. English silver was copied by Portuguese silversmiths after the Methuen treaty of 1703 and in the early 19th century imitations of London marks were not infrequently stamped.

Holland.—Holland in the 17th century was rich in domestic silver. Many of the old gilds were provided with silver, some of which is in the Rijks Museum at Amsterdam. Adam van Vianen (c. 1555–1627) of Utrecht introduced a new decoration in silver which profoundly affected Dutch silversmiths' work for 50 years and spread to England and Germany. His brother, Paul, entered the service of the emperor Rudolph II. at Prague and there executed the superb ewer of jasper and gold, now at Vienna. Adam van Vianen, the younger, is chiefly known for his designs for silver (published 1892). Christian van Vianen visited England and made plate for Charles I. Next to the van Vianen family, the most prominent goldsmith of the 17th century was Johannes Lutma, the elder, of Amsterdam, a few of whose works are in the Rijks Museum.

Typical objects in silver are the wine-glass holder (bekersclzroef), the windmill cup (molenbeker) and the *brandewijnkom,* for brandy and raisins. "Still-life" pictures of the 17th century are interesting for the silver vessels they depict. Important silver was made in most of the other old towns of Holland in the 17th and 18th centuries. French taste of the 18th century in silver and furniture spread to Holland.

Scandinavia.—Denmark and Norway are noted for the great number of silver-mounted drinking horns of the 14th and 15th centuries. Distinctive beakers and tankards were common from the 16th century. The "peg" tankard of Denmark was made by English silversmiths, mostly at York, between about 1650 and 1690 The influence of French of the 18th century and the First Empire ornament on Danish and Norwegian domestic silver is manifest, as is also in a less degree that of English designs of the 18th century.

Domestic silver was extensively wrought in Sweden in the 17th century, much of it in the German taste. The beaker and the tankard were popular. Characteristic of Swedish silversmiths is the filigree work of about 1675–1725. In Sweden as in Norway, a charming old custom is commemorated by the silver bridal crowns, preserved in churches. French decoration prevailed here as elsewhere.

The Netherlands.—Flemish pictures and illuminated manuscripts afford a glimpse of the sumptuous vessels in daily use in Flanders, including the popular beaker. The only known work by Gerard Loyet is the famous gold reliquary (1466–67), in Liége cathedral. At Antwerp, the most important centre of the goldsmiths' art in Belgium in the 16th century, was made in 1558–59 the historic "Charles V." ewer and basin (in the Louvre). Excellent plate was executed in the French style in Belgium in the 18th century.

Russia.—As early as the 14th century, Russian workers under Greek influence began to cover the figures of icons with a plate (*riza*) of silver. The most conspicuous Russian silver domestic vessel in the 16th and 17th centuries is the drinking cup (bratina). Many are enriched with inscriptions in highly decorative Slavonic lettering called *Vyaz,* conveying a toast or sentiment or welcome. One of the most precious (at Vienna) is of solid gold, enriched with gems and enamel, and was the gift of the tsar Michael to Vladislaus IV. (1632–48), king of Poland. Another popular vessel from the 16th to the 18th centuries was the kovsh, used for dispensing drinks. One of gold is in the "Green Vaults" at Dresden. The third characteristic Russian vessel is the charka, a small cup, generally fitted with a single handle, for drinking strong liquors or for brandy. Many are wholly of precious metal, while others are of rock crystal, ivory, coral, and amber, cornelian and other semi-precious stones, mounted in gold and richly enamelled. One other vessel is the bowl of the 17th century, decorated with painted enamel.

Hungary.—Hungarian silver has certain individual features, and shows various external influences at different periods. A conspicuous feature of ecclesiastical work, especially on chalices, is the richly coloured enamel of the second half of the 16th century and the first half of the next century, introduced probably by Venetian goldsmiths. A prosperous school of goldsmiths was established at the Transylvanian town of Nagyszeben. An important phase of Hungarian goldsmiths' work are the garnitures de corsages for the national costumes from the 16th century. Highly important early mediaeval treasure has been found buried in Hungary of which the most important are the 23 gold objects from Nagy-Szent-Miklos, all in the Kunsthistorisches Museum, Vienna. Some authorities ascribe them to native craftsmen and others to Caucasian work of the 9th century.

Austria.—Several towns in Austria had their goldsmiths. Vienna claims Wenzel Jamnitzer (later of Nuremberg) as one of its most celebrated goldsmiths. An earlier worker was Wolfgang Zulinger, of Wiener Neustadt, the supposed maker of the "Matthias Corvinus" cup of the 15th century, in the Rathaus there. This great cup is covered with the familiar lobes or bosses of German cups. Erhard Efferdinger of Vienna is identified by his imposing Gothic monstrance, 1524, in the church at Schattau in Moravia. Later came the well known Marx Kornblum (d. 1591).

In the 18th century the goldsmiths flourished in Vienna and were markedly under French influence. Anton Matthias Domanek (1713–79) was prominent and was the maker of the gold toilet service for Maria Theresa, at Vienna. Another was Ignaz Joseph Wiirth, a member of a flourishing family. An exponent of the Louis XVI. and "First Empire" styles was Ignaz Krautauer.

Poland.—Ecclesiastical vessels are the oldest relics of the goldsmiths' art in Poland. The many-sided artist, Wit Stoss (Stwosz), of Cracow, provided designs for goldsmiths at the end of the 15th century, among whom was his brother, Maciej (Matthew). Several Italian craftsmen emigrated to Poland during the early Renaissance, including Gian Jacopo Caraglio, designer, engraver, goldsmith, enameller and gem-cutter to the Polish court, 1539–60. German goldsmiths were also employed at this time. Later in the century several French goldsmiths were attracted thither. Characteristic of Poland from mediaeval times are the silver belts to be seen in early Polish portraits and the elaborate silver harness for horses.

Other European Work.—Bohemian goldsmiths were much employed in the 15th and 16th centuries in the execution of ecclesiastical vessels. Rudolph II. (1552–1612) attracted talented goldsmiths to his court at Prague, among them the Dutchman, Paul van Vianen.

Prague was a centre for the fashioning of domestic vessels of great beauty from rock crystal, jasper, lapis-lazuli and other

BY COURTESY OF (1) THE METROPOLITAN MUSEUM OF ART, NEW YORK, (2) PHOTOGRAPHISCHES ATELIER DER KUNSTHISTORISCHEN SAMMLUNGEN, VIENNA

EXAMPLES OF THE GOLDSMITH'S ART ATTRIBUTED TO CELLINI

Above: Gold and enamel cup, known as the Rospigliosi cup, by Benvenuto Cellini (1500–71), metal-worker and sculptor of the Florentine school, at the height of the Italian Renaissance. The cup'is now in the Metropolitan Museum of Art, New York

Below: Golden salt-cellar, wrought by Cellini for Francis I of France, who was his patron during his exile in that country. Now in the Museum of Vienna

BY COURTESY OF (1, 3, 7) THE TRUSTEES OF THE BRITISH MUSEUM, (4) THE MUSEUM OF THE AMERICAN INDIAN, HEYE FOUNDATION, (5) THE AMERICAN MUSEUM OF NATURAL HISTORY, (6) THE CURATOR OF THE CYPRUS MUSEUM, (8-11) A. K. COOMARASWAMY, (2) FROM THE GEORGE EUMORFOPOULOS COLLECTION

EARLY AND RECENT EXAMPLES OF SILVERSMITHS' AND GOLDSMITHS' HANDIWORK

1. Bimaran gold reliquary set with rubies (100 B.C.–A.D. 100)
2. Chinese silver tazza-shaped cups ornamented with floral scrolls and birds on granulated ground (8th–9th cent.)
3. Persian gold armlet (5th–4th cent. B.C.)
4. Aztec gold ornaments (about A.D. 1500)
5. Peruvian gold objects (about A.D. 1500)
6. Greek silver dish (6th cent. A.D.)
7. Sassanian silver dish with Persian bird and dragon design (3rd–6th cent.)
8. Gold fan, in the Temple of the Tooth Relic, Kandy, Ceylon, probably 18th cent.
9. Nineteenth century Punjab silver jug.
10. Eighteenth century gold tray, in the Temple of the Tooth Relic, Kandy, Ceylon
11. Eighteenth century Indian silver enamelled hookah base

ETRUSCAN, GREEK, HELLENISTIC AND ROMAN ORNAMENTS DATING FROM 6TH CENTURY B.C. TO A.D. 400

Greek buckle, in upper left, and beneath it an earring of gold decorated with enamel and stones of about 400 B.C.

In upper centre an Etruscan silver and gold relief with electrum plating, from Perugia. Said to be Ionic work of the 6th century B.C.

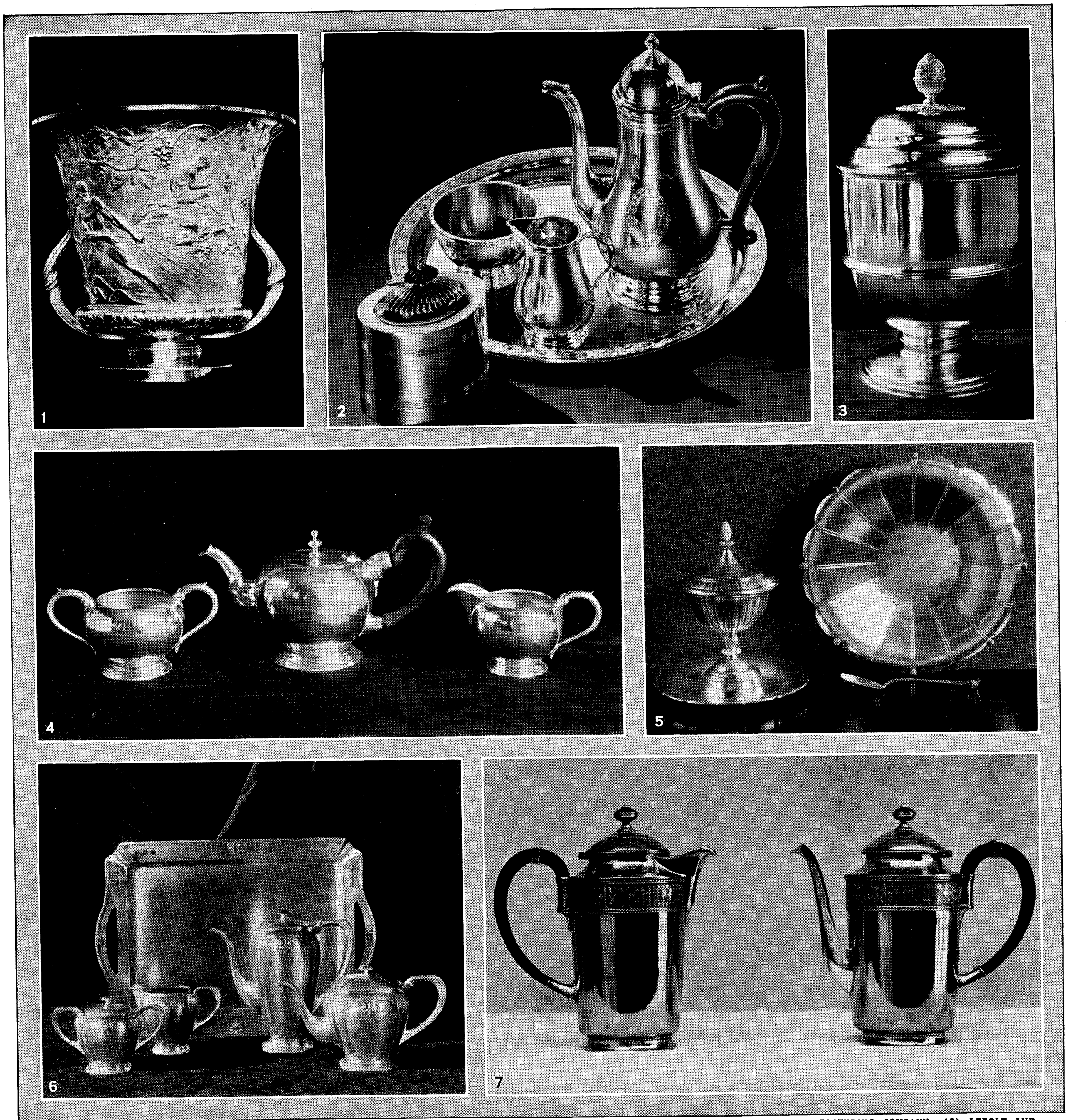
Beneath third jewel in the necklace, a Hellenistic earring of about 200 B.C. In lower centre is the front panel of the lid of Projecta's bridal casket; early Christian All other objects are Roman—necklace, earrings, beads and pendants, A.D. 100 to 400

BY COURTESY OF (1) THE MASTER OF CHRIST'S COLLEGE, CAMBRIDGE, (2) THE WORSHIPFUL COMPANY OF GOLDSMITHS, (3) KUNSTHISTORISCHE SAMMLUNGEN, PHOTOGRAPHISCHES ATELIER, VIENNA, (4, 5) THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM, (7) THE CORPORATION OF KING'S LYNN, (8) SCHLOSSMUSEUM, BERLIN, (9) THE NEWMAN CONGREGATIONAL CHURCH, EAST PROVIDENCE, R.I., (10, 11) THE METROPOLITAN MUSEUM OF ART, NEW YORK; PHOTOGRAPH, (6) GIRAUDON

MEDIAEVAL SILVER AND GOLDSMITH'S WORK

1. Foundress' Cup. Silver gilt, dated 1440. Stem, bowl and cover ornamented with branches. 2. Bowes Cup, dated 1554. Note two different methods of employing crystal — in the bowl and stem. Enamel used in the coat of arms. Shows influence of South German craftsmen. 3. Jasper and gold ewer made for Emperor Rudolph II., by Paul van Vianen, a Dutch goldsmith, in 1608. 4. An English salt cellar dated 1592–3. Cover is raised above the receptacle for salt. Elaborately chased and enamelled. 5. A steeple cup of silver gilt, dated 1627–8. This type of cup believed to be an original conception of English craftsmen. 6. Silver gilt ewer with elaborate design, Antwerp, 1558–9. In the Louvre. 7. English cup, made 1350–75. Decorated with enamel figures. Believed to be one of the earliest of its type now in existence. 8. A Dutch silver ewer. Made in 1610 by Adam van Vianen. 9. Silver cup by Sanderson and Hull of Boston, Massachusetts. Bought in 1674 with legacy of Capt. Thomas Willett. Inscribed "Capt. Willett's donation to ye Ch. of Rehoboth, 1674." 10. "Banquet of the Gods," gold on lapis-lazuli slab, 16th century. Jacob Cornelisz Cobaert. 11. Silver spoon with figure of a bishop on the handle. Believed to be work of a German craftsman of the 17th or 18th century

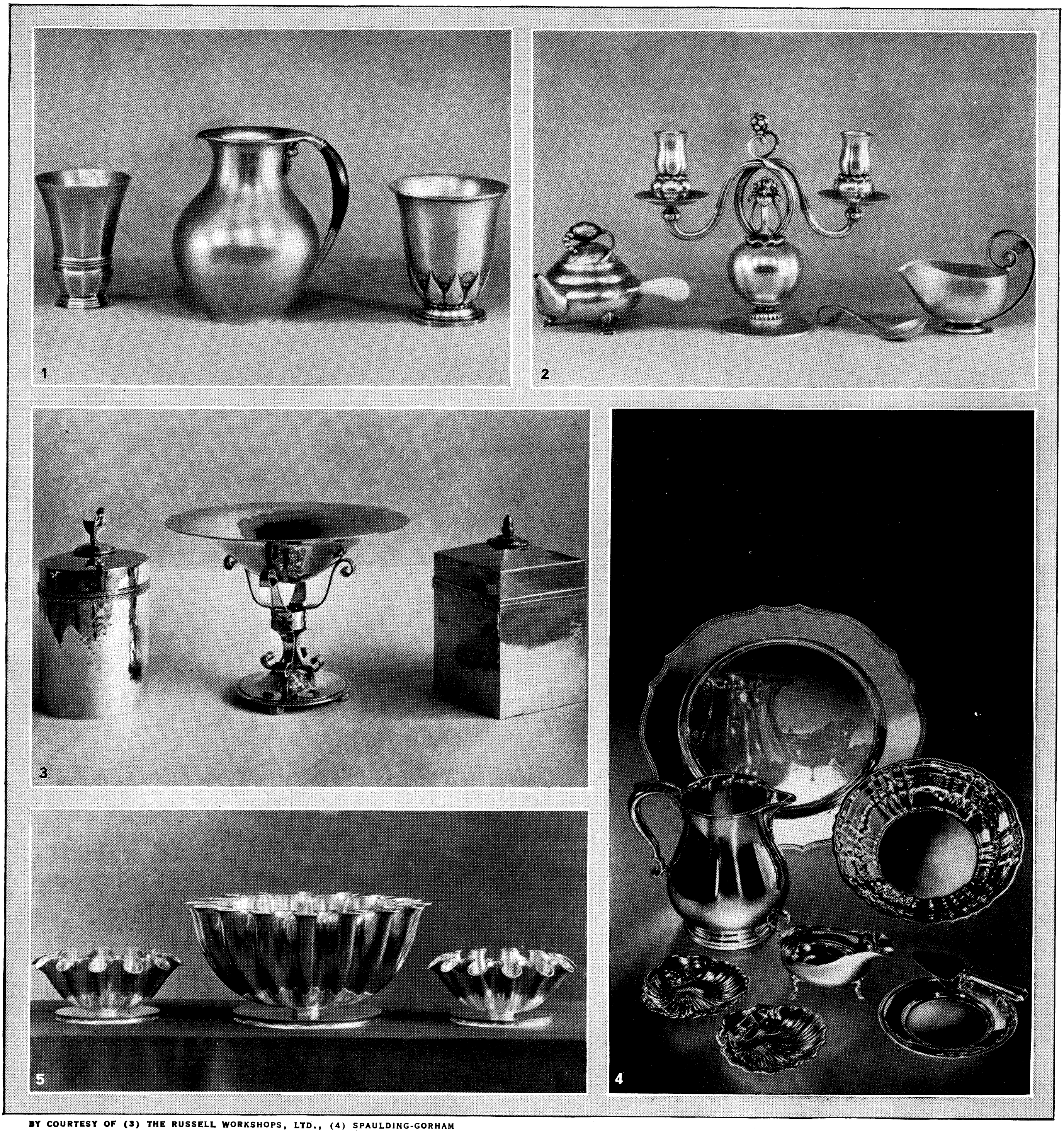
SILVERSMITHS' AND GOLDSMITHS' WORK



BY COURTESY OF (1) HIS MAJESTY KING GEORGE THE FIFTH, (2) SPAULDING-GORHAM, (3, 4) GEORGE C. GEBELEIN, (5) THE GORHAM MANUFACTURING COMPANY, (6) LEBOLT AND COMPANY, (7) BERNARD CUZNER

EXAMPLES OF SILVERSMITHS' WORK

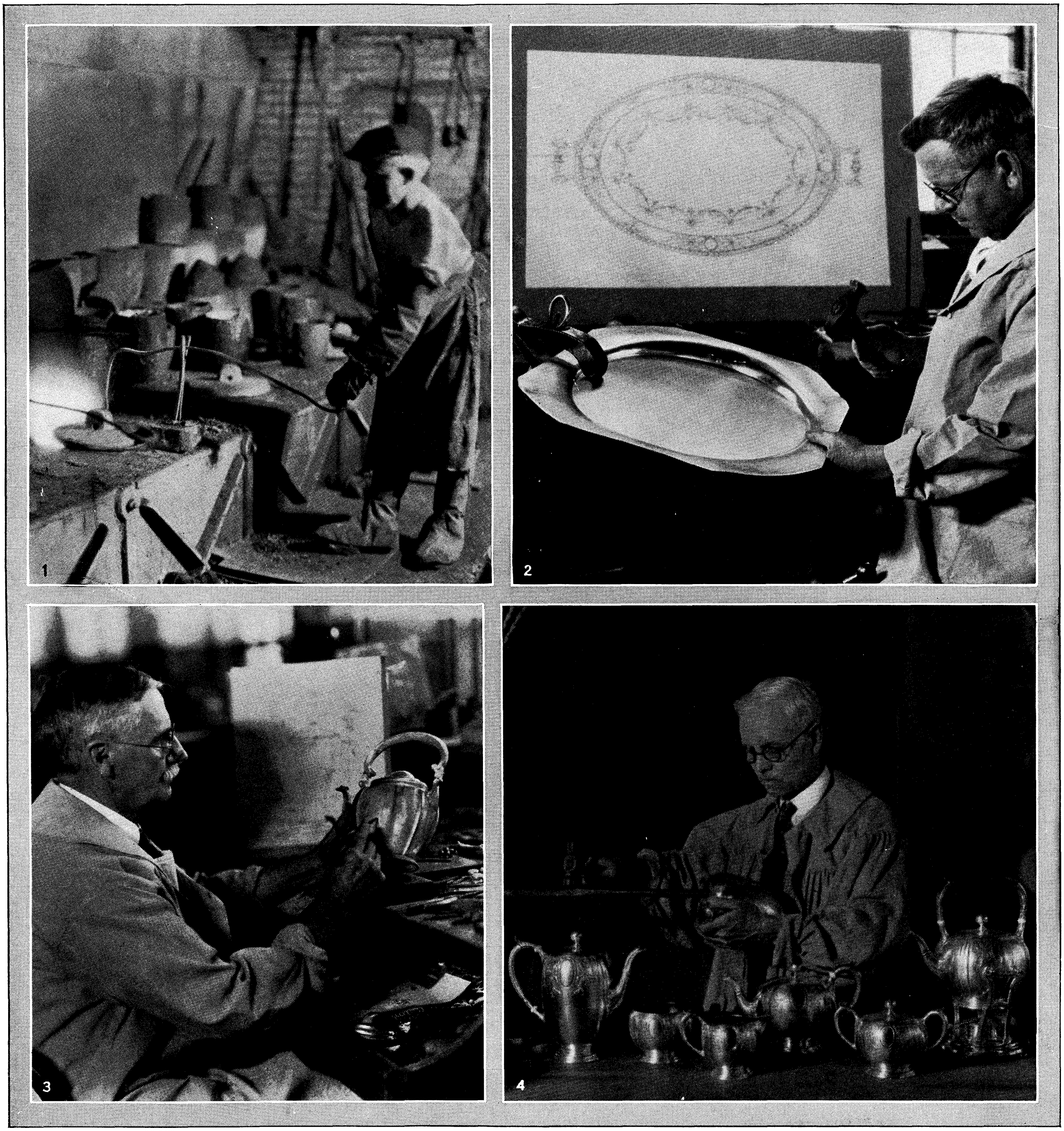
1. Silver-gilt cup designed by John Flaxman, 1812, and made by Paul Storr
2. Antique reproduction of a George I after-dinner coffee service and tea caddie used as cigarette jar
3. Sterling silver Guild cup, English and continental adaption
4. Reproduction in sterling silver of an early American teapot, sugar bowl and cream pitcher
5. Silver service of modern design ornamented with ivory or lapis-lazuli balls
6. Hand chased tea service
7. Hot water jug and coffee pot of silver with chased decorations and fibre handles and knobs



BY COURTESY OF (3) THE RUSSELL WORKSHOPS, LTD., (4) SPAULDING-GORHAM

MODERN DESIGNS IN SILVER AND OTHER METALS

1. A pitcher and two cups by Georg Jensen
2. Teapot, candelabrum, ladle and jar, the work of Georg Jensen
3. Left: Brass biscuit box with silver-plated interior. Right: Biscuit box in gilding metal, with silver-plated interior. Centre: Copper fruit dish. Group designed and made by Gordon Russell, Broadway, Worcestershire
4. Modern American sterling silverware inspired by creations of 18th century silversmiths
5. Silver bonbonnières made by A. Michelsen (Danish)



BY COURTESY OF THE GORHAM MANUFACTURING COMPANY

PROCESSES IN WORKING SILVER AND GOLD

1. Heating and alloying the silver in an American plant. The silver is placed in a crucible, mixed with other metals in the proper proportions, and melted in the furnace

2. Shaping a sheet of sterling silver. The design to be worked into the silver tray is seen on the wall in the background

3. Skilled worker in silverware plant drawing the design on a teapot preparatory to working

3. Silver chaser using the snarling iron. A snarling iron has a long beak and is used in making raised work on silverware. The worker is holding one end of the snarling iron in a vise and striking the shank with a hammer. It makes its impression on the rebound from the inside

PLATE VIII

SILVERSMITHS' AND GOLDSMITHS' WORK

BY COURTESY OF THE GORHAM MANUFACTURING COMPANY

DIFFERENT PROCESSES OF SILVER WORK

1. Skilled workman engraving with a gravec elaborate design on a silver tray. 2. Soldering the top on a silver candlestick. 3. Erik Magnussen, noted European designer, hand-chasing a sterling silver vase. A new and modern motif is expressed in his work. 4. Stamping the Hall Mark on a finished piece of silverware. The Hall Mark is used to identify the maker of the piece and the date, and to attest to the purity of the silver

semi-precious stones.

Swiss silver in form and decoration not unexpectedly was under the domination mainly of Germany. Zürich was an important centre of the goldsmiths' art. It was here that Rudolph Wyssenbach issued in 1549 his very rare pattern-book of arabesques for silversmiths. Many other Swiss towns had flourishing goldsmiths.

Silver is known to have been wrought for several centuries at Reval and Riga. Hans Ryssenberch, the elder, of Reval, was the maker of an important monstrance in 1474, now in the Hermitage museum at Leningrad. Here also was probably mounted (1551) the rare horn-shaped cup of Islamic glass, perhaps of the 14th century, also in the Hermitage. In Finland there were goldsmiths from mediaeval times.

In the monastery at Putna in Bukovina, founded shortly after 1465, are important treasures of the 15th and 16th centuries, which reveal a glimpse of art and culture in the Balkans. The Petrossa treasure of gold (found near Petrossa in Wallachia) probably made in the Balkans in the 4th or 5th century A.D., consisted originally of 22 vessels, including an elegant ewer.

NORTH AND SOUTH AMERICA

The history of silver in America begins actually with Robert Sanderson (1608–93), a London silversmith settled in Boston. John Hull (1624–83) became his partner. An example of their work is the plain cup in Newman Congregational church East Providence, R.I., bought with the bequest in 1674 of Capt. Thomas Willett the first mayor of New York city. More than 150 names of silversmiths had been recorded at Boston before 1800. Colonial silver is dependent for its undoubted charm on the simplicity of its lines and graceful forms, copied for the most part in New England from contemporary English silver before 1775. Paul Revere of Boston achieved prominence for his work not because of superior technical merit but as the hero of Longfellow's poem. From the end of the 17th century the wealthy merchants of Boston acquired silver, especially tankards and porringers. The last-named vessel, not to be confused with the English vessel of this name, became common in silver and pewter in every well-ordered household. Besides Boston, there were other places in New England where silver was made, chief among them being Newport, R.I. Silversmiths settled in New York soon after the settlement by the Dutch, and much of their work is identifiable by the decoration. Important work was made at Philadelphia late in the 17th and early in the 18th centuries.

Silversmiths were working in Quebec in Canada soon after the French conquest. In the 18th century excellent work was executed by François Ranvoyze (b. 1739) and later by Laurent Amyot.

The high skill of the metal-workers of old Mexico is well known. In the American Museum of Natural History at New York (Heye Foundation) is a precious collection of gold ornaments, including a wonderful eagle's head (*quauhtli*), conferred upon certain warriors for valour in warfare. Highly skilled also were the craftsmen of Peru. The natives had little to learn from the Spanish craftsmen but new models and patterns. Silver plates and dishes for the tables of Spanish officials were hammered out by the hundred and many delightful pieces still survive in Peru and Bolivia. Stirrups, spurs and horse trappings are also common. Silver was more accessible than tin or iron to the South Americans and since alloys were not understood, it was used in pure form. One common object found in various parts of ancient America, notably Mexico, Costa Rica, Panama, Colombia, Ecuador and Peru, is the golden breast-plate in the form of a disc. The Keith collection in New York of gold work from Costa Rica and Panama is unsurpassed, and contains many beautiful amulets.

Soon after the Spanish conquest, goldsmiths from Spain emigrated to Mexico, though most of their early works have perished. Churches were richly furnished with sacred vessels, but many of these were imported from Spain. Several names of goldsmiths of the 16th, 17th and 18th centuries are recorded.

ORIENTAL WORK

The goldsmiths of the famous Achaemenid period in Persia were in an advanced state of culture, as witness the Oxus treasure of the 5th and 4th centuries B.C., in the British Museum, which with the Susa find (in the Louvre) alone presents a comprehensive group of goldsmiths' work of ancient Persia. In the same museum is some important silver of the later Sassanian dynasty. Persian silversmiths in more recent times have shown by many fine examples that they have retained their skill.

Ancient China was poor in gold. Of the T'ang dynasty (618–906), when the progress of the arts was most marked, but little goldsmiths' work has survived; it includes 15 silver vessels in the British Museum. In the great collection of Chinese art of George Eumorfopoulos are two pieces of exquisite gold jewellery: a hair-pin and an ornament, of about the 9th century A.D., and of the 9th to 11th century A.D. respectively. Two little silver cups are of the 8th or 9th century A.D. A rare little gold plate, chased with flowers and foliage, is of about the 12th century A.D.

Earlier than either of these are the superbly wrought gold pommel of a dagger or staffhead and the silver bowl chased with characteristic Chinese fret work, both of the Ch'in dynasty 255 to 207 B.C.

The goldsmith's craft in India is of ancient origin. Highly important is the Bīmarān gold reliquary, set with rubies (British Museum), attributed to the beginning of, or a little earlier than, the Christian era. In the British Museum are a silver dish of the 3rd or 4th century A.D., decorated with a bacchanalian scene representing perhaps Kuvera, king of the Yakshas, treated in Indian style; and a silver bowl of the 7th century from northern India, embellished with medallions in low relief. Delhi was famous for its craftsmen, especially in the time of Akbar the Great, Jahāngīr, and Shah Jehan. The Indian museum at South Kensington contains a rosewater sprinkler of chased gold, enriched with champlevé enamels, probably made for Shah Jehan. vessels and Ornaments of jade, inlaid with gold and gems, are a distinct and delicate branch of art, practised at Delhi in the 17th century. A graceful vase of this kind, set with emeralds and rubies, was brought from India by the great Lord Clive with other notable specimens of Indian goldsmiths' work.

A characteristic Indian ewer, with and without a cover, in silver, copper and brass, has been used from early times for the ceremonial ratification of gifts by pouring water, and for domestic purposes. Decorated trays of silver and brass are used for offerings and for conveying gifts, but more especially for flowers to be offered in temples, as may be seen in many of the old Sīgiri paintings.

Enamelling has deservedly attained a great reputation in northern India. Enamellers from Lahore were brought by Man Singh to Jaipur in the 16th century and enamel was extensively employed in the 17th and 18th centuries here and elsewhere in gold and silver work. The craftsmen of the Punjab were renowned for their skill and Lucknow was long celebrated for its metal work, as was Chanda. At Kutch and Gujarat (Bombay Presidency) were clever goldsmiths. The metal work of the Sinhalese is of special excellence. Siamese goldsmiths executed excellent work in the 18th and 19th centuries and Turkish craftsmen have not been without skill.

In consequence of the prohibition of the use of gold and silver in ceremonial worship, there are no vessels or ornaments in these precious metals in religious use in Burma, Similarly, the use of gold or silver vessels for domestic purposes was denied to all but those of royal blood. The India museum at South Kensington contains part of the Burmese regalia of gold, and other relics. Some fine work executed at Tibet in the 17th and 18th centuries is in the Indian museum at South Kensington.

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(E. A. J.)

SILVER SPRINGS, one of the largest limestone springs in the world, is located in Marion county, Fla., 6 mi. E. of Ocala. The average flow of the springs is about 530,000,000 gal. per day and more than 480 tons of minerals are carried off in solution each 24 hours. The water maintains a constant temperature of 72" F. The source of the main spring is a cavern 65 ft. long and 12 ft. high. Most of the water discharged from the more than 100 springs in the group is from the abundant rainfall of north central Florida, which passes through the porous surface soil and sand of the region and enters the limestone lying immediately beneath. This filtration causes the extreme clearness of the spring water.

Silver springs is the source of Silver river, a 7-mi.-long navigable stream which eventually reaches the Atlantic ocean via the Oklawaha and St. Johns rivers.

There are more than 30 varieties of fish, as well as turtles and shellfish in Silver springs. Remains of mastodons, manatees and extinct elephants have also been found in the springs or in the Silver river.

Swimming facilities, glass-bottomed boat rides, cruises on the Silver river, religious exhibits, a zoo and a snake farm are provided for visitors. Thousands of tourists visit the springs each year. Because of the clarity of the water, Silver springs is a favourite location for motion-picture companies that wish to film underwater scenes.

The explorer Hernando de Soto was probably the first European to see Silver springs when he camped at Ocali, an Indian village near the springs, in 1539. The Indian name for Silver springs is *Sua-ille-oka,* which means "sun-glinting water." (J. E. Jo.)

SILVER TREE (*Leucadendron argenteum*), a South African tree, the leaves of which are covered with fine silky hairs, and are used for painting on. The tree has been nearly exterminated. There are about 70 species of the genus *Leucadendron* (family Proteaceae) all South African.

SILVESTER, or SYLVESTER, the name of three popes and an antipope.

SILVESTER I, pope from 314 to 335, succeeded Melchiades in Jan. 314. The story of his having baptized Constantine the Great is fictitious. as contemporary evidence shows that the emperor received this rite near Nicomedia at the hands of Eusebius. bishop of that city; and the *Donation of Constantine* (*q.v.*) has long been known to be spurious.

An important event of this pontificate was the council of Nicaea in 325, to which Silvester sent legates. Silvester died in Dec. 33j and is commemorated on Dec. 31.

SILVESTER II (Gerbert), pope from 999 to 1003, was born in the county of Xuvergne. Educated in the abbey of St. Géraud at Aurillac in Xuvergne under the abbots Gerald and Raymund. he was taken beyond the Pyrenees in 967 by Borel, count of Barcelona. who entrusted his further education to Atto, bishop of Vich (Ausona). Accompanying these two patrons to Rome in 970–971, Gerbert was presented to the emperor Otto I, to whom he admitted his skill in the quadrivium while deploring his comparative ignorance of logic. About 972, he went to Reims to study under Archbishop Adalbero, under whom he seems to have lectured for many years. having among his pupils Robert. the future king of France, and the chronicler Richer. His growing fame roused the envy of Otric of Saxony. who, suspecting him of error in his classification of the sciences, accused him of this before the emperor Otto II. By Otto's command the two rivals then had a disputation at Ravenna. which is said to have lasted a whole day (about Christmas, 980).

Otto subsequently gave Gerbert the abbey of Bobbio (982 or early 983), but Gerbert found such difficulty in collecting his dues that he returned to Reims in 984 to resume service under Adalbero. The latter involved him in his intrigues against the last Carolingian kings of France.

Adalbero died in Jan. 989, having, according to Gerbert. designated him his successor as archbishop. The appointment, however, was given instead to Arnulf, an illegitimate son of the late king Lothair. Arnulf took an oath of fealty to Hugh Capet, who had taken the place of Lothair's son Louis V as king of France, and Gerbert was persuaded to remain with him. Then, in the late summer or autumn of 989. Reims was taken by Lothair's brother Charles of Lorraine, now the head of the Carolingian house. Gerbert, falling into Charles's hands, continued for a time to serve under Xrnulf, who had gone over to his uncle's side. He was able, however, to return to the Capetian allegiance before the treachery of Xdalberon-Xscelin of Laon put both Charles and Xrnulf at the mercy of Hugh Capet (March 991). At the synod of St. Basle, near Reims, Xrnulf was degraded from the archbishopric and Gerbert, in recognition of his services, appointed his successor (June 991).

The vigour and the activity of Gerbert as a metropolitan made thernselves felt as far away as Tours: Orléans and Paris. But meanwhile Arnulf's friends were active! and Pope John XV objected to the summary deposition of Xrnulf. Gerbert had to appear before a papal legate at Mouzon in 995 and went himself to Rome to put his case before the new pope, Gregory V, in 996 (he was present at Otto III's coronation). Finally, in 997, after Gregory's synod of Pavia had suspended all the bishops concerned in the proceedings of St. Basle. Gerbert despaired of his archbishopric and left France for the court of his former pupil the young emperor Otto III.

Otto welcomed him as an old supporter of the imperial family as well as a great scholar and quickly procured his appointment to the archbishopric of Ravenna (about April 998). The death of Gregory V during the following year enabled the emperor to do even better for his protégé, by sponsoring his elevation to the papacy.

Gerbert was consecrated as Silvester II on April 2, 999. It is he who is generally credited with having encouraged the splendid vision of a restored empire that then began to fill Otto's mind.

In ecclesiastical administration Silvester was by no means inactive. He confirmed his old rival Arnulf in the see of Reims (999), rebuked Adalberon-Ascelin of Laon for his crimes (1000) and settled the dispute between Willigis archbishop of Mainz and Bernward bishop of Hildesheim (1001). Of more lasting importance was the erection of Gniezno to metropolitan status in a Polish Church independent of the German hierarchy (1000). The genuineness of the letter to St. Stephen of Hungary. accepting his kingdom as a fief of the Holy See, is contested. Silvester's plans for the advancement of the church and empire together were halted by Otto III's death on Jan. 23, 1002. Little more than a year later. on May 12. 1003, the pope himself died. He was buried in the church of St. John Lateran.

Besides being the most distinguished statesman. Gerbert was also the most accomplished scholar of his age. Richer has left a detailed account of his system of teaching at Reims. So far as the trivium is concerned; his textbooks were Victorinus' translation of Porphyry's *Isagoge,* Aristotle's *Categories* and Cicero's *Topics* with the commentaries of Boethius. From dialectics he urged his pupils to the study of rhetoric; but, recognizing the necessity of a large vocabulary. he accustomed them to read Virgil. Statius. Terence, Juvenal, Horace, Persius and Lucan. More remarkable still were his methods of teaching the quadrivium. To assist his lectures on astronomy he constructed elaborate globes of the terrestrial and celestial spheres, on which the course of the planets was marked. For facilitating arithmetical and perhaps geometrical processes he constructed an abacus with 27 divisions and a thousand counters of horn. A younger contemporary speaks of his having made a wonderful clock or sundial at Magdeburg. It is known from his letters that Gerbert was accustomed to exchange his globes for manuscripts of those classical authors that his own library did not contain.

More extraordinary still was his knowledge of music—an accomplishment which seems to have been his earliest recommendation to Otto I. Gerbert's letters contain more than one allusion to organs which he seems to have constructed. and William of Malmesbury preserved an account of a wonderful musical instrument still to be seen in his days at Reims. The same historian says that Gerbert borrowed from the Saracens the abacus with ciphers (*sc.*, for numerals from one to nine, instead of mere units, but without the zero).

Perhaps Gerbert's chief claim to the remembrance of posterity is to be found in the care and expense with which he gathered together manuscripts of the classical writers. His love for literature was a passion. In the turmoil of his later life he looked back with regret to his student days, and "for all his troubles philosophy was his only cure." Everywhere (Rome, Trier, Montier-en-Der, Gerona and Barcelona) he had friends or agents to procure copies of the great Latin writers for Bobbio or for Reims. To the abbot of Tours he writes that he is "labouring assiduously to form a library." and "throughout Italy, Germany and Lorraine [Belgica] is spending vast sums of money in the acquisition of mss." It is noteworthy, however, that Gerbert never wrote for a copy of one of the Christian fathers, his aim being, seemingly, to preserve the fragments of a fast-perishing secular Latin literature.

So remarkable a character as that of Gerbert left its mark on the age, and fables not unlike those later accumulated around Faust soon began to cluster round his name. Toward the end of the 11th century Cardinal Benno, the opponent of Hildebrand, is said to have made Gerbert the first of a long line of magician popes. William of Malmesbury adds a love adventure at Córdova, a compact with the devil, the story of a speaking statue that foretold Gerbert's death at Jerusalem — a prophecy fulfilled, somewhat as in the case of Henry IV of England, by his dying in the Jerusalem church of Rome — and that imaginative story of the statue with the legend "Strike here" which found its way into the *Gesta Romanorum.*

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Silvester III (John), bishop of Sabina, became pope on Jan. 20, 1045, after the Romans had driven out Benedict IX; but he resigned the papacy on March 10, 1045. Retiring to his old bishopric, he recognized Gregory VI as pope. The synod of Sutri (Dec. 1046), under the presidency of the emperor Henry III, formally passed sentence of deposition on him, as is shown by the documents issued in his capacity as bishop of Sabina during 1046.

Silvester IV (Maginulf), antipope from 1105 to 1111, a man of dubious antecedents. was elected in opposition to Paschal II by the dissident nobles under Werner. margrave of Ancona. on Nov. 18. 1105. Though Paschal's troops expelled him from Rome the next day, his supporters continued to give trouble during the following year; and the emperor Henry V accorded him some recognition. When Paschal and Henry came to terms, however, the antipope's pretensions were dismissed (April 1111).

SILVESTRINES (Sylvestrines), an order of monks under the Benedictine rule, founded 1231 by St. Silvester Gozzolini, who in 1231 built a monastery at Montefano. The rule was the Benedictine, but as regards poverty in external things, far stricter than the Benedictine.

The order was approved in 1247 by Innocent IV, and at Silvester's death in 1267 there were 11 Silvestrine monasteries. At a later date there were 56, mostly in Umbria, Tuscany and the March of Ancona. In 1941 there were 75 Silvestrine monasteries and 8 monks houses.

See Max Heimbucher, *Orden* u. *Kongregationen* (1907), i, § 30; Wetzer and Welte, *Kirchenlexicon* (ed. 2); and the *Catholic Encyclopaedia,* art. "Sylvestrines."

SILVICULTURE is the technical branch of forestry *(see* Forests and Forestry) which is concerned with the establishment and maintenance of the forest.

See Arboriculture.

SIMALUR (Simeulue), the northernmost island of the chain off the west coast of Sumatra, Indonesia. It is about 61 miles long, and is hilly, the coasts being rocky and reef-bound.

Sinabang, on a bay in the southeast, is the capital and port, where vessels of the Royal Packet Navigation company ordinarily call, giving connection with Tapa Tuan, on the Sumatran mainland; there is also a cable between Simalur and Singkep, in Achin, Sumatra.

Other small places on the coast are Sibigo and Sigule; they are connected by a road. The Banyak Islands, nearly 70 in number, lie southeast of Simalur. They are prolific in coconut palms and form a port of call for copra. Simalur was occupied by the Japanese in World War II.

SIMANCAS, a town of Spain, in the province of Valladolid; 8 mi. S.W. of Valladolid, on the road to Zamora and the right bank of the Pisuerga river. Pop. (1950) 1,423 (mun.). Simancas is a town of great antiquity, the Roman Septimanca, with a citadel dating from the Moorish occupation in the 9th century. In 934 it was the scene of a battle between the Moors and Christians.

The citadel is now the Archivo General del Reino, to which the national archives of Spain were removed by order of Philip II in 1563. Their transference thither was first suggested to Charles V by Cardinal Ximenes or Cisneros (d. 1517).

The extensive alterations were made by three celebrated 16th-century architects, Juan de Herrera, Alonso Berruguete and Juan Gomez de Mora; the arrangement of the papers was entrusted to Diego de Ayala. They include important private as well as state papers. The archives of the Indies were transferred in 1784 to the Lonja of Seville.

SIMAROUBACEAE, the quassia *(q.v.)* family. shrubs or trees, many of which yield a bitter principle. About 32 genera are recognized, with about 200 species, chiefly in the tropics of both hemispheres. *Quassia amara* and *Aeschrion excelsum,* both natives of tropical America, are used in the practice of medicine and as a tonic, and locally species of *Brucea, Samadera, Simarouba, Harrisonia, Castela* and others are considered to have medicinal properties. Several members of the family produce useful timber, and a few are cultivated as ornamentals, mostly in warm regions. The Chinese tree of heaven, widely naturalized in Europe and in the United States, is *Ailanthus (q.v.) altissima.*

(E. D. Ml.)

SIMBIRSK: *see* Ulianovsk.

SIMCOE, JOHN GRAVES (1752–1806), British soldier and first lieutenant governor of Upper Canada (1791–96), was born at Cotterstock, Northamptonshire, Eng., on Feb. 25, 1752. As commander of a Loyalist corps, the queen's rangers, he served nith distinction during the American Revolution. Although well-to-do after his marriage in 1782. he found no satisfactory career in England

As lieutenant governor he proved an energetic administrator and. although seldom moderate in his language about the United States, he acted discreetly in the border crisis of 1794. His enthusiasm for the new Canadian colony and for aristocratic government in it quickly waned. the more so as he greatly disliked the governor in chief. Lord Dorchester. Given sick leave in 1796, he nevertheless agreed to go as governor and commander in chief to St. Domingue (Haiti), half-conquered by the British from the French. In seven months he reformed its administration and waged a successful campaign, but returned to England and resigned his colonial appointments. He was unable to get more active service, but was given command of the Western district with headquarters in Exeter (1799--1806). Then a new British government made him commander in chief in India. Diverted on a diplomatic mission to Lisbon, Spain, he fell ill and returned to die at Exeter, Oct. 26, 1806.

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(S. R. M.)

SIMEON, SAINT, the New Theologian (949–1022), Byzantine abbot and mystic whose works had a formative influence on Orthodox spirituality, was born in Paphlagonia, of an aristocratic family, and came to Constantinople as a young boy. He insisted on entering the monastery of Studios (977). but differences with the abbot resulted in his migration to the neighbouring house of St. Mamas in the same year. There he became abbot (980) and imposed strict discipline. His vigorous cult of his spiritual father, Simeon the Studite, and other reasons brought him into conflict with the patriarch and he was exiled to the Asian shore of the Bosphorus (1009). There he built up the monastery of St. Marina near Chrysopolis (Scutari) and, though eventually reconciled to the patriarch. refused to return to the capital. He was a well-known and popular figure and was called the Younger or the New Theologian. perhaps to distinguish him from the two other "theologians" par excellence in the Orthodox Church—John the Evangelist and Gregory of Kazianzus. Some of his works have been translated into modern Greek, Russian and Latin; much has not been published in the original Greek.

His numerous writings fall into three main groups: sermons, the *capita,* and the "hymns of the divine loves." One group of the sermons. the catecheses, originally preached to the monks of St. Mamas, were later drastically revised and combined with other writings of Simeon to provide a compilation suitable for a wider public. Both his sermons and his hymns are illuminated by his own personal experience, and his underlying theme is the means, particularly obedience and tears, whereby through grace union with God may be attained in this life. His emphasis was often Christo-centric, though the climax of his mystical experiences was the indwelling of the Trinity revealed as divine light. His contribution is highly individual; he provides a link between earlier mystics. as John Climacus, and later Byzantine spirituality.

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SIMEON, CHARLES (1759–1836), evangelical leader in the Church of England. was born at Reading on Sept. 24, 1759, and educated at Eton and Ring's college. Cambridge. where he was a fellow from 1782 (vice-provost, 1790–92). He came under the influence of Henry and John Venn and in 1782 was presented to the living of Trinity church. Cambridge. where he remained until his death. He was at first unpopular with his parishioners who had wanted the curate. John Hammond. in his place and his services were noisily interrupted. But his pastoral care. especially in sickness and in the famine of 1788, and his quiet. peaceable nature. slowly won the regard of the town and the university. and he became widely known as an evangelical leader who was yet a convinced member of the Church of England and lover of its liturgy and discipline.

He was concerned for missionary work, especially in India, and persuaded his best pupils to the venture, above all his curate. Henry Martyn; he helped to found the Church Missionary society (1799) and assisted the newly founded (1804) British and Foreign Bible society and the Society for Promoting Christianity Among the Jews; he gave to the support of missions from his own pocket. including part of the payment for his *Horae Homileticae,* discourses on the Bible published in 21 vol. in 1832–33. Following the example of Henry Thornton. in order to ensure the continuity of evangelical teaching. he administered the Simeon trust (founded 1816) to purchase the right to appoint clergymen to livings. He died on Kov. 13, 1836. and is buried in the chapel of King's college.

Simeon was a representative of the evangelical tradition at its best. and his influence upon the university left an indelible mark on religious life at Cambridge.

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SIMEON, in the Old Testament, the name of a tribe of Israel, named after the second son of Jacob by Leah (Gen. xxix. 33). According to Gen. xxxiv, the brothers Simeon and Levi massacred the males of Shechem to avenge the violation of their sister Dinah ("judgment") by Shechem the son of Hamor. Jacob disavowed the act, and on his deathbed solemnly cursed their ferocity, condemning the two to be divided in Jacob and scattered in Israel (xlix, 5–7). Subsequently the priestly Levites are found distributed throughout Israel without portion or inheritance (Deut. xviii, 1, Josh. xiii, 14).

On the other hand. Simeon is reckoned among the northern tribes in II Chron. xv, 9, xxxiv, 6, but is elsewhere assigned a district in southern Palestine. the cities of which are otherwise ascribed to Judah (*cf.* Josh. xix. 1–9 with xv. 26–32). An interpolation in I Chron. iv, 31 states that Judah was their seat in David's time. but there is no support ior this in other records (*see* I Sam. xxvii, xxxj. In fact. Simeon is not mentioned in the "blessing of Moses" (Deut. xxxiii. *see* S. R. Driver, *Deut.*, p. 397 ff.) or in the stories of the "judges"; and notwithstanding references to it in the chronicler's history of the monarchy. it is not named in the earlier books of Samuel and Kings. But is Gen. xxxiv to be taken literally? Shechem is the famous holy city, Hamor a well-known native family, Jacob talks of himself as being "few in number," and the deeds of Simcon and Levi are those of communities, not of individuals. What historical facts are thus represented, and how they are to be brought into line with the early history of Israel. are problems which have defied solution (*see* J. Skinner. *Genesis,* p. 421 ff.). It is conjectured that Dinah represents a clan or group (*see* TWELVE TRIBES OF ISRAEL) which settled in Shechem and was exposed to danger (*e.g.,* oppression or absorption); the tribes Simeon and Levi intervened on its behalf. the ensuing massacre was avenged by the Canaanites and the two were broken up. These events are supposed to belong to an early stage in the invasion of Palestine by the Israelites (15th–13th century B.C.), perhaps to a preliminary settlement by the "sons" of Leah (Reuben, Simeon. Levi and Judah), previous to the entrance of the "son" of Rachel. Joseph, the "father" of Ephraim and Manasseh.

In the New Testament, (1) the seer who recognized the infant Jesus as the Redeemer; (2) an alternate form of Simon.

SIMEON (or SYMEON) **OF DURHAM** (d. after 1129), English chronicler! embraced the monastic life before the year 1053 in the monastery of Jarrow; but only made his profession at a later date, after he had removed with the rest of his community to Durham.

He composed his *Historia ecclesiae Dunelmensis,* extending to the year 1096, at some date between 1104 and 1108. The original manuscript is at Durham in the library of Bishop Cosin. There are two continuations. both anonymous. The first carries the history from 1096 to the death of Ranulf Flambard (1129); the second extends from 1133 to 1144.

A Cambridge manuscript contains a third continuation covering the years 1141–54. About 1129 Simeon undertook to write a *Historia regum Anglorum tit Dacorum.* This begins at the point where the *Ecclesiastical History of Bede* ends. The section dealing with the years 1119–29 is. however, an independent and practically contemporaneous narrative.

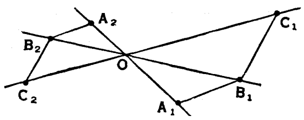
The most complete modern edition of his works is that of Thomas Arnold, "Rolls Series." 2 vol. *(1882–8.5).* Simeon's works have been translated by J. Stevenson in his *Church Historians of England,* vol. iii, part ii (1855).

SIMEON STYLITES, ST. (390–459), the first and most famous of the Pillar-hermits (Gr. *stylos,* "pillar"), n-as born in N. Syria. After having been expelled from a monastery for his excessive austerities. at thirty years of age he built a pillar six feet high on which he took up his abode. He made new pillars higher and higher. till after ren years he reached the height of sixty feet. On this pillar he lived for thirty years without ever descending. A railing ran round the capital of the pillar, and a ladder enabled his disciples to take him the necessaries of life. From his pillar he preached and exercised a great influence, converting numbers of heathen and taking part in ecclesiastical politics. The facts would seem incredible mere they not vouched for by Theodoret, who knew him personally *(Historia religiosa,* c. *26).* Moreover, Simeon had many imitators, well authenticated pillar-hermits being met with till the 16th century.

The standard work on the subject: is *Les Stytites* (1895), *by H.* Delehaye, the Bollandist; for a summary *see* the article "Saulenheilige," in Herzog's *Realencyklopadie* (ed. 3). *On* Simeon *see* Th. Nöldeke's *Sketches from Eastern History* (1892), p. 210, the *Dictionary* of *Christian Biography* and *The Catholic Encyclopaedia.*

SIMFEROPOL, the administrative centre of the Crimean *oblast,* situated on the northern slopes of the Chatyr-dagh mountains in 44° 58' N., 34° 3' E. on the Salgar river. Simferopol grew rapidly after the railway linking it with the main Russian net was constructed. Pop. (1959) 189,000. The small fortress of Napoli erected by the ruler of Taurida about 100 B.C. existed near the town until the end of the 3rd century. Later it was a Tatar settlement Ak-mechet (Sultan Serai), the residence of the chief military commander of the khan. It was captured and burned by the Russians in 1736 After the conquest of the Crimea by the Russians in 1784, it received its present name.

SIMILAR FIGURES. Geometric figures are said to be *similar* if they have the same shape but not necessarily the same size; *e.g.,* any two squares are similar; if they are of the same size, they are *congruent,* or *identically equal,* but they are still similar. Any two circles are similar, but not any two ellipses, for ellipses may have different shapes *(see* ELLIPSE). Solids may also be similar, as in the case of cubes or of spheres. Similarity of figures is the basis of trigonometry *(q.v.)* and of indirect measures in general. Speaking more precisely, two systems of points, $A_1, B_1, C_1, \ldots$ and $A_2, B_2, C_2, \cdots$ are said to be similar when they can be so placed that all lines A_1A_2, B_1B_2, $C_1C_2, \ldots$, joining corresponding points form a pencil whose vertex. O, divides each line into segments having a constant ratio r. In the figure here shown, the constant ratio is 2/3. Two figures are said to be similar when their systems of points are similar. The point O is called the *centre* of *similitude.* If $r=1$, the figures are said to he *symmetric with respect to the centre O (see* SYMMETRY).



SIMILAR FIGURES

SIMLA, a municipal town and district in the Ambala division of Punjab, India. The area was used as a rest area for troops after the Gurkha War, 181j–16. The first English house was built there in 1819. The town was from 1840 to 1939 the summer residence of the viceroy and the staff of the Indian and the Punjab governments. After the outbreak of World War II, the essential government departments remained in Delhi and those of lesser importance in Simla. From 1947 until 1953 (when it was moved to Chandigarh) it mas the headquarters of the (East) Punjab government and later the seat of the government of the adjacent state of Himachal Pradesh. It is 53 mi. N.E. of Ambala. with which it is connected by rail (metre-gauge from Kalka, 2j mi. below Simla). Between Kalka and Simla there are 103 tunnels. Mean temperature: 39° F. (Jan.) to 67° F. (July). Annual rainfall is 63 in.; snow often falls in winter. Pop. (1951) 46.150.

The mountains about Simla (southern outliers of the central chain of the east Himalaya) are forested with deodar; rhododendrons clothe the slopes up to the limit of perpetual snow. Simla occupies a spur of the lower Himalaya, running east and west for about 6 mi The ridge culminates at the east in the eminence of Jakko, where residences are most numerous; the old viceregal lodge stands on Observatory hill (7.050 ft.). The east of the town is known as Chota [Little] Simla and the west as Boileauganj. The situation is one of great beauty; and the residential parts lie at elevations between 6,600 and 8,000 ft. above sea level. To the north, a beautiful wooded spur, branching from the main ridge, is known as Elysium. Three miles west is the cantonment of Jutogh. The minor health resorts of Kasauli, Sabathu, Dagshai and Solan lie a distance to the south. In Solan are the headquarters of the federal university of the Punjab, founded in 1947. Simla has become the permanent headquarters of many official establishments.

The two chief medical institutions are the Ripon and Walker hospitals. In Simla are tuo undergraduate colleges and a women's training college attached to Punjab university.

SIMLA DISTRICT (8 sq.mi.) comprises only the town. Before 1948 it covered 80 sq.mi. around the town.

The former SIMLA HILL STATES AGENCY (4,960 sqmi) consisted of Bashahr, Jubbal, Keonthal, Nalagarh and 23 other states contrclled from Simla. Control was transferred to the resident for the Punjab states, at Lahore, in 1921.

SIMMEL, GEORG (1858–1918), German philosopher and sociologist whose fame as an original scholar rests on several lengthy and brilliantly written essays on sociological methodology and analysis, although during the last decade of his life he devoted himself mainly to metaphysics and aesthetics. He became well known to U.S. sociologists, in part because of the translations and commentaries on his works by A. W. Small. Simmel was born in Berlin, March 1, 1858, and was appointed a lecturer in philosophy at Berlin university in 1885. where he remained until called to the chair of philosophy at Strasbourg university in 1914. He died there on Sept. 28, 1918. Simmel is noted for his analytical study of the forms of social interaction. He sought to isolate the general forms or recurrent regularities of social interaction from the specific content of association in concrete types of activity, such as political, economic and aesthetic. Hence, his sociological writings were abstract rather than realistically descriptive of life.

In his studies of social interaction Simmel gave special attention to the problem of authority and obedience. His methodological contributions did much to clarify the scope of sociology, to give it greater precision, and to establish it as a basic social science in Germany. Simmel made one important effort to apply his abstract principles to the interpretation of social behaviour in a specific field. economics. in his essay *The Philosophy* of *Money.* He stressed the role of a money economy in specializing social activity and depersonalizing individual and social relationships, a concept later developed more fully by Werner Sombart in his famous work on capitalism. Simmel's writings on the philosophy of history, ethics, religion and art are also important.

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SIMMONS, EDWARD EMERSON (1852–1931), U.S. artist. one of the original members of the Ten American Painters, was born at Concord. Mass., on Oct. 27, 1852. He graduated from Harvard college in 1874, and was a pupil of Jules Joseph Lefebvre and Gustave Boulanger in Paris, where he took a gold medal. Simmons was awarded the prize by the Municipal Art Society of New York for a mural decorative scheme, carried out for the criminal courts building. Later he decorated the Waldorf-Astoria in New York city, the Library of Congress, the state capitol at St. Paul. Minn., and other public and private buildings. He was elected to the National Institute of Arts and Letters. Simmons died on Nov. 17, 1931.

SIMMS, WILLIAM GILMORE (1806–1870), U.S. regional novelist, was born in Charleston, S.C., April 17, 1806.

Edgar Allen Poe stated in 1844 that Simms had "more vigor, more imagination, more movement and more general capacity than all our novelists (save Cooper) combined." A 20th-century critic J. B. Hubbell, stated that, Simms "rather than Poe is the central figure of the literature of the Old South. He knew personally most of the southern writers of the time, and he more than any other man stimulated them to write and to publish. But he was a national as well as a sectional figure, and he was the most important literary link between North and South." (J. B. Hubbell, *The South in American Literature,* p. 572, Duke University Press, 1954.) Of Simms' 82 volumes, his historical novels are most important. His field of fiction is the frontier of the lower south—Spanish explorations of the 16th century, the settlement of South Carolina in the 17th, the revolution in South Carolina in the 18th and southwestward migration in the 19th, preserving for the social historian an authentic and salty cast of woodsmen, Indians, Negro slaves, partisan fighters, outlaws, adventurers, loyalists, shyster lawyers, land speculators, gamblers, half-breeds and typical ladies and gentlemen of what to Simms was an heroic age.

Motherless at two, Simms was reared by his grandmother, while his Scotch-Irish father fought in the Creek wars and under Jackson at New Orleans. Simms lived a vicariously adventurous childhood through his father, while absorbing history through his storytelling grandmother who had lived through the Revolution. He attended public schools four years. Upon entering the College of Charlestori at the age of ten he knew enough French, Latin, German and Spanish to dabble in translations. At the age of 12 he completed the study of materia medica, and leaving college became a druggist's apprentice. He began publishing poetry in Charleston papers at 16, edited a magazine and published a volume of poetry at 19, married at 20 and was admitted to the bar at 21.

Simms was a prodigious worker, whether at Woodlands plantation in winter, Charleston in summer or on yearly publishing trips north. As state legislator and magazine and newspaper editor (the *Charleston City Gazette*), he became embroiled in political and literary quarrels. From Charleston and the south he nevertheless received lifelong praise approaching adulation; from the north, wide audience and eminent literary friendships. Though he was shadowed by the defeat of the Confederacy, the death of his second wife, poverty and the destruction of his home and library by Gen. William T. Sherman's stragglers, the five volumes of his published letters attest a gallant figure, the richness of whose performance was too long underestimated by literary historians. He died on June 11, 1870 in Charleston.

Simms' chief fault was writing too much, too carelessly and with too frequent use of stock devices; he was at his best the master of a racy and masculine English prose style. His gift as a charming teller of tales in the oral tradition, and the care of an antiquarian in preparing historical materials, triumph over hasty composition, whether in *Vasconselos* (1853) in a 16th-century setting; *The Yemassee* (1835) in a colonial setting; his revolutionary series—*The Partisan* (1835), *Mellichampe* (1836), *The Kinsmen* (1841), *Katherine Walton* (1851), *Woodcraft* (1854), *The Forayers* (1855), *Eutaw* (1856); the best of his border romances—*Richard Hurdis* (1838) and *Border Beagles* (1840); his short story collection *The Wigwam and the Cabin* (1845); or in his *History of South Carolina* (1840). Of his 19 volumes of poetry the collected *Poems* (1853) deserve mention. Most popular of his biographies were *The Life of Francis Marion* (1844) and *The Life of Chevalier Bayard* (1847). His literary criticism is represented in *Views and Reviews of American Literature* (1845).

See A. S. Sallep and Donald Davidson (eds.), *Letters of William Gilmore Simms*, introd., vol. i (1952). Vernon L. Parrington, *Main Currents in American Thought*, vol. ii (1927). (M. C. S. O.)

SIMNEL, LAMBERT (fl. 1477–1534), English impostor, was probably the son of a tradesman at Oxford. About 10 years old in 1487, he was described as a handsome youth of intelligence and good manners. In 1486, the year following the accession of Henry VII, rumours were spread by the Torkists that the two sons of Edward IV, who had been murdered in the Tower of London, were still alive. A young Oxford priest, Richard Symonds, decided to put forward the boy Simnel as one of these princes and provided him with a suitable education. Meanwhile a report had gained currency that the young earl of Warwick, son of Edward IV's brother George, duke of Clarence, had died in the Tower and Symonds decided that the impersonation of Warwick would be more effective. The Yorkists had many adherents in Ireland, and thither Lambert Simnel was taken by Symonds early in 1487. He gained the support of the earl of Kildare, the archbishop of Dublin, the lord chancellor and a powerful following, and was crowned as King Edward VI in the cathedral in Dublin on May 24, 1487.

Messages asking for help were sent to Margaret, duchess of Burgundy, sister of Edward IV, to Sir Thomas Broughton and other Yorkist leaders.

On Feb. 2, 1487, Henry VII held a council at Sheen to concert measures for dealing with the conspiracy. Elizabeth Woodville, widow of Edward IV, was imprisoned in the convent of Bermondsey; and the real earl of Warwick was shown in public in the streets of London. John de la Pole, earl of Lincoln, himself a nephew of Edward IV, had probably connived at the Simnel impersonation. He fled to Flanders, where he joined Lord Lovell, who had headed an unsuccessiul Yorkist rising in 1486, and in May 1487 the two lords proceeded to Dublin, where they landed a few days before the coronation of Lambert Simnel. They were accompanied by 2,000 German soldiers under Martin Schwarz, procured by Margaret of Burgundy to support the enterprise, Margaret having recognized Simnel as her nephew. This force, together with some ill-armed Irish levies commanded by Sir Thomas Fitzgerald, landed in Lancashire on June 4. King Henry immediately marched to Nottingham, where his army was strengthened by the addition of 6,000 men. Making for the fortress of Newark, Lincoln and Sir Thomas Broughton, accompanied by Simnel, attacked the royal army near Stoke-on- rent on June 16, 1487. After a fierce and stubborn struggle the Royalists were completely victorious, though they left 2,000 men on the field; Lincoln, Schwarz and Fitzgerald with 4,000 of their followers were killed, and Lovell and Broughton disappeared. The priest Symonds and Simnel were taken prisoners. Henry VII, recognizing that Lambert Simnel had been a tool in Yorkist hands, took him into his own service as a scullion. He was later promoted to be royal falconer, and is said to have afterward become a servant in the household of Sir Thomas Lovell. He was still living in the year 1534.

See Francis Bacon, *History of Henry VII*, notes by J. R. Lumby (1876); James Gairdner, *Henry VII* (1889); J. D. Mackie, *The Earlier Tudors* (1951).

SIMOCATTES, THEOPHYLACT (or THEOPHYLACTUS; Gr. THEOPHYLAKTOS SIMOKATTES) (fl. 6th–7th century A.D.), Byzantine writer whose history is a valuable source for the reign of Maurice (582–602). He was an Egyptian, who after legal training held office at Constantinople under Heraclius (610–641). His history, for which he had access to official sources of information, shows keen awareness of the Greek tradition of historiography, for he was acquainted with the work of Herodotus and Diodorus as well as later historians including near contemporaries. He also wrote a work on natural history (*Quaestiones naturales*) and a number of literary exercises in epistolary form.

His *Historia* was edited by C. de Boor in the "Teubner Series" (1887) and I. Bekker in the Bonn corpus (1834). Other works edited include *Quaestiones naturales*, ed. by J. L. Ideler, *Physici et medici graeci minores*, vol. i, pp. 168–183 (1841), and. together with the *Epistulae*, by J. F. Boissonade (1635); *Epistulae* ed. by R. Hercher, *Epistolographi Graeci*, pp. 763–787 (1873).

See K. Krumbacher, *Geschichte der byzantinischen Litteratur*, pp. 247–251, 2nd ed. (1897); G. Moravcsik, *Byzantinoturcica*, vol. 1, pp. 544–548, 2nd ed. (1958). (J. M. Hy.)

SIMON, SAINT, one of the 12 apostles, always mentioned in the last of the three groups of four names in the apostle lists (Mark iii. 18; Matt. x, 3; Luke vi, 15; Acts i, 13). In Mark and Matthew he bears the surname *Kananaios*, or the Cananaian, often wrongly interpreted as meaning "from Cana" or "from Canaan." It is in fact the Greek transliteration of an Aramaic word *qan'anaya*, meaning "the Zealot," which is precisely the title given him by Luke both in his Gospel and in Acts. Whether he was one of the group of Zealots (the Jewish nationalistic party prior to A.D. 70) cannot be answered for lack of evidence. Nothing further is known about him from the New Testament. He is said to have preached the Gospel in Egypt and then joined St. Judas (Jude Thaddeus) in Persia, where both were martyred (according to the apocryphal Passion of Simon and Jude). Oct. 28 is the feast of SS. Simon and Jude. (J. A. Fi.)

SIMON, SIR JOHN (1816–1904), English surgeon and sanitary reformer, was born in London on Oct. 10, 1816. He was the son of Louis Michael Simon, for many years a leading member of the London Srock exchange. Simon was educated at a preparatory school in Pentonville, spent seven years at Charles Parr Burney's school in Greenwich and then ten months with a German priest in Rhenish Prussia.

He began the study of medicine on Oct. 1, 1833, when he was a few days short of the age of 17. He was an apprentice of Joseph Henry Green, surgeon at St. Thomas's who was well known for his friendship with Samuel Taylor Coleridge, whose literary executor Green became. He became a demonstrator of anatomy and in 1840 was appointed assistant surgeon to King's College hospital. In the autumn of 1847 he was made surgeon and lecturer on pathology at his old school, St. Thomas's, where, with progressive changes, he continued to remain an officer.

In the spring of 1844 he gained the first Astley Cooper prize by a physiological essay on the thymus gland, and the following year was elected F.R.S. Simon published many clinical surgical lectures of the greatest importance. and contributed an article on "Inflammation" to Holmes's *System of Surgery* which has become a classic of its kind. It was, however, on his appointment in 1848 as medical officer of health to the City of London, and afterward to the government, that his great abilities in sanitary science found full scope. Simon can claim priority over Edward Cock in the operation of perineal puncture of the urethra in cases of retention from stricture. He died on July 23, 1904.

SIMON, JOHN ALLSEBROOK SIMON, 1ST VISCOUNT (1873–1954), British lawyer and politician, who was leader of the Liberal National party (*see* LIBERAL PARTY) from 1930 until 1940, was born in Manchester on Feb. 28, 1873. Educated at Fettes college, Edinburgh, and Wadham college, Oxford, he became a fellow of All Souls in 1897 and was called to the bar in 1899. He took silk in 1908. In 1906 he entered parliament as a Liberal, becoming solicitor general in 1910 (in which year he was also knighted) and attorney general in 1913. In 1915 he chose a political rather than legal career when he refused the lord chancellorship to become home secretary, a post which he resigned a year later in opposition to conscription. A follower of H. H. Asquith, he lost his seat in 1918, but was re-elected in 1922. As chairman of the commission which examined the working of the 1919 Government of India act, he visited India during 1927–30, and while there announced his resignation from the bar, where he had been making more than £50,000 a year.

Simon became foreign secretary in the national government of 1931; many thought his advocacy of disarmament unrealistic in the face of Japanese aggression in Manchuria and the growing territorial ambition of Germany and Italy. As home secretary, 1935–37, he introduced much-needed factory legislation. He became chancellor of the exchequer in 1937. He shared Neville Chamberlain's downfall in 1940 and accepted a viscountcy and the lord chancellorship, a position in which his legal acumen and lucidity made him outstanding. After the fall of the coalition government in 1945 he remained active in the house of lords. He died in London on Jan. 11, 1954.

SIMON, JULES FRANÇOIS (1814–1896), French statesman and philosopher, was born at Lorient on Dec. 27, 1814. His father was a linen-draper from Lorraine, who abjured Protestantism before his second marriage (of which Jules Simon was the son) with a Catholic Breton. The family name was Suisse, which Simon dropped in favour of his third prenomen. At the École Normale in Paris he came in contact with Victor Cousin, who sent him to Caen and then to Versailles to teach philosophy. He helped Cousin, without receiving any recognition, in his translations from Plato, and in 1839 became his deputy in the chair of philosophy at the Sorbonne, with the meagre salary of 83 francs per month. He also lectured on the history of philosophy at the École Normale. At this period he edited the works of Malebranche (2 vols., 1842), of Descartes (1842), Bossuet (1842) and of Arnauld (1843), and in 1844–1845 appeared the two volumes of his *Histoire de l'école d'Alexandrie.* He became a regular contributor to the *Revue des deux mondes,* and in 1847, with Amédée Jacques and Émile Saisset, founded the *Libertk de penser,* with the intention of throwing off the yoke of Cousin, but he retired when Jacques allowed the insertion of an article advocating the principles of collectivism. In 1848 he represented the Côtes-du-Nord in the National Assembly, and in 1849 entered the Council of State, but was retired on account of his republican opinions. After the *coup d'état,* which was followed by his dismissal from his professorship, he used his leisure in writing *Le Devoir* (1853), which was translated into modern Greek and Swedish, *La Religion naturelle* (1856, Eng. trans., 1887), *La Liberté de conscience* (1857), *La Liberté politique* (1859), *La Liberté civile* (1859), *L'Ouvrière* (1861), *L'École* (1864), *Le Travail* (1866), *L'Ouvrier de huit ans* (1867) and others. In 1863 he was returned to the Corps Législatif for the 8th *circonscription* of the Seine, and supported "les Cinq" in their opposition to the government.

He became minister of instruction in the government of National Defence on Sept. 5, 1870. After the capitulation of Paris in January 1871 he was sent down to Bordeaux to prevent the resistance of Gambetta to the peace. But at Bordeaux Gambetta, who had issued a proclamation excluding from the elections officials under the Empire, was all powerful. He affected to dispute Jules Simon's credentials, and issued orders for his arrest. Meanwhile Simon had found means of communication with Paris, and on Feb. 6, was reinforced by Eugène Pelletan, E. Arago and Garnier-Pagès. Gambetta resigned, and the ministry of the Interior, though nominally given to Arago to avoid the appearance of a personal issue, was really in Simon's hands. Defeated in the department of the Seine, he sat for the Marne in the National Assembly, and resumed the portfolio of education in the first cabinet of M. Thiers's presidency. He retained office until a week before the fall of Thiers in 1873.

Simon was regarded by the monarchical Right as one of the most dangerous obstacles in the way of a restoration, which he did as much as any man (except perhaps the comte de Chambord himself) to prevent, but by the extreme Left he was distrusted for his moderate views, and Gambetta never forgave his victory at Bordeaux. In 1875 he became a member of the French Academy and a life senator, and in 1876, on the resignation of M. Dufaure, was summoned to form a cabinet. He replaced antirepublican functionaries in the civil service by republicans, and held his own until May 3, 1877, when he adopted a motion carried by a large majority in the Chamber inviting the cabinet to use all means for the repression of clerical agitation. Marshal MacMahon then practically demanded his resignation. This act of the president, known as the "Seize Mai," drove him finally from office. He justified his action in submitting instead of appealing to the Chamber by his fear of providing an opportunity for a *coup d'état* on the part of the marshal.

The rejection (1880) of article 7 of Ferry's Education Act, by which the profession of teaching would have been forbidden to members of non-authorized congregations, was due to Simon's intervention. He was in fact the chief of the Left Centre opposed to the radicalism of Jules Grévy and Gambetta. He was director of the *Gaulois* from 1879 to 1881, and his influence in the country among moderate republicans was retained by his articles in the *Matin* from 1882 onwards, in the *Journal des Débats,* which he joined in 1886, and in the *Temps* from 1890.

He left accounts of some of the events in which he had participated in *Souvenirs du 4 septembre* (1874), *Le Gouvernement de M. Thiers* (2 vols., 1878), in *Me'moires des autres* (1889), *Nouveaux me'moires des autres* (1891) and Les *Derniers me'moires des autres* (1897), while his sketch of *Victor Cousin* (1887) was a further contribution to contemporary history. For his personal history the *Premiers me'moires* (1900) and *Le Soir de ma journée* (1902), edited by his son Gustave Simon, may be supplemented by Léon Séché's *Figures bretonnes, Jules Simon, sa vie, son oeuvre* (new ed., 1898), and G. Picot, *Jules Simon: notice historique . . .* (1897); also by many references to periodical literature and collected essays in Hugo P. Thieme's *Guide bibliographique de la litt. franç. de 1800 à 1906* (1907).

SIMON, RICHARD (1638–1712), French biblical critic, born at Dieppe on May 13, 1638, was educated by the Fathers of the Oratory at Dieppe and at the university of Paris. Simon entered the priesthood in 1670, and the same year wrote a pamphlet in defence of the Jews of Metz, who had been accused of having murdered a Christian child. About this time began his controversies with the Port Royalists and with the Benedictines, and his enemies sought to drive him from Paris. He was engaged at the time in superintending the printing of his *Histoire critique du Vieux Testament,* which was to be dedicated to Louis XIV.

The proof sheets were held up pending the return of the king from Flanders, and fell into the hands of the Port Royalists, who had in hand a translation into French of the Prolegomena to *Walton's Polyglott.* Simon now announced his intention of publishing an annotated edition of the Prolegomena, and actually added to the *Critical History* a translation of the last four chapters of that work, which had formed no part of his original plan. Simon's announcement prevented the appearance of the projected translation, but his enemies found the desired opportunity in the alleged heterodoxy of some of the views expressed by Simon. A decree of the council of state was obtained, and the whole impression, consisting of 1,300 copies, was seized by the police and destroyed. Simon was expelled by the Oratorians from their fellowship, and retired in 1679 to his curacy of Bolleville, Normandy. Finally the *Critical History* appeared, with Simon's name on the title page, in the year 168j, from the press of Reenier Leers in Rotterdam. Simon died at Dieppe on April 11, 1712.

The remaining works of Simon were: *Histoire critique du texte du Nouveau Testament* (1689), *Histoire critique des versions du Nouveau Testament* (1690); *Histoire critique des principaux commentateurs du Nouveau Testament* (1693), and his *Nouvelles Observations sur le texte et les versions du Nouveau Testament* (1695).

The principal authorities for the life of Simon are the life or "éloge" by his grand-nephew De la Martinière in vol. i. of the *Lettres choisies* (4 vols., 1730); *Richard Simon et son Vieux Testament,* by A. Bernus (Lausanne, 1869); H. Margival, *Essai sur Richard Simon et la critique biblique au XVIIe siècle* (1900). For the bibliography, *see,* in addition to the various editions of Simon's works, *A.* Rernus, *Notice bibliographique sur Richard Simon* (Basel, 1882).

SIMON, THOMAS (c. 1623–1665), English medalist, who designed coins, medals and seals for the Commonwealth and Restoration governments. was born, according to Vertue, in Uorkshire about 1623. He studied engraving under Nicholas Briot, and about 163j received a post in connection with the mint. In 1645 he was appointed by the parliament joint chief engraver along with Edward Wade. and. having executed the great seal of the Commonwealth and dies for the coinage, he was proinoted to chief engraver to the mint and seals. He produced several fine portrait medals of Cromwell, one of which is copied from a miniature by Cooper. After the Restoration he was appointed engraver of the king's seals. In the course of his contest with his rival. John Roettiers in 1662, Simon produced his celebrated design for a crown piece of Charles II. on the margin of which he engraved a petition to the king. This is usually considered his masterpiece. He died of the plague in London in June 1665.

A volume of *The Medals, Coins, Great Seals and Other Works of Thomas Simon, Engraved and Described by George Vertue,* was published in 1753.

SIMON BEN YOHAI (2nd century A.D.), a Galilean Rabbi, one of the most eminent disciples of Akiba Ben Joseph (*q.v.*). His master was executed by Hadrian, and Simon's anti-Roman sentiments led to his own condemnation by Varus c. A.D. 161 (according to Graetz). He escaped this doom and dwelt for some years in a cavern. Emerging from concealment. Simon settled in Tiberias and in other Galilean cities. He acquired a reputation as a worker of miracles, and on this ground was sent to Rome as an envoy. To Simon were attributed the important legal homilies called *Sifre* and *Mekhilta (see* MIDRASH), and the *Zohar*, the Bible of the Cabala (*q.v.*). This latter ascription is altogether unfounded, the real author being Moses de Leon (*q.v.*).

The fullest account of Simon's teachings is to be found in W. Bacher's *Agada der Tannaiten,* ii. pp. 70–149.

SIMONDS, FRANK HERBERT (1878–1936), American writer, was born in Concord, Massachusetts, April 5 1878. He graduated from Harvard University in 1900, after having seen active service in the war with Spain. He became a reporter on the New York *Tribune* in 1901, and was with the Washington bureau of that paper in 1903, and its Albany correspondent in 1904–05. He was Albany correspondent for the New York *Evening Post* in 1906–08, became an editorial writer for the *Sun* in 1908, was editor of the New York *Evening Sun* in 1913–14, and from 1915 to 1918 was associate editor of the New York *Tribune.* During the World War his brilliant articles in the American *Review of Reviews,* analysing the military and political situation from month to month, brought him a wide reputation. After the Armistice he continued to contribute articles on international politics to this review (of which he became foreign editor in 1914), to other periodicals, and to a newspaper syndicate. His books include *They Shall Not Pass* (1916), an account of Verdun; *History of the World War* (1917–20); and *How Europe Made Peace without America* (1927).

SIMONIDES (or SEMONIDES) **OF AMORGOS,** Greek iambic poet, flourished in the middle of the 7th century B.C. He was a native of Samos, and derived his surname from having founded a colony in the neighbouring island of Amorgos. According to Suïdas, besides two books of iambics, he wrote elegies, one of them a poem on the early history of the Samians. The elegy included in the fragments (85) of Simonides of Ceos is more probably by Simonides of Amorgos. We possess about thirty fragments of his iambic poems, written in clear and vigorous Ionic, satiric in type, but less personal than Archilochus. His largest fragment is an elaborate comparison of various types of women with various animals.

See Fragments in *T.* Bergk, *Poëtae lyrici Graeci;* separate editions by F. T. Welcker (1835), and especially by P. Malusa (1900), with exhaustive introduction, bibliography and commentary.

SIMONIDES OF CEOS (*c.* 556–469 B.C.), Greek lyric poet, was born at Iulis in the island of Ceos. During his youth he taught poetry and music in his native island, and composed paeans for the festivals of Apollo. Later he went to live at Athens, at the court of Hipparchus, the patron of literature. After the murder of Hipparchus (514), Simonides withdrew to Thessaly, where he enjoyed the patronage of the Scopadae and Aleuadae (two celebrated Thessalian families). Apparently some disaster overtook the Scopadae, which resulted in the extinction of the family. After the battle of Marathon Simonides returned to Athens, but soon left for Sicily at the invitation of Hieron, at whose court he spent the rest of his life.

His reputation as a man of learning is shown by the tradition that he introduced the distinction between the long and short vowels (ε, η, ο, ω), afterwards adopted in the Ionic alphabet which came into general use during the archonship of Eucleides (403). He was also the inventor of a system of mnemonics (Quintilian xi. 2, 11). So unbounded was his popularity that he was a power even in the political world; we are told that he reconciled Theron and Hieron on the eve of a battle between their opposing armies. He was the intimate friend of Themistocles and Pausanias the Spartan, and his poems on the war of liberation against Persia no doubt gave a powerful impulse to the national patriotism. For his poems he could command almost any price: later writers, from Aristophanes onwards, accuse him of avarice, probably not without some reason.

Of his poetry we possess two or three short elegies (Fr. 85 seems from its style and versification to belong to Simonides of Amorgos, or at least not to be the work of our poet), several epigrams and about ninety fragments of lyric poetry. The epigrams written in the usual dialect of elegy, Ionic with an epic colouring, were intended partly for public and partly for private monuments. There is strength and sublimity in the former, with a simplicity that is almost statuesque, and a complete mastery over the rhythm and forms of elegiac expression. Those on the heroes of Marathon and Thermopylae are the most celebrated. In the private epigrams there is more warmth of colour and feeling, but few of them rest on any better authority than that of the Palatine anthology. One interesting and undoubtedly genuine epigram of this class is upon Archedice, the daughter of Hippias the Peisistratid, who, "albeit her father and husband and brother and children were all princes, was not lifted up in soul to pride." The lyric fragments vary much in character and length: one is from a poem on Artemisium, celebrating those who fell at Thermopylae, with which he gained the victory over Aeschylus; another is an ode in honour of Scopas (commented on in Plato, *Protagoras,* 339 b); the rest are from odes on victors in the games, hyporchemes, dirges, hymns to the gods and other varieties. The poem on Thermopylae breathes a lofty national pride; the others are full of pathos and feeling, combined with a genial worldliness. "It is hard," he says (Fr. 5), "to become a truly good man, perfect as a square in hands and feet and mind, fashioned without blame. Whosoever is bad, and not too wicked, knowing justice, the benefactor of cities, is a sound man. I for one will find no fault with him, for the race of fools is infinite." His most celebrated fragment is a dirge, in which Danae, adrift with the infant Perseus on the sea in a dark and stormy night, takes comfort from the peaceful slumber of her babe. Simonides here illustrates his own saying that "poetry is vocal painting, as painting is silent poetry."

Of the many English translations of this poem, one of the best is that by J. A. Symonds in *Studies on the Greek Poets.* Fragments in T. Bergk, *Poetae lyrici Graeci;* standard edition by F. G. Schneidewin (1835) and of the *Danaë* alone by H L. Ahrens (1853). Other authorities are given in the exhaustive treatise of E. Cesati, *Simonide di Ceo* (1882); *see* also W. Schroter, *De Simonidis Cei melici sermone* (1906).

SIMON MAGUS. One of the most ancient and interesting rivals of early Gentile Christianity was the sect of the Simonians. Its founder was a skilful magician who had established himself in the city of Samaria just prior to its evangelization and had captivated the populace by his sorcery, so that he was generally known as "the power of God which is called great." His ascendancy was broken by the arrival in Samaria of Philip (Acts 8.5; the interpretation of this story depends somewhat on the view taken of the sources of Acts), whose novel cures and teaching attracted many converts to Christianity and ultimately won over Simon himself who was baptized with the rest. It is probable that Simon's conversion was due less to a change of heart than to a misunderstanding that baptism and the apostle's cures were evidence of a magic superior to his own, the art of which he might hope to acquire as Philip's disciple. Proof that he had carried over the mentality of his old profession into his new religion was not slow in forthcoming. When Philip was reinforced by Peter and John who supplemented baptism by the gift of the Spirit through the laying on of hands, Simon asked that he might be taught to perform this rite and to obtain power to dispense the Holy Spirit and he offered the Apostles a fee for their instruction. Peter, perceiving how slight an impression Christianity had made upon the magician's mind, rebuked him severely and pointed out that, as he had no right understanding of Christianity, he could not share in its benefits. Simon accepted the reproof and begged Peter to pray for his forgiveness.

We hear no more of Simon in Acts and might have assumed that his repentance was enduring and that he had been absorbed into the mass of Samarian Christians, if we did not have later references to him and fragments of a sectarian literature in which he figures as a god and which show that he must have withdrawn from Christianity and initiated a movement of his own in which Christian and Pagan elements were freely and curiously combined. From these later sources (Justin Martyr, Irenaeus, Epiphanius and Hippolytus), it appears that Simon's birthplace was Gitta, that he journeyed to Rome where he had some success in gaining followers under Claudius, that he was generally accompanied by a Phoenician woman named Helen, who had formerly been a prostitute but whom he associated with his own claims for divine honours, that he had a number of disciples of whom the most important were Menander and Saturninus and that he met his end through a foolish attempt to reproduce the resurrection of Jesus by allowing himself to be buried alive in the mistaken supposition that he would be able to rise again on the third day. Justin has a story that a statue was set up in Simon's honour on the Tiber with the inscription, *Simoni Deo Sancto,* but this is probably an error, as a statue answering to Justin's description and inscribed, *Semoni Sancto Deo Fidio Sacrum Sex Pompeius, S P. F. Col. Mussianus Quinqennalis Decur Bzdentalis Donum Dedit,* was unearthed on the Tiber in modern times. Semo was a local, perhaps Sabine, deity and had nothing to do with Simon, but the mistake was not an impossible one for Justin or his source to have made.

On the development of Simonian theology we are better informed than on the external history of the sect. Just what was implied in the view, current in Samaria in Simon's pre-Christian days, that he was "the power of God which is called great" is obscure and it is only a possibility that the god whose power he was thought to be was Jehovah. Evidence that he was influenced by Judaism apart from Christianity is wholly lacking. The recurrence of the phrase, "power of God," or its equivalent, in all the later accounts suggests a certain continuity and it seems probable that, even before his conversion, he advanced a theology similar to that described by Irenaeus (Adv. *haer.* 1.16.1 Harvey) but lacking the elements borrowed later from Christianity and that after his withdrawal from the church he revised this system into a parallel and rival of Christianity.

Apart from Justin's meagre statement that Simon was worshipped as the supreme God and Helen regarded as the "primary notion" emanating from him, our first satisfactory account of Simonian theology is given by Irenaeus, whose assumption that he is describing Simon's own teaching is erroneous, for he is evidently drawing from a later source in which reflections from contemporary christological speculation are unmistakable. In this system Simon is identified with the supreme God, the Father and most exalted Power from whom, before the creation of the world, a female principle emanated. This principle was his first notion through whom it occurred to him to create angels and archangels. Knowing the Father's mind, she issued from him to execute his will and made the angels and powers who, in turn, fashioned the visible world. These inferior beings were ignorant of the Father's existence but were jealous of their mother and, unwilling to be thought the offspring of another, detained her on the earth and forced her through a series of degrading incarnations. She appears in history as Helen of Troy and later as Simon's companion, Helen of Tyre, whom he came to save and who, in Simonian exegesis, is identical with the lost sheep of the parable. To rescue her and to bring salvation to men the supreme Power became incarnate and descended to earth where the angels were quarrelling for ascendancy. He came in human form, though in fact he was no man, and played the Passion in Judaea, though his sufferings were only apparent. He appears among the Jews as the Son, but also descended in Samaria as the Father and among the Gentiles as the Holy Spirit. The advent of this hitherto unknown god abrogated the precepts of the Prophets whose utterances had been inspired by the angels and designed to enslave man and obscure the truth that salvation comes not through good works but through the grace of Simon and hope in Helen and him.

The interesting features in this otherwise rather commonplace myth are the curiously Sabellian-like Trinitarian doctrine, the Iocetic theory of incarnation, and the doctrine of justification by faith or rather by hope—all of which appear to have been transferred bodily from Christianity and adapted to Simon's theology. The meaning of the Father's appearance in Samaria is obscure, but may refer to the Samaritan temple at Gerizim. It is also impossible to make out the relative importance of Jesus and Simon in the system. The Simonians evidently believed that the same divine principle was incarnate in both, but the reference to the Passion shows that they could not have confused the two historical figures. Further clarity cannot be expected as Irenaeus was not sufficiently interested or well informed to describe the doctrine of salvation in detail.

More remote from the original stock is a system preserved in a document quoted at length by Hippolytus and entitled "the Great Pronouncement" (apophasis megale). Here fragmentary survivals of the original Simonian myth serve only to cloak a philosophic system allied to Stoicism. Elaborate metaphor and fanciful exegesis do much to obscure the meaning and the affinities with other known Simonian systems are very slight. The substitution of an innate saving principle in human nature for a personal saviour is reminiscent of Saturninus, but the underlying ideas are more philosophical and myth serves only as a symbol, not as a naïve statement of fact. Still more tenuous is the connection between Irenaeus' account and a system of theology attributed to Simon in the Clementines, but this problem can be satisfactorily treated only after further research on the text and sources of that literature have been made.

Both Irenaeus and Hippolytus inform us of the liturgical practices of the Simonians. Apart from magic of various kinds, worship was paid to Simon and Helen before statues of Zeus and Athena It was, however, customary not to mention their names but to use the titles "Lord" and "Mistress" (kyrios, kyria). Anyone violating this convention was detected as an outsider and expelled from the mysteries. (R. P. C.)

SIMON OF ST. QUENTIN (*fl.* 1247), Dominican mission-traveller and diplomatist, accompanied, and wrote the history of the Dominican embassy under Friar Ascelin or Anselm, which Pope Innocent IV. sent in 1247 to the Mongols of Armenia and Persia. Large sections of Simon's history have been preserved in Vincent of Beauvais's *Speculum* historiale, where 19 chapters are expressly said to be ex *libello* fratris *Simonis,* or entitled frater Simon. The embassy proceeded to the camp of Baiju or Bachu Noyan (*i.e.,* "General" Baiju, Noyan signifying a commander of 10,000) at *Sitiens* in Armenia, lying between the Aras river and Lake Gokcha, 59 days' journey from Acre. The papal letters were translated into Persian, and thence into Mongol, and so presented to Baiju; but the Tatars were irritated by the haughtiness of the Dominicans. The Frankish visitors were treated with contempt: for nine weeks all answer to their letters was refused. Thrice Baiju even ordered their death. At last, on July 25, 1247, they were dismissed with the *Noyan's* reply, dated July 20, which complained of the high words of the Latin envoys, and commanded the pope to come in person and submit to the Master of all the Earth (the Mongol emperor). The mission thus ended in complete failure.

See Vincent of Beauvais, Speculum historiale, book xxxii. (sometimes quoted as xxxi.), chaps. 26–29, 32, 34, 40–52 (*cf.* pp. 453 A-454 B in the Venice edition of 1591); besides these, several other chapters of the Spec. *hist.* probably contain material derived from Simon, *e.g.,* bk. xsxi. (otherwise xxx.), chaps. 3, 4, 7, 8, 13, 32; and bk. xxx. (otherwise xxix.), chaps. 69, 71, 74–75, 78, 80. See also d'Ohsson, *Histoire des Mongols,* ii. 200–201, 221–233; iii. 79 (edition of 1852); Fontana, Monumenta Domtnicana, p. 52 (Rome, 1675); Luke Wadding, Annales *Minorum,* iii. 116–118; E. Bretschneider, Mediaeval *Researches* from *Eastern* Asiatic Sources, vol. i., notes 455, 494 (London, 1888); M. A. P. d'Avezac's Introduction to Carpini, pp. 404–405, 433–434, 464–465, of vol. iv. of the Paris Geog. Soc.'s *Recueil de Voyages,* etc. (Paris, 1839); W. W. Rockhill, *Rubruck,* pp. xxiv.–xxv. (London, Hakluyt Soc., 1900); C. R. Beazley, *Dawn of Modern Geography,* ii. 277, and *Carpini and Rubruquis,* 269–270.

SIMON'S TOWN, a town and naval base in South Africa, used by the British admiralty under agreement with the South African government, 22½ mi. from Cape Town. A tidal basin of 26 ac.. with a depth of 30 ft. at L.W.O.S.T. was completed in 1910. South of this, in a reclaimed area, are the dockyards. Simon's Town dates from the close of the 17th century and is named after Simon van der Stel, governor of the Cape. 1679–99. Pop. (1951) 7,776 of whom 3.374 were Europeans. On the south side is a popular seaside resort. An industrial area has been laid out and there is a large fish oil refinery.

SIMONY, an offence, defined below, against the law of the church. The name is taken from Simon Magus (*q.v.*). In the canon law the word bears a more extended meaning than in English law. "Simony according to the canonists," says Ayliffe in his Parergon, "is defined to be a deliberate act or a premeditated will and desire of selling such things as are spiritual, or of anything annexed unto spirituals, by giving something of a temporal nature for the purchase thereof; or in other terms it is defined to be a commutation of a thing spiritual or annexed unto spirituals by giving something that is temporal." In the Corpus *juris canonici* the Decretum (pt. ii. cause i. quest. 3) and the Decretals (bk. v. tit. 3) deal with the subject. The offender whether *simoniacus* (one who had bought his orders) or *simoniace promotus* (one who had bought his promotion), was liable to deprivation of his benefice and deposition from orders if a secular priest,—to confinement in a stricter monastery if a regular. No distinction seems to have been drawn between the sale of an immediate and of a revers'ionary interest. The innocent *simoniace promotus* was, apart from dispensation, liable to the same penalties as though he were guilty. Certain matters were simoniacal by the canon law which would not be so regarded in English law, *e.g.,* the sale of tithes, the taking of a fee for confession, absolution, marriage or burial, the concealment of one in mortal sin or the reconcilement of an impenitent for the sake of gain, and the doing homage for spiritualities. So grave was the crime of simony considered that even infamous persons could accuse of it. English provincial and legatine constitutions continually assailed simony.

For the purposes of English law simony is defined by Blackstone as the corrupt presentation of any person to an ecclesiastical benefice for money, gift or reward. The offence is one of purely ecclesiastical cognizance, and not punishable by the criminal law. The penalty is forfeiture by the offender of any advantage from the simoniacal transaction, of his patronage by the patron, of his benefice by the presentee; and now by the Benefices Act 1892, a person guilty of simony is guilty of an offence for which he may be proceeded against under the Clergy Discipline Act 1892. An innocent clerk is under no disability, as he might be by the canon law. Simony may be committed in three ways—in promotion to orders, in presentation to a benefice, and in resignation of a benefice. The common law (with which the canon law is incorporated, as far as it is not contrary to the common or statute law or the prerogative of the Crown) has been considerably modified by statute. Where no statute applies to the case, the doctrines of the canon law may still be of authority. Both Edward VI. and Elizabeth promulgated statutes against simony.

The general result of the law before the Benefices Act 1898, as gathered from statutes and decisions, may be stated as follows: (1) it was not simony for a layman or spiritual person not purchasing for himself to purchase, while the church was full, an advowson or next presentation, however immediate the prospect of a vacancy; (2) it was not simony for a spiritual person to purchase for himself a life or any greater estate in an advowson, and to present himself thereto; (3) it was not simony to exchange benefices under an agreement that no payment was to be made for dilapidations on either side; (4) it was not simony to make certain assignments of patronage under the Church Building and New Parishes Acts; (5) it was simony for any person to purchase the next presentation while the church was vacant; (6) it was simony for a spiritual person to purchase for himself the next presentation, though the church be full; (7) it was simony for any person to purchase the next presentation, or in the case of purchase of an advowson the next presentation by the purchaser would be simoniacal if there was any arrangement for causing a vacancy to be made; (8) it was simony for the purchaser of an advowson while the church was vacant to present on the next presentation; (9) it was simony to exchange otherwise than simpliciter; no compensation in money might be made to the person receiving the less valuable benefice. The law on the subject of simony was long regarded as unsatisfactory by the authorities of the church. In 1879 a royal commission reported on the law and existing practice as to the sale, exchange and resignation of benefices. Many endeavours were made in parliament to give effect to the recommendations of the commission, but it was not until 1898 that any important change was made in the law. The Benefices Act of that year absolutely invalidated any transfer of a right of patronage unless (a) it is registered in the diocesan registry, (b) unless more than 12 months have elapsed since the last institution or admission to the benefice, and (c) unless "it transfers the whole interest of the transieror in the right" with certain reservations; in other words, the Act abolished the sale of next presentations, but it expressly reserved from its operation (a) a transmission on marriage, death or bankruptcy or otherwise by operation of law, or (b) a transfer on the appointment of a new trustee where no beneficial interest passes. It also substituted another form of declaration for that required under the Clerical Subscription Act 1865, and this form has been again amended by the measure of 1923 (*infra*). It abolished the sale by auction of an advowson in gross, and empowered a bishop to refuse to institute or admit a presentee to a benefice on a number of specified grounds: among others, on the ground of possible corrupt presentation through a year not having elapsed since the last transfer of the right of patronage, and constituted a new court to hear appeals against a bishop's refusal to institute. This court consists of a judge of the Supreme Court, who shall decide all questions of law and of fact, and of the archbishop, who gives judgment. The Benefices Act 1892 has non been amended in many details by the Benefices Act 1898 Amendment Rfeasure 1923 and the Benefices Rules 1926.

In Scotland sirnony is an offence both by civil and ecclesiastical law. The rules are generally those of the canon law. There are few decisions of Scottish courts on the subject. By the Act of 1584, c. 5. ministers, readers and others guilty of simony provided to benefices were to be deprived. An Act of Assembly of 1753 declares pactions simoniacal nhereby a minister or probationer before presentation and as a means of obtaining it bargains not to raise a process of augmentation of stipend or demand reparation or enlargement of his manse or glebe after induction.

In the United States, there is no recognition of simony in the courts.

SIMOOM: *see* WIND.

SIMPLICIUS, SAINT (d. 483). pope from 468 to 483. was born at Tivoli. During his pontificate the western empire was overthrown, and Italy passed into the hands of the barbarian king Odoacer (476). In the east. the usurpation of the empire by Basiliscus (475–476), who supported the Rfonophysites, gave rise to many ecclesiastical troubles. The emperor Zeno, having procured the removal of Basiliscus, endeavoured to compound with the Monophysite party; and Acacius. bishop of Constantinople. nho had previously been on the pope's side in defense of the council of Chalcedon, abandoned Simplicius and subscribed to the Henoticon. the conciliatory document promulgated in 482 by the emperor.

Simplicius died on March 2, or perhaps March 10, 483. He is commemorated on hfarch 2.

SIMPLICIUS (6th century A.D.), Greek philosopher, a native of Cilicia, was a pupil of Damascius at Athens and of Ammonius at Alexandria ; his work displays the influence of both these schools of Neoplatoriism (*q.v.*). The school of philosophy at Athens having been disendowed and its teaching forbidden (529). Damascius, Simplicius, Priscianus and four others resolved in 531 or 532 to seek refuge with Chosroes, king of Persia, but within two years they returned to Greece.

After his return Simplicius wrote commentaries on Aristotle's *De coelo, Physica, De anima* and *Categoriae,* which, with a commentary on the *Enchiridion* of Epictetus. have survived. These contain many valuable fragments of the older philosophers as well as of his immediate predecessors. One of his general principles is that Xristotle is in harmony with Plato, being opposed only to a superficial understanding of his words. (D. J. A.)

SIMPLON PASS, Alpine pass and tunnel. Not known early save as a purely local route, the Simplon pass rose into importance when Napoleon caused the carriage road to be built across it between 1800 and 1807. The Simplon tunnel was opened in 1906. The pass proper starts from Brig in the upper Rhône valley. $90\frac{1}{2}$ mi. by rail from Lausanne. From Brig it is about 14 mi. to the pass (6,592 ft.), close to which is the hospice (first mentioned in 1235) in charge of Austin canons from the Great St. Bernard. The road descends past the Swiss village of Simplon, and passes through the wonderful rock defile of Gondo before entering Italy above Iselle (28 mi. from Brigj. There the road joins the railway line through the tunnel, which is $12\frac{1}{4}$ mi. in length, and 2,313 ft. high, being thus both the longest and the lowest tunnel through the Alps.

From Iselle it is about 11 miles by rail to Domo d'Ossola, whence the Toce or Tosa valley is followed to the Lago Maggiore (23 miles).

SIMPSON, SIR JAMES YOUNG (1811–1870), Scottish obstetrician. whose fame rests principally upon his pioneer work in the introduction of anesthesia into midwifery practice, was born at Bathgate. Linlithgowshire, Scot.. on June 7. 1811. He was sent at the age of 14 to Edinburgh university and obtained his M.D. degree in 1832. He was elected senior president of the Royal Medical society of Edinburgh in 1835 and in 1837–38 acted as deputy for John Thonison, professor of pathology. In 1840 he was appointed to the chair of midwifery in the university. When news of the first trials of ether reached Scotland in 1846, Simpson immediately realized its potential value and tried it in obstetric practice. In March 1847 he advocated its use in a paper read before the Royal Medical society. He continued. however. to make systematic search for more efficient anesthetics, carrying out many self-experiments with his assistants, and on Nov. 4. 1847, he discovered the anesthetic properties of chloroform. He published a full account of chloroform (1847) in which he stressed its advantages over ether and strongly advocated its use in surgical operations and in obstetric practice.

The use of chloroform for the relief of pain in childbirth mas violently opposed both on medical and on theological grounds. but Simpson's uncompromising advocacy and, finally. the administration of chloroform to Queen Victoria at the birth of Prince Leopold in 1853. silenced all opposition.

Apart from his great work on anesthesia, Simpson made contributions of permanent value to many departments of obstetrics and gynecology. His principal writings are *Obstetric Memoirs and Contributions* (2 vol., 1855–56); *Selected Obstetrical and Gynaecological Works* (1871) ; *Anaesthesia, Hospitalism, Homoeopathy, etc.* (1871) ; *Clinical Lectures on the Diseases of Women* (1872). He was also greatly interested in archaeology and in the history of medicine; two volumes of his *Archaeological Essays* were published in 1873. He was appointed one of the queen's physicians, for Scotland in 1847 and in 1866 was created a baronet. He died on May 6. 1870, in London.

See John Duns, *Memoir of Sir J. Y. Simpson, Bart.* (1873) ; E. B. Simpson, *Sir James Young Simpson* (1896) ; H. L. Gordon. *Sir James Young Simpson and Chloroform* (1897). (W. J. BP.)

SIMPSON, MATTHEW (1811–1884), U.S. bishop of the Methodist Episcopal Church. was born in Cadiz, O., on June 21, 1811. Largely self-educated, he began to practise medicine in 1833, but the same year was licensed as a preacher of the Methodist Episcopal Church. In 1837 he was appointed professor of natural science in Allegheny college, Meadville; and was from 1839 until 1848 president of the newly established Indiana Xsbury (later De Pauw) university. Greencastle, Ind. He was editor of the *Western Christian Advocate,* which he made a strong temperance and anti-slavery organ, from 1848 to 1852, and was elected a bishop in May 1852. Simpson died on June 18. 1884. in Philadelphia.

He published *A Hundred Years of Methodism* (1876) and *Lectures on Preaching* (1879), and edited a *Cyclopedia of Methodism* (1878). *A* volume of his *Sermons* (1885) was edited by G. R. Crooks.

See his *Life by G. R.* Crooks (1890) ; E. M. Wood, *The Peerless Orator* (1909).

SIMROCK, KARL JOSEPH (1802–1876), German poet and man of letters, was born on Aug. 28. 1802. at Bonn, where his father was a music publisher. He studied law at Bonn and Berlin, and in 1823 entered the Prussian civil service: from which he was expelled in 1830 for writing a poem in praise of the French July revolution. He became lecturer and eventually (1850) professor at Bonn, where he died on July 18. 1876. Simrock established his reputation by his excellent modern rendering of the *Nibelungenlied* (1827), of the poems of Walther von der Vogelweide (1833), and other Old High German poems.

Of his republications the most popular and the most valuable were the *Deutsche I'olksbucher,* of which 55 were printed between 1839 and 1867. His best contribution to scholarship was his *Handbuch der deutschen Mythologie* (1853–55). Simrock took a high place among students of Shakespeare by his *Quellen des Shakespeare in Novellen, Märchen und Sagen* (1831); and afterward he translated Shakespeare's poems and a considerable number of his dramas. His *Ausgewählte Tt'erke* were published by G. Klee (12 vol., 1907).

See N. Hocker, *Karl Simrock, sein Leben und seine Werke* (1877).

SIMS, WILLIAM SOWDEN (1858–1936), U.S. naval officer! was born of American parents at Port Hope, Ont.. on Oct. 15, 1858, moving in childhood to Pennsylvania. He graduated from the U.S. Naval academy in 1880, and for eight years served on board various ships in the North Atlantic. During 1889–93 he was with the nautical school ship "Saratoga." was transferred to the Pacific station and later to the China station. From 1897 to 1900 he was naval attaché to the U.S. embassy at Paris and at St.

Petersburg (Leningrad), but in 1900 he returned to the Pacific station.

Convinced of the inadequacy of U.S. methods of target practice, he pressed his views upon the government, and in the end was enabled to arrange for a gunnery test and prove his claims. This resulted in his being made inspector of target practice in the bureau of navigation, where he served seven years (1902–09). In 1907 he was made commander and appointed naval aide to Pres. Theodore Roosevelt. and in 1909 he became commander of the battleship "Minnesota."

During a visit of the Atlantic fleet to England in 1910, Commander Sims caused a stir at a dinner at the Guildhall, London, where he said: "Speaking for myself, I believe that if the time ever comes when the British empire is menaced by an external enemy you may count upon every man, every drop of blood, every ship and every dollar of your kindred across the sea." A semi-official protest against this utterance was made at Washington by the German government, but the incident ended in a severe reprimand from the president of the United States.

In 1911 Sims was promoted captain and for two years was a member of the class of the Naval War college, Newport, R.I. During 1913–15 he was in command of the Atlantic torpedo flotilla and in 1916 in command of the battleship "Nevada." In 1917 he returned to Newport as president of the Naval War college. When the United States entered World War I in April 1917 he was chosen to command U.S. naval forces in European waters. In January he had been promoted rear admiral and in May he was given the temporary rank of vice-admiral.

On the conclusion of the war he relinquished command of the fleet and resumed his position as president of the Naval War college. In 1920 he made a formal report to the U.S. navy department, charging it with serious errors in the conduct of naval operations during the war.

He published The Victory *at* Sea (1920). He died in Boston, Mass., on Sept. 28, 1936.

SIN is the name given to moral evil, when regarded from the point of view of religion, as distinguished from that of civic law or that of ethics. The Christian's ideal is to do all things as unto the Lord; and he looks upon his shortcomings as offences against a divinely given law or as grieving the Holy Spirit. But if this aspect of sin, or the religious associations with which moral evil is tinged, be of high significance for religious life, the nature of sin as moral evil correlated with responsibility and guilt, is fundamentally a question for ethics and psychology. That "sin is lawlessness," even when the law transgressed is regarded as divine, is a description which needs amplification, in order to fulfil the requirements of theological doctrine.

Of the several conditions of accountable moral conduct, the one just indicated may be treated first; the forthcomingness of a law, of which sin is transgression; or of a mark, of which sin is the missing. Moral law is a social acquisition; and knowledge of it is socially mediated, not innate to the individual. It is only when we begin to find certain kinds of behaviour expected of us, as what we owe, and become spectators of our conduct from the point of view from which others see us, that conscience emerges in us. It is not inborn, like instinct; nor does the soul possess it, before embodiment. We are born non-moral, not sinners. Further, St. Paul's teaching, that where no law is, sin cannot be imputed, needs to be supplemented. This brings us to the second condition of the possibility of sin. In order that an individual be accountable, it is not enough that there is moral law forthcoming, whether primitive customs or unconditional standards of Christian ethic; he must be aware of them as binding on himself, and must be in a position to perceive his act to be a shortcoming at the time of its occurrence. This reference to time is also essential. For instance, a heathen who may be blameless as to such law as he knows, is no sinner against Christian law that, as yet, he cannot know; and if he become a Christian and learn a higher ethic, he cannot then rightly accuse himself of guilt, in that, in his heathen past, he left undone what, had he been a Christian he should have done. The conduct of the infant that knows no law, or that of the adult heathen who obeys some law but knows not the highest, cannot even from the Christian standpoint, be deemed sinners. Else we should have to attribute sin to snakes and volcanoes. For the only relevant difference between the moral and the non-moral agent, is that the former can, and the latter cannot, be aware of law having dominion over it. We cannot assert sin to be non-compliance with moral law, as distinct from known moral law, without destroying the ethical significance of sin. All sin is imperfection; not all imperfection is sin. Thus it follows that there cannot be one absolute standard of perfection, to fall short of which, in any conditions and at any stage of moral enlightenment, convicts of sin. The only relevant standard is comparable to a sliding scale: it is what, to the all-seeing eye of God, is the highest that a given agent can recognize, at the time of his activity that is in question. Hence the wisdom of the counsel; "then at the balance let's be mute." Development is incompatible with perfection; the Christian, of ali men, cannot say it is incompatible with sinlessness.

Turning now from the moral law and knowledge thereof to the acts and conduct to which ethical standards are applicable, we may consider the remaining conditions of what, in the strict sense, is to be called sin. Conscience and moral status, it has been said, are not innate; they are socially acquired, as human experience evolves from its earliest stages. But certain instincts and impulsive or appetitive tendencies are undoubtedly inherited. That is to say that in the body, with which an individual subject or soul becomes associated, are already ingrained aptitudes, etc., transmitted and fixed by heredity, which evoke specific reactions and responses from the soul, with its actual and potential faculties and capacities. Such appetites, instincts, strivings, etc. are involuntary, because, as yet, will or volition is not in existence. They are necessary and inevitable; the embodied soul is not responsible for them, and had no part in moulding them. They are also, from the biologist's point of view, natural or normal; not the outcome of derangement. Some of them, at least, are essential to the health and life of both individual and race. Theology must affirm that they belong to man, as it has pleased God to make him, *i.e.*, through evolutionary process. Lastly they are not only non-moral, in that they are involuntary and prior to conscience, but also neutral, in respect of what shall eventually be made out of them by the moralized person. They are the basis of virtues as well as of vices. In themselves, therefore, these propensities, or tendencies of the stock, are not sinful; no natural passion is base-born or condemnable. They are, however, the primary stuff out of which sinful conduct is shaped. But it is the will that shapes, not the stuff that is shaped, which alone calls for moral evaluation. They can no more be wicked than can alcohol or prussic acid. For the fact that they are strongly entrenched in us at birth, we are not responsible. Nor are we responsible, for the fact that they continue to assert themselves clamorously, after will and conscience have been acquired, and without respect for moral considerations; though it is thus that arise most of the "manifold temptations that death alone can cure." Temptation, however, is not sin; nor is temptability a sign of sinfulness—it is a condition of morality. But before these ethical and psychological reflections suggested themselves with the urgency they now possess, it was usual, and indeed natural, to call such inborn propensities sinful. Hence the expressions "inherited sin" and "original sin." Theologians who have framed and taught the doctrine of original sin have generally, though not universally, been willing to allow that original sin is not sin proper, and that, unlike actual sin, it is not a matter of moral responsibility and guilt. It is now generally admitted to be "sin" in but a figurative sense. Some would urge that retention of the old name "original sin" is no longer expedient, because ministering to confusion and inconsistency. What is "original" in the sense of innate or thrust upon us willy-nilly, cannot strictly be called sin. The root of sin is not a sinful root. For the fourth condition of the possibility of sinful activity is volition, and indeed intention. There must be capacity to choose between higher and lower ends, as has been recognized throughout the history of the doctrine of sin. Consequently, if there be in us, as some authorities have maintained, a moral taint that cleaves to us at our birth; some tendency, the origin of which must be beyond the conscious exercise of our freedom of will; an abiding root of sin, which a man finds present in himself when his moral consciousness awakes; it must be brought by the soul itself, and have been contracted voluntarily in a life previous to the soul's embodiment. This speculative view has found supporters here and there down the ages; but we have no knowledge as to such life, and certainly, if the soul possessed such moral volition before embodiment, it must somehow have become dispossessed of it on entering into this life, because psychology can trace the development of volition and conscience which, at birth, are absent This suggestion, like all other forms of doctrine of a fall, whether of the race collectively or of each soul singly, has doubtless been cherished because it has seemed difficult to many minds to account otherwise for the prevalence — often assumed to be strictly universal — of sinfulness throughout mankind; also. perhaps, because it seems to explain the emergence of moral evil in God's good world. But, as for the former of these motivations, it is enough to know that the race has solidarity in respect, not of ready-made sin, but of the non-moral appetites, etc. which prompt the will to evil choice As for the latter of them. any kind of fall such as is invoked to account for racial sinfulness, would seem only to put the difficulty further back, not to eliminate it. Evil must have entered into the human world somehow and at some time, whether in Adam, or in Satan, or in each soul in a previous life; and that presents just the same difficulty as does the origination of sin in each man in this life. Indeed, in the case of the theory that sin originated in a previous life, the difficulty would seem to be increased. For had we all been in the same case as Milton's Satan, to account for all sinning without exception, each being the Adam of his own soul, and that before embodinicnt, is hardly possible; whereas our bodily nature supplies the motives which make our sinfulness explicable enough, however condemnable it be. On the other hand, the traditional doctrine that we all owe our sinfulness to the sin of the first parent of the race, either offends our moral consciousness and sense of responsibility or else confounds sinfulness with the non-moral "material" out of which our will makes sin.

Sin has, so far, been dealt with only in its elemental aspects and its earliest stages It is, in fact, there that we encounter the controversial issues, and the features of the problem that present most difficulty and most interest for theology. The more advanced and complex stages present no further disputable issues. But it should be observed that from the dawn of volition. of thought or ideation. and of morality, our blind springs of action cease to be blind. When imbued with volitional response, they become desires, and eventually personal attitudes. Actions engender habits; emotions establish sentiments; and so on We soon discover that appetites, the satisfaction of which yields pleasure, can be stimulated, in order to be enjoyed Hunger may be voluntarily transformed into gluttony, sensibility into voluptuousness; and as knowledge and experience widen the lengths to which "making provision for the flesh" can be carried. become indefinitely extended. But it is not necessary to follow further the development of the intricacy of the moral life of man; the essentials for a sound psychology of sin are manifested, and can be most clearly studied, in the primary moral situations to which attention has here been almost exclusively directed

LITERATURE —For a critical account oi the main theories and treatment from the standpoint of sin-consciousness, see W. E. Orchard, *Modern Theories* of *Sin* (1909). For a discussion of sin on the lines indicated above, see F. R. Tennant, *The Concept of Sin* (1912).

(F. R. T.)

SIN, the name of the moon-god in Sumerian, derived from *zu-en,* usually written *en-zu,* "lord of wisdom" He became one of the principal deities of the (Semitic) Babylonian pantheon, and only in the period of the later West Semitic occupation (22nd–18th centuries) is found any trace of the pure Semitic cult of the moon god, when the title *'ammu, ḫammu* "uncle" appears As god of the new moon he has the title *šeš-ki,* "brother of the earth," pronounced by the Semites *Nannar>Nanna.* The chief seats of his worship were Ur in the South and Harran in northern Assyria, hut the cult at an early period spread to other centres, and temples to the moon-god are found in all the large cities of Babylonia and Assyria. During the period (*c.* 2399–2282 B C.) that Ur exercised a large measure of supremacy over the Euphrates valley, Sin was naturally regarded as the head of the pantheon. It is to this period that we must trace such designations of the god as "father of the gods," "chief of the gods," "creator of all things," and the like. The development of astrological science culminating in a calendar and in a system of interpretation of the movements and occurrences in the starry heavens would be an important factor in maintaining the position of Sin in the pantheon. The name of Sin's chief sanctuary at Ur was E-gish-shir. gal. "house of the great light"; that at Harran was known as E-khul-khul, "house of joys." On seal-cylinders he is rcprrsented as an old man with flowing beard. with the crescent as his symbol. In the astral-theological system he is represented by the number 30, and the planet Venus as his daughter by the number 1 j. The number 30 stands obviously in connection with the thirty days as the average extent of his course until he stands again in conjunction with the sun. The "wisdom" personified by the moon-god is likewise an expression of the science of astrology in which the observation of the moon's phases is so important a factor. The tendency to centralize the powers of the universe leads to the establishment of the doctrine of a triad consisting of Sin, Shamash and Ishtar (q *v.*), personifying the moon, sun and Venus.

Nabunidus, the last king of Babylonia, inaugurated a movement to elevate the cult of Sin to the supreme place in religion, a movement clearly based upon astrological and astronomical theory that the triad, moon. sun and Venus are the controlling forces of divine providence. There is no doubt but that the emphasis placed upon moon worship by Sargon of Agade is due to his Semitic connection; in Arabia and throughout the Semitic races of Western Asia the moon god was from the beginning the most important deity. The consort of Sin was Ningal, to whom a special temple was built at Cr, and her cult was widely known in Syria where her name appears as Nikal. The cult of the Babylonian Sin seems to have been particularly favoured by the Assyrian colony in Cappadocia in the 21st–19th centuries, and among the Hittites of Anatolia and Syria.

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(S. L.)

SINAI, the name given to the triangular peninsula lying between Egypt, Israel, and Saudi Arabia, with the Mediterranean forming its northern boundary, the Suez canal and Gulf of Suez on the west, and the Gulf of Aqaba to the southeast. Sinai is usually regarded geographically as part of Asia, but poiitically is a governorate of the United Arab Republic (Egypt). Area 23.200 sq.mi. ,Pop. (1960) 126.000.

The oldest rocks and the highest mountains in Sinai are to be found in the southern third of the peninsula, an extension of the Red sea mountains of the African mainland. These form a complex of Pre-Cambrian crystalline rocks: gneisses and schists into which were intruded masses of igneous plutonic rocks with varied igneous dikes veining the whole great complex. They form high, rugged mountains predominantly red in colour, from which the Red sea takes its name. In the west, basaltic lava flows, probably of Miocene age, rest upon the old rocks. Along the Gulf of Suez coast a narrow plain of recent rocks separates the mountains from the sea except just south of the Wadi Feiran where for 20 mi. abrupt cliffs of red granite rise from the shore. All along the shore of the Gulf of Aqaba the Sinai mountains rise in a precipitous wall. North of the well-watered Wadi Feiran outcrops of red (Nubian) sandstone terminate the ancient core of the peninsula. Against them to the north in a series of dissected scarps successively younger strata outcrop, mainly of limestone of Cretaceous and Eocene age. The gravel-covered central part of the limestone plateau, known as the wilderness of el Tih ("the wandering") averages 3.000 ft.: its highest part, the Egma plateau in the south, attains 5,335 ft. To the north the land slopes down to the Mediterranean, its surface broken by inlier of older rocks creating marked limestone and sandstone hill masses, principally Yelleg (3,570 ft.). Hellal (2,900 ft.), both of middle Cretaceous series, and Maghara (2.400 ft.) of Jurassic age. Near the Mediterranean shore line is a broad tract of sand dunes, some over 300 ft. high. This northern shore line, fringed with salt marsh, is sinking. In the west this is compensated for locally by the eastward drift of Nile sediment.

The granite peaks in the south, the highest mountains in the governorate of Sinai, include Katharina (8,651 ft.), Um Shomer (8.482 ft.), El Thebt (7,997 ft.) and Musa or Mt. Sinai (7.495 ft.). The area is difficult of access: deep, rocky gorges hem in the maze of sharp ridges and gaunt peaks. This mountainous area experiences a few inches of rain each year, mostly in irregular, heavy downpours, insufficient for agriculture, but sustaining springs and wells, and in a few bordering wadis small streams flow and nourish oases, such as at Feiran. The greater part of the scanty drainage of the northern two-thirds of the peninsula is ultimately to the Wadi al Arish which, rising in the Egma plateau, eventually reaches the Mediterranean. For most of the year the plateau is waterless except for a few permanent springs, as at Nakhl.

The Wadi al Arish rarely carries water to the sea, but water is obtained from wells dug in its bed. Underground water is also tapped by wells in the hollows between dunes along the northern coast where. four or five feet down, a foot or so of fresh water rests on salt.

The railway between Palestine and Egypt was inoperative to some extent after 1948. The main paved road runs from Ismailia to Abu Aweiqila, where it forks, one branch going north to Gaza and the other to El Auja. The old pilgrim route, still in use, runs from Suez via Nakhl, Al Thamed and Aqaba to Medina and Mecca. Most of the country is not suitable for wheeled vehicles but it is possible to pass along the wadi beds when these are not in flood.

In general the climate is healthful but liable to sudden changes in temperature. In the mountain regions the nights are usually cold, but over most of the peninsula the heat of summer is intense. The rainy period from mid-October to mid-April often results in serious floods In a normal year there is sufficient rainfall to support scrub and tamarisk bushes and even a few poor crops. Vegetation consists mainly of tamarisk and camel's-thorn, with date palms at al Arish, Feiran, and al Tor. Agriculture is practised only in limited areas. A dam was recently built in the Wadi al Arish.

Animals are rare. They include ibex, gazelle, sand fox, leopard, wildcat, jackal, hare, hedgehog and mole. Falcons and eagles are indigenous, and in addition there are the seasonal migrants such as quail, partridge and grouse, which are shot for food as are the ibex and gazelle.

Sinai is sparsely populated by Bedu tribes, which are divided into two main groups. In the south the most numerous are the Sawalihah; in the north, the Terabin. The estimated Bedu population amounted in 1948 to about 17,000. The people of the coastal area are an admixture, and after 1948 there was a great influx of refugees encamped in the Gaza strip. A small group, the Jebeliyeh, situated round St. Catherine's monastery, are said to be the direct descendants of Bosnian and Wallachian serfs settled there by Justinian as guards for the monastery and forcibly converted to Islam at the time of the Arab invasion. A few retained their Christianity, the last descendant dying in 1750. The majority of the sedentary population lives near the north coast, especially at al Arish. the administrative centre (pop. [1947] 10,791) and at Kantara Sharq (East) on the eastern side of the Suez canal—pop. (1947) 13,384.

History. — The name Sinai is thought to be derived from the Akkadian moon-god Sin. Mt. Sinai is famous as the scene of the giving of the law to Moses and the entering of the Israelites into a covenant with the Lord, but there is considerable doubt as to which of the mountains of Sinai was the relevant site. Mt. Serbal was originally so accepted. with the result that the city of Paran was built at its foot and in time became a cathedral city and a bishopric; but the claims of Mt. Sinai were later preferred, and on this mountain was built St. Catherine's monastery.

In the Wadi al Arish, at al Kossaima, Bir Hassaneh and Nakhl, implements of Acheulo-Levalloisian type were discovered, and it is therefore thought that paleolithic man was present in north, central and southwestern Sinai. Neolithic and Chalcolithic remains were found on the Ismailia-Bir Hassaneh track. Stone circles, rectangular stone ruins and circular tombs, all of uncertain date, occur in the Wadi Solaf and in many other regions of the peninsula. The ancient Egyptians mined turquoise and copper in the mountains, in the Wadi Maghara and in the Feiran oasis; their inscriptions date from the 1st dynasty. At Serabit al Khadim, Sir W. M. Flinders Petrie found a temple dedicated to Hathor. It was used by the mine workers and contained records and inscriptions of many of the Middle and New Kingdom rulers. The last Egyptian king to make recorded offerings at this place was Rameses V of the 20th dynasty.

The Serabit inscriptions collected by Petrie and published by A. H. Gardiner and E. T. Peet may be the earliest alphabetic script, but the matter is still undecided. The passage of the Israelites through Sinai and the route and date of the Exodus are still matters for argument. At Sheikh Zuwaid in the north of Sinai there is an Egyptian frontier fortress dating at least from the time of the 18th dynasty, and it is likely that there was a chain of these fortresses extending along the northern coastal route. There is evidence from the texts and from surface finds that the Egyptians held all this region at the time when they were effectively controlling Palestine and Syria. After the decline of the Egyptian empire, Nabataeans from Petra controlled the trade routes of the Wadi 'Araba and the peninsula during the first two centuries B.C., until they were defeated by the Romans in A.D. 106. The region then became the Arabian province of the Roman empire and a capital was established at Bosra.

During the early Christian period Sinai became the home of many hermits, particularly in the southern mountain region where natural springs made habitation possible.

The building of the monastery of St. Catherine dates from AD. 530 when Justinian I, after complaints of robber incursions from the monks who had settled there, fortified the traditional site of the burning bush observed by Moses on the lower slopes of Mt. Sinai. This provided a centre for the scattered communities of Christians, and was spared by the invading Moslems; to conciliate the latter, the monks, according to tradition, erected the small mosque that stands within the malls. The monastery was a pilgrimage centre during the middle ages. It still retains much of its original appearance and has had an unbroken history since the 6th century. The original gray granite walls (280 x 250 ft.) still stand, and so does the church dedicated to the Virgin Mary, which was built at the same time. In the apse is a mosaic of the Transfiguration, probably also dating from this period, though it has been restored. The monastery's greatest treasures are its icons, some of nhich are prior to the 8th century, and its manuscripts. These, housed in the library built in 1945, are mainly in Greek and Arabic. In 1949–50 most of these manuscripts were microfilmed by the American Foundation for the Study of Man, acting on behalf of the Library of Congress and with the assistance of the University of Alexandria.

The most important manuscript now in the monastery is the Codex Syriacus, a Syriac text of the Gospels written about 400. The Codex Sinaiticus, now in the British museum, is a Greek manuscript of the Bible dating to the 4th century.

After 1517 Sinai formed part of the Ottoman empire and the country was administered by an official from Constantinople. When Egypt became independent of Turkey, conditions in Sinai deteriorated and traveling became difficult. Order was not restored until 1831, when Ibrahim Pasha, son of Mohammed Ali, advanced through Sinai and defeated the Turks at Acre. At the Treaty of London in 1840 Egypt was nominally restored to Turkish rule, and remained in this position until the outbreak of war in 1914. In October of that year Turkish forces seized al Arish, and in 1915 and 1916 they advanced to the Suez canal, but were driven off. In Jan. 1917 the battle of Rafah in northern Sinai marked the final advance through the country of the British army. At the end of World War I Sinai was returned to Egypt and has since been administered by that country. After 1948 the Sinai-Israeli border was the scene of frequent frontier incidents. In 1956 the Israeli army advanced through Sinai to the Suez canal, defeating units of the Egyptian army.

As the land bridge between Asia and Africa, Sinai retains considerable importance in middle eastern affairs.

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(A. B.M.; M.V. S.-W.)

SINAIA, a town of Rumania, on the railway from the city of Ploeşti to Braşov in the region of Ploeşti. Pop. (1956) 9,006. It resembles a large model village, among the pine forests of the lower Carpathians and along the banks of the Prahova, a swift alpine stream. The monastery of Sinaia, founded by Prince Michael Cantacuzino in 1695, was the residence of the royal family until the present chateau was built. Its library contains valuable jewels belonging to the Cantacuzene family. Castle Peleş, the modern palace, named after the hill on which it stands, is of a mixed style of architecture on the whole Germanic. Until 1850 Sinaia consisted of little more than the monastery and a group of huts.

SINALOA, a Mexican state on the Gulf of California and Pacific ocean. established in 1830. Pop. (1950) 635,681; area 22,-582 sq.mi. Sinaloa is bounded north by Sonora, east by Chihuahua and Durango and south by Nayarit, with about 400 mi. of coast on the west. The state is coastal. barren and tropical, with mountains on its eastern border. Five main streams and river valleys run from these mountains to the coast. Each river valley system is relatively isolated and is the scene of extensive irrigation, hydroelectric and communications projects. The Miguel Hidalgo dam on the Fuerte river, completed in 1956, waters about 123,550 acres.

Sinaloa is primarily an agricultural area which raises wheat, chick-peas, cotton, tobacco?sugar cane. tomatoes, fruits and winter vegetables on irrigated lands. Its cities and towns support local manufacturing, notably production of beer, ice, cigarettes, cooking oils, soap, cotton textiles and an iron foundry and a plating and galvanizing establishment.

The most important coastal industry is fishing, chiefly for sharks, the livers of which are processed into vitamin products, and for shrimps, canned and frozen locally. Tourism and game fishing are also significant.

The'backbone of Sinaloa is the Mexican Southern Pacific railway, acquired from its U.S. owners by Mexico in 1951. It runs from Nogales to Guadalajara and, in its course through Sinaloa, parallels the coast and ties the river valleys together. A spur of the Southern Pacific line extends to the water's edge at Mazatlán, where there are improved port works and a large airport. The Pacific highway, which reaches Nogales, ties Culiacbn (*q.v.*), the state capital and commercial centre, to Mazatlán (*q.v.*), and both to Guadalajara.

A railway between Mazatlán and Durango opened agricultural and mining outlets. The latter are of considerable importance, as Sinaloa produces salt, graphite, manganese, gold, silver, copper, iron and lead. (J. A. Cw.)

SINANTHROPUS (PEKING MAN). Remains of this significant fossil mere found in a cave or fissure filling at Chou-k'ou-tien, about 31 mi. S.W. of Peking. The site was discovered in 1921 by G. Anderson, W. Granger and O. Zdansky and the latter conducted the first excavations in 1923. In a Middle Pleistocene faunal assemblage, containing rhinoceros, deer, horse, pig, bears, sabre-toothed tiger, hyena, giant beaver (*Trogontherium*), etc., several human teeth were found (*Homo* sp.): a large lower molar of unusual pattern, discovered by B. Bohlin on Oct. 16, 1927, is the type specimen of *Sinanthropus pekinensis*.

During the excavations up to 1940, remains of about 45 individuals of *Sinanthropus* were found, including many isolated teeth, parts of lower jaws and the remains of 14 skulls, but of the rest of the skeleton little is known. The skulls had been damaged for the purpose of extracting the brains — in all cases the surrounding of the foramen magnum was damaged and this was the only part of the skull which could not be reconstructed — and the long bones had been broken to extract and, presumably eat, the marrow. The industry associated with the bones consisted of crude tools, made largely in quartz. Layers of ashes showed that Sinanthropus also used fire.

Since D. Black (1932) pointed out the close relationship between Sinanthropus and Pithecanthropus *erectus* from Java, some authors write Pithecanthropus pekinensis or even Pithecanthropus *erectus* pekinensis rather than Sinanthropus, putting the latter into the same genus as Java Man.

The thick skull is long and low with a prominent continuous supraorbital ridge and a cranial capacity varying from about 915 to 1,225 c.c. The dentition is robust, the pattern of the molars being complicated by secondary wrinkles. The chinless lower jaws exhibit a strong sexual dimorphism. Body height is estimated as about 5 ft. for the males and 43 ft. for the females.

D. Black's and F. Weidenreich's material was lost during World War II, after which only a few teeth were found at Chou-k'ou-tien, but more complete finds were reported from southern China.

See also MAN, EVOLUTION OF: Pithecanthropus; PITHECANTHROPUS.

For original descriptions of Sinanthropus (including industry and fauna) see Bull. geol. *Soc.* China (1930), and Palaeont. *Sinica* (1931–45). (G. H. R. V. K.)

SINCLAIR, the name of an old Scottish family, members of which have held the titles of earl of Orkney and earl of Caithness. The word is a variant of Saint Clair.

SIR WILLIAM SINCLAIR, OR SAINT CLAIR (c. 1260–c. 1303), was the descendant of a line of Anglo-Norman barons, one of whom obtained the barony of Rosslyn from King David I. in the 12th century. Sir William took part in the dispute over the succession to the crown of Scotland in 1292, and was one of the leaders of the Scots in the revolt against Edward I. His grandson SIR WILLIAM SINCLAIR, was slain by the Saracens in August 1330, while journeying through Spain to Palestine with Sir James Douglas, the bearer of the heart of Bruce. This Sir William Sinclair married Isabel, daughter of Malise, earl of Strathearn, Caithness and Orkney (d. c. 1350), and their son Sir Henry Sinclair (d. c. 1400) obtained the earldom of Orkney by a judgment of the Norwegian king Haakon VI. in 1379. He then helped to conquer the Faeroe Islands, and took into his service the Venetian travellers, Niccolo and Antonio Zeno, sailing with Antonio to Greenland.

WILLIAM, the 3rd earl of his line, whose earldom of Orkney was a Norwegian dignity, was made chancellor of Scotland in 1454 and Lord Sinclair and earl of Caithness in 1455. When in 1470 the Orkney Islands were ceded by Norway to King James III. he resigned all his rights therein to his sovereign and was known merely as earl of Caithness. His eldest son, William, having offended his father by his wasteful habits, the earl settled his earldom on his eldest son by another marriage, also called William, who was killed at Flodden in 1513. The elder William, however, inherited the title of Lord Sinclair, and the family was thus split into two main branches.

GEORGE, 4th earl of Caithness (*c.* 1525–1582), a son of the 3rd earl, was a Roman Catholic and a supporter of Mary Queen of Scots, but he was mainly occupied with acts of violence in the north of Scotland. His grandson George, the 5th earl (c. 1566–1643), was outlawed and compelled to fly to the Shetlands. He left many debts, and his great-grandson and successor, George, the 6th earl (d. 1676), who was childless, arranged that his estates should pass to a creditor, Sir John Campbell, afterwards earl of Breadalbane.

Campbell was created earl of Caithness in 1677, but the title was also claimed by George Sinclair (d. 1698), a grandson of the 5th earl, and in 1681 the privy council decided in his favour. When Alexander, the 9th earl, died in 1765 the title was successfully claimed by William Sinclair (d. 1779), a descendant of the 4th earl, who became the 10th earl.

The title of Lord Sinclair passed from William, the 2nd lord, who died about 1488, to John (1610–1676), who became the 9th lord in 1615. At first a covenanter, afterwards he became a royalist, and was taken prisoner at the battle of Worcester. He died without male issue and the title became dormant. His estates, however, passed to his grandson, Henry St. Clair (1660–1723), the son of his daughter Catherine (d. 1666) and her husband, John St. Clair of Herdmanston, and in 1677 Henry was created Lord Sinclair with the precedence of the older title. He had two sons, John Sinclair (1683–1750) the Jacobite, and James Sinclair, who became a general in the British army, and was also ambassador at Vienna and Turin and a member of parliament for many years. After the attainder of John, in consequence of his share in the rising of 1715, the family estates were settled on James, but he resigned them to his elder brother when the latter was pardoned in 1726. The pardon, however, did not include the restoration of the title. Earlier in life John Sinclair had killed a man named Shaw in a duel and had afterwards shot this man's brother. He was tried by court-martial and sentenced to death, but was pardoned. An account of the proceedings in the court-martial was edited by Sir Walter Scott for the Roxburghe Club (Edinburgh, 1828). Sinclair himself wrote Memoirs *of the Rebellion*, published by the Roxburghe Club in 1858.

Neither of the brothers left male issue, and the title devolved upon a cousin, Charles St. Clair (d. 1775), who was not included in the attainder. Charles did not claim it, but in 1782 his grandson Charles (1768–1863) was declared to be Lord Sinclair. He was a Scottish representative peer from 1807 to 1859 and is the ancestor of the present holder of the title.

See Sir R. Douglas, *The Peerage of Scotland*, new ed. by Sir J. B. Paul; G. E. (Cokayne), *Complete Peerage;* Sinclair, *The Sinclairs of England* (1887); Sir R. Gordon and G. Gordon, *The Earldom of Sutherland* (Edinburgh, 1813), and Hay, *Genealogy of the Sinclairs of Roslin* (1835).

SINCLAIR, SIR JOHN, BART. (1754–1835), Scottish writer on finance and agriculture, was the eldest son of George Sinclair of Ulbster, a member of the family of the earls of Caithness, and was born at Thurso Castle on May 10, 1754. After studying at Edinburgh, Glasgow, and Trinity College, Oxford, he was admitted to the faculty of advocates in Scotland, and called to the English bar, but never practised. He established at Edinburgh a society for the improvement of British wool, and was the first president of the board of agriculture. His reputation as a financier and economist had been established by the publication. in 1784, of his *History* of *the Public Revenue of the British Empire;* in 1793 widespread ruin was prevented by the adoption of his plan for the issue of exchequer bills. He died Dec. 21, 1835.

SINCLAIR, UPTON BEALL (1878–), U.S. author of the "muckraking" school, was noted for his denunciations of U.S. business practices and of the alleged malign influence of big business in education, religion and the law courts. Born in Baltimore, Md., on Sept. 20, 1878, he was graduated from the City College of New York in 1897 and pursued graduate study at Columbia university.

An extremely prolific writer, Sinclair. produced many early novels, but first won wide recognition nith *The Jungle* (1906), a realistic study of social conditions among immigrant workers in the Chicago stockyards that was instrumental in the passage of pure food laws. With the proceeds he founded the Helicon Home colony, Englewood, N.J., a socialist community. He continued his career as a propaganda novelist with such works as *King Coal* (1917), based on his investigations of the Colorado coal strike in 1913; *100%* (1920), based on the Tom Mooney preparedness day bombing case of 1916 in California; *Oil!* (1927), an examination of the Teapot Dome scandal, the film industry and popular evangelism; and *Boston* (1928), a treatment of the controversial Sacco-Vanzetti case. Between 1917 and 1927 he also wrote a series of nonfiction studies of aspects of U.S. life. *Tlze Profits of Religion* (1918); *The Brass Check* (1919), a study of journalism; *The Goose-Step* (1923) and *The Goslings* (1924), dealing with education; *Mammonart* (1925); and *Money Writes!* (1927); and an autobiographical account of his early life, *American Outpost* (1932). Sinclair ended his long activity in the Socialist party in 1933 by organizing the EPIC ("End Poverty in California") movement in California; in 1934 he was defeated as Democratic candidate for governor.

In 1940 Sinclair began a widely read series of contemporary historical novels covering the period preceding and including World War I. The hero of the series, Lanny Budd, witnesses the rise of Naziism in Germany and later becomes a personal representative of Pres. Franklin D. Roosevelt. Included in the series were *World's End* (1940); *Between Two Worlds* (1941); *Dragon's Teeth* (1942; Pulitzer prize fiction, 1943); *Wide is the Gate* (1943); *Presidential Agent* (1944); *Dragon Harvest* (1945); A *World* to *Win* (1946); *Presidential Mission* (1947); *One Clear Call* (1948); and *O Shepherd, Speak!* (1949). *In* 1953 he published *The Return* of *Lanny Budd.*

Sinclair's intense political preoccupations inject an often heavy didacticism into his works. Always vigorous and far-ranging, his writings stimulated his generation to a critical re-examination of the American scene. His numerous books were widely published and translated in other countries. *See* also MUCKRAKERS.

See Floyd Dell, *Upton Sinclair* (1927); Carl Van Doren, *Contemporary American Novelists, 1900–1920,* rev. ed. (1940).

SIND, the region of West Pakistan east and southeast of Baluchistan and south of the Punjab. Strictly, the name should belong only to the alluvial plain created and watered by the Indus: excluding, that is, westward the Kohistan, or uplands north of Karachi, and the fringe of the Kirthar range, and eastward the Registan or Thar (Thal) desert extending from the Nara channel into Indian Rajasthan. Politically it refers to a former autonomous province of British India and of Pakistan, which excluded the principality of Khairpur and, from 1948 to 1955, the federal capital area (Karachi diltrict and division). which were administered separately. Areas (sq.mi.): Sind province 50,397; Khairpur 6,050; icderal capital 812. Pop. (1951) Sind 4,608,514; Khairpur 319,543; federal capital 1,126,417 (Karachi city 1,064,557). There were eight administrative districts in Sind: Upper Sind Frontier (later Jacohabad). Sukkur. Larkana and Nawabshah, later. with Khairpur state. forming the Khairpur commissioner's division of West Pakistan; Hyderabad, Tatta, Dadu and Tharparkar (lnter divided into Mirpurkhas and Sanghar). lnter forming the Hyderabnd division. Karachi (*q.v.*) was the seat of the Sind government from 1843 to 1948, when it was restored to Hyderabad city. The population (1951) of Sind was mainly composed of Sunni Moslems. Xlovements of population following the 1947 partition produced in Sind, as in other parts of Pakistan. large numbers of reiugees who were being gradually absorbed into the population in the 1950s. The prevailing language is Sindhi. but Rajasthani, Baluchi, Punjabi and Gujarati are also spoken *(see* SINDHI LANGUAGE).

Soils and Vegetation. — The generally fine fertile alluvium of Sind is coarser toward the north. where it retains moisture better and is easier to plow; the south rarely yields such rich harvests. All regions are liable to the deposition of kalar salts. which so reducc fertility that land seriously infested is useless. the worst effects being observed in the fine-textured soils of southern Sind.

Toward the desert parts of Mirpurkhas, the soil approximates increasingly to pure sand, fertile only if well fertilized and watered. The richest soil is that resulting from recent inundation (kacho).

Aridity limits forest to about 1,200 sq.mi. near the Indus from Ghotki to the mid-delta. Babul (*Acacia arabica*) is most characteristic in lower Sind and yields fuel and timber for boats; its bark is used for tanning and the leaves and pods are fodder for camel and goat. Kandi *(Prosopis spicigera)* gives fuel and fodder; bahan (*Populus euphratica*) building timber and lacquer wood, and tamarisk (lai or *Tamarix gallica,* and jhao or T. *dioicn)* fuel and wood for turning and for farm implements. The bahantamarisk zone is on land subject to flood, the kandi zone is farthest from the river, the babul zone is intermediate. The lower delta is without forest. apart from mangrove growths used for fuel and fodder. Tamarind and tali (*Dalbergia sissoo*) were introduced. the latter into the north. Arid and dune areas show growth of herbs and shrubs, often adapted to salt conditions. (See *Agriculture*, below.)

Fauna. — Wild animals include hyaena, gurkhar or wild ass (in the south of the Mirpurkhas district), wolf, jackal, fox, wild hog, antelope, pharho or hog deer. hares and porcupines. Of birds of prey, the vulture and several varieties of falcon may be mentioned. Flamingo, pelican, stork. crane and Egyptian ibis frequent the shores of the delta. Besides these there are the ubara or tilur (hustard). the rock grouse. quail. partridge and various kinds of parrots. Waterfowl are plentiful; in the cold season the lakes or *dhandhs* are covered with wild geese. kulang, ducks, teal, curlew and snipe. There are scorpions, lizards, centipedes and many snakes. (X.)

History. — Changes of the Indus channels make it difficult to picture even the Sind of Alexander the Great (32j B.C.), although a picture of a very much earlier civilization. about 3,000–2,000 B.c., akin to the Sumerian, began to be afforded in the 20th century by excavations at the "lost city" of Mohenjo Daro, 180 mi. N.E. of Karachi. At Alexander's death (323 B.C.) Sind passed to Seleucus Nicator, who yielded it in jog to Chandragupta Maurya (*q.v.*). After a phase of Buddhist influence under Asoka (about 274–232 B.c.), came inroads from west and north. A Sudra dynasty ruling from the Salt range to the sea. with capital at Aror (Alor), was followed by Brahman rule (7th century A.D.) and Islamic invasion (711) under Mohammed ibn Kasim. The invasion was by land through Makran; and for nearly three centuries Sind remained nominally subject to the Arab caliphs.

Though conquered by Mahmud of Ghazni, who raided into India, Sind long remained semi-independent, under local dynasties. the Sumras and the Sammas. both Rajput, but Mohammedans in religion. The latter had their capital at Tatta, in the Indus delta. a seaport until the 18th century. The Sammas rrere followed by the Xrghuns. of Persian origin, and the Xrghuns by the short-lived Turkhan dynasty. It was not till the time of Akbar, himself horn at Umarkot in Sind, that the province was regularly incorporated in the Delhi empire. When that empire broke up. on the death of Aurangzeb, local dynasties again arose. The first of these was the Kalhoras. succeeded by the Talpurs. of Baluch descent. who were ruling under the title of mirs, with their capital at Hyderabad, at the coming of the British.

The East India company had established a factory at Tatta in 1758; but the Talpur mirs were never friendly to trade. and the factory was withdrawn in 1775. In 1830 Alexander Burnes was permitted to pass up the Indus on his way to the court of Ranjit Singh at Lahore. and two years later Henry Pottinger concluded a commercial treaty with the mirs.

During the first Afghan War (1839–42), the British army under Sir John Keane marched through Sind, and the mirs were compelled to accept a treaty by which they paid a tribute to Shah Shuja. surrendered the fort of Bukkur to the British and allowed a steam flotilla to navigate the Indus. In 1842 Sir Charles Napier arrived in Sind and fresh terms were imposed on the mirs. The Baluch army resented this loss of independence and attacked the residency near Hyderabad, which was bravely defended by Outram. Then followed Sir Charles Napier's decisive victory of Rleeanee (*q.v.*) and the British annexation of Sind.

Napier's earlier successes in this campaign were reported in his memorable and humourous message — "Peccavi" (I have sinned).

Sind was formally administered. in the days of British rule, as a nonregulation province attached to Bombay, but under a commissioner residing in Karachi. On April 1. 1936, it became a governor's province by the transfer of the Sind division from the Bombay presidency. On April 1, 1937, it became autonomous! its legislative assembly being then composed of 60 members. On Aug. 1j. 1947, the transfer of power led to its becoming a governor's province under a Pakistani governor. When West Pakistan was consolidated into a single province on Oct. 14, 1955, the separate Sind government ceased to exist. (A. V. W.; X.)

Agriculture. — About 90% of the people derive their income from agriculture. the remaining 10% being engaged in manufacturing industries. mostly of the cottage type. There are two principal cultivating seasons. *kharif* and *rabi*. In general. the former extends normally from the beginning of June to the end of October and coincides for the first three months with 'the height of the Indus inundation. Ordinarily, the rabi season covers the period from early October to the close of March. The chief *kharif* crops are rice. millets (bajri and jowari) and cotton. Wheat, pulses, oilseeds. barley and vegetables constitute the main rabi sowings.

Rice. the main crop, occupies in an average crop year about 1,250,000 ac. It is particularly identified with two tracts: one in northern Sind centring on Larkana. where the finest is grown, and the other in southern Sind, centring on Hyderabad. The former accounts for about one-third, the latter for more than one-fifth, of the total rice acreage. Bajri and jowari are the main food of the working classes. The former is the more wholesome and occupies about 1,000,000 ac., while jowar is grown over about half this area. Nawabshah is the main seat of bajri; jowari is identified particularly with northern Sind. There also wheat is found, which rivals jowari in the area normally occupied. Other cereals are insignificant. Among pulses. matar (chickling vetch), grown in northern districts. is the chief. Rape and jambho (a variety of mustard) are noteworthy oilseeds; they are fairly widespread outside the desert. and the average area occupied by the two crops together exceeds 300,000 ac. Cotton stands fourth in area among *kharif* crops, being surpassed by rice, bajri and jowari only. It is limited entirely to the left bank of the Indus, where it reaches its maximum development under the eastern Nara canal system.

The net area sown nith food crops is about 5,000,000 ac.. of which paddy (rice) constitutes 57%, wheat 27%, millet 9% and barley and other food crops the remainder. In addition, there were about 20 000 ac. (1952–53) under sugar cane.

Grasses and fodder crops are less important for the Sind pastoralist than shrubs and trees. The best milch cows of Sind are famous; and its buffaloes, sustained on the swampy tracts in the delta. are the basis of a large export of *ghee* (clarified butter). The camel — the main beast of burden in the province — thrives on salt marsh feed, and the abundance of poor dry land together with the hilly tracts, supports large herds of sheep and goats. Small hardy horses are also in evidence, and Jacobabad district breeds mares. Mules, asses and bullocks are well represented. Poultry was undeveloped at the mid-19jos.

Irrigation in Sind is virtually synonymous with canal irrigation. About 80% of the cropped area is irrigated The major irrigation work in the province is the Sukkur (Lloyd) barrage at Rohri, one of the world's largest darns which commands about 7,500,000 ac. The lower Sind or Kotri (Ghulam Muhammad) barrage at Jamshoro opened in 1955 was expected eventually to command a cultivable area of 2,750,000 ac.; the upper Sind barrage at Gudu go mi. from Sukkur, 2,300 ooo ac (including areas to be irrigated in Baluchistan).

Manufacturing **Industries.**—Sind remains well known for its famous pottery and tiles. leather and lacquer work. carpets and silk embroidery, though all declined with the advent of the age of machine-made goods. Other crafts for which the province was once renowned, such as armoury work and the fashioning of precious metals, are little more than a memory. There are numerous cotton ginning mills. mainly in Hyderabad, and rice husking factories, primarily in Larkana. Karachi and its neighbourhood have cotton presses, metal foundries, bone mills, printing presses, a glass and tile factory, an arsenal and the railway and Port Trust workshops; taken together, these furnish employment to several thousands. This employment was being increased in the 1950s on the Sind Industrial Trading estate on the outskirts of the capital. which accommodated various medium and light industries. Karachi district also supplies salt by evaporation from the sea. Another industry with a considerable number dependent upon it is the making of mats (*phanka*) from the rank grasses in the delta. Karachi receives natural gas from Sui in Baluchistan.

Trade. — The overseas exports of Sind embrace, in order of value. raw cotton, wheat, wool, rapeseed, flour, unhusked rice. raw skins, bones and rawhides. Leading imports include cotton manufactures, sugar. railway materials and machinery, mineral oil, woollen goods. motorcars and associated items. The chief port is Karachi, the natural collecting and distributing centre for Pakistan and northern India and the focus of a number of trade routes which ramify through Afghanistan and central Asia. The overseas trade of Sind is limited to Karachi; its subordinates. Keti Bandar and Sirpanda, only engage in coastal trade. handling mainly rice. The coasting trade of Karachi includes, on the import side, benzine and gasoline from Burma; cotton twist yarn and piece goods from Bombay; gunny hags mainly from Indian West Bengal; coconut oil from Madras; coal from West Bengal; *ghee* from Baluchistan and Saurashtra; pepper from Travancore and Bombay, and teak from Burma. On the export side. the items are similar to the overseas items, with the addition of rice.

Sind normally receives raw cotton and wheat from the Punjaband from India (Uttar Pradesh and Rajasthan). which adds wool also.

From Asia come livestock, pastoral products and silk. In return Sind gives of its own staple products in addition to what it passes on from overseas.

Communications.—Sind is traversed by the North-Western railway. which. entering from the Punjab, follows the Indus southward and terminates at Karachi. The Indus is twice bridged: at Rohri, where the main line crosses the river (nearby at Ruk a branch goes off via Jacobabad to Sibi and Quetta) and at Kotri opposite Hyderabad. From the latter place a metre-gauge railway runs east via Mirpurkhas to link Sind with India (Rajasthan); there is one feeder to this route from Hyderabad south to Badin and two from Rlirpurkhas, one south to Jhudo and the other north to Khadro and to Nawabshah on the Hyderabad-Rohri chord. This chord line evades the erosion of the Indus and serves as an alternative from Karachi to the northwest. The desert part of the region is accessible only by camels. the roads being rough tracks of heavy sand. The few metalled main roads in Sind mostly follow the railways. In the eastern part of the Indus delta the traffic is almost entirely by water. The area is riddled with interlacing creeks, and small boats can make their way at high tide up to 20 mi. inland. Numerous ferries serve the river and, generally speaking, the canals are adequately bridged.

Karachi has a major international airport.

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(A. V. W.; E. HD.; X.)

SINDBAD THE SAILOR, VOYAGES OF, a collection of Arabic travel-romances, partly based upon experiences of oriental navigators (especially in the 8th–10th centuries); partly upon ancient poetry, Homeric and other; partly upon Indian and Persian collections of *mirabilia.* In Sindbad's First Voyage, from Baghdad and Basra, the incident of the Whale-Back island may be compared with the Indian ocean whales of Pliny and Solinus, covering four *jugera,* and the *pristis* sea-monster of the same authorities, 200 cubits long. With the Island of tha Mares of Ring Mihraj, or Mihrjan, we may find (rather imperfect) parallels in Homer's *Iliad* (the mares impregnated by the wind), in Ibn Khurdadbih and Al Kazwini, and in Wolf's account of the three *Ilhas de Cavallos* near Ceylon, so called from the wild horses with which they abounded, to which the Dutch East India merchants of the 17th century sometimes sent their mares for breeding purposes. Sindbad's account of the kingdom of Mihraj (Mihrjan) is perhaps derived from the *Two Musulman Travellers* of the 9th century; it would seem to refer to one of the greater East Indian islands, perhaps Borneo. Sindbad's Valley of Diamonds has fairly complete parallels in Al Kazwini, in Benjamin of Tudela, in Marco Polo and in the far earlier Epiphanius, bishop of Salamis in Cyprus, who died AD. 403. As to the Mountain, or Island, of Apes in the Third Voyage, Ibn Al Wardi and Idrisi each recognizes an island of this kind, the former in the China sea, the latter near Sokotra. Sindbad's negro cannibal adventure reproduces almost every detaii of the Cyclops story in the *Odyssey;* among the Spice islands, and perhaps at Timor, may be located the island rich in sandal-wood, where the wanderer rejoins his friends. The cannibal land of the Fourth Voyage, producing pepper and coco-nuts, where Sindbad's companions were offered food which destroyed their reason, has suggested the Andamans to some enquirers and certain districts of Sumatra to others; with this tale we may compare the lotus-eating of the *Odyssey,* Plutarch's story of Mark Antony's soldiers maddened and killed by an "insane" and fatal root. in their Parthian wars, a passage in Davis's *Account* of *Sumatra* in 1599, and more complete parallels in Ibn Al Wardi and Al Kazwini. The burial of Sindbad in, and his escape from, the cavern of the dead is faintly foreshadowed in the story of Aristomenes, the Messenian hero, and in a reference of St. Jerome to a supposed Scythian custom of burying alive with the dead those who had been dear to them; the fully-developed Sindbad tale finds an echo in "Sir John Mandeville." For the "Old Man of the Sea," in the Fifth Voyage, we may also refer to Al Kazwini, Ibn Al Wardi and the romance of Seyf Zu-1 Yezen; Sindbad's tyrannical rider has usually been explained as one of the huge apes of Borneo or Sumatra, improved to make a better story.

See Richard Hole, *Remarks on the Arabian Nights' Entertainments, in which the Origin of Sindbad's Voyages . . . is particularly considered* (1797); Eusebius Renaudot's edition of the *Two Musulman Travellers* (1718, translated into English, 1733, as *Ancient Accounts of India and China by two Mahommedan Travellers . . . in the 9th Century*); *J. T.* Reinaud, *Relations des voyages faits par les Arabes et les Persans dans l'Inde et à la Chine dans le IX^e^ siècle* (1845); E. W. Lane's translation of the *Ambiun Nights* (1859), especially the notes in vol. iii. pp. 77–108; M. J. de Goeje, *La Légende de Saint Brandnn* (1890); C. R. Beazley, *Dawn of Modern Geography* (1897), i. 235–238, 438–450.

SINDHĪ LANGUAGE is spoken by over 4,000,000 people in the province of Sind (1951 census of Pakistan). With Lahndā and Kashmiri it belongs to the northwestern group of Indo-Aryan languages (*q.v.*) Sindhi-speaking people are also found in neighbouring districts, in the Rann of Cutch, and in Kathiawar. Many Sindhi-speaking Hindus from Pakistan have migrated to Bombay and other Indian cities. *e.g.* Delhi, Xjmer, Jaipur, and Gwalior.

Linguistically, Sindhi is bounded on the west by the Balōchī language (*q.v.*), an Iranian language, and by the Lahndii language (*q.v.*), to which it is closely akin, on the west. Of the four dialects of Sindhi, Vichōlī (Hyderabad), is standard, being employed for literary purposes. Another important dialect, Kacchī, is spoken in Cutch, and is strongly influenced by Gujariiti.

Moslem influence, over 1,000 years, gave a large number of Persian and Arabic borrowings, and the written character used for Sindhi is a variety of the Persian, with necessary modifications for sounds peculiar to the language; Hindus use a form of Devanāgarī.

Phonology.––The Sindhi system corresponds, in general, to that of Indo-Aryan. It shares one peculiarity with Kāshmīrī, viz., instead of a single final consonant, it has the consonant plus a voiceless vowel—for example, *chōkar*^{u} "boy" and *chōkar*^{e} "girl." Another feature is the series of "recursive" consonants, transcribed $\bar{g}$, $\bar{j}$, $\bar{d}$, $\bar{b}$ (or gg, *jj,* dd, *bb),* which are pronounced by drawing in (instead of expelling) the breath. with the larynx lowered and the glottis closed. These may occur initially. Still another feature is the occurrence of cerebrals where dentals are found in other Indo-Aryan languages. (*Cf.* Sindhi *ḍ̄iaṇ* and Hindi *dēnā* "give.")

Morphology.—Sindhī has two genders, masculine and feminine, and two numbers, singular and plural. Generally, case relationship is indicated by means of postpositions added to the oblique forms. An adjective agrees in gender, number and case with its noun. Sindhi, like Lahndā and Kāshmīrī, uses pronominal suffixes attached, as in Lahndā, to nouns as well as participial forms, while in Kashmiri they are used only with verbs.

The Sindhi verb has two conjugations, intransitive and transitive. Compound tenses consist of combinations of participles plus auxiliary. (For Sindhi *see* the *Linguistic Survey of India,* vol. viii. pt. i, 1919.)

Literature.— Until recently little Sindhi literature had been printed, activity quickened during the nineteen twenties with the formation of literary societies and availability of publishing outlets. The Sindhi Sahitya Mandal (Sindhi Literary circle) was Founded in 1949 in Bombay; others are active in other Sindhi cities.

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SINDING, CHRISTIAN (1856–1941) Norwegian composer and pianist, best remembered for his piano music. Born at Kongsberg. Jan. 11, *1856,* he was trained at the Leipzig Conservatoire and studied in Munich and Berlin before settling in Oslo. An annual grant and later a life pension from the Norwegian government enabled him to devote himself to composition.

More than his compatriot Grieg, Sinding was influenced by the German surroundings of his formative years, and his style, although not without romantic Nordic features! remained noticeably Wagnerian. Outside his own country, one best seller, the piano piece *Rustle* of *Spring,* has maintained his name. But his orchestral works and his chamber music, especially his pianoforte quintet, were much in vogue during the earlier part of the 20th century. He died at Oslo, Dec. 3, *1941.* (H. GA.)

SIN EATER, a man who for trifling payment was believed to take upon himself, by means of food and drink, the sins of a deceased person. The custom was once common in many parts of England and in the Highlands of Scotland. Usually each village had its official sin eater to whom notice mas given as soon as a death occurred. He at once went to the house, and there, a stool being brought, he sat down in front of the door, A groat, a crust of bread and a bowl of ale were handed him, and after he had eaten and drunk he rose and pronounced the ease and rest of the dead person, for whom he thus pawned his own soul.

In the earlier form the sin eater was taken into the death chamber, and a piece of bread and possibly cheese, having been placed on the breast of the corpse by a relative, usually a woman, was afterward handed to the sin eater, who ate it in the presence of the dead. He was then handed his fee and at once hustled and thrust out of the house amid execrations and a shower of sticks, cinders or other missiles. The custom of sin eating is generally supposed to be derived from the scapegoat in Lev. xvi, 21, 22. A symbolic survival of it was witnessed in 1893 at Market Drayton, Shropshire. After a preliminary service had been held over the coffin in the house, a woman poured out a glass of mine for each bearer and handed it to him across the coffin with a "funeral biscuit." In Upper Bavaria sin eating long survived; a corpse cake was placed on the breast of the dead and then eaten by the nearest relative.

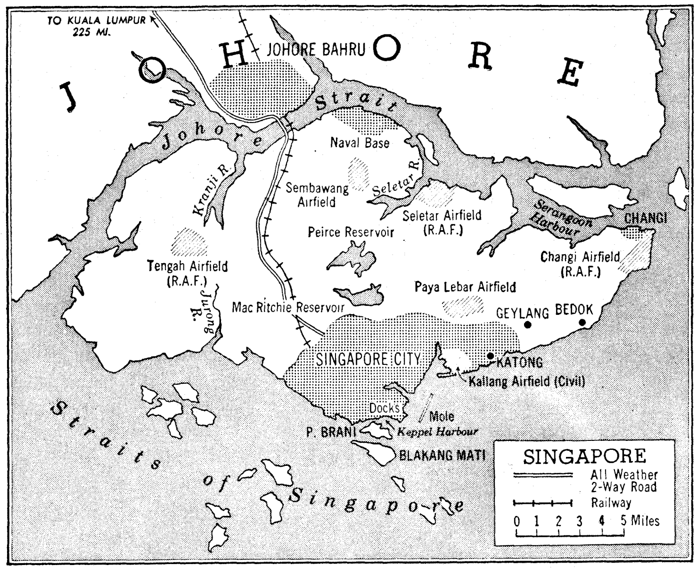
SINECURE, properly a term of ecclesiastical law for a benefice without the cure of souls. In the English Church such sinecures arose when the rector had no cure of souls nor resided in the parish, the work of the incumbent being performed by a vicar. Such sinecure rectories were expressly granted by the patron. They were abolished by parliament under the Ecclesiastical Commissioners act of 1840.

Other ecclesiastical sinecures were certain cathedral dignities to which no spiritual functions attached or incumbencies where by reason of depopulation and the like the parishioners disappeared or the parish church was allowed to decay. Such cases eventually ceased to exist.

The term is also used of any office or place to which salary emoluments or dignity but no duties are attached. The British civil service and the royal household, for example, were loaded with innumerable officeswhich by lapse of time had become sinecures and were only kept as the rervard of political services or to secure voting power in parliament. They were prevalent in the 18th century, but were gradually abolished by statutes during that and the following century.

SINEW, a tendon, a cordlike bundle of fibrous tissue at the end of a muscle forming the attachment to the bone or other hard part. The broad, flat tendons are usually called aponeuroses. See MUSCLE AND MUSCULAR SYSTEM; CONNECTIVE AND SUPPORTING TISSUES.

SINGAPORE, island and internally self-governing state within the British Commonwealth, situated at the southern end of the Malay peninsula with which it is connected by a rail and road causeway ($\frac{3}{4}$ mi.) across the Johore strait. The island, bounded south by the Singapore strait, is roughly diamond shaped *(26* mi. by *14* mi.) with an area of *209* sq.mi. and a mid-point of 1° 22′ N., 103° 50′ E. Within the state are about *40* small islands totaling 15 sq.mi. Until *1941,* with Malacca and Penang (*qq.v.*), Singapore formed the British colony called the Straits Settlements.



Singapore owes much of its wealth and continued prosperity to its focal position in southeast Asia on international sea and air routes. Its strategic position and deepwater harbour have enabled the city of Singapore to become the largest port in southeast Asia, the natural outlet for the products of the Malay peninsula and one of the world's greatest commercial centres. The island also serves as an important naval and air base.

Physical **Geography.**—An outlier of rocks and structures running through the Malay peninsula. Singapore has a central granite zone culminating in Bukit Timah, *581* ft., west of which Triassic quartzites and shales dip to the southwest and form low degraded scarps which are heavily eroded into hills aligned in a northwest-southeast direction with the steepest ridge behind Pasir Panjang. East of the granite zone lies a mass of weathered detritus averaging 100 ft. in height. Weathered red and yellow lateritic soils and thick ironpan cap all rocks. A quarter of the island is lower than *25* ft. and mangrove swamps fringe the coast, extending inland and almost dividing the surface into three islands. Only Pasir Panjang has a steep coast, and the deepwater channel of Keppel harbour is sheltered from the south by the hilly Blakang Mati and Brani Islands. Elsewhere the coast is silting and has dangerous coral reefs and sandbanks lying offshore. The Johore strait has a deep scoured channel at its eastern end, permitting large vessels to approach the naval dockyard at the northern corner of Singapore Island. The solid causeway across the strait prevents the through movement of vessels and hastens silting at the western end. On the central granite hills is the only remnant of the forest of dense. mixed evergreen trees which protects three reservoirs formed by damming small streams; they are now inadequate for the island and water is piped from south Johore. The climate is equatorial with temperatures throughout the year varying a fen- degrees either side of the 82° F. mean. There is no well-defined wet or dry season and the annual rainfall of 95 in. is evenly distributed throughout the year. Prevailing winds are from the northeast from November to

February and from the south during May to August, but strong daily land and sea breezes maintain agreeable physiological conditions. Heavy rains and high seas come during the northeasterlies, from which the harbour is well protected. Singapore river?a tidal estuary which afforded protection for early shipping, remains a shelter for lighters and is the city centre. Everywhere within a six-mile radius of the river is built over multistoried workers' flats and large residential suburbs. (E. H. G. D.)

History.—Malay tradition confirms that the first colonizer of Singapore was a prince from Palembang, the Sumatran capital of Srivijaya. It may have been Rajendracola Deva I (1012–44), ruler of Tanjore, who, to commemorate the lion courage of his men, gave the island the Indian name of Singapore ("Lion city"). He almost certainly attacked the island in A.D. 1025 during his descent on Srivijaya and its colonies. In Javanese inscriptions and Chinese records down to the end of the 14th century the commoner name for the island is the Javanese Tumasik from *tasek,* "sea." In 1275. when he raided Pahang, the Javanese king Kritanagara probably attacked Tumasik, and it may have been he who erected the stele in the Singapore river that was blown up by the British to widen the entrance. According to a Chinese traveler, Wang Tayuan, just before 1349 about 70 Siamese war boats besieged Tumasik for a month but had to withdraw. A Javanese work. the *Nagarakritagama,* written in 1365, includes Turnasik among the conquests of the Javanese empire of Majapahit. Jewelry of Majapahit workmanship, buried beneath a tree on Fort Canning, may have belonged to Singapore's last ruler, a Palembang prince, the *Parameswara,* before he and his Majapahit consort were driven upcountry by another Siamese attack. Clearly what Wang Tayuan describes as a den of pirates was at once a pest and a prize for Siam and Java: though both were too far away to control and develop it, and after the destruction of its suzerain Srivijaya at the end of the 14th century, it fell into decay and was supplanted by Parameswara's new port. Malacca. Yet in 153'2 it was still a port of call from which St. Francis Xavier dispatched letters to Goa, and João de Barros, writing in 1553, describes it as "a resort not only of Indian shipping but of traders from China, Siam, Champa, Cambodia and the Malay archipelago." John Crawfurd, resident of Singapore from 1823 till 1826, claimed to have traced the remains of a walled settlement that ran a mile inland and was half a mile broad.

On Jan. 28, 1819, Sir Thomas Stamford Raffles (*q.v.*) of the British East India company, forestalled in his search for a factory site by the Dutch at Riouw (Riau, Rhio) and having found the Carimon Islands unsuitable, landed at Singapore. He found only a fen Chinese planters, some aborigines and a few Malays, and was told by the hereditary chief. the *temenggong* (direct ancestor of the sultans of modern Johore); that there were no Dutch there and that the company could purchase land. The *temenggong,* however, was a subordinate of his cousin Xbdul Rahman, sultan of Riouw, Lingga, Pahang, Johore and Singapore, who was under Dutch surveillance. Abdul Rahman was a younger son and not a sultan *de jure*. Raffles. disobeying instructions not to offend the Dutch, took advantage of this fact by withdrawing his own recognition of Abdul Rahman as sultan of Singapore and installing Rahman's elder brother, Husain, to validate the purchase of land there on behalf of the company. The Dutch protested. In London the court of directors, though it decided Raffles had contravened instructions, took no action. In 1824 an Anglo-Dutch treaty left Malaya and Singapore in the British sphere. On Xug. 2, 1824, the whole of Singapore Island was ceded to the British for a money payment. By 1825, while Malacca's trade stood at £300,000 and that of Penang at £1,000,000, the trade of Singapore was estimated at £2.610.440. Already the free port was fulfilling its dual functions of helping the Canton (China) trade of the British East India company and breaking the Dutch monopoly of trade in the Malay archipelago. In 1526 Singapore; Penang and Malacca were combined as the Straits Settlements to form an outlying presidency of India. In 1830 they were reduced to a residency under Bengal. In 1832 Singapore became their capital. However the British East India company now lost its monopoly of the China trade and with it, its interest in Malaya. The settlements were transferred to the direct control of the governor general of India in 1851; in 1867 they were made a crown colony under the colonial office. Meanwhile! the trade of Singapore had suffered from British development after 1842 of a rival port. Hong Kong, as later it was to suffer from the French occupation of Indochina. the development of Saigon and Haighong, and from the establishment of Dutch ports and shipping lines in the Netherlands Indies. With the opening of the Suez canal in 1869 and the advent of steamships. an era of prosperity began that led eventually to the construction of three miles of wharves at Tanjong Pagar and finally in 1921 to a naval base. The economic growth of the Malay states after becoming British protectorates enlarged transit trade. Finally the demand of the motor industry for tin (European processes of tin smelting were introduced in 1887) and rubber made Singapore one of the greatest ports in the world. Steps were taken for its defense. But the naval base afforded no protection against a totally unexpected overland attack and an airfield mas useless in the absence of an adequate air force. On Dec. 8, 1941, the Japanese landed in Kelantan and by Jan. 30, 1942, the peninsula was conquered and Japanese troops were opposite the island of Singapore. On Feb. 8 they landed on the one coastal spot that was concealed by a mangrove belt. Gen. Xrchibald Wavell ordered a fight to the end. But 36.000 troops newly arrived were raw and Japanese bombs hindered the landing of equipment. Above all the island's water supply from the hills of Johore was cut. On Feb. 15 the British surrendered. The Japanese ruled the island under the alias of Syonam until it was recovered bloodlessly on Sept. 5, 1945, by forces under Lord Louis (later Earl) Mountbatten.

Following the expulsion of the Japanese the island's history was that of constitutional progress. .After 1946. when a union of all the Malay states plus Penang and Malacca was made, it was deemed politically unwise to include Singapore in the union. mainly because of its predominantly Chinese population. Singapore remained a crown colony. A new constitution was introduced in Feb. 1955. Under its provisions. 25 out of 32 members of its legislature were elective, and elected ministers became heads of all departments other than defense and external affairs, which still remained the concern of Great Britain. After 1955 the British governor was bound to consult and accept the advice of the chief minister. In 1959 the British colony became internally self-governing, with a locally born head of state, who was also the queen's representative, appointed by the crown in consultation with the Singapore government. *(See* also *Administration and Social Conditions,* below.) (R. O. WT.)

Population.—At the census of the colony of Singapore taken in June 1957 the population numbered 1,445,929, comprising 1,090,595 Chinese (75.4% of the total),197.060 Malaysians, 124,084 Indians and Pakistanis, 11.332 Eurasians, 10.826 Europeans, 5,426 Ceylonese and 6,556 others. When British rule was first established on the island in 1819 there were fewer than 200 inhabitants, but the rapid influx of Chinese and Indians brought the total population to 10.683 in 1824, the year in which the first census was taken. In 1860 it was 81.734. of whom more than 50% was Chinese, and by 1931 it was 559,945, of whom the Chinese formed nearly 75%. During the 1930s, immigration was reduced and a quota system established to regulate the entry of aliens into Singapore. After World War II there was a great increase in the number of immigrants and selective immigration was introduced. The religions are mainly Moslem, Buddhist and Hindu; the languages, Chinese. Malay, Tamil and English, which is the official language.

Administration and Social Conditions. — On June 3, 1959, a new constitution came into being. establishing the state of Singapore with full internal self-government. The queen's representative is a *yang di-pertuan negara,* or head of state, who must be Malayan-born. There is a cabinet of nine ministers presided over by a prime minister and a fully elected legislative assembly of 51 members, presided over by a speaker and a deputy speaker elected by the legislative assembly members themselves. The cabinet ministers are collectively responsible to the legislative assembly. but have full executive authority over their own departments. The right to vote in elections to the legislative assembly is confined to citizens as defined by the Citizenship act passed in 1957. The U.K. government is responsible only for defense and external affairs. The Singapore government is responsible for internal security, subject to the oversight of an internal security council, composed of representatives of the U.K. and Singapore governments and of the government of the Federation of Malaya.

Local government of Singapore city is by city council (see SINGAPORE, city), while the state's rural areas are administered by three district councils.

Income Tax.—In the early 1960s income tax was levied on income accruing in or derived from Singapore or received in Singapore from outside. Resident individuals paid tax on a sliding scale ranging from 5% on the first M$1,500 of chargeable income to 50% on incomes exceeding M$50,000. Personal allowances were M$3,000 for an unmarried person and M$5,000 for a married couple There was a sliding scale of allowances for children and deductions were also allowed in respect of life assurance premiums and contributions to approved pension or provident funds.

Housing.—The Singapore Improvement trust, partly financed by the government, was the recognized government agency and planning authority in the early 1960s. It was responsible for the building of nearly 15,000 dwellings after World War II. With an estimated population of 2,000,000 in Singapore by 1965, plans were made for building houses at the rate of 10,000 a year in the congested city area and in the rural areas. In the latter three new self-contained townships with a total population of about 200,000 were projected.

Labour and Welfare.—In the late 1950s there were more than 200 registered trade unions with a total membership of about 140,000. Conditions of employment are regulated by ordinances covering working hours, paid holidays and the employment of women and young persons, etc. Social security services available included a workmen's compensation scheme, a central provident fund scheme, free medical treatment and hospital services, homes for orphans and old people and a public assistance scheme.

Health.—In the early 1960s the ministry of health in Singapore controlled nine hospitals, containing more than 7,000 beds. There were 23 static dispensaries, 9 traveling dispensaries, 2 floating dispensaries and 63 main and subsidiary maternal and child welfare centres serving the population in the rural areas. The Institute of Health, opened in 1958, houses the city council outpatient clinic, the government school health services and the university's department of social medicine and public health, and also provides training facilities for public health personnel. The extensive tuberculosis-control program in operation had made vaccination available in all parts of the island and a tuberculosis-control unit has been established. The hospital system was being decentralized: a district hospital was opened in 1959, and an outpatient treatment centre for leprosy patients was started. There is a medical faculty in the University of Malaya where training is also given in dental surgery. A school of nursing provides general training in nursing. The Singapore birth rate of 41.9 per 1,000 is one of the highest in the world and more than half the population is under the age of 19. The gross expenditure of public funds on medical and health services in 1958 amounted to M$42,100,000, compared with M$6,300,000 in 1947.

Justice.—In Singapore there is a supreme court of justice, comprising a high court, a court of appeal and a court of criminal appeal. The supreme court is composed of a chief justice and five or more puisne judges. Appeal may be made from the supreme court to the privy council.

Education.—In the late 1950s Singapore provided education for about 325.000 pupils in 729 regular schools. The University of Malaya in Singapore had an enrollment of more than 1,000 men and about 400 women. A teachers' training college gave courses for approximately 1,150 men and more than 1,100 women students, about 2,000 of these being on part-time courses while working as trainee teachers in primary schools. There were also more than 600 students in technical schools and adult and evening classes were maintained and aided by the government. Of the pupils attending regular schools, more than 50% were being taught in English, about 40% in Chinese and 10% in the vernacular languages. About 15% of the pupils were taught in secondary schools. Nanyang university (founded in 1954), with more than 1,300 students, had faculties of arts, science and commerce. The Singapore polytechnic had 2,700 students attending classes in five departments: general education, science and technology, engineering, building and architecture, and commerce. More than 400 were full-time students, 500 were attending one day and two evenings a week and the remainder were evening students. The net cost of education in 1958 was M$81,400,000, compared with M$4,725,000 in 1948.

Defense.—Singapore is the headquarters of U.K. armed forces in the far east and a base for other Commonwealth forces. Local troops consist of the regular 1st battalion Singapore infantry regiment and various part-time forces.

Political Parties.—In 1955 elections were held under the constitution giving the legislative assembly an elected majority. The Labour front won ten seats and formed a government in coalition with an alliance of the United Malay National organization (U.M.N.O.), the Malayan Chinese association (M.C.A.) and the Singapore Malay union (S.M.U.), which altogether won three seats. The main opposition group, the People's Action party (P.A.P.), had three seats. In Nov. 1958 the Labour front was dissolved and in its place was formed the Singapore People's alliance, comprising the Labour front, the U.M.N.O.-M.C.A.-S.M.U. alliance and parts of the Liberal Socialist and Workers' parties. In the 1959 election the P.A.P. emerged as the dominant party, winning 43 seats out of a total of 51. (X.)

The Economy.—This city-state is based on its harbour and international trade; its agricultural and mineral resources are negligible. Old rubber and coconut plantations on the island have become housing estates; market gardens, piggeries and chicken farms totaled only about 9,000 ac. in the late 1950s. Large acreages are used for reservoirs, the dockyard and five airfields, the largest being the international airport at Paya Lebar (opened 1955) where more than 10,000 passengers and 9,000,000 lb. of air freight were handled in 1958. The offshore islands are unproductive except for fishing. Hundreds of fixed Chinese fishing traps and many Chinese trawlers land more than 14,000 tons annually.

The commerce of the harbour, the largest and best serviced within 1,500 mi., arises from handling goods and commodities from other places for re-export. These include: (1) Malayan produce, rubber, tin ore, copra and timber, which move outward by sea and are mostly raw, apart from a little copra milled into oil and some refined tin from Brani in the harbour. (2) Sumatran, Thai and Bornean produce which comprises rubber, tin ore, rice, timber and dried fish, and arrives in small steamers either for regrading and bulking into ocean-going vessels or for local consumption. Oil from North Borneo and Sumatra is stored on Pulau Bukum for redistribution inland and overseas and for fueling the passing ships, replacing Singapore's old function as a coaling station. (3) Textiles, machinery, equipment, European and Asian foodstuffs are brought from overseas for distribution to the Federation of Malaya, Thailand, Indonesia and Borneo. Forwarding, shipping, reshipping, rebulking, grading and distribution give rise to the modern warehouses, offices and banks which line the multistoried, European-style water front. In 1958 the harbour handled about 18,000,000 tons of cargo. Such entrepdt trade means that similar goods appear in both import and export statistics and it flourishes with free port facilities. These came to an end when the first independent government in 1959 introduced protective tariffs. The naval dockyard and the aerodromes serve functions similar to those of the harbour. Many people are employed in servicing and maintaining shipping, vehicles, planes and machinery. Fear that nationalism in surrounding territories will reduce entrepôt trade has led to the growth of small factories for remilling rubber, making rubber footwear, electric batteries, bottles, furniture, pipes, industrial gases, soap, metal windows and plywood, though local labour costs and unrest have been prejudicial. For power, the island depends on diesel-generated electricity from Pasir Panjang, which has a yearly output of 500,000,000 kw.hr. and enables more homes, offices and factories to be electrified than anywhere else in southeast Asia.

Roads radiate from the city of Singapore to satellite towns and suburbs at Pasir Panjang, Woodlands (opposite Johore Bahru), Changi, Seletar and Sembawang; the 280 mi. of metaled roads are used by more than 65,000 local motor vehicles (1958) and by truck traffic to and from the Federation of Malaya along the arterial road to Johore Bahru. The terminus of the Singapore-Kuala Lumpur-Bangkok railway adjoins the harbour. Radio and cable links to business centres of the world make Singapore an important centre for telecommunications.

Singapore currency is the Malayan dollar (M$), tied to sterling at 2s. 4d. (33 U.S. cents) for the last 50 years under currency commissioners common to Singapore, Malaya and North Borneo.

In 1957 the island's external trade including entrepôt movements was valued at about £1,000,000,000 exports and £1,190,000,000 imports, western European, British and far eastern markets dominating. In that year, Singapore received commodities worth £280,000,000 from the federation and sent to it goods worth £250,000,000. These movements included 250,000 tons of rubber and more than 1,000,000 tons of mineral oil. Singapore revenue in 1958 was M$282,000,000 (39% from customs and 40% from income taxes), and expenditure M$277,000,000 (23% administration, 27% social services and 12% police). (E. H. G. D.)

See MALAYA; *see* also Index references under "Singapore" in the Index volume.

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SINGAPORE (city), capital of the self-governing British colony of Singapore, is situated at the southern end of Singapore Island and occupies an area of 31.5 sq.mi. Pop. (1957 census) 912,343. The settlement of Singapore dates from 1819. The town then planned and founded by Sir Thomas Stamford Raffles (*q.v.*) centred on a landing place at a small river mouth with a roadstead sheltered in some degree by the neighbouring islands. The place had great commercial possibilities and considerable strategic value, and these assets were enhanced by the opening of the Suez canal in 1869. However, with the growth of trade and of the size of ships the old harbour proved inadequate. Keppel harbour took the place of the old river mouth and the original roadstead was left to coasting craft. The present commercial harbour centres on the Empire dock and Main wharf with the other docks and wharves adjacent to the railway station in Keppel road. The docks, warehouses and wharves were first developed by the Tanjong Pagar Dock company, but after 1905 they were controlled by the Singapore Docks and Harbour board. Of the islands which shelter Keppel harbour, some are fortified and some afford sites for a tin-smelting works and for petroleum storage tanks.

Round the older part of the city are grouped the public buildings and principal offices. Business is mostly done in or near Raffles place, the government offices being on the opposite side of the river. Next to these are the Victoria Memorial hall and theatre, the supreme court, the city hall and St. Andrew's cathedral (Anglican). The Raffles museum and library is at some little distance from this central group, in Stamford road. The museum contains collections covering the zoology, ethnography and archaeology of the Malaysian region. The library has about 120,000 volumes, including many books on Malaya. Farther out of the city in a northwesterly direction are the botanical gardens and the buildings of the University of Malaya.

An extensive building program was being carried out in Singapore during the 1950s and the construction of modern multistoried buildings has given the water front a distinctive sky line. Singapore is not only an important seaport for long-distance and coasting trade, but is also an airport of growing significance and the focal point of air communications in southeast Asia. The civil airport at Kallang, built on reclaimed land, proved inadequate for jet-propelled aircraft, which had initially to use the Royal Air Force base at Changi. The new airport at Paya Lebar, opened in 1955, is $7\frac{1}{2}$ mi. from the city centre and has an 8,000-ft. runway.

The royal charter granted Singapore in 1951 gave control to a primarily elected city council, under a president nominated by the governor. In Dec. 1957 the council became a completely elected body presided over by an elected mayor. The council was dissolved after Singapore colony became self-governing (see SINGAPORE [state]). (C. N. P.)

SINGER, ISAAC MERRIT (1811–1875), U.S. inventor who developed the first practical domestic sewing machine and brought it into general use, was born on Oct. 27, 1811, in Rensselaer county, N.Y. In 1851 he developed and patented a sewing machine which embodied a spring presser foot and feed synchronous with the needle action and thus permitted continuous and curved stitching. An overhanging arm projecting the needle bar over the work, which was spread over a horizontal table, made it possible to sew on any part of the work. Singer's machine was the first that could perform these necessary functions, and its basic design features have been followed in almost all subsequent machines. Nonetheless, Elias B. Howe (*q.v.*) must be credited with the first employment of the basic eye-pointed needle and lock stitch (in 1846), nhich, since Singer had embodied these in his machine, resulted in Howe's winning an infringement suit against Singer in 1854. The suit did not prevent Singer from manufacturing his machine, however, and in June 1851 he formed a partnership with Edward Clark, their company becoming, by 1860, the largest producer of sewing machines in the world. Singer left commercial development of his invention to Clark while he supervised manufacturing and the "experimental department," where he perfected other improvements. In 1863 he and Clark formed the Singer Manufacturing company and Singer retired to England. where he died on July 23, 1875. (A. B. J.)

SINGER, ISRAEL JOSHUA (1893–1944), Polish-born U.S. Jewish author and playwright, was born at Bilgoraj, Pol., on Nov. 30, 1893. He prepared for a career as a clergyman at the Rabbinical Yeshivah school in Warsaw, but abandoned theological studies at an early age and worked at various occupations, including artist's model, traveling tutor and compulsory labourer for the German army which occupied Warsaw in 1915.

In 1917 he went to Kiev in the Ukraine, where he became a proofreader for a Yiddish newspaper and began to write short stories. He returned to Warsaw in 1921 and first came to public notice with the publication of a number of short stories, collected in a volume entitled *Pearl* (1923) after the first story in the book. He was invited to contribute articles to the *Jewish Daily Forward* by the editor in New York and continued to serve thereafter as a correspondent for the publication and fiction writer.

In 1932 appeared the novel *Yoshe Kalb,* produced as a play in the same year at the Yiddish Art theatre in New York city. The book was translated into English as *The Sinner* in the following year. The plot concerns the tribulations of a rabbi who committed a grave act of sin.

In 1934 Singer, who had visited the United States earlier in connection with the production of *Yoshe Kalb,* settled in New York city. In 1939 he became a U.S. citizen. His *The Brothers Ashkenazi* (Yiddish title *Di Brider Ashkenazi)* was translated into English in 1936 and also into several other languages. It was produced on the stage by the Yiddish Art theatre. Other works by Singer which were translated into English include a collection of short stories, *The River Breaks Up* (1938), and the novel *East of Eden* (1939). produced as a play by the National theatre, New York city, in 1939. In 1943 his play *The Family Carnovsky* was a popular success. Singer died on Feb. 10, 1944.

SINGER, SIMEON (1846–1906), Jewish preacher, lecturer and public worker, was born in London. In 1867 he became minister of the Borough synagogue, London. In the following year he married. He moved to the new West End synagogue in 1878, and remained minister of that congregation until his death.

He introduced regular sermons to children. and as a preacher to the young, Singer showed rare gifts. His pulpit addresses in general won wide appreciation, his services often being called for at public functions. In 1890 the rabbinical diploma was conferred on him by Lector Weiss of Vienna; in the same year he showed evidence of his self-denial by declining the stand for the post of associate chief rabbi.

Singer was a power in the community in the direction of moderate progress; he was a lover of tradition, yet at the same time he recognized the necessity of well-considered changes. In 1892 at his instigation the first English Conference of Jewish Preachers was held. and some reforms were then and at other times introduced, such as the introduction of Bible readings in English, the admission of women as choristers and the inclusion of the express consent of the bride as well as the bridegroom at the marriage ceremony.

Singer did much to reunite Conservatives and Liberals in the community, and he himself preached at the Reform synagogue in Manchester. He had no love for minute critical analysis of the Bible, but he was attracted to the theory of progressive revelation, and thus was favourably disposed to the modern treatment of the Old Testament.

His cheerv optimism was at the basis of this attitude and strongly coloured his belief in the messianic ideals. He held aloof from all Zionist schemes.

His interest in the fortunes of foreign Jews led him to make several continental journeys on their behalf; he was one of the leading spirits of the Russo-Jenish committee. of the International Jewish Society for the Protection of Women and of other philanthropic organizations.

Despite his devotion to public work, Singer published some important works. In 1896 was published *Talmudical Fragments in the Bodleian Library*, of which Singer was joint author. His most famous work was his new edition and English translation of the *Authorized Daily Prayer Book*, first published in 1870, a work which went through many large editions and which proved to be popular with both Jews and Christians.

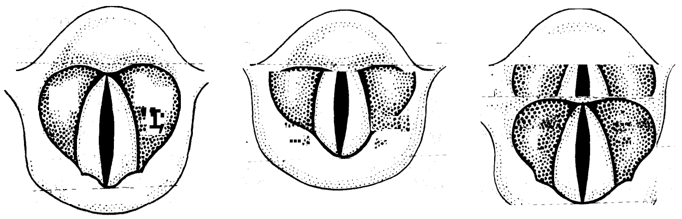
See *The Literary Remains of the* **Rev.** *Simeon Singer*, 3 vol., with memoir (1908). (I. A.)

SINGHBHUM, a district in the Chota Nagpur division of Bihar, India. The administrative headquarters are at Chaibasa, 162 mi. W. of Calcutta; pop. (1951) 16.474. Area of district is 5,123 sq.mi., after the absorption in 1948 of certain former hereditary territories. Pop. (1951) 1,685,195. Singhbhum is a hilly district on the fringe of the Chota Nagpur plateau with mountains in the northwest rising to a height of 2.joo ft.. and in the southwest. where they are called the Saranda hills, to nearly 3,000 ft. The central part consists mainly of well-cleared country. which is the most fertile tract in the district. The south is another undulating plateau. The eastern part of the district, called Dhalbhum. contains the valley of the Subarnarekha, the principal river. Over one-third of Singhbhum is covered with primaeval forest, in which tigers, leopards. bears, bison and deer are found. Valuable timber is obtained from the forest. a minor product of which is sabai grass for the manufacture of paper, ropes and string. Nearly two-thirds of the inhabitants belong to aboriginal tribes. among whom the Hos. meaning simply "men." are predominant. Their warlike character won for them the name of Larka. or fighting, Kols among outsiders. They were not finally subjugated until 1836, when the Kolhan. the area in the centre and southwest of the district, was brought under British rule. In Porahat they broke out in rebellion during the Mutiny, and after a long campaign submitted in 1859.

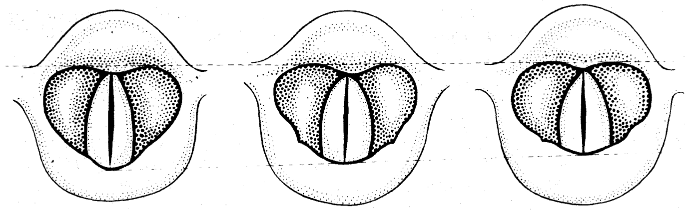
Singhbhum became one of the most important industrial tracts in Bihar. largely the result of the establishment of the works of the Tata Iron and Steel company and of subsidiary concerns at Jamshedpur (pop. 193,775), 20 mi. E. of Chaibasa, and in its neighbourhood. The deposits of iron ore in the Saranda hills, reputed to be among the finest in the world, supply material to large works near Asansol, in West Bengal. There is a belt of copper extending for about 80 mi.; mining has been in operation for many years. Other mineral resources include chromite, manganese ore, apatite and gold. Several companies also were formed for the production of silica bricks. firebricks and pottery. for which materials are obtained northeast of the mineral area. Jainshedpur contains one of the undergraduate colleges of Bihar university.

SINGING. Singing is vocal expression with words and music. It is indeed the art of using the voice freely and effectively according to a musical pattern. Beautiful singing requires a healthy body and vocal organs, an alert mind, expressive and pleasing tonal quality. a musical ear, sound musicianship and excellent vocal technique. In addition, it demands that the singer have a clear idea about the meaning of the lyrics and that he has the ability to project his understanding so that the song will have significance to his listeners. In short, he must interpret the composition intelligently.

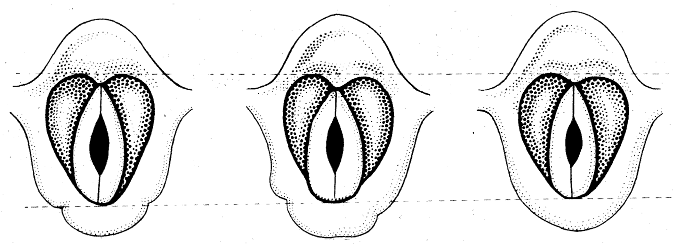
Not all singers, however, are trained and not all attain a high



LOW PITCH



MEDIUM PITCH



HIGH PITCH

FROM "PLAIN WORDS ON SINGING" (WM. SHAKESPEARE, PUTNAM SONS, LTD.)

DIAGRAM SHOWING THE UNCONSCIOUS SHORTENING OF THE VOCAL CORDS DURING SINGING

degree of skill. The singer of popular songs. for example, produces his voice quite differently from the operatic and concert singer and often his production violates the best principles of artistic singing. In church, community and school where spontaneous singing is done by many as well as in much solo performance the results cannot be described as tonally beautiful. Nevertheless it is "singing," and its sincerity and the emotional feeling it arouses generally are pleasing to both performers and listeners. It should be noted also that untrained and natural singing varies with peoples and civilizations, being conditioned by anatomic structure. language, culture and environment. For example. the folk-type singing of orientals is as different from that of western peoples as are their ideas and ways of living. The voices of the Indians are unlike those of the Negroes. The open vowels of the Italian language. the nasal sounds of the French and the guttural consonants of the Germans influence the singing of natives of these nations.

The voice in singing, as in speaking, is produced by the outgoing breath setting into vibration the vocal cords or lips located in the larynx. The sound'initiated there is reinforced or strengthened by the cavities of the throat. head and mouth—the resonators. Words are formed by the lips. teeth, tongue and palate—the articulators. Although produced by the same organs, singing differs from speaking in that the range of voice is often extensive and the vowels are prolonged. Moreover, a singer must conform to a definite musical design whereas the speaker can inflect his voice and determine his phrasing and rate of utterance at will.

The vocal instrument is the same in men and women except for size, the vocal cords being usually longer and thicker and the resonating cavities being usually larger in men than in women. In boys and girls it is the same until the age of puberty. Length of the vocal cords determines the pitch of voice, the longer cords producing lower pitches than the shorter ones. Therefore: the adult man's voice is about an octave lower than the woman's.

A division of singing is made on the basis of sex and age—namely, men and women, boys and girls. adults. youths and children. Further classification is made with reference to timbre or quality and, to some extent, range of voice. The number of pitches a person can sing, however, varies with individuals and with training. But, as a rule: the well-tutored adult singer has a compass of approximately two octaves. Men's voices from the lighter and higher to the heavier and lower are tenor, baritone and bass. Women's voices in the same order are soprano, mezzo-soprano and contralto. Another division denotes quality. such as lyric tenor. dramatic tenor. bass baritone, basso cantante. basso profundo, lyric soprano. dramatic soprano and coloratura soprano.

The lyric tenor voice is light and flexible. The dramatic tenor has a more robust quality. The baritone is heavier in texture than the tenor but lighter than the bass. The bass baritone is a lighter voice than the real bass but heavier than the baritone. The words *cantante* (singing) and *profundo* (profound or deep) characterize bass voices. Descriptions for lyric and dramatic tenor apply also to lyric and dramatic soprano. The mezzo-soprano, between the soprano and contralto. bears the same relationship to these voices that the baritone does to the tenor and bass. The coloratura soprano is a high and extremely flexible and clear voice. The true contralto has deep, rich. mellow tones.

Children's singing voices are called treble or soprano because the range is within the G or treble staff. Range as well as quality, however. differs with individual children. As a rule, the quality is light, lacking the resonance of mature voices. Even so, children are capable of singing superbly, singly or in groups, as is attested by boy sopranos and many choirs or choruses. At adolescence, voices of boys and girls change in quality and the boy's voice drops in pitch. first moving into alto and then into what is often designated as alto-tenor, a mixed voice of limited range. From this stage it develops into the adult tenor. baritone or bass. Before the change occurs, the upper tones of boys frequently become clear and brilliant; during mutation their voices often are rough and reedy in quality and are difficult to control. At puberty, some girls' voices also become lower in pitch but not to the extent of boys'; and their quality is often husky.

Singing is done by individuals alone or in groups, as in solos, duets, trios. quartets, quintets. sextets, glee clubs and choruses. Ensembles sing from one to eight (possibly more) parts, the common number for a male and a mixed group being four. for women's three and four, for children's one, two and three parts. When persons sing together their voices should blend if the effect is to be musical. Therefore. each member must be willing to submerge his musical interests and identity for the sake of the group. Although less demanding in regard to vocal range. control and beauty than solo performance, even a small chorus under an able conductor can produce tonal richness and variety. Some organizations may rival the qualities of musical precision and impressiveness of symphonic orchestras and instrumental chamber groups. In fact. in the opinion of some choral enthusiasts. nothing can surpass the performance of a carefully selected and directed *a cappella* chorus — that is, a group singing without instrumental accompaniment.

Singing, first in unison and later in parts, was introduced into religious worship in early centuries. and measures were soon taken to train singers to perform the chant. It is believed that it required nine years for singers to complete the course at the Roman Schola Cantorum, established about 590. During the 12th and 13th centuries, the crusades gave impetus to the growth of music outside the church. The development of secular singing also was furthered during these centuries by the troubadours and trouvères in France and the minnesingers in Germany, whose contests or tournaments gave opportunity to display vocal and musical talent. Songs with lute accompaniments. motets, madrigals and the mass indicate that by the 15th century singers must have had excellent technical skill to adequately perform both secular and sacred music. In the 16th century, the time of Giovanni Pierluigi da Palestrina (?1526–94), the art of singing was ready to meet the demands of the new musical forms of the next era.

Solo singing came into prominence about 1600 with the development of opera and oratorio. The music required of singers voices of wide range, great flexibility and tonal purity. In order that their compositions be sung properly, composers often became teachers and succeeded in producing many fine singers. Among them were the *castrati* (male sopranos and contraltos) whose artificial voices of ethereal quality could perform spectacular vocal feats. Their popularity in opera waned during the 18th century when composers ceased to give them prominent roles. They, however, sang in some church choirs through the 19th and even into the 20th century.

During the 17th and 18th centuries, known as the age of *bel canto* (beautiful singing), singers studied long and diligently to acquire technical perfection instrumental in character. Niccolo Antonio Porpora (1686–1766), recognized as the outstanding teacher of his time and credited with being the founder of the old Italian school of singing. had his pupil Caffarelli practise one page of exercises for several years. some say six. He then dismissed him saying. "You are now the greatest singer in the world." Among the famous teachers of this period were Pier Francesco Tosi (c. 1650–1732) and Giambattista Mancini (1716–1800). Outstanding in the 19th century mas Manuel Garcia (1805–1906) who probably marked the beginning of scientific interest in vocal training by his invention in 1855 of the laryngoscope, an instrument for examining the larynx. Other teachers of the 19th century who gained eminence were Mathilde Marchesi, a pupil of Garcia, Michelle Pauline Garcia Viardot, his sister, Giovanni Sbriglia, and Francesco and Giovanni Lamperti, father and son.

Many of the principles and methods of the early teachers have been perpetuated because beauty of tone and technical facility are still essential for artistic singing. In the 20th century. however, instructors have had recourse to audio-visual aids unknown in previous centuries. For example, hi-fi (high-fidelity) phonograph recordings, radio and television provide pupils many opportunities to learn through hearing and seeing. The recording machine whereby singers may record and play back their performances help both them and their teachers in critical analysis. Xevertheless, despite these inventions and scientific studies pertaining to singing, much of the teaching and learning continues to be empirical. This must of necessity be so because singers cannot easily observe the action of their own voices and it is difficult to give accurate descriptions. Therefore, teachers must provide exercises and imaginative concepts to establish good singing habits, to release nervous and muscular tensions, and to help pupils co-ordinate the singing organism. Differences in methods are the result of various ideas and ideals of teachers. But whatever means teachers advocate, doubtless all would agree that the voice must be musical and produced without strain.

Different types of compositions and changing points of view affect both styles of singing and teaching procedures. For example, in the age of *bel canto* purity of tone and virtuosity were the fashion In the 19th century, composers and audiences alike wanted much more from singers than beautiful voices nith flawless technique. In the songs by Franz Schubert qnd Robert Schumann vocal artists found opportunity for lovely singing but not vocal exploitation In the songs by Johannes Brahms, Richard Strauss and Hugo Wolf. they could give voice to profound feelings. In his operas. Richard Wagner exacted vocal and dramatic strength from singers. The arias of Giuseppe Verdi's operas had emotional and melodic appeal requiring variety in tonal colour. To render modern music with its difficult intervals, intricate rhythms and indefinite tonality a singer must have a keen musical ear and superior vocal control. Often he must seek realistic rather than beautiful effects.

Because of musical and histrionic demands, singers usually become specialists in grand or light opera, musical comedy, *lieder* or song and popular music. Within these fields there is also specialization. Some achieve renown in the operas by Wagner. others in those by Puccini; some excel in songs by French composers, others in those written by Germans. In popular music. some become known as crooners, others as blues, folk or ballad singers. Pet there are versatile singers who have been successful in two or more fields, as Helen Traubel, well-known Wagnerian opera soprano and night club entertainer, Ezio Pinza famous in both grand and light opera, and Lotte Lehmann, notable in grand opera and in *lieder* or song.

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SINGLESTICK, a slender, round stick of ash about 34 in. long and thicker at one end than the other, used as a weapon of attack and defense, the thicker end being thrust through a cup-shaped hilt of basketwork to protect the hand. The original form of the singlestick was the "waster," which appeared in the 16th century and was merely a wooden sword used in practice for the backsword, and of the same general shape. By the first quarter of the 17th century wasters had become simple cudgels provided with sword guards, and when: about 25 years later. the basket hilt came into general use, it was employed with the cudgel also, the heavy metal hilt of the backsword being discarded in favour of one of wickerwork. The guards, cuts and parries in singlestick play were at first identical with those of backsword play, no thrusts being allowed *(see* FENCING). The old idea, prevalent in England in the 16th century, that hits below the girdle were unfair, disappeared in the 18th century, and all parts of the person were attacked.

Under George I and George II, backsword play with sticks was immensely popular under the names "cudgel play" and "single-sticking." not only in the cities but in the country districts as well, wrestling being its only rival. Toward the end of the 18th century the play became very restricted. The players were placed near together, the feet remaining immovable and all strokes being delivered with a whiplike action of the wrist from a high hanging guard. the hand being held above the head. Blows on any part of the body above the waist were allowed, but all except those aimed at the head were employed only to gain openings, as each bout was decided only by a "broken head"; *i.e.,* a cut on the head that drew blood. At first the left hand and arm were used to ward off blows not parried with the stick, but near the close of the 18th century the left hand grasped a scarf tied loosely round the left thigh, the elbow being raised to protect the face.

The French cane fencing *(q.v.)* has a general similarity to singlestick play but is designed more for defense with a walking stick than as a school for the sabre.

SINGLE TAX, as the term originally developed in the United States, referred to a tax upon land values, or, in other words, on the annual economic rent of land, proposed as the sole source of government revenues, to replace all existing taxes. The term ultimately came to be used in reference to a tax of this type whether or not it was to be the only tax imposed.

The idea of a single tax on land is centuries old, appearing for example in the writings of the 18th-century physiocrats and of the famous English economist David Ricardo. But the term itself and the modern single-tax movement originated with the publication of *Progress and Poverty,* the first systematic presentation of the plan, written by a San Francisco newspaper editor, Henry George *(q.v.)* in 1879. The proposal gained substantial strength in ensuing decades, and then gradually declined in popular appeal. There were, however, in the second half of the 20th century still a number of very devoted disciples, the best known of whom was Harry Gunnison Brown, and publications in the field were sponsored by the Schalkenbach foundation, established for this purpose.

The basic arguments for the single tax were twofold. On the one hand it was argued that land rent, unlike other income, is a product of the growth of the economy. not of individual effort, and thus society is justified in recovering it to support the costs of government. Since land rent is a surplus return, a tax on it cannot be shifted forward to consumers, and cannot reduce the supply of land available to the economy. Land rent is essentially an "unearned increment" and thus governments are justified in taxing it at a 100% annual rate. On the other hand, use of the tax would allow elimination of other forms of tax, and particularly taxes on buildings, which interfere with construction and economic development generally. Thus the tax would stimulate gromth of the economv.

The critics of the proposal condemn the tax as contrary to usual standards of ability to pay, since there is no correlation between land ownership and total wealth and income. Portions of other incomes may be regarded as much "unearned" as land rent. If the tax were imposed today it would in large measure rest on the wrong persons, on those who had invested their capital in land rather than those who had benefited from the increase in land values. Furthermore, as a practical matter, separation of land values from those of buildings and other improvements would be extremely difficult.

While no attempt has ever been made to use the land tax as a single tax. and it is universally recognized that the levy could not meet all needs of governments, some of the states of Australia and municipalities in the western provinces of Canada have applied their property taxes to land only instead of to land and buildings, and several local governments in the United States and Canada have deliberately taxed land more heavily than buildings. The single-tax supporters claim that the use of the plan in Australia has greatly stimulated building in the states using it, but the evidence is not conclusive.

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SINGLETON, ESTHER (1865–1930), U.S. author, editor and antiquarian. published anthologies and books on various countries and cities, historic events: antique furniture, music and other topics. Her interests ranged widely and her books were based on painstaking research. Born at Baltimore, Md., on Nov. 4, 1865, she was educated there in private schools and by private teachers.

In 1887 she went to New York city to study music, and for the rest of her life made New York her permanent place of residence. Her first book, entitled *Turrets, Towers and Temples: The Great Buildings of the World as Seen and Described by Famous Writers,* was published in 1898. The following year her guide to the opera appeared and in 1909 a guide on modern opera was published. Other books on music included *The Orchestra and Its Instruments* (1917), *The Music Dramas of Richard Wagner* (1898) and *Musical Education* (1903), the two latter English translations of Albert Lavignac's works in French.

Editor of the *Antiqzrarian,* from 1923 to 1930, she turned to antiques and history for several books—The *Furniture of* Our *Forefathers,* 2 vol. (1900); *Social New York Under the Georges* (1902); *Historic Buildings* (1903j; *Great Events of the World's History,* j vol. (1903); *Historic Buildings of America* (1906); *Dutch New York* (1909); etc.

She died at Stonington, Conn., on July 2, 1930.

SINGLETON, the oldest town of the Hunter River valley *(see* HUNTER RIVER) in New South Wales, Austr., about 150 mi. N.W. of Sydney. Pop. (1954) 4,506. Though the town is situated in a river valley liable to floods, the possibility of petroleum in its neighbourhood, the production of good-quality coal from both opencut and tunnel mines. its grazing, timber cutting and sawmilling, mixed agriculture, fruit and vegetable growing and vineyards from which the renowned Hunter valley wines are made, co-operative dairying and cheese and butter making, cattle, sheep and pig marketing typify the growth of the area in which it occupies a central, linking position. The town has an efficient rail and road transport system, being served by the New England highway and two main roads.

Around Singleton there are large estates and timber cutting continues but farming, dairying and fruit and vegetable growing have increased during the 20th century. Sydney is to a large extent dependent upon this area for its milk supply. Singleton was formerly regarded as a rural area, but the production of coal from both opencut and tunnel mines has placed the town in the industrial category also, and it now competes with the Newcastle-Cassnock area as the chief source of coal production in New South Wales. (*See* also NEWCASTLE.)

SINGORA or SONGKHLA (the *Sangore* of early navigators), a port and *changwad* (province) of Thailand on the east coast of the Malay peninsula. Singora is situated in 7° 12′ N. and 100° 35' E.

Singora was settled at the beginning of the 19th century by Chinese from Amoy, the leader of whom was appointed by Siam to be governor of the town and district. Having been sacked more than once by Malay pirates, the town was encircled. about 1850, by a strong wall, which, as both Chinese governors and Malay pirates became things of the past, later supplied the public works department with good road metal. The population of Songkhla *changwad* (area, 2,576 sq.mi.) was 488,050 in 1960, having increased from 350,687 in 1947. The town became an important administrative centre; good roads and the railway connected it with Kedah and other places in the peninsula; mining was developed in the interior.

In the 20th century plans mere studied for improving the port so as to give all-year access to the inland sea. Singora by the time of World War II acquired a new importance through improved communication with the capital.

SINHA, SATYENDRA PRASSANO, 1ST BARON OF RAIPUR (1864–1928), Indian statesman, was born of an ancient family of the Kayashta or writer caste in the village of Raipur, Birbhum district, Bengal, in June 1864. From the Presidency college. Calcutta, he went to London in 1881 to join Lincoln's Inn, where he won many prizes and scholarships and was called to the bar in 1886.

On his return to India Sinha at once began to plead before the high court in Calcutta. In 1903 he became standing counsel to the government. He was the first Indian to be appointed advocate-general of Bengal (1908), and the first to become a member of the government of India. He held the law portfolio from April 1909 to Nov. 1910. He then resumed his lucrative practice at the bar. He presided at the Indian National congress session at Bomhay in 1915; in his presidential speech he begged the British government to declare their policy with regard to the development of constitutional government. He and the maharaja of Bikaner were the first Indians to participate in empire deliberations in London, for in 1917 they jointly assisted the secretary of state at the meetings of the imperial war cabinet. and were members of the Imperial War conference. Sinha joined the Bengal executive council in the same year, but returned to England in 1918 as a member of the imperial war cabinet and Imperial War conference. subsequently becoming a representative of India at the peace conference.

Knighted in 1914, in 1918 Sinha was made K.C., a distinction not previously conferred upon a barrister of Indian birth or practice. At the beginning of 1919 he joined the Lloyd George ministry as undersecretary for India, being raised to the peerage as Baron Sinha of Raipur and made a member of the privy council. He skilfully conducted the Government of India act. 1919, through the house of lords. At the close of 1920 he was appointed governor of Behar and Orissa. being the first Indian to preside over a British province. Ill-health prevented him from serving his full term in that office; in 1921 he resigned. In 1926 Sinha was appointed a member of the judicial committee of the privy council. He was opposed to the setting up of the statutory commission on the government of India at an earlier date than that indicated in the Government of India act, 1919, in view of the divided state of India; but, the decision once taken. he supported the Simon commission. He died March 5. 1928.

Sinha is remembered by Indians as the first to break down all the barriers against Indians. and by lawyers as a learned. patient and courteous judge. Circumstances drove him into politics but his real interests lay in the progress of education.

SINHAILIEN, (HSIN-HAI-LIEN). an important city and rail-terminal seaport on the Yellow sea in north Kiangsu province, China. It is an amalgamation of several settlements founded at different times. bearing many individual names between 1900 and 1949. Haichow (Hai-chou) mas the name once applied to an old junk port at the coastal end of a canal system. Sinpu (Hsin-p'u) was the early inland eastern terminal of the Lunghai railway. Lao-yao and Lien-yun-kang appeared on some maps to name a new deepwater port built in the 1930s south of the unusable silted estuary of the Yun-yen Ho and Shu Ho. Tung-hai and Ta-p'u both were used as names for the central portion of the urban complex. Sinhailien. applied to the whole city, and Lien-yun-kang, applied to the port, were both in use in the second half of the 20th century. Pop. (1953) 207.600. (J. E. SR.)

SINING (HSI-NING), capital of Tsinghai province. China, on the south bank of Sining river, a tributary of the Yellow river! and 110 mi. W.N.W. of Lanchow. Sining, which is situated on the northeast margin of the Tibetan highlands at an elevation of 7,500 ft., is the centre of an agricultural district east of Lake Koko-Nor. producing spring wheat and barley. Wool, hides and salt are also marketed. Long linked only by highways with the rest of China. the city was in 1959 reached by a railroad from Lanchom. Sining is the gateway to the Tsaidam basin. where the Chinese have developed new petroleum fields and mining industries. Pop. (1953) 93.700. (T. SD.)

SINKIANG (HSIN-CHIANG), name of a former province of westernmost China, converted Sept. 1955, into the Sinkiang Uigur Autonomous Region (Hsin-chiang Uigur Tzu-chih Ch'ü), a political division at the provincial level set aside for the Uigur ethnic minority. Area 635.829 sq.mi.; pop. (1957 est.) 5,640,000. The name Sinkiang means "new borderland" and is roughly coextensive with what was historically known as Chinese Turkistan.

Sinkiang is bordered on the northeast by the Mongolian Peoples Republic. on the southwest by Kashmir and a narrow strip of Afghanistan, and on the west and north by the Central Asian republics of the Soviet Union. Physiographically, Sinkiang consists of two mountain-ringed basins separated by the east-west-trending Tien Shan (*q.v.*). The Dzungarian basin, in the north, has an elevation of 600 to 1,500 ft., and receives summer rainfall that makes Dzungaria (*q.v.*) ideal as a grazing land. The Tarim (*q.v.*) basin, south of the Tien Shan, has an average elevation of 2.500 to 3,000 ft. It is much more arid than Dzungaria, and its centre is occupied by the sandy Takla Makan (*q.v.*) desert. At the eastern end of the Tarim basin lies the salt lake and marshland of Lop Nor (*q.v.*).

Sinkiang is multinational. The Uigurs, a Moslem Turkic-speaking people, the most important ethnic group, numbered 3,640,125 persons (1953) and comprised 75% of the regional population. They settled primarily in irrigated agricultural oases along the northern foot of the Tien Shan, and around the edge of the Tarim basin. The second largest ethnic group is the Kazakh. also a Moslem Turkic people. related to the Kazakhs of the Soviet Cnion. They numbered 475.000 in Sinkiang in the 1953 census. Unlike the Uigurs, the Kazakhs are primarily nomadic herders and graze their livestock in the Dzungarian pasture lands where a separate political division (Ili Kazakh Autonomous Chou, with its capital at Kuldja) was set aside for them. The Kazakhs also have two autonomous *hsien* (counties); at Mu-lei-ho and Barkol (Chen-hsi), in eastern Sinkiang (see also TURKS OR TL-RKIC PEOPLES.)

There were about 300,000 Chinese in Sinkiang, residing mainly in cities and towns. where they worked as government officials, merchants and professional people. Chinese Moslems (*Hui*), numbering 200.000 in 1953. were concentrated in the Urumchi area in the Ch'ang-chi Autonomous Chou and also in the Yen-ch'i Autonomous district. south of the Tien Shan. There were 120.000 Mongols in Sinkiang occupied mainly as livestock herders. Mongol autonornous areas include the Boro Tala. Autonomous Chou, on the south slopes of the Dzungarian Ala-Tau on the Soviet border; the Bayin Gol Autonomous Chou in the basin of the lake

Baghrash Kol south of the Tien Shan; and the Kobuk-Sai-li Autonomous district, on the slopes of the Saur range on the Soviet border. The Kirghiz people (70,000 in 1953) constitute the Kizil Darya Autonomous Chou, north and west of Kashgar, adjoining the Kirghiz S.S.R. of the Soviet Union. About 20,000 Sibo people, a Tungusic group near Kuldja, and 15,000 Tadzhiks are also set up in an autonomous district. (See also MONGOLS; KIRGHIZ, TUNGUSES; TAJIKS.)

Sinkiang's economy is primarily agricultural. Its cultivated land was expanded after 1949 through addition of new irrigated areas, such as the Manas river project on the northern foot of the Tien Shan. Grain crops, mainly wheat, corn, kaoliang and sorghum and ginned cotton are important products of the Tarim basin oases. Sinkiang's livestock herds, estimated about 21,000,000 head in the late 1950s, included about one-quarter of China's sheep, which yielded more than 60% of the nation's wool. In the early 1960s industry was in an early stage of development. with handicrafts (cotton goods. paper. rugs, leather goods and jade articles) accounting for two-thirds of the total value of manufacturing. The principal cities and their 1953 census populations are: the regional capital, Urumchi (140,700), Kashgar (91,000), Yarkand (80,000) (*qq.v.*), I-Ning (Kuldja) (108,200) and Aksu (90,000). The development of modern industry depends in part on the development of the region's mineral resources and the construction of modern transportation routes. Petroleum was produced on a small scale at Tu-shan-tzu, near Wu-su. A large petroleum centre at Karamai, 70 mi. N. of Wu-su. was under development in the early 1960s. Mineral prospects also include tungsten, molybdenum and other nonferrous metals, as well as coal and iron ore. A major railroad crossing Sinkiang from Kansu province to the junction of Aktogai on the Turksib railroad in the Soviet Union was completed in the early 1960s.

South Sinkiang was controlled by China (200 B.C.–A.D. 220) during the Han dynasty. The Uigurs ruled for many centuries until the area was conquered by Jenghiz Khan and his successors and later by the Kalmucks, Sinkiang eventually came under Chinese control in the 17th century during the Manchu dynasty. It became a Chinese province in 1884. During the Kationalist period, warlords ruled Sinkiang, sometimes with Soviet support. Chinese Communists seized control in Oct. 1949. (T. SD.)

SINKING FUNDS: see DEBT, PUBLIC.

SINO-JAPANESE WAR: see CHINESE-JAPANESE WAR (1894–95).

SINOP, the capital of an *il* on the north coast of Turkey, on a low isthmus joining the promontory of Boz Tepé to the mainland. Though it possesses the only safe roadstead between the Bosporus and Batum, the difficulties of communication with the interior and rivalry of Ineboli on the west and Samsun on the east prevented Sinop from becoming a great commercial centre. It is shut off from the plateau by forest-clad mountains. Pop. (1960) 9,899. On the isthmus stands a huge but for the most part ruined castle, originally Byzantine and afterward strengthened by the Seljuk sultans. The Mohammedan quarter is surrounded by massive walls. Of early Roman or Greek antiquities there are only the columns. architraves and inscribed stones built into the old walls; but the ancient local coinage furnishes a very beautiful and interesting series.

See M. Six, paper in *Numismatic Chronicle* (1885); Babelon and Reinach, *Recueil des monnaies grecques d'Asie* Mineuve (1903).

Sinop, whose origin was assigned by its ancient inhabitants to Autolycus, a companion of Hercules, was founded 630 B.C. by the Ionians of Miletus, and ultimately became the most flourishing Greek settlement on the Euxine, as it was the terminus of a great caravan route from the Euphrates through Pteria to the Black sea, over which were brought the products of central Asia and Cappadocia (whence came the famous "Sinopic" red earth). In the 5th century B.C. it received a colony of Athenians, and by the 4th it had extended its authority over a considerable tract of country. Its fleet was dominant in the Euxine. except toward the west, where it shared the field with Byzantium. When in 220 B.C. Sinop was attacked by the king of Pontus, the Rhodians enabled it to maintain its independence. But where Mithradates IV failed, Pharnaces succeeded; and the city, taken by surprise in 183 B.C., became the capital of the Pontic monarchy. Under Mithradates VI the Great, who was born in Sinop, it had just been raised to the highest degree of prosperity, with fine buildings, naval arsenals and well-built harbours, when it was captured by Lucullus and nearly destroyed by fire (70 B.c.). In 64 B.C. the body of the murdered Mithradates was brought home to the royal mausoleum. Under Julius Caesar the city received a Roman colony, but was already declining with the diversion of traffic to Ephesus, the port for Rome, and in part to Amisus (Samsun). In the middle ages it became subject to the Greek empire of Trebizond. and passed into the hands of the Seljuk Turks. and in 1461 was incorporated in the Ottoman empire. In Kov. 1853 the Russian vice-admiral Nakhimov destroyed there a division of the Turkish fleet and reduced a good part of the town to ashes.

SINS, SEVEN DEADLY, a classification that goes back to the early history of Christian monasticism. A sin was classified as deadly not merely because it was a serious offense morally but because "it gives rise to others. especially in the manner of a final cause" or motivation (Thomas Aquinas). The traditional catalogue of the seven deadly sins is: (1) vainglory or pride; (2) covetousness; (3) lust, understood as inordinate or illicit sexual desire; (4) envy; (5) gluttony. which usually included drunkenness; (6) anger; and (7) sloth. sometimes called acedia or accidia. The classical discussion is in Thomas Aquinas, *Summa* theologine, i–ii. Q. 84. art. 4. (J. J. PN.)

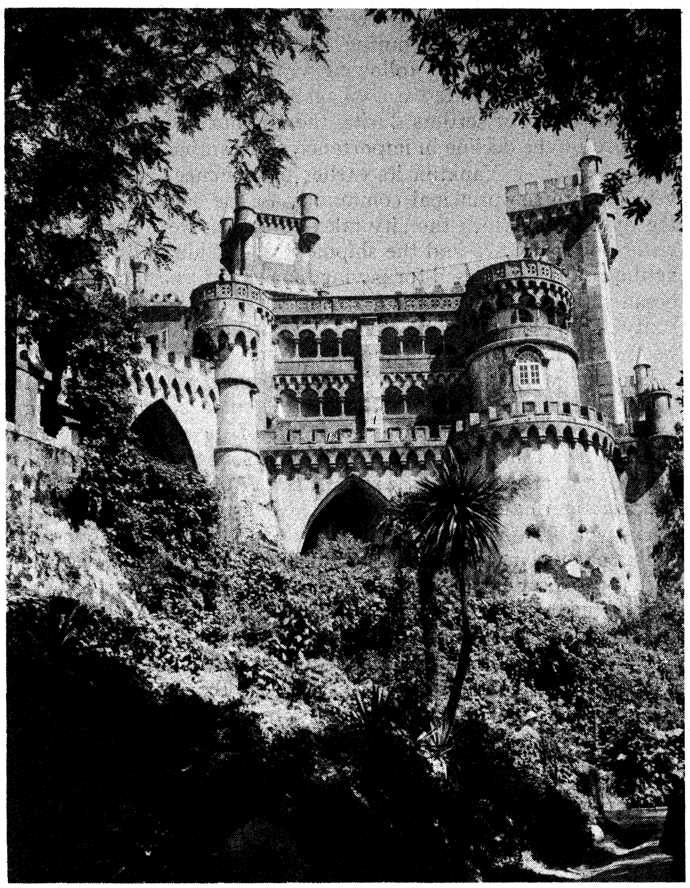
SINTER, in petrology, certain mineral deposits, more or less porous or vesicular (cinderlikei in texture. At least two kinds of sinter are recognized: one siliceous, the other calcareous. Siliceous sinter is a deposit of opaline or amorphous silica from hot springs and geysers. occurring as an incrustation around the springs, and sometimes forming conical mounds or terraces. The deposition of siliceous sinter is largely due to the action of algae and other forms of vegetation in the thermal waters. Siliceous sinter has also been called geyserite and fiorite.

Calcareous sinter is a deposit of calcium carbonate. exemplified by travertine. which formed the principal building stone of Rome. and was named from the Italian *travertino,* a corruption of *tiburtino,* the stone of Tibur. now Tivoli (see STONE). So-called petrifying springs, not uncommon in limestone districts, yield calcareous waters which deposit a sintery incrustation on objects exposed to their action.

The cavities in calcareous sinter are partly due to the decay of mosses and other vegetable structures which have assisted in its precipitation. Even in thermal waters, like the hot springs of Carlsbad, Bohemia, which deposit *Sprudelstein,* the origin of the deposits is mainly due to organic agencies, as shown as far back as 1862 by the German botanist Ferdinand Julius Cohn. While calcareous deposits in the open air form sinterlike travertine, those in caves constitute stalactites and stalagmites. See also CALCITE; STALACTITES AND STALAGMITES.

SINTRA (CINTRA), a town of Lisboa district, west central Portugal, lies 28 km. (17 mi.) W.N.W. of Lisbon by rail or road. Pop. (1960) 83,646 (municipal). It is picturesquely situated on the northern slope of the Serra de Sintra. a rugged mountain mass largely overgrown with pine, mimosa, cedar, eucalyptus, cork and other trees, above which rise bare and jagged gray rocks (Cruz Alta. 1,732 ft.). The beauty of Sintra is celebrated by Lord Byron in *Childe* Harold and by Luis Vaz de Camões in *Os* Lusiadus. On one of the peaks is the Palacio da Pena, a fantastic 19th-century building. partly an adaptation of a 16th-century monastery and partly an imitation of a medieval fortress. On another peak is the Castelo dos Mouros, an extensive Moorish fortification. In the town itself is a 12th–15th-century royal palace, partly Moorish. partly debased Gothic, and remarkable for the decoration of its rooms and its two immense conical chimneys. On the road to the village of Colares are the palace and park of Montserrate. The park, with its tropical luxuriance of vegetation and its variety of lake, forest and mountain scenery, is one of the finest examples of landscape gardening in the Iberian peninsula.

Sintra has given its name to two conventions, one in 1509 between Portugal and Castile settling differences concerning voyages



BURTON HOLMES FROM EWING GALLOWAY

PALACIO DA PENA, SINTRA, CASTLE OF FANTASTIC DESIGN BUILT IN THE EARLY 19TH CENTURY

of exploration, and one in 1808 by which the British and Portuguese allowed the beaten French army to return home during the Peninsular War.

SINUIJU, (Japanese, SHINGISHU) a city and capital of North Pyongan province, North Korea, was developed by the Japanese during their occupation (1910–1945) at a site 7 mi. W. of the old city of Uiju where a railroad bridge mas built across the Yalu river connecting with the Manchurian city of An-tung. Sinuiju (or New Giju) is an industrial and commercial city and wood rafted down the Yalu forms the base of a large forest products industry. Trade with Manchuria and China is funneled through the city to Korea. Pop. (1958 est.) 200.000. (S. McC.)

SINUS, in anatomy, is a space filled with blood (as in the sinuses of the brain) or air (as in the cranial bones). The word is also used by surgeons to signify a discharging tract that will not heal and has in many cases a foreign body or dead bone at the bottom. Popularly, however, the term sinus is used most often to designate one of the air-containing cavities connected with the nose. The largest of these cavities (the maxillary sinus. or antrum of Highmore) is contained in the cheek bone; the next in size in the forehead (frontal sinus); smaller cavities open into the back (sphenoidal sinusj and sides (ethmoidal cells) of the nose. The paranasal sinuses are bilateral extensions of the nasal air chambers and are lined with ciliated mucous membrane continuous with that of the nose. *See* SINUSITIS. (S. HA.; X.)

SINUSITIS, in common usage, refers to disease of the paranasal sinuses (see SINUS).

Acute Sinusitis. — This may occur as an aftermath of a cold, due to secondary bacterial infection, or it may be precipitated by faulty breathing habits in swimming or by sudden changes in barometric pressure in flying or diving. Allergy and conditions resulting in lowered general resistance may predispose to attacks. Infections of the upper molar and bicuspid teeth may cause acute maxillary sinusitis.

Symptoms are pain and headache, tenderness over the affected area, nasal obstruction and discharge and malaise. Conservative treatment, bed rest, fluids, heat externally, sedation for pain. and vasoconstrictor sprays to relieve obstruction generally are effective. Persistence of symptoms may indicate the use of suction to promote drainage, and antibiotic therapy, based upon culture and sensitivity studies. X-rays may suggest irrigation of the maxillary or external drainage of the frontal sinus.

Chronic Sinusitis. — Chronic sinusitis may follow repeated or neglected attacks of acute sinusitis, particularly if there is impaired nasal breathing and drainage due to intranasal obstruction. These may be aggravated by poor environmental conditions, dust or excessively dry air of heated dwellings. Dental infection in the upper molar and bicuspid area may cause chronic disease in the maxillary sinus

Symptoms are tendency to colds, purulent nasal discharge, obstructed breathing, loss of smell and sometimes headaches. Pain is rare except during acute phases. Foul-smelling discharge may indicate dental origin. While there may be increased postnasal discharge. its significance often is overstressed. as the normal drainage from the nose is posteriorly to the pharynx Frequently symptoms attributed to sinusitis may be manifestations of general conditions (particularly allergy or disturbance of the endocrine system) or result of faulty nutritional or living conditions or of habitual use of nasal sprays or drugs. Stress and tension may be contributing factors.

Successful treatment depends upon a thorough systematic evaluation of the patient, including X-rays and other diagnostic studies, to determine not only the status of the sinuses but also the significance of any underlying conditions. Surgery may be indicated to restore ventilation and drainage, to eliminate irreversibly diseased tissues and to avoid complications. (F. T. HI)

SION, the capital of the Swiss canton of Valais (1,680 ft. above sea level). There are (1960) 16,051 inhabitants (mainly Roman Catholics). The majority of the population of the town is French-speaking. Sion (Sedunum) dates from Roman times. and the bishop's see was removed thither from Martigny (Octodurum) about 580. In 999 the bishop received from Rudolf III, king of Burgundy. the dignity of count of the Valais, and henceforward was the temporal as well as the spiritual lord of the Valais, retaining this position, at least in part, till 1798. Sion is one of the most picturesque little cities in Switzerland. being built around two prominent hillocks. The north hillock is crowned by the castle of Tourbillon (built 1294, burned 1788), which was long the residence of the bishops. The south hillock bears the castle of Valeria (which contains an historical museum) with the interesting 13th-century church of St. Catherine.

SION COLLEGE, in London. an institution founded as a college. guild of parochial clergy and almshouse. under the will (1623) of Thomas White, vicar of St. Dunstan's in the West. The clergy who benefit by the foundation are the incumbents of the city parishes, of parishes which adjoined the city bounds when the college n·as founded and of parishes subsequently formed out of these. The original buildings in London Wall were on a site previously occupied by Elsing Spital, a hospital for the blind founded in 1320, and earlier still by a nunnery. They comprised the almshouses, a hall and chapel and the library added to the foundation by John Simson, rector of St. Olave's, Hart street; one of White's executors. There were also: at least originally, apartments for students. In 1884 the almshouses were abolished and the almsfolk became outpensioners. It was subsequently found possible to extend their numbers from the original number of 10 men and 10 women to 40 in all, and to increase the pension. In 1886 Sion college was moved to new buildings on the Victoria embankment and is now principally known for its theological library. A governing body appointed by the members to administer the foundation consists of a president, two deans and four assistants.

SIOUAN INDIANS. This great family of American natives takes its name from that of the largest tribe, the Sioux or Dakota (*q.v.*). Next to the Algonkin, they were perhaps the most populous stock north of Mexico. They held three territories, the largest mainly west of the Mississippi river, another, east of the Appalachian mountains in Virginia and the Carolinas; the smallest, in two fragments, in Mississippi. The last two divisions are nearly extinct. The culture was not uniform, but accorded with the region in which each tribe lived. Physical types probably varied similarly. In the Plains area, the Siouans were the preponderant linguistic stock. The principal Siouan tribes were (those asterisked being separately treated): (1) in the nest, *Dakota and *Assiniboin, the former really seven tribes: *Mandan, *Hidatsa and *Crow; *Winnebago; tribes speaking the Chiwere dialect, namely the Iowa, Oto Missouri; tribes speaking Dhegiha, viz., *Omaha, Ponca, Kansa, *Osage, Quapaw or Arkansas; (2) in the south, Ofo and *Biloxi; (3) in the east, Monacan, Manahoac, Tutelo, Saponi, Occaneechi, Woccon, *Catawba, Santee, Cheraw or Sara, and probably Wateree, Congaree, Pedee and others. About 40,000 remain; the original numbers were probably at least twice as great. See also Index references under "Siouan Indians" in the Index volume. (A. L. K.; X.)

SIOUX CITY, a city of northwestern Iowa, U.S., is located on the bluffs of the Missouri at the mouths of the Big Sioux and Floyd rivers, where the states of Iowa, South Dakota and Nebraska meet; a port of entry and the seat of Woodbury county.

In 1804 Captains Meriwether Lewis and William Clark visited the site of Sioux City and there buried Sgt. Charles Floyd, the only man lost on their famous journey (see LEWIS AND CLARK EXPEDITION). Theophile Bruguier, a French-Canadian fur trader, settled there in 1849 and married the daughter of War Eagle, a powerful chief of the Yankton Sioux. In 1854 John K. Cook platted Sioux City while surveying the region for the U.S. government. It prospered originally as a supply centre for the northern plains and as a land-office town. The first steamboat from St. Louis reached Sioux City in 1856 and in 1857 the city, with a population of 400, was incorporated. The first railroad arrived in 1868 and the first meat-packing plant was opened a few years later. During the boom of the 1880s, when settlers occupied northwestern Iowa and the Dakotas, the packing industry expanded and the population jumped from 7,366 to 37,806. Although retarded by depression in the 1890s, during which its population dropped, Sioux City grew rapidly between 1900 and 1920 when its population topped 70,000. Pop. (1960) 89,159; standard metropolitan statistical area (Woodbury county) 107.849.

Early settlers in Woodbury county came mainly from the Ohio valley, New York, Pennsylvania and older Iowa. French Canadians, Germans and Scandinavians also settled there and a Russian group was present by 1900. A community of Negro packing-house workers developed after 1910.

The Sioux City stockyards receive large consignments of local and out-of-state livestock for slaughter and packing. Commerce is also marked by heavy wholesale trade and grain exchange activity. Besides meat packing, industries include food processing and feed and clothing production, as well as other diversified manufactures.

Morningside college, a Methodist liberal arts institution which maintains a conservatory of music, was founded in Sioux City as the University of the Northwest in 1889. In 1930 the Sisters of St. Francis established Briar Cliff college (Roman Catholic) for women. Sioux City has a symphony orchestra and an extensive park system in which are preserved memorials of. Indian days including War Eagle's grave and the Council Oak of the Sioux. Sioux City adopted a commission form of government in 1910 and in 1953 switched to the council-manager plan. (A. G. Bo.)

SIOUX FALLS, the seat of Minnehaha county, in southeastern South Dakota, U.S., a few miles from the Minnesota border and about 75 mi. N. of Sioux City, Ia., on the rolling hills and in the wooded valley bordering the Big Sioux river. Pop. (1960) 65,466; standard metropolitan statistical area (Minnehaha county) 86,575. (For comparative population figures see table in SOUTH DAKOTA: Population.) The population of the city is much like that of the Dakota farm area, heavily Scandinavian and German. There are few Indians.

Except for an early fur-trading establishment that later became Fort Pierre, Sioux Falls is the oldest community in South Dakota. It was founded in 1857 by Iowa and Minnesota land speculators who were disappointed when in 1861 Yankton, rather than Sioux Falls, was named capital of the new Territory of Dakota. The settlement was deserted during the uprising of the Minnesota Sioux which started the following year. Settlement dates from 1870; it was incorporated as a village in 1877 and as a city in 1883. With the influx of settlers during the Dakota boom of the 1880s, followed by the decline in importance of steamboat transportation which had given Yankton its earlier prominence, Sioux Falls developed into the principal community in the state. The falls of the river, from which the city takes its name, were harnessed for water power in 1873 and the shipment of "Sioux Falls granite." a hard quartzite once used for paving blocks and as a building stone, began with the arrival of the first railroad in 1878. Because of the laxity of the South Dakota divorce laws prior to 1908 Sioux Falls was for a time nationally famous as a "divorce mill."

Located in an area of diversified farming where corn is the principal crop and livestock feeding the main source of income, Sioux Falls came into its own as a result of the wide use of trucks and the increasing dependence of farmers upon specialized farm machinery, fertilizers and mixed feeds. A distributing centre for the neighbouring farm area of Iowa, Minnesota and South Dakota, it has over 200 wholesale firms. Its main industries are food processing, particularly meat packing, and wood and metal fabrication. Farm prosperity of the World War II period, which lasted several years after the war, also helped to build Sioux Falls as a shopping, entertainment and commercial centre.

Educational facilities include Augustana, a Lutheran college founded in 1860, and Sioux Falls coflege, a Baptist institution established in 1883. The city has several parks and two golf courses. It has superior medical facilities, including a veterans hospital and a crippled children's hospital. The state penitentiary and a school for the deaf are also located there. (E. W. ST.)

SIOUX INDIANS: *see* DAKOTA.

SÍPHNOS (It. SIPHANTO; mod. Gr. SIPHÉNO), an island of the Greek archipelago, 30 mi. S.W. of Sýros (area 32 sq.mi.). Along the west slope of a limestone ridge, whose principal summits, Hagios Elias and Hagios Simeon, are crowned by old Byzantine churches, lies a series of villages, each whitewashed house with its own garden and orchard. Apollonia, the modern capital, has the name of an ancient town: Kastro has medieval fortifications, and the town hall bears the date 1365. Inscriptions show that Kastro represents the ancient city of Siphnos. Another ancient town, Minoa, is marked by two Hellenic white marble towers known as the Pharos (lighthouse) and St. John. Byzantine churches and convents are scattered about the island. The School of the Holy Tomb was founded by Greek refugees from the iconoclastic persecutions at Byzantium and became a centre of culture. Its endowments are held by the Gymnasium of Syra. In ancient times Siphnos was colonized by Ionians from Athens. It refused tribute to Xerxes, and sent one ship to fight on the Greek side at Salamis. It was famous for its gold and silver mines, easily recognized by excavations and refuse heaps. In antiquity, as now, it exported pottery. During the Venetian period it was ruled first by the Da Corogna family and after 1456 by the Gazzadini, who were expelled by the Turks in 1617.

SIPHON (SYPHON), an instrument, usually in the form of a bent tube, for conveying liquid over the edge of a vessel and delivering it at a lower level (Lat. sipho; Gr. siphon, "a tube"). The action depends upon the difference of the pressure on the liquid at the extremities of the tube, the flow being toward the lower level and ceasing when the levels coincide. The instrument affords a ready method of transferring liquids over a hump or elevation, and is made of glass, india rubber, copper or lead, according to the liquid which is to be transferred. The simple siphon is used by filling it with the liquid to be decanted, closing the longer limb with the finger and plunging the shorter into the liquid; and it must be filled for each time of using. Innumerable forms have been devised, adapted for all purposes and provided with arrangements for filling the tube or for keeping it full and starting it into action automatically when required. Pipes conveying the water of an aqueduct across a valley and following the contour of the sides are sometimes siphons, when they depend on the principle of the above instrument. Such a large siphon must be fitted with a valve for getting rid of entrapped air at the top of the hump or upper elevation of the siphon pipeline. In the siphon used as a container for aerated waters a tube passes through the neck of the vessel, one end terminating in a curved spout while the other reaches to the bottom of the interior. On this tube is a spring valve which is opened by pressing a lever. The vessel is filled through the spout, and the water is driven out by the pressure of the gas it contains, when the valve is opened. The "Regency portable fountain." patented in 1825 by Charles Plinth, was the prototype of the modern siphon, from which it differed in having a stopcock in place of a spring valve. The "siphon champenois" of Deleuze and Dutillet (1829) was a hollow corkscrew, with valve, which was passed through the cork into a bottle of effervescent liquid, and the "vase siphoïde" of Antoine Perpigna (Savaresse *père*), patented in 1837, was essentially the modern siphon, its head being fitted with a valve which was closed by a spring.

SIPHONAPTERA, an order of insects (*q.v.*) comprising the flea (*q.v.*), which are also known as the Aphaniptera.

SIPPAR, a city of ancient Mesopotamia, situated in 33° N., 44° E. The site today lies 5 mi. E. of the Euphrates, just south of the Royal canal (Nahr al Malik), but in ancient times the Euphrates flowed by the city. The temple of E-Babbar, "the House of the Sun," and its stage tower (ziggurat) occupied a terrace beside the river with a superficial area of about 1,300 sq.ft. East of the temple area and separated from it by a wide avenue lays the residential quarter, the whole city being surrounded by a wall. This wall forms a rectangle, 860 yd. wide and 1,400 yd. long, the long sides facing north and south. The excavations in the northern part of the eastern mound and on the ziggurat produced more than 60,000 tablets, chiefly contracts, and religious and grammatical texts of Neo-Babylonian date. The antiquity of the city, however, is shown by the fact that there are ancient records of the Euphrates being called the river of Sippar. Its Sumerian name appears to have been Zib-Bar Nun. The Sumerian sun-god was identified with the Semitic Shamash, and it was in this city that the sun-god had his principal cult. In ancient times the two rivers approached closely there and the site therefore commanded the entrance to the southern plain from the north.

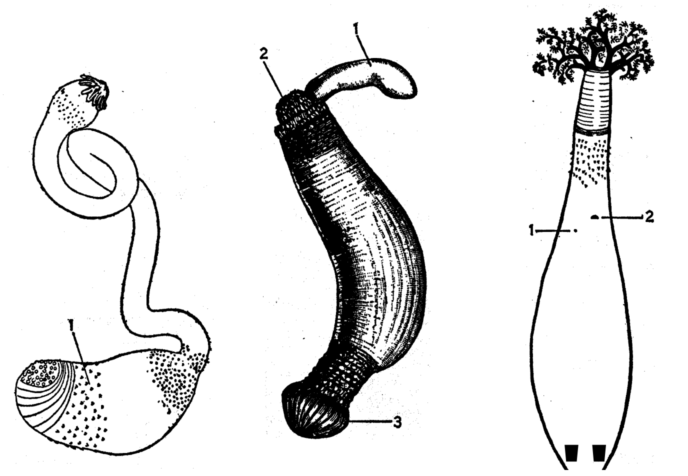
See Cambridge Ancient History, vol. i, with bibliography (1923).

SIPUNCULIDA, a phylum of marine worms which inhabit burrows, tubes or borrowed shells and which are adapted for this mode of life by a forward displacement of the anus, situated on the dorsal surface near the base of the proboscis. The body is thus elongated in a ventral direction almost at right angles to the anteroposterior axis, as it is in Bryozoa (see POLYZOA) and Phoronida (*q.v.*). This curious arrangement led E. R. Lankester to coin the name Podaxonia for them. The Sipunculida are distinguished from the Annelida (*q.v.*) not so much by the position of the anus —in some annelids the anus may be displaced dorsally—as by an apparent total lack of segmentation. The phylum Gephyrea, created by Jean L. A. de Quatrefages de Bréau to include Sipunculida, Echiurida (*q.v.*) and Priapulida (*q.v.*), cannot be sustained in view of the lack of relationships between its members, although it has persisted with remarkable tenacity in the literature.

External Characters.—The body of a sipunculid is divided into two regions, a trunk consisting chiefly of the elongated belly of the worm and a retractile proboscis which bears the mouth at its anterior end. The mouth is partly or completely surrounded by tentacles or tentacle-bearing folds. Many authors prefer to call the proboscis an introvert, to distinguish it from the proboscis-like prostomium of the Echiurida, which is a preoral lobe projecting forward above the mouth. Retractor muscles, of which the typical number is four but which may be reduced to two or only one, originate from the body wall of the trunk region and are inserted at the base of the tentacles. Contraction of these muscles serves to withdraw the proboscis which is invaginated into the body like the finger of a glove. Evagination depends upon hydraulic pressure, which is developed in the coelomic fluid by contraction of the circular muscles of the body wall. In *Sipunculus,* according to J. von Uexkull, this contraction may cause a pressure of nearly 600 mm. of mercury, approaching one atmosphere.

The number and arrangement of the tentacles varies widely (fig. 6). The mouth of *Sipunculus* is completely encircled by a lobed fold, frequently indented dorsally so that it assumes the shape of a horseshoe. In many genera the tentacles arise individually and they may or may not form a complete circle. Sometimes, as in most species of Phascolosoma, there are several concentric rings, while four to six branching plumose tentacles characterize the genus Dendrostoma (fig. 1[C]) of tropical and subtropical waters. In very small species, as of the genus *Onchnesoma*, the tentacles may be reduced or represented by tentacular discs.

The proboscis may be smooth but more frequently it is armed with chitinous spines and hooks whose form and arrangement as-



(A) AFTER GEROULD. "PROC. U.S. NAT. MUS."; (B) FROM SHIPLEY, "CAMBRIDGE NATURAL HISTORY" (MACMILLAN AND CO., LTD.); (C) FROM FISHER. "ANN. AND MAG. NAT. HIST." (TAYLOR AND FRANCIS, LTD.)

FIG I.— REPRESENTATIVE SPECIES OF SIPUNCULIDA

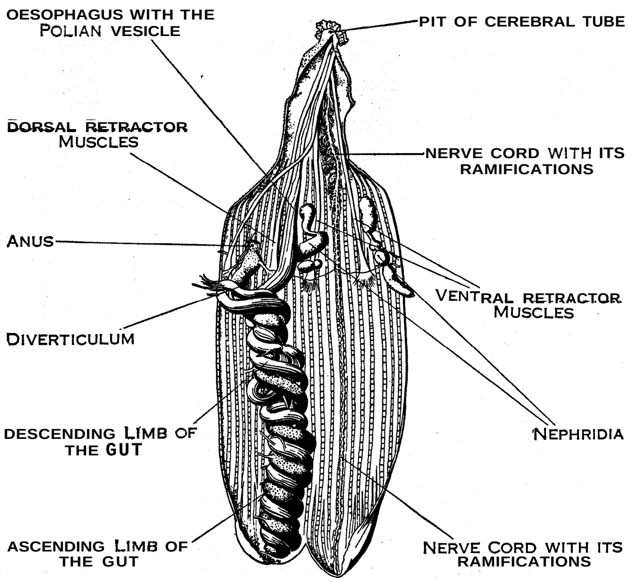
(A) Phascolion *strombi*: (1) holdfasts; (B) Aspidosiphon *truncatus*: (1) prostomium, (2) preanal plate, (3) apical plate; (C) Dendrostoma *petraeum*: (1) right nephridial pore, (2) anus

sumes importance in the identification of species. The anus, usually situated at the base of the introvert, is said to be shifted forward onto the proboscis itself in Onchnesoma. In *Cloeosiphon* the proboscis base is encircled by a calcareous collar formed by rows of close fitting calcified plates. The coral inhabiting symbiont Aspidosiphon (fig. 1[B]) uses a shield-shaped preanal plate to close the mouth of its burrow and on account of the presence of this plate the proboscis itself is displaced ventrally and appears to arise at an angle from the body. In the related genus *Lithacrosiphon* there is a remarkable calcified preanal cone.

The shape of the trunk varies greatly in the different genera. It may be short and saclike or long and vermiform. In Phascolion *strombi* (fig. 1[A]), a common North Atlantic species which inhabits self-cemented tubes of sand grains or empty shells of mollusks. the shape of the body depends upon that of the house in which it lives. Those individuals which inhabit gastropod shells acquire a spiral twist which is almost completely lacking in those that dwell in straight tubes. Nevertheless, in this genus, there is a fundamental asymmetry of the body, only the right nephridium being developed. In correlation with its habit of living in shells, Phascolion is provided with forwardly directed papillae, armed with U- or V-shaped chitinous holdfasts, which are especially abundant toward the apex of the body. Glands in the body wall secrete a substance which cements the lining of the tube and also a conical cap which partially closes the entrance hole. Those genera which have preanal shields often have chitinous or calcified thickenings at the apex of the body. Aspidosiphon has a caplike structure resembling an acorn.

Body Wall.—A simple epithelium secretes a chitinous cuticle, thicker on the trunk than on the proboscis. When horny or calcareous plates are present. they are special secretions of the epidermis. Glandular and sensory papillae, frequently accompanied by hooks and holdfast organs, are found on the trunk and on the proboscis, variously distributed in the different genera and species.

Some are almost completely smooth. Beneath the epidermis there is a connective tissue layer which seems to be more fully developed in some of the larger species. In *Sipunculus,* as in two closely related genera described by J. W. Spengel, coelomic diverticula penetrate into the body wall and may form longitudinal canals beneath the skin. The muscular coat consists of three layers, circular, oblique and longitudinal. The longitudinal coat may be continuous or divided into bundles and this provides a convenient, if not very fundamental, taxonomic character. The retractor muscles of the proboscis are special developments of the longitudinal coat. The muscle fibres are smooth, but histological preparations fixed in a state of isometric contraction simulate an appearance of cross striation (M. Olson, 1940).



FROM THEEL, "NORTHERN AND ARCTIC INVERTEBRATES" (VETENSKAPSAKADEMIEN)

FIG. 2.—GENERAL DISSECTION OF SIPUNCULUS PRIAPULOIDES FROM THE DORSAL SURFACE SHOWING THE INTERNAL ORGANS IN POSITION

Body Cavity.—The body cavity is a schizocoele. It is traversed by muscular strands and small mesenteries which support the internal organs but shows no evidence of true segmentation, although partitions resembling septa have been described in one species, *Siphonosoma cumanense.* It would be difficult to interpret a regular series of folds of this sort as true segmentation, in view of the extreme displacement of the anus and podaxonial elongation of the body. Evidence of true metamerism is found in the larval mesoderm, however *(see* below). Chlorogogue tissue similar to that of the Annelida is found on the coelomic surface of the intestine and its function presents similar problems in the two groups.

Coelomic Fluid.—The fluid itself is isotonic with sea water and contains only traces of protein. Among the various types of corpuscles may be mentioned phagocytic amoebocytes, free chlorogogue cells often aggregated in clumps and nucleated hemerythrocytes. The coelomic fluid also contains complex ciliated structures known as urns and in mature individuals, developing sex cells. Hemerythrin, the respiratory pigment of the hemerythrocytes, is madder pink when oxidized and colourless when reduced. Outside of the sipunculids, it is known only from a single species of polychaet *(Magelona).* It differs from hemoglobin both spectrographically and in its chemical properties. Although it is an iron-containing protein, the prosthetic group has never been identified, and G. F. Marrian believes that it is not hemin. The molecular weight is low, as in the intracorpuscular respiratory pigments of some annelids and vertebrates and differing strikingly from the macromolecular respiratory pigments found in solution in the plasma of other annelids and various invertebrates. According to M. Florkin, the dissociation curve is such that the pigment gives up oxygen to the tissues only when there is an extreme deficiency and as in the intracorpuscular hemoglobin of the echiurid *Urechis,* its main function is to serve as a reservoir which may be drawn upon during times when the worm is confined'to its burrow.

The ciliated urns (fig. 3) are budded off from the coelomic epithelium in certain regions, in *Sipunculus* from the surface of the so-called dorsal Polian vesicle *(see* below), in *Physcosoma* from the gut wall. Each urn is a closed vesicle, covered by flat peritoneal cells and containing fluid with connective tissue strands in its interior. A single ciliated cell sits like a cap on the vesicle, its circlet of cilia forming the brim, as it were, of the hat. The urns are believed to perform two functions: by their movement they aid in the circulation of the coelomic fluid, and the ciliary beat is such that foreign particles are collected in the central crown of the cap. In this way the coelomic fluid is very rapidly cleared of injected particles, as of india ink; such particles are not taken into the interior of the vesicle, but it is supposed that the accumulation is delivered in some way to the nephridia for elimination from the body. Although the presence of these remarkable bodies is very characteristic of the sipunculids, similar structures are found in other invertebrates, as in *Synapta.*

Tentacular System and Polian Vesicles.—Canals lined by an endothelium similar to that of the coelom form the so-called vascular system (fig. 4). A circular lophophoral vessel forms a ring surrounding the mouth and closely associated above with the brain; canals extend forward from it into the tentacles while one or two backwardly projecting blind tubes lie against the wall of the esophagus, above and below. These tubes, the so-called hearts or Polian vesicles, are named after a fancied resemblance to structures of that name in echinoderms. In small forms with reduced tentacles they may be lacking, while in some species of *Phascolosoma* the esophagus is studded with large numbers of little vesicles communicating with the main tube. The embryological origin of this system is not known but the canals contain corpuscles similar to those of the coelom and, in *Sipunculus,* the urns are budded off from both surfaces of the Polian vesicle, forward into the lacuna and backward into the coelom. Morphologically, the tentacular system is therefore probably a part of the body cavity; physiologically it appears to perform two different functions. P. R. Awati and L. P. Pradhan have shown that in *Dendrostoma signifer,* a tropical species with branching tentacles, the Polian vesicle is a pulsating organ which pumps the fluid alternately in and out of the lophophoral canals by frequent reversals of its beat. The fluid is thus kept in motion and hemerythrocytes are circulated in and out of the tentacles by lateral and median vessels. On the other hand, in forms like *Sipunculus* in which the tentacles are short, the respiratory function of the canals may be subservient to a hydrostatic function. When the proboscis is everted the pressure set up in the body cavity compresses the Polian vesicles and fluid is thus forced forward into the tentacles, causing them to become extended.

Digestive System.—The mouth lacks jaws. A ciliated esophagus lying in the proboscis is followed by the long, coiled mid-gut. The latter passes backward in a loop to the apex of the body and then forward again to the anus. The limbs of this loop are usually twisted together in a spiral. This spiral is frequently supported by a spindle muscle which originates near the anus, traverses the central axis of the spiral and inserts itself apically. The mid-gut opens into a short hind-gut which often receives a blind sac and with which are associated anal glands of unknown function.

Sipunculids feed on organic matter contained in mud and sand which is taken up by the tentacles and swept into the mouth by ciliary action. The mid-gut is generally laden with such material and it has been suggested that these worms play an important role in the comminution of mineral matter on the floor of the ocean, similar to that played by earthworms on the land.

Vascular System.—A true vascular system appears to be rudimentary but it is probably represented by a closed system of lacunae in the walls of the intestine. The functions of the blood are largely taken over by the coelomic fluid. The tentacular lacunae, discussed above, are frequently considered to be blood vessels.

Respiration.—Respiratory exchanges probably take place through the skin and in forms like *Sipunculus,* which have sub-epidermal coelomic skin canals, this function must be greatly facilitated. In others, as in *Dendrostoma,* the gill-like branching tentacles may be the chief respiratory organ.

Excretory Organs.—A pair of metanephridia of relatively simple structure opens on the ventral surface of the body in front of the level of the anus. In *Phascolion* and *Onchnesoma* the development of one member of the pair, usually the left, is suppressed. The tube may be straight or U shaped, and the limbs of the U may be more or less completely fused. Excretion takes place through the mediation of special cells lining the tube and also, apparently, by the migration. of excretophores from the coelomic fluid into the lumen. The ciliated nephrostome may also play a part in collecting waste products, but it is believed to serve primarily as a collecting organ for the genital products which develop in the coelom.

Nervous System.—Paired cerebral ganglia form a bilobed brain which is situated above the pharynx and closely associated with the special sense organs (fig. 5). The brain may lie quite superficially beneath the skin, as in *Phascolosoma verrillii,* or it may be more or less deeply sunken at the bottom of a cephalic tube that communicates with the exterior by a small opening behind the tentacles. According to J. H. Gerould, the development of the cephalic tube is probably an adaptation to burrowing; it reaches an extreme condition in species like *Sipunculus nudus* which may dig themselves down to nearly a metre in loose sand. In some species the cephalic tube is said to open into the mouth, a condition which led M. A. Hérubel to make an interesting if somewhat fantastic comparison with the vertebrate hypophysis.

In addition to the neurones of the special sense organs, the brain receives sensory nerves from the tentacles and sends motor nerves to the retractor muscles of the proboscis. Circumpharyngeal connectives unite the brain with the ventral nerve cord which is ganglionated along its whole course and gives off mixed nerves to the body wall. There is no evidence of metameric segmentation. The speed of conduction in the ventral cord approaches that of the somatic motor nerves of cold-blooded vertebrates, 10–20 cm. per second.

Sense Organs.—The surface of the body responds both to tactile and chemical stimuli; sense organs vaguely resembling taste buds are located in the skin papillae and may contain both bipolar sensory neurones and gland cells. Gerould clarified our understanding of the special sense organs, which are of three sorts:

1. The frontal organ, a lobe of the brain which projects forward and is united with an epithelial cushion at the base of the cerebral tube or depression. This cushion consists of a loose mass of epithelial cells several layers in thickness and covered by a very thin cuticle; in it are embedded the spindle-shaped terminations of sensory neurones whose nuclei are situated in the anterior part of the brain. The function is unknown.

2. The nuchal organ, a ciliated paired or quadripartite elevation, resembling the organ of this name in Polychaeta, is present in some genera, above the frontal organ. *Sipunculus,* which has the frontal organ at the bottom of a long cerebral tube, lacks a nuchal organ but the dorsal wall of the canal bears long cilia. Although well innervated its function is unknown.

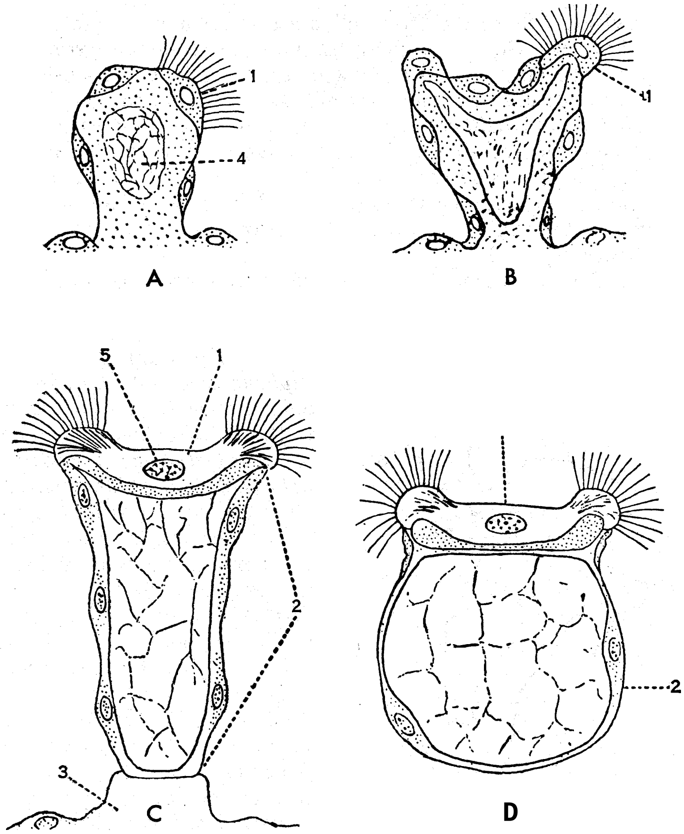
3. Paired eyes are present in sipunculid larvae and persist in the adults of various species. In larvae they are simple pigment spots associated with the future brain; in adults they may disappear or, if present, they may become deeply sunken at the bottom of ocular tubes which lie embedded in the brain and are closed to the exterior by cuticular plugs. Within the ocular tubes a secretion forms a lenslike body. Neurons from sensory cells at the base of the eye communicate by a direct reflex pathway with the motor nerves of the retractor muscles. Retraction in response to a light stimulus is extremely rapid in species which have well-developed eyes.

Reproductive Organs.—The sexes are separate but externally similar. The gonads are attached at the origin of the retractor muscles from the body wall and are of various forms. In *Sipunculus* there are paired branching glands on little stalks; in *Dendrostoma* there is a single transverse ridge. The sex cells are shed into the coelom at an early stage and grow to maturity nourished by the coelomic fluid. The eggs are usually spherical but in *Physcosoma* they are flattened. The nephridia function as gonoducts.

Development.—Segmentation is of the annelidan-molluscan type with spiral cleavage, but developmental studies have only been made upon a very few species. The blastopore forms the mouth, the anus develops later and is situated somewhat dorsally from the very beginning. The retractor and circular muscles are derived from mesectoderm. In *Phascolosoma vulgare* no trace of metamerism was found by Gerould. His later studies show that the "mesoblastic somites" described in parasagittal sections of a larva of *P. gouldii* were probably caused by contraction of the trunk and buckling of the viscera. The free-swimming trochophore of *Phascolosoma* differs from that of annelids in the large yolk-filled cells bearing the preoral, or adoral, band of cilia (prototroch). These cells, disintegrating at metamorphosis, shed their yolk granules and nuclei into the freely circulating coelomic fluid.

The locomotor function of the prototroch is taken over by a metatroch, provided with much longer cilia, which encircles the body below the level of the mouth. In *Sipunculus,* the prototroch, cells form a thin, ciliated mantle, or serosa, cast off at metamorphosis (B. Hatschek).

Natural History.—The sipunculids are bottom dwellers but since the anus is shifted forward toward the mouth it is not necessary for them to inhabit U-shaped tubes with entrance and exit holes, as in the case of echiurids and many tubicolous annelids.



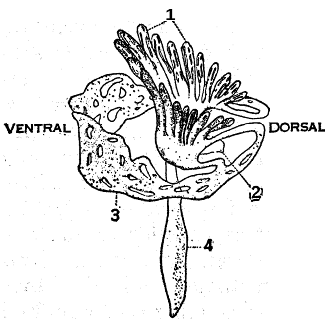
FROM WALTZER, IN KUKENTHAL'S "HANDBUCH DER ZOOLOGIE"

FIG. 3.—SIPUNCULUS NUDUS. DNELOPMENT OF URNS

(1) Ciliated cell forming the cap; (2) vesicle; (3) wall of Poiian vesicle; (4) connective tissue; (5) nucleus of ciliated cell

The proboscis is used in digging and some species burrow to considerable depths. Others construct tubes of their own by cementing sand grains together while yet others take up their abode in tubes of annelids or shells of mollusks. In some species of *Aspidosiphon* there is a kind of symbiosis between the worm and a coral which grows on the outside of the shell. As the coral grows, the worm enlarges its tube which becomes encased in the calcareous base of the coral. In this genus and in others there are horny or calcareous preanal plates which are used to close the mouth of the burrow.

Zoogeographical studies by various authors (M. A. Hérubel, W. Fischer, A. C. Stephen and others) indicate that sipunculids may provide useful marine faunistic indices. North sea species are divided into deep and shallow water groups; an Indo-Pacific element in the South African intertidal fauna is absent, as might be expected, from the west coast. Some species, like those found in the Baltic or *Thalassema dendrorhyncus* from the Chilka lake, are tolerant of low salinities while, according to W. Harms, the Sumatran species *Physcosoma lurco* is terrestrial, living in dry mangrove soil like an earthworm. The probable role of sipunculids in the comminution of the sea bottom has already been referred to. The supposedly planktonic genus *Pelagosphaera* is undoubtedly a larval stage; C. N. Dawydoff observed the metamorphosis of a larva of this type from the coast of Annam.



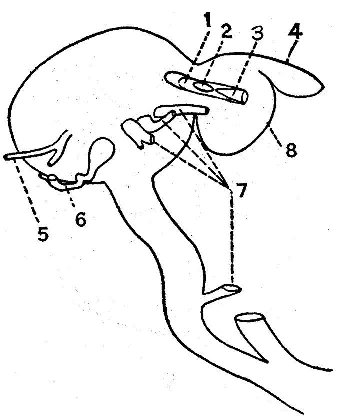
FROM BALTZER, IN KÜKENTHAL'S "HANDBUCH DER ZOOLOGIE"

FIG. 4.—PHYSCOSOMA GRANULATUM. TENTACULAR SYSTEM, INJECTED

(1) Tentacular vessels; (2) blood sinus above the cerebral ganglion; (3) lophophoral vessel; (4) Polian vesicle

Classification. — There appear to be 10 or 12 accepted genera comprising more than 130 species, but the group is badly in need of revision. Since the Sipunculida are so frequently treated as a family of the Gephyrea, there has been no attempt to group the genera into families and in view of the close interrelationships it is probable that any such attempt would be doomed to failure. J. H. Gerould believes that species of the genus *Phascolosoma* provide an ancestral group whose divergent members became specialized in different directions. The only clear-cut distinction appears to lie between those genera which possess calcareous or horny plates and those which do not, but even this grouping is probably artificial.

The following grouping of the genera may prove useful: group **A,** with horny or calcareous preanal and apical plates: *Aspidosiphon* and *Lithacrosiphon;* group B, mith preanal plates only: *Cloeosiphon;* group C, without plates, the longitudinal muscles in bundles: *Sipunculus, Xenosiphon, Siphonosoma* and *Physcosoma;* group D, without plates, the longitudinal muscles in a continuous sheath: *Dendrostoma, Phascolosoma* (= *Golfingia*), *Phascolion, Onchnesoma* and *Siphonomecus.* The arrangement of the tentacles (fig. 6) and the number of retractor muscles provide valuable taxonomic characters.



FROM GEROULD, "TRAN. STAT. ZOOL. WIMEREUX" (PRESSES UNIVERSITAIRES DE FRANCE)

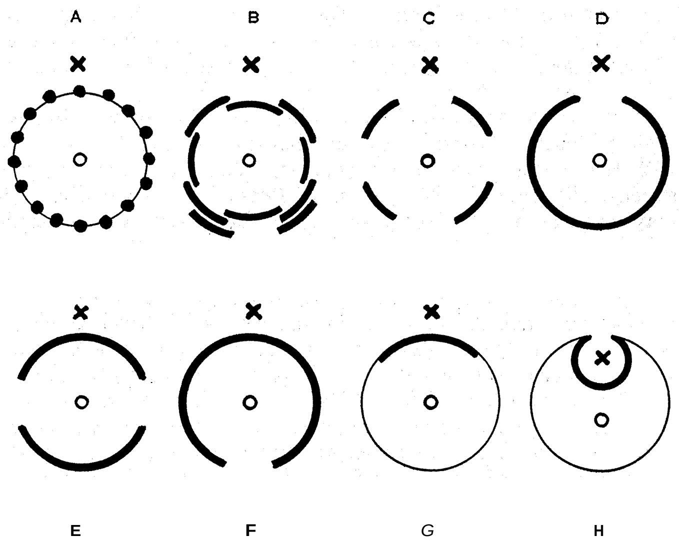
FIG. 5.— CEREBRAL GANGLION OF PHASCOLOSOMA VERRILLII

(1) Ocular tube; (2) rhabdome of ocular tube; (3) plug of cuticula at distal end of ocular tube; (4) nuchal organ; (5) nerve to retractor muscle; (6) nerve to wall of mouth; (7) tentacular nerves; (8) frontal organ

Fossil Remains. — It is uncertain whether any of the remarkable Middle Cambrian forms, some of which were referred by C. D. Walcott to the Gephyrea, can be regarded as sipunculids since the intestine, when preserved, appears to be straight. *Epitrachys,* a supposed sipunculid, has been described from the lithographic shales of Germany (Mesozoic).

Relationships. — There can be no doubt that the sipunculids have pronounced annelidan affinities in spite of their apparent lack of segmentation. The latter condition is possibly a suppression, correlated with the forward displacement of the anus. Molluscan relationships have also been claimed, on embryological grounds; in both groups the blastopore forms the mouth and the sipunculidan prototroch has been compared with the velum of a molluscan larva. The term "Podaxonia" (Lankester), implying close relationships mith the Phoronida (*q.v.*), is misleading. It does not apply accurately to the Sipunculida. the development of which from an extremely simple unsegmented trochophore, by terminal growth backward, is entirely unlike the peculiar larval growth of *Phoronis.*

The total lack of setae may be a primary character but could equally well result from a suppression correlated with the mode of life of the animal; setae are absent in various aberrant annelids, including the entire class of the Hirudinea.



FROM BALTZER, IN KÜKENTHAL'S "HANDBUCH DER ZOOLOGIE"

FIG. 6.— DIAGRAM SHOWING ARRANGEMENT OF TENTACLES. THE CROSS REPRESENTS THE POSITION OF THE BRAIN; THE CIRCLE, THAT OF THE MOUTH

(A) Ancestral type; tentacles in a single or double circle: *Sipunculus, Siphonosoma*, some species of *Phascolosoma, Phascolion;* (B) tentacles in one or more concentric circles: *Phascolosoma* spp.; (C) four or six plumose tentacles: Dendrostoma; (D) tentacle ring interrupted dorsally: Phascolosoma spp.; (E) tentacles in two groups: Onchnesoma (after Hérubel); (F) tentacle ring interrupted ventrally: some species of Aspidosiphon; (G) tentacles restricted to a dorsal crescent: other species of Aspidosiphon; (H) tentacles forming a horseshoe around the brain, open dorsally: Physcosoma

Relationships between Sipunculida, Priapulida and Echiurida are discussed under the title ECHIURIDA.

BIBLIOGRAPHY.—A good account of the Sipunculida is given by F. Baltzer in Kukenthal and Krumbach, *Handbuch der Zoologie,* vol. 2, part 2 *(1931);* the article by W. Harms in the *Handw. Naturwiss.,* 2nd. ed., vol. 9 *(1934)* can also be recommended. There is no modern account in the English language but the article by **A.** Shipley in the *Cambridge Natural History,* vol. 2 (1901), is still interesting and usable although in some respects out of date. *Taxonomy and classification:* keys to the sipunculid genera have been published by many authors but most are either out of date or refer to restricted geographical regions. That given by F. Baltzer appears to be most complete but it includes two genera which are not generally accepted as distinct (*Tylosoma* = ? *Phascolion* and *Petalostoma* = *Phascolosoma)* and excludes the remarkable genus *Lithacrosiphon.* The following provide for the identification of species from certain restricted regions: W. Fischer, *Die Tierwelt der Nord-und Ostsee,* sec. *6 (1925)*; A. C. Stephen, "The Echiuridae, Sipunculidae and Priapulidae of Scottish and Adjacent Waters," *Proc. R. Phys. Soc. Edinb.,* vol. *22,* pp. 159–185 *(1934)*; J. H. Gerould, "The Sipunculids of the Eastern Coast of North America," *Proc. U.S. Nat. Mus.,* vol. *44,* pp. 373–437 *(1913)*; H. Sato, "Studies on the Echiuroidea. Sipunculoidea and Priapuloidea of Japan," *Sci. Rep. Tôhoku Imp. Univ.* (4), vol. *14,* pp. *359–362 (1939)*; for more complete information consult the *Zoological Record. Morphology:* P. R. Awati and L. P. Pradhan, "The Anatomy of Dendrostoma Signifer Selencka and De Man," **J.** *Univ. Bombay,* vol. *4,* pp. 119–125 *(1936)*; *J. H.* Gerould, "The Eyes and Nervous System of Phascolosoma Verrillii and Other Sipunculids," *Trav. Sta. Zool. Wimereux,* vol. *13,* pp. 313–325 *(1939)*; M. Olson, "Histology of the Retractor Muscles of Phascolosoma Gouldii Pourtalès," *Biol. Bull.,* vol. 78, pp. *24–28 (1940)*; Haemerythrin: G. F. Marrian, "A Note on Haemerythrin," **J.** *Exp. Biol.,* vol. *4,* pp. *357–364 (1927)*; a series of articles by M. Florkin, among which may be mentioned "Recherches sur les hémérythrines," *Arch. Int. Physiol.,* vol. *36,* pp. *247–328 (1933)*; evidence indicating a low molecular weight: T. Svedberg and A. Hedenius, "The Sedimentation Constants of Respiratory Proteins," *Biol.*

Bull., vol. 66, pp. 191–233 (1934). Distribution and ecology: A. C. Stephen, "The South African Intertidal Zone and Its Relation to the Ocean Currents. Notes on the Intertidal Sipunculids of the Cape Province and Natal." *Ann.* Natal *Mus.*, vol. 10, pp. 245–256 (1942). *Development*: C. N. Dawydoff, "Quelques observations sur Pelagosphaera, larve de Sipunculide des côtes d'Annam," Bull. *Soc. Zool.* France, vol. 55, pp. 88–90 (1930). (G. E. P.)

SIQUEIROS, DAVID ALFARO (1896–), youngest of the "big three" of 20th-century Mexican mural painters (the others being José Clemente Orozco and Diego Rivera; *qq.v.*), was born in Chihuahua on Dec. 29, 1896. Although he signed his painting "Siqueiros," his true patronymic was Alfaro. A sublieutenant in the Constitutionalist army at the age of 15, Siqueiros had already entered upon a lifelong dual career as artist and militant propagandist. In Paris from 1919 to 1921, he later visited the U.S.S.R., the U.S. and various Latin-American countries. In the 1920s he helped to found the Mexican magazine Machete. During the Spanish civil war of 1936–39 he served in the republican army.

Alone or with organized groups of colleagues, Siqueiros produced thousands of square metres of vivid wall paintings, indoors and outdoors, commonly using synthetic lacquer colours sprayed from paint guns to produce his powerful, brightly coloured effects. In his studio paintings as well as on public walls, he portrayed social, political and industrial change and ferment with a dazzling mixture of photographic realism, illusion and fantasy. His most persuasive and permanent murals are to be seen at the headquarters of the Electrical Workers' syndicate, the Palace of Fine Arts, the Polytechnic institute, the National university, the nurses' home at Social Security hospital no. 1, all in Mexico City, and at Chillán in Chile. Scores of his easel paintings—signed "El *Coronelazo*" after 1943—are in private collections and museums, notably the Museum of Modern Art in New York city.

BIBLIOGRAPHY.—MacKinley Helm, Modern Mexican Painters (1941); David Alfaro Siqueiros, Siqueiros (1951); Bernard S. Myers, Mexican Painting in Our Time (1956). (MACK. H.)

SIRENIA, an order of aquatic placental mammals, comprising the manatees (*Trichechus*), the dugongs (Dugong), the extinct (since the 18th century) Steller's sea cow (Hydrodamalis), as well as their fossil relatives of the Tertiary period. The torpedo-shaped body ends behind in a horizontal tail fluke, as in the dolphins; but in contrast with the latter the broad muzzle is truncate and the transversely expanded lips are very mobile. The name Sirenia was given in allusion to the supposed resemblance of these animals to mermaids. A dugong as seen at a distance from the deck of a ship and especially if floating half upright, with its baby under its flipper, might well be mistaken for a mermaid; and many legends gathered around them in the early days of exploration of the Indian ocean. For the evolutionary history and relationships of the Sirenia, see UNGULATA. See also DUGONG; MANATEE; SEA COW.

SIRENS, in Greek mythology, the daughters of Phorcys the sea-god (Gr. Seirones) or, in later legend, of the river-god Acheloiis and one of the nymphs. In Homer they are two in number (in later writers generally three); their home is an island in the western sea between Aeaea, the island of Circe, and the rock of Scylla.

They are nymphs of the sea, who lured mariners to destruction by their sweet song. Odysseus, warned by Circe, escaped the danger by stopping the ears of his crew with wax and binding himself to the mast until he was out of hearing (Odyssey xii). When the Argonauts were passing by them, Orpheus sang so beautifully that no one had ears for the Sirens. After one or other of these failures they drowned themselves. When the adventures of Odysseus were localized on the Italian and Sicilian coasts, the Sirens were transferred to the neighbourhood of Neapolis (Naples) and Surrentum, the promontory of Pelorum at the entrance to the Straits of Messina, or elsewhere. The tomb of one of them, Parthenope, was shown in Strabo's (v, p. 246) time at Neapolis, where a gymnastic contest with a torch race was held in her honour.

Perhaps the most reasonable explanation of the Sirens is that they are soul birds; *i.e.,* winged ghostly figures who brought the living to join them. They are in this respect not unlike the Harpies (*q.v.*). In early art, they were represented as birds with the heads of women; later, as female figures with the legs of birds, with or without wings.

SIRGUJA (properly SURGUJA), a district in Madhya Pradesh, India. Area 8,623 sq.mi. Pop. (1951) 822.041. In the central part there is fairly well-cultivated country, surrounded on three sides by massive hill barriers and tablelands, of which the Jamirapat, a winding ridge 2 mi. in width, separates it from Chota Nagpur. The southern barrier of the state is the Mainpat, a fine tableland 18 mi. by 6 mi., rising to 3,700 ft. The Ramgarh hill is a rectangular mass of sandstone rising abruptly from the plain, containing a remarkable natural tunnel, many rock caves and remains of temples made of enormous blocks of stone. There are other ruins in the jungles, indicating a higher state of civilization at an earlier epoch than that now prevailing. The majority of the population is made up of a remarkable variety of aboriginal tribes. Surguja, formerly one of the Chhattisgarh states within the Eastern States agency and ruled over by a Rajput family, was merged in Madhya Pradesh on Jan. 1, 1948. The state had been ceded to the British in 1818. The chief town is Ambikapur (pop. 10,-362).

SIRHIND, a tract of land in the Punjab, India. It consists of the northeastern portion of the plain between the Jumna and Sutlej rivers, and is watered by the Sirhind canal, which draws its water supply from the Sutlej near Rupar. The canal, which was opened in 1882, irrigates over 2,000 sq.mi.

SIRICIUS, SAINT (c. 334–399), pope from 384 to 399, was a Roman by birth. In spite of the antipope Ursinus, Siricius was unanimously elected pope in Dec. 384. He often followed the lead of St. Ambrose (*q.v.*), but was conscious that he bore "the burdens of all who are burdened, or rather, the Blessed Apostle Peter carries them in our person," as he wrote to Himerius, bishop of Tarragona, in answer to disciplinary questions. These responses are the earliest surviving texts of papal decretals. St. Jerome's departure from Rome, while not forced by Siricius, was not unwelcome to him. Jerome's later activities in anti-Origenism displeased the pope. Ambrose and Siricius ended the Meletian controversy at Antioch by recognizing Flavian as patriarch. Although he opposed Priscillianism and other errors, Siricius disapproved of Catholic extremists. Siricius was pope when the emperor rebuilt the basilica of St. Paul; a still surviving column commemorates Siricius's dedication. He is venerated as a saint; his feast day is Nov. 26. (W. M. K.)

SIRIONO INDIANS, a group of seminomadic, Guarani-speaking aborigines who live in isolated pockets of tropical forest land in eastern Bolivia. Of a total population of about 2,000 less than a third still roam the forests near the Rio Blanco, the Rio Grande and the Rio Piray. The remainder live in missions or under conditions of forced labour on farms and cattle ranches in the political departments of the Beni and Santa Cruz.

Few tribes of the world are more technologically handicapped than the Siriono in their native state. Their only weapon is a cumbersome bow and arrow; their only tool, a digging stick of palm. They live almost exclusively by hunting and by gathering wild fruits and nuts, although occasionally maize, cassava and papaya are planted in natural clearings in the forest. They wear no clothing and live on the margin of subsistence the year around. They are not warlike, being preoccupied with food getting. The aged and infirm are sometimes abandoned, as is the house when a person dies.

The Siriono are organized into endogamous bands of from 60 to 100 persons. An entire band lives in a single hut, a crude, roughly rectangular palm shelter providing little resistance to wind and rain. Within the hut the matrilineal family groups cluster around a series of hammocks and hearths.

In part because of the difficult nature of supplying sufficient food for survival, ceremonial, aesthetic and religious life are also not highly elaborated among the Siriono. A form of ring dance is practised but no other forms of art are developed. Religion is highly animistic, centred on a fear of evil spirits and monsters.

See Allan R. Holmberg, Nomads of the Long Bow, Institute of Social

Anthropology, publ. no. 10 (1950) for a full account of Siriono life and a bibliography related to the Siriono Indians. (A. R. Ho.)

SIRIUS (the Dog star) is the brightest star of the constellation Canis Major (*q.v.*); it is also visually the brightest star in the heavens. Intrinsically, it is a normal blue star 21 times as luminous as the sun; it is somewhat larger than the sun and has a considerably higher surface temperature. Its apparent brilliance in the skies is mainly because of its relative nearness to Earth. The distance of Sirius from the solar system is 8.6 light-years, which is only twice the distance of the nearest known star beyond the sun. (See also STAR.)

Sirius was known as Sothis to the Egyptians, who early in their history were aware that this star made its first appearance of the season in the twilight before sunrise at about the time when the annual floods were beginning in the Nile delta. The Egyptians long believed that Sothis caused the Nile floods and accordingly was the "creator of all green growing things," as a Pyramid text declares. They discovered that the heliacal risings of the star occurred at intervals of $365\frac{1}{4}$ days rather than the 365 days of their calendar year, a correction incorporated by Julius Caesar (in 45 B.C.) by use of the plan of leap years in his reform of the Roman calendar. Among the Romans the hottest part of the year was associated with the heliacal rising of the Dog star, a connection that survives in the modern expression "dog days."

The fact that Sirius is a binary star was reported in 1844 by F. W. Bessel at Konigsberg. He had observed that the bright star was pursuing a wavy course among its neighbours in the sky instead of going ahead uniformly in a straight line, as a single star would do. Bessel concluded that Sirius had a traveling companion, with which it revolved in a period of about 50 years. This discovery constituted the first chapter in what came to be known as the "astronomy of the invisible"; *i.e.*, the detection of unseen celestial bodies by their effects on visible bodies. The discovery of the planet Neptune two years later by its gravitational effects on Uranus was another famous example. Whereas Neptune was sighted soon after its place in the sky was predicted, the companion of Sirius waited nearly 20 years for direct telescopic verification. The companion was first seen in 1862 by Alvan Clark, a U.S. telescope maker who was using the bright star for testing the lens of the 184-in. refractor now at the Dearborn observatory.

Sirius and its companion revolve together, once around in 49.9 years, in orbits of considerable eccentricity and with average separation of the stars equal to the distance of Uranus from the sun. Despite the glare of the bright star, the 8th-magnitude companion is readily seen with a large telescope except when the two appear closest together, as they did in 1944. The two stars are respectively 2.3 and 1.0 times as massive as the sun. Although the companion has one-third the mass of Sirius and about the same surface temperature, its light is only $\frac{1}{10,000}$ as bright as that of the brilliant star. The conclusion seemed inescapable that the companion has the mass of a star, the size of a planet and therefore a density many thousand times the density of water. Although so high a density of matter seemed surprising at that time when little was known about atomic structure, a test of the conclusion was available from the theory of general relativity. Albert Einstein showed that the lines in the spectrum of a star should be displaced to the red by an amount that is directly proportional to the cube root of the star's mean density. Small enough in the case of the sun to be masked by other factors, this displacement would be conspicuous in the spectrum of an extremely dense star.

W. S. Adams reported (1925) on his observations of the spectrum of the companion of Sirius. He had found the lines displaced in the predicted direction, but by an amount somewhat different than might be expected. It may be that the diffused light of the bright star was confused in the spectrum with that of the companion. Later, D. M. Popper studied the spectrum of another excessively dense star, the 9th-magnitude white dwarf companion of the star 40 Eridani; he reported a red shift of the lines in satisfactory agreement with the shift that would be predicted from the calculated density in this case. *See* also Index references under "Sirius" in vol. 24. (R. H. BR.)

SIRMOOR, a district in Himachal Pradesh, north India. Area 1,095 sq.mi. Pop. (1951) 166,077. In British days it was a princely state subject to the Lahore resident. It was also called Nahan after its chief town (pop. 9,431), which is 33 mi. E.N.E. of Ambala.

The district is in the lower ranges of the Himalayas, between Simla and Mussoorie. On the northern border Chor Peak is at about 12,000 ft. above sea level.

SIROCCO: see WIND.

SIROHI, a municipality and a district in the southwest of Rajasthan. India. The town in 28 mi. N. of Abu Road station, on the main Delhi-Bombay line via Ahmadabad. It manufactures sword blades and other weapons. Pop. (1951) 11,956.

SIROHI DISTRICT (1,973 sq.mi.) had a population in 1951 of 289.791. It is most of the former princely state (1.988 sq.mi.), which under British rule was controlled through the Rajputana agency. After India became independent it was merged with Bombay (Jan. 5, 1949). but ethnic considerations led to its being transferred to Rajasthan (Jan. 24, 1950), with the exception of Abu Road tehsil and part of Dilwara tehsil. The Aravalli range traverses the district from northeast to southwest; 12 mi. S.W. of Sirohi is Mt. Abu (*q.v.*). Much of the district is covered with jungle, in which tiger, bear, leopard and other wild animals abound. Many splendid ruins bear witness to the former prosperity of the country. On Abu the average annual rainfall is about 64 in.; at Erinpura, less than 50 mi. N. it is only 13 in.

In 1823 Sirohi state concluded a treaty with the British. The chief, whose title was maharao, was a Deora Rajput of the Chauhan clan.

SIS (KOZAN; anc. SISION or SISKIA, later FLAVIOPOLIS or FLAVIAS), a kaza in the Adana vilayet of Asiatic Turkey, situated on the left bank of the Kirkgen Su, a tributary of the Jihun (Pyramus), and at the south end of a group of passes leading from the Anti-Taurus valleys to the Cilician plain and Adana. It was besieged by the Arabs in 704 but relieved by the Byzantines. The caliph al-Mutawakkil took it and refortified it; but it soon returned to Byzantine hands. It was rebuilt in 1186 by Leo II, king of Lesser Armenia, who made it his capital. In 1374 it was taken and demolished by the sultan of Egypt, and it never recovered its prosperity. In the 20th century it was only a big village of about 3,000 inhabitants. It has had, however, a great place in Armenian ecclesiastical history from the times of St. Gregory the Illuminator. Gregory himself was there consecrated the first catholicus in A.D. 267, but transferred his see to Vagarshapat (Echmiadzin, Etchmiadzin), whence, after the fall of the Arsacids, it passed to Tovin. After the constitution of the kingdom of Lesser Armenia, the catholicate returned to Sis (1294), the capital, and remained there 150 years. In 1441, Sis having fallen from its high estate, the Armenian clergy proposed to remove the see, and on the refusal of the actual catholicus, Gregory IX, installed a rival at Echmiadzin, who, as soon as Selim I had conquered Greater Armenia, became the more widely accepted of the two by the Armenian Church in the Ottoman empire. The catholicus of Sis maintained himself nevertheless, and was supported in his pretensions by the Porte up to the middle of the 19th century, when the patriarch Nerses, declaring finally for Echmiadzin, carried the government with him. In 1885 Sis tried to declare Echmiadzin schismatic, and in 1895 its clergy took it on themselves to elect a catholicus without reference to the patriarch; but the Porte annulled the election, and only allowed it six years later, on Sis renouncing its pretensions to independence. The lofty castle and the monastery and church built by Leo II, and containing the coronation chair of the kings of Lesser Armenia, are interesting. (D. G. H.)

SISAK, a town of Croatia, Yugoslavia. Pop. (1953) 19,238. Sisak was a flourishing city under Roman rule. Augustus made it a military station; Tiberius chose it as his headquarters against the Pannonian rebels; and Septimius Severus made it the centre of a military government. In the 3rd century the city contained the chief imperial mint and treasury; and an engraved coffer, found in Croatia, dating from the 4th century, represents

Siscia among the five foremost cities of the empire. Its bishopric was removed to Salona in 441, when Attila appeared, and thenceforward the city declined. For a brief period in the 7th and 8th centuries it was held by the Serbian princes, but in the 10th century it was sacked by the Magyars, and in 1092 its territories were bestowed upon the cathedral chapter of Zagreb (Agram) by Ladislaus I. king of Hungary.

Under the walls of its castle, built by this chapter in 1544, the Turks were thrice defeated in 1593. At a fourth venture the city fell, only to be evacuated in 1594. It witnessed a final Turkish defeat in 1641. and from that date until 1918 it was included in the Austro-Hungarian empire.

See C. de St. Aymour, *Les Pays sud-slaves de l'Autriche-Hongrie* (1883).

SISAKET, a province in northeast Thailand, formerly known as Khukhan. Area 3,403 sq.mi. Pop. (1956 est.) 537,890. Chief products include rice, cattle, timber and forest products. In the Dongrek mountains in the south, through which runs the Cambodian boundary, is the lofty Khmer temple complex of Khao Phra Wihan (Preah Vihear), which is one of the most spectacular ruins in southeast Asia. The southern part of the province is peopled primarily by Cambodians and Kui; Thai-Lao predominate in the more densely populated Mun river valley in the north. Sisaket town (pop., 1957, 9,519), the provincial capital, is on the railroad, 31 mi. from its eastern terminus at Ubon. (G. W. Sk.)

SISAL FIBRE, a hard fibre obtained from the leaves of Agave sisalana (family Amaryllidaceae), also known as sisal hemp. It is entirely different from true hemp—the product of Cannabis sativa, which is soft fibre. A closely related plant, Agave fourcroydes, produces the henequen fibre of Yucatán and Cuba, known in the trade as Yucatán sisal and Cuban sisal. Both sisal and henequen are indigenous to Mexico, but the east African colonies, Indonesia and Haiti are the main sources of supply of true sisal fibre.

The common century plant, Agave americana, suggests the habit of sisal and henequen. Both of these plants consist of a large rosette of rigid, straight, fleshy leaves arising from a short trunk. The sisal leaves are dark green in colour and have a terminal spine but ordinarily no marginal prickles. The life period of this plant is from five to ten years. The henequen plant has grayish-green leaves which bear both a terminal spine and marginal prickles. The life period of this plant is from 15 to 25 years. Both sisal and henequen, when mature, produce a flower stalk or pole which develops from the centre of the leaf cluster and grows to a height of 15–25 ft. The light-yellow flowers are borne in dense clusters at the ends of the lateral branches. The flowers of the sisal plant are followed by small bulbils, and those of the henequen plant by both bulbils and seed pods. The plants die after flowering. Both sisal and henequen may be propagated either from the bulbils or from suckers that grow from the rootstocks. The suckers are ordinarily used for commercial plantings. In harvesting, the lower mature leaves are cut off at the base, the spines and prickles are removed and the leaves are carried in bundles to the cleaning machines. The cleaning of these fibres is a scraping process in which the leaves as they pass through the machine are carried over curved metal plates and are scraped by rapidly revolving scraping wheels that remove the pulp and waste material. The fibre is then dried either in the sun or by artificial drying methods, is sometimes brushed and is then graded and baled for market.

COURTESY OF U.S BUREAU OF PLANT INDUSTRY, SOILS AND AGRICULTURAL ENGINEERING

HENEQUEN OF YUCATAN

The leaves are cut, one at a time, with a butcher knife. The first crop of leaves is cut when the plants are 6 or 7 years old, and afterward, two tiers are cut every 6 or 8 months for 8 to 15 years. The best plants average about 250 leaves during their lifetime

These fibres are white to yellowish-white in colour, strong, flexible and in value for cordage purposes are second only to abaci. Henequen is used principally for the manufacture of binder twine, while sisal is used for binder twine and many other types of cordage. These fibres have a limited use in the manufacture of coarse fabrics. See also FIBRE PLANTS. (H. T. Es.)

SISINNIUS, a Syrian, was pope from about Jan. 15 to Feb. 4, 708.

SISKIN (ABERDEVINE; *Carduelis spinus*), a canarylike bird which has long been known in England as a cage bird, is one of the finches (*q.v.*). It often feeds upon the catkins of alder or birch, frequently hanging upside down like a titmouse. Above, the male is olive green marked with black and yellow, and beneath, yellowish-white marked with black. The hen is grayer and streaked with white on its underparts. The male's song is a rapid musical twitter pierced with high squeaky call notes. The siskin breeds locally throughout Europe, and its range stretches across Asia to Japan.

Coniferous woods and thickets are favoured as nest sites. The nest of the siskin is like that of the goldfinch, but not so neatly built; the eggs, except in their smaller size, resemble those of the greenfinch.

A larger and more brightly coloured species, C. spinoides, inhabits the Himalayas. In the United States of America the name siskin or pine siskin is sometimes used for the pine finch (*Spinus pinus*).

SISLEY, ALFRED (1839–1899), French Impressionist painter, essentially a colourist who, like Monet, delighted in recording the changing effects of light in the successive hours of the day, and paid little attention to form, was born in Paris on Oct. 30, 1839, of English parents. He studied painting under Charles Gleyre and was afterward influenced first by Corot and then by the Impressionists Monet and Renoir. He worked both in France and in England and made the Seine, the Loing and the Thames the subjects of many pictures that are remarkable for the subtle appreciation of the most delicate colour effects. His life was one of constant poverty and hard struggle. Sisley died at Moret-sur-Loing on Jan. 29, 1899.

SISMONDI, JEAN CHARLES LÉONARD DE (1773–1842), whose real name was Simonde, was born at Geneva, on May 9, 1773. During the revolutionary disturbances of 1793–94 the Simonde family took refuge in England. On their return the greater part of the family property was sold, and with the proceeds they emigrated to Italy, bought a small farm at Pescia near Lucca, and set to work to cultivate it themselves. Sismondi's experiences gave him the material of his first book, Tableau de *l'agriculture* toscane, which, after returning to Geneva, he published in 1801. In 1803 he published his *Traité* de la richesse commerciale. As an economist, Sismondi represented a humanitarian protest against the dominant orthodoxy of his time. In his first book he followed Adam Smith, but in his principal subsequent economic work, Nouveaux Principes *d'économie politique* (1819), he insisted on the fact that economic science studied the means of increasing wealth too much, and the use of wealth for producing happiness too little.

Meanwhile he began to compile his great *Histoire* des *Républiques Italiennes* du moyen *âge,* and became intimate with Madame de Stael. He was invited or commanded (for Madame de Stael's invitations had something of command) to accompany her on the journey into Italy, described in *Corinne*. During this journey he made the acquaintance of the countess of Albany (*q.v.*) Louisa of Stolberg, widow of Charles Edward. Sismondi's relations with her were close and lasted long, and they produced much valuable and interesting correspondence. In 1807 appeared the first volumes of his history. The completion of this book, which extended to 16 volumes, occupied him for the next 11 years. He lived at first at Geneva, where he held a minor official post. In 1813 he visited Paris for the first time. During the Hundred Days he defended Napoleon's constitutional schemes or promises, and had an interview with the emperor. After the Restoration he left Paris. On completing (1817) his great book on the Italian republics, he undertook (1818) a still greater, the *Histoire* des *Français,* of which during the remaining 23 years of his life he published 29 volumes.

Sismondi died at Geneva on June 25, 1842.

Among his other works are: *Littérature du midi de l'Europe* (1813), an historical novel entitled *Julia Severa ou l'an 492* (1822), *Histoire de la Renaissance de la libertk en Italie* (1832), *Histoire de la chute de l'empire romain* (1835), *Précis de l'histoire des Français*, an abridgment of his own book (1839), with several others, chiefly political pamphlets. Sismondi's journals and his correspondence with Channing, with the countess of Albany and others have been published chiefly by Mlle. Mongolfier (1843) and M. de Saint-René Taillandier (1863). The latter work serves as the chief text of two admirable *Lundis* of Sainte-Beuve (Sept. 1863), republished in the *Nouveaux Lundis*, vol. vi.

SISSALA. A people resembling the Nunuma who inhabit the borders of Upper Volta (Gourounsi) and the Northern Territories, Ghana, Africa, and speak a language related to Nunuma and Kassena. A subtribe known as the Puguli live about 70 mi. west of Leo and Tumu in the Diébougou district of Upper Volta.

See Tauxier, *Le Noir du Soudan* (1912).

SISTERHOODS (MODERN ANGLICAN). The dissolution of religious houses in England (1536–1540) under Henry VIII swept away more than 140 nunneries, and the Anglican Church was left without sisterhoods for three centuries. But as these had for 900 years formed part of its system, there were protests from time to time and attempts at restoration. Among such protests, which generally dwelt a good deal on the want of provision for unmarried women, may be mentioned three in successive centuries. The historian Fuller would have been glad "if such feminine foundations had still continued," only without vows (Bk. vi). Richardson the novelist, in *Sir Charles Grandison*, wishes there could be a Protestant nunnery in every county, "with a truly worthy divine, at the appointment of the bishop of the diocese, to direct and animate the devotion of such a society"; in 1829 the poet Southey, in his *Colloquies* (cxiii), trusts that "thirty years hence this reproach also may be effaced, and England may have its Beguines and its sisters of mercy. It is grievously in need of them." Also small practical efforts were made in the religious households of Nicholas Ferrar at Little Gidding, 1625, and of William Law at King's Cliffe, 1743; and under Charles II, says Fr. Bede "about 12 Protestant ladies of gentle birth and considerable means" founded a short-lived convent, with Sancroft, then dean of St. Paul's, for director.

Southey's appeal had weight, and before the 30 years had passed compassion for the needs of the destitute in great cities, and the impulse of a strong church revival, aroused a body of laymen, among whom were included Gladstone, Sir T. D. Acland, A. J. Beresford-Hope, Lord Lyttelton and Lord John Manners (chairman), to exertions which restored sisterhoods to the Church of England.

On March 26, 1845, the Park Village community was set on foot in Regent's Park, London, to minister to the poor population of St. Pancras. The "rule" was compiled by E. Pusey, who also gave spiritual supervision. In the Crimean War the superior and other sisters went out as nurses with Florence Nightingale. The community afterward united with the Devonport Sisters, founded by Miss Sellon in 1849, and together they form what is known as Ascot priory. The St. Thomas's sisterhood at Oxford commenced in 1847; and the mother superior of the Holy Trinity convent at Oxford, Marian Hughes, dedicated herself before witnesses to such a life as early as 1841 (Liddon's *Life of Dr. Pusey*, iii).

Practically all Anglican sisterhoods originated in works of mercy, and this fact largely accounts for the rapidity with which they have won their way to the good will and confidence of the church. This change in sympathy, again, has gained a hearing from modern historians, who tend more and more to discredit the wholesale defamation of the dissolution period. Another modern feature is the fuller recognition of family ties: rule 29 of the Clewer sisters directs that "the sisters shall have free intercourse with relations, who may visit them at any time." But in most essential respects modern sisterhoods follow the ancient traditions. They devote themselves to the celibate life, have property in common, and observe a common rule of prayer, fellowship and work. Government is by a sister superior, assisted by various officers. The warden and chaplain are clergy, and the visitor is commonly a bishop.

In one important regard there has been hesitation, and authorities like Dr. Littledale and Bishop Grafton contend strongly for the primitive ideal of the convent as family, with a constitutional government, as against the later and widespread Jesuit ideal of the convent as regiment, with a theory of absolute rule and obedience. On the other hand, the doctrine of obedience itself, as applied to Anglican Sisterhoods, is subject to the atmosphere of free institutions and a respect for individuals

For religious orders of women in the Roman Catholic Church *see* MONASTICISM: *Women's Part.*

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SISTOVA (Bulg. *Svishtov*), a town of Bulgaria, capital of the department of the same name, on the Danube, 40 mi. W. of Rustchuk. Pop. (1956) 18,537. A branch line connects it with the main Sofia-Rustchuk railway. It is an important commercial centre. exporting wine and grain and importing petroleum. The Roman colony Novae, mentioned by Ptolemy, lay a little westward of the present town, which has been destroyed and rebuilt many times (1797, 1810, 1829, 1878). The treaty of Sistova, determining the Austro-Turkish boundary. was signed there (1790). Near by are the ruins of the palace of Theodoric the Goth. The Walachian town of Alexandria was founded by fugitives from Sistova in 1878.

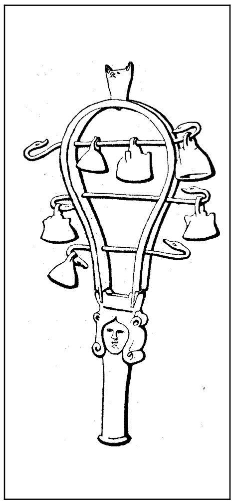
SISTRUM, an ancient Egyptian instrument of percussion of indefinite musical pitch, a kind of metal rattle. It consisted of an oval metal frame fastened to a handle and crossed by metal horizontal rods passing through holes large enough to allow them to rattle when the instrument was shaken.

The sistrum could also be played by beating it with a metal stick. This ancient instrument was extensively used by the priests in the temple of Isis to attract the attention of worshippers to different parts of the ritual.

The Egyptians attributed to it, as well as to the tambourine, the power of dispersing and terrifying evil spirits.

Queen Cleopatra made use of a large number of sistra at the battle of Actium (31 B.C.), and accordingly the instrument nas satirically called Queen Cleopatra's war trumpet.

SISYPHUS (etymology uncertain), son of Aeolus and Enarete, and king of Ephyra (Corinth). He was the father of the sea-god Glaucus and (in post-Homeric legend) of Odysseus. He was said to have founded the Isthmian games in honour of Melicertes, whose body he found lying on the shore of the Isthmus of Corinth From Homer onward Sisyphus was famed as the craftiest of men. When Death came to fetch him, Sisyphus put him into fetters so that no one died till Ares came and freed Death. and delivered Sisyphus into his custody. But Sisyphus was not yet at the end of his resources. For before he died he told his wife that when he was gone she was not to offer the usual sacrifice to the dead. So in the underworld he complained that his wife was neglecting her duty, and he persuaded Hades to allow him to go back to the upper world and punish her. But when he got back to Corinth he did no such thing and so lived until he died of old age (Pherecydes, frag. 119, Jacoby). In the underworld Sisyphus was compelled to roll a big stone up a steep hill; but before it reached the top of the hill the stone always rolled down. and Sisyphus had to begin all over again *(Odyssey,* xi, 593). The reason for that punishment is not mentioned in Homer. According to some. he had revealed the designs of the gods to mortals;



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EGYPTIAN SISTRUM, USED BY PRIESTS IN THE TEMPLE OF ISIS according to others. he was in the habit of attacking and murdering travellers. The subject was a commonplace of ancient writers and was depicted by the painter Polygnotus on the walls of the Lesche at Delphi (*Pausanias*, x, 31).

According to the solar theory. Sisyphus is the disk of the sun that rises every day and then sinks below the horizon. Others see in him a personification of the waves rising to a height and then suddenly falling, or of the treacherous sea. It was suggested that the legend is symbolical of the vain struggle of man in the pursuit of knowledge.

The name Sisyphus was generally explained as a reduplicated form of σοφός ("the very wise"); Otto Gruppe, however, held that it may be connected with σίσυς ("a gdat's skin"), the reference being to a rain charm in nhich goats' skins were used.

S. Reinach (*Revue archéologique*, 1904) found the origin of the story in a picture, in which Sisyphus was represented rolling a huge stone up Acrocorinthus. symbolical of the labour and skill involved in the building of the Sisypheum. When a distinction was made between souls in the underworld, Sisyphus was supposed to be rolling up the stone perpetually as a punishment for some offense committed on earth; and various reasons were invented to account for it.

The way in which Sisyphus cheated Death is not unique in folk. tales. Thus in a Venetian story the ingenious Beppo ties up Death in a bag and keeps him there for 18 months; there is general rejoicing, nobody dies and the doctors are in high moods.

In a Sicilian story an innkeeper corks up Death in a bottle; nobody dies for years, and the long white beards are a sight to see.

In another Sicilian story a monk keeps Death in his pouch for 40 years. For several examples, see T. F. Crane, Italian Popular Tales (1885).

The German parallel is Gambling Johnny, who kept Death up a tree for seven years, during which time no one died (Grimm, Household Tales).

The Norse parallel is the tale of the Master Smith (E. W. Dasent, *Popular* Tales *from* the *Norse*). A Lithuanian parallel was covered in A. Schleicher's *Litauische Märchen, Sprichworte,* Ratsel und Lieder (1857) and Slavonic parallels appeared in F. S. Krauss's *Sagen und Märchen* der Sudslaven, ii. nos. 125 and 126.

SITAPUR, a municipality, with tehsil (administrative subdivision), and a district in the Lucknow division of Uttar Pradesh, India. The town is on the Sarayan river. 50 mi. N.N.W. of Lucknow. Pop. (1951): town 44,397; tehsil (511 sq.mi.) 389,408. It has a cantonment and is at an important junction of the Northern and North-Eastern railways. It has a considerable grain trade. There is a well-equipped eye hospital.

SITAPUR DISTRICT has an area of 2,206 sq.mi. Pop. (1951) 1,380,472. It is a vast plain, well wooded with numerous groves and well cultivated, except in those parts where the soil is barren and cut up by ravines. Except in the eastern part, which lies in the doabs between the Kewani and Chauka and the Gogra and Chauka rivers, the soil is as a rule dry. but even this moist tract is interspersed with patches of land covered with saline efflorescence called reh. The principal rivers are the Gogra, navigable throughout the year, and the Chauka.

SITKA (formerly NEW ARCHANGEL), historically the most notable settlement of Alaska, U.S.. on the west coast of Baranof Island, in Sitka sound. The city is on an island-studded and mountain-locked harbour, with a background of forest and snow-capped mountain cones; an extinct volcano, Mt. Edgecumbe (3,201 ft.), on Kruzof Island, is a conspicuous landmark in the bay. Monthly mean temperatures range from 33° F. (January) to 56° F. (August). Normal rainfall is 85.97 in. and annual snowfall averages 26.1 in.

Old Sitka or Ft. Archangel Gabriel. 6 mi. from the present town, was founded in May 1799 by Aleksandr Baranov, first Russian governor of Alaska. The fort was destroyed by the Tlingit Indians in 1802; the present town was founded in Sept. 1804 when Baranov moved his headquarters there from Kodiak. Commonly known by its Indian name, Sitka. probably the name of a local tribe or village, it was the headquarters of the Russian-American company until 1867. It was the leading trading post of Alaska and had shipyards, sawmills, flour mills, foundries and other industrial establishments. The formal transfer of Alaska to the U S. took place at Sitka on Oct. 18, 1867. From 1867 until 1906 Sitka was the capital of Alaska. The modern industries are logging and lumber manufacture, fishing and fish processing. There are salmon canneries, facilities for cold storage and processing of halibut, salmon and other fishery products and a large fishing fleet.

The public schools are attended by both whites and Indians of the Tlingit tribe. The Presbyterian-supported Sheldon Jackson high school and junior college are accredited schools. Other institutions include the Alaska Pioneers home for aged residents of the state; Sitka National monument, a 54-ac. natural park; Sitka National cemetery; Sheldon Jackson Ethnological museum; Magnetic and Seismological observatory of the coast and geodetic survey; St. Michael's cathedral, of the Orthodox (Russian) Church (1848); St. Peter's by the Sea (Episcopal, 1899); Lutheran church (founded in 1840, the first Protestant church in Alaska); Presbyterian and Roman Catholic churches.

On 475-ac. Japonski Island, in the harbour, the federal Alaska native service has established the Mt. Edgecumbe vocational boarding school for natives, a tuberculosis sanatorium and the Mt. Edgecumbe Orthopedic hospital, maintained jointly with the state of Alaska.

The population is about 3,000. (J. E. CL.)

SITTER, WILLEM DE (1872–1934), Dutch astronomer and cosmologist, whose papers on relativity published in London during World War I brought Einstein's General Theory to the notice of British scientists, with important consequences for cosmology. De Sitter was born at Sneek, Friesland. Neth., on May 6, 1872. He studied at the University of Groningen to become a mathematician, but, on the invitation of Sir David Gill, her majesty's astronomer at the Cape of Good Hope, he spent two years (1897–99) at the Cape observatory, as a result devoting himself to astronomy thereafter. In 1908 he was appointed professor of astronomy at Leiden, and in 1918 he became director of the Leiden observatory. There he trained student astronomers, many of whom obtained important posts abroad, especially in the U.S. As a practical astronomer he established a station at Johannesburg to observe the southern sky and sent expeditions to stations near the equator in Kenya to determine fundamental declinations by azimuth observations of stars at low altitudes.

From the time of his visit to the Cape, De Sitter had studied the motion of Jupiter's four great satellites. Theoretical discussions published in 1918, 1919 and 1925 used observations dating from 1668 and included results obtained by him from several observatories. He died at Leiden on Nov. zo, 1934. (J. JN.)

SITTIDAE: see NUTHATCH.

SITTINGBOURNE AND MILTON, an urban district in the Faversham parliamentary division of Kent, England, formed in 1930 by the union of Milton Regis with Sittingbourne. Pop. (1951) 21,904. Area 7.7 sq.mi. It is on a navigable creek of the Snale, 38 mi. E.S.E. of London by road. Sittingbourne consists principally of one long street, the Roman Watling street. Papermaking is its chief industry, brick and cement making and fruit preserving are also important, and as an agricultural market town it is the centre of the Kentish cherry-growing area. Sittingbourne is mentioned in Saxon documents in 989 and frequently in contemporary records of the 13th and 14th centuries. The first charter was obtained in 1573; a second in 1599.

From Roman until comparatively recent times Milton was a noted oyster fishery centre. It was a royal manor whose revenues formed part of the dowry of successive queens. An earthwork known as Castle Rough. in the marshes below Milton, was probably the work of Hasten the Dane in 892, and Bayford castle, 1 mi. distant, occupies the site of one said to have been built in opposition by King Alfred.

Tong castle, about 2 mi. E. of Sittingbourne, consists of a high mound surrounded by a moat and is said to have been erected by Hengest. The story of the founding of the castle resembles that connected with the city of Carthage. Vortigern is said to have granted Hengest as much land as an ox-hide could encompass, and the hide being cut into strips the site of Tong castle was accordingly marked out. The same tradition attaches to Tong castle in Shropshire. Tradition also asserts. according to the 12th-century chronicler, Geoffrey of Monmouth, that it was in Tong castle that Vortigern met Rowena, Hengest's daughter, and became so enamoured of her as to resign his kingdom to her father.

SITTING BULL (*c.* 1831–1890), a chief of the Teton Dakota or Prairie Sioux and son of Jumping Bull, was born on Grand river, in what is now South Dakota, about 1831. Fearless in battle with other tribes, he soon became leader of the Strong Heart Warrior society, and attacked U.S. troops invading his hunting grounds, 1864–68. He became principal chief of the northern hunting Sioux in 1866, and in 1868 made peace with the whites. But his failure to go upon a reservation led, in 1876, to the campaign in which Gen. George A. Custer (*q.v.*) and his immediate command were killed. Fearing retaliation, Sitting Bull and his band crossed into Canada in 1877.

Famine forced his return and surrender in 1881, and after 1883 he lived at the Standing Rock agency, where he vainly opposed the sale of tribal lands. Hunger, disease and rumours of a coming Indian Messiah who would sweep away the whites caused such unrest among the Sioux that, as a precaution, Indian police and soldiers were sent to arrest the chief. Seized by the police on Grand river, Dec. 15, 1890, Sitting Bull was killed while his warriors were trying to rescue him. (W. S. C.)

SIVA (*Shiva*), in post-Vedic mythology the destroyer-god who with Brahma the creator and Vishnu the preserver forms the Indian trinity. In the Vedas *shiva* ("auspicious") was the epithet applied to any god, even euphemistically to the baleful Rudra (*q.v.*).

In the Epic literature Siva has many attributes and various functions. He is lord of spirits (*bhuts*), protector of cattle (as Pasupati) and god of letters, music and dancing. As Nataraja ("dance-king"). however, his worship is confined to southern India; and there, too. is to be found one of his peculiar sects, the Lingayats (*q.v.*). His spouse is essentially Devi ("the goddess") under the various names, Uma, Parvati, Durga (*q.v.*), Kali (*q.v.*), or Karali.

See W. E. Hopkins, *Epic Mythology* (Strasbourg, 1915); O. C. Ganpoly, *South Indian Bronzes* (Calcutta, 1915).

SIVAJI (1627–1680), founder of the Maratha power in India, was born in April 1627. He was the son of Shahji Bhonsla, a Maratha soldier of fortune who held a jagir under the Bijapur government and regarded himself as appointed to free the Hindus from the Mohammedan yoke. Forming a national party among the Hindus of the Deccan, he opposed in turn the vassal power of Bijapur and the imperial armies of the Mogul of Delhi. By intrigue and hard fighting) Sivaji won for the Marathas practical supremacy in western India.

In 1659 Sivaji lured Afzul Khan, the Bijapur general, into a personal conference and killed him with his own hand. while his men attacked and routed the Bijapur army. In 1666 he visited the Mogul emperor Aurangzeb at Delhi, where, on his expressing dissatisfaction at not being treated with sufficient dignity. he was placed under arrest. Having effected his escape in a sweetmeat basket, he raised the standard of revolt and assumed the title of raja and the prerogative of coining money in his own name. He died in 1680. Sivaji had a genius both for war and for peaceful administration, but he always preferred to attain his ends by fraud rather than by force. He is the national hero of the Marathas.

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SIVAS, a *vilayet* in Turkey. Pop. (1955) 590,890. SIVAS (anc. *Megalopolis-Sebasteia*), altitude 4,420 ft., is the chief town of the province. It is situated in the broad valley of the Kizil Irmak. on one of its right-bank tributaries, the Murdan Su. Pop. (1955) 66,350. The climate is healthful but severe in winter. Coarse cotton cloth and woolen socks are manufactured. The *medresses* (colleges), built in the 13th century by the Seljuk sultans of Rum, are among the finest remains of Moslem art in Asia Minor. In one of them is the tomb of its founder, Izz ud-din Kai Kaus I (1210–1219). Near the town is the Armenian monastery of the Holy Cross, in which are kept the throne of Senekherim and other relics. Under Diocletian Sebasteia became the capital of Armenia Minor, and in the 7th century that of the Sebasteia Theme. Justinian rebuilt the walls and. under the Byzantine emperors, it was second only to Caesarea in size and wealth. In 1021 Senekherim, king of the Armenian province of Vaspuragan (Van), ceded his dominions to Basil II, and became the Byzantine viceroy of Sebasteia and the surrounding country. This position was held by his successors until the town fell into the hands of the Turkomans after the defeat of Romanus II by the Seljuks (1071).

After having been ruled for nearly a century by the Danishmand amirs. Sivas was taken (1172) by the Seljuk sultan of Rum, and in 1224 was rebuilt by Sultan Xla-ed-din Kaikobad I. In 1400, when captured by Timur, the city is said to have had 100,000 inhabitants, and to have been famous for its woolen stuffs. On this occasion the bravest defenders were massacred, and 4.000 Armenians were buried alive. Mohammed the "Conqueror" restored the citadel, and the place was for many years an important Ottoman provincial capital. Early in the 19th century, like all other Ottoman towns, it was terrorized by janissaries. with whom Mahmud II commissioned the great Dere Bey of Yuzgat, Chapan Oglu. to deal in 1818. The news of his drastic success provoked a dangerous riot in Stambul, which postponed by some years the final tragedy of the janissaries. Mechithar, the founder of the Mechitharists (*q.v.*) and of the famous monastery at Venice. was born (1676) at Sivas. Sivas is connected with Angora by a railway which was extended to Erzeroum.

SIVATHERIUM, a gigantic extinct giraffe, larger and heavier than the living giraffe but with short legs. The female was hornless, but the male had a large pair of posterior horns, widespreading and simply branched, and a small conical pair over the eyes. *Sivatherium* is from the Pleistocene of India. Closely allied fossil giraffesoccur in the Pliocene of Europe and Asia and in the Pleistocene of Africa. (G. G. SI.)

SIVRI-HISSAR, "Pointed-Castle," a kazah in the Eski Shehir vilayet in Turkey, situated 8 mi. N. of the site of Pessinus, at the foot of a lofty double-peaked ridge of rock, which bears the ruins of a Byzantine castle. It is a road and commercial centre, with a trade in opium and mohair. Pop. (1955) 6,257. The town occupies the site of ancient *Paliæ*, refounded and renamed Justinianopolis by the emperor Justinian. It was one of the chain of fortresses on the Byzantine military road across Asia Minor, and became the chief city of Galatia Salutaris about. A.D. 700.

SIWA, an oasis in Western Desert province, Egy., near the Libyan frontier and about 350 mi. W.S.W. of Cairo. Also known as the oasis of Amon or Jupiter Ammon, its ancient Egyptian name was *Sekhet-am* (Palm land). Its chief town, also called Siwa, is situated in 29" 12' N., 25° 30' E. The oasis is about 6 mi. long by 4 to 5 wide, with a population (1956 est.) 1,100. Ten miles northeast is the small oasis of Zetun, and westward a chain of little oases and small salty pools extends for about 50 mi. Two rock outcrops provide the sites of the old walled ruins of Siwa and Aghurmi, veritable fortresses. The Siwans, who live in mudbrick houses at the foot of their old strongholds, are a mixture of Berber, Bedouin and Sudanese; they are distinct from the Egyptians, being connected more closely with north Africa than the Nile valley. They speak their own Berber dialect, although most of the men understand Arabic and about 10% of the people are literate. The only properly developed industry is basketmaking. The oasis is extremely fertile, with about 200 springs, of which 80 are important. Evidence suggests that in ancient times the area of cultivated land was greater than at mid-20th century, but modern attempts to enlarge the agricultural area have failed, mainly through lack of labour. Many kinds of fruit and cereals are grown, although some food is imported. The export of dates and olive oil provides the chief source of income; there are about 40.000 olive trees and 200,000 date palms. Desert caravans for trading are rare since the introduction of motor transport and the road connecting with the railway at Mersa Matruh.

The oasis owes its distinction to the oracle temple of Amon (*q.v.*), already famous in the time of Herodotus and consulted by Alexander the Great. The fragmentary remains of the temple, with inscriptions dating from the 4th century B.C., lie in the ruins of Aghurmi. The oracle fell into disrepute during the Roman occupation of Egypt. Half a mile from Aghyrmi is the ruined temple of Umm Beda, of the same period, with reliefs depicting the prince of the oasis making offerings to Amon. There are many remains of the Roman period. The area of the Libyan frontier is dominated by the Senussi sect who formerly prevented various explorers from penetrating westward beyond Siwa. The first European to reach Siwa since Roman times was William George Browne, who visited the oasis in 1792. In 1910 a telegraph line was built across the desert from Alexandria to the oasis. (A. B. M.)

SIWALIK HILLS, the Himalayan foothills extending from Dehra Dun district, Uttar Pradesh. India. across Himachal Pradesh (Sirmur district), and into Punjab state (Hoshiarpur. Nalagarh and Patiala districts). The range runs parallel with the Himalayan system from Hardwar on the Ganges to the Beas. with a length of 200 mi. and an average width of 10 mi. The elevation varies from 2,000 to 3,500 ft. Geologically speaking the Siwaliks belong to the tertiary deposits of the outer Himalayas, and are chiefly composed of low sandstone and conglomerate hills, the solidified and upheaved detritus of the great range in their rear. The intermediate valley lying between the outer hills and the Mussoorie mountains is known as the Dehra Dun (or Dehra valley) and was a popular residential area of Europeans and Anglo-Indians. The principal pass is that of Mohan by which the main road from Saharanpur to Dehra and Mussoorie traverses the range. The Siwalik formation (distinguished for its extraordinary wealth of paleontological remains) is found on the northwest frontier of Pakistan occupying much the same position relatively to the Suliman range as it does to the Himalayas. *i.e.,* it faces the plains and becomes the outermost wall of the hills.

SIWARD (d: 1055), a Danish warrior of whose origin nothing is certainly known. He appears as earl in the later charters of King Canute. His first sphere of government seems to have been Yorkshire, but from 1041 until his death in 1055 he was ruler of the whole Northumbrian earldom. His task was to hold the northern frontier of England against the Scots and to establish public order in the north after the general confusion of the previous generation. His life was spent in perpetual warfare, partly against the Scots, whose king. Macbeth, he defeated in a notable battle in 1054, but also against the more independent subjects of his own earldom. It was chiefly due to him that the far north of England became an integral part of the English kingdom. He died in 1055, at York. and was buried there in a minster which he had founded to the honour of God and Olaf. the sainted king of Norway, a contemporary of his own youth.

See E. A. Freeman, *History of the Norman Conquest,* vol. ii and iii (Oxford, 1870–75); W. F. Skene, *Celtic Scotland* (Edinburgh. 1886–go); F. M. Stenton, *Anglo-Saxon England,* 2nd ed. (Oxford, 1939); R. H. Hodgkin, *A History of the Anglo-Saxons,* 2 vol., 3rd cd. (Oxford, 1953). (F. M. S.)

SIX NATIONS: see IROQUOIS.

SIXTUS, the name of five popes.

SIXTUS I (Xystus). saint. pope for nine or ten years in the second and third decades of the 2nd century. was the-successor of Alexander I and thus the sixth bishop of Rome after St. Peter.

SIXTUS II (Xystus), saint. pope from 257 to 258, succeeded Stephen I in Aug. 2j7. He restored the relations with the African and Asiatic churches that had been severed by his predecessor on the question of heretical baptism. He suffered martyrdom under the emperor Valerian and is commemorated on Xug. 6.

SIXTUS III (Xystus), saint, pope from 432 to 440. succeeded Celestine I on July 31, 432. He had previously been suspected of favouring the Pelagians. but on becoming pope he disappointed their expectations and repelled their attempts to enter again into communion with Rome. The dispute between Cyril of Alexandria and John of Antioch, who had been at variance since the Council of Ephesus. was settled in 433, but Sixtus himself had some difficulties with Proclus of Constantinople with regard to the vicariate of Thessalonica. He died on Aug. 18, 440, and is commemorated on ?\larch 28.

SIXTUS IV (Francesco della Rovere), pope from 1471 to 1484, was born of a poor family near Savona on July 12, 1414. He entered the Franciscan order at an early age and studied philosophy and theology at the universities of Padua and Bologna. He was chosen general of his order in 1464. Three years later. in 1467, he was, to his own surprise, made cardinal-priest of S. Pietro in Vincoli by Paul II. He was elected pope in succession to Paul on Aug. 9, 1471. The fleet that he sent. under Cardinal Caraffa, against the Turks in 1472 participated in the landing at Smyrna, but a new expedition in the following year was a failure. His relations with France were strained because of the Pragmatic Sanction of 1438 and more so after Louis XI's ordinance of 1475 requiring that no papal decree be published in France without the royal placet. Sixtus likewise continued in 1474 and in 1476 his predecessor's negotiations with the grand duke Ivan III of Muscovy for the reunion of the Russian Church with the Roman see and for support against the Turks, but without result. He was visited in 1474 by King Christian of Denmark and Norway, and in the following year he established the University of Copenhagen. Sixtus soon abandoned universal interests in order to concentrate attention on Italian politics and showed himself a confirmed nepotist. He was cognizant of the conspiracy of the Pazzi (1478), plotted by his nephew, Girolamo Riario, against Lorenzo de' Medici. He entered into a fruitless and inglorious war with Florence which kept Italy for two years (1478–80) in confusion. He next incited the Venetians to attack Ferrara (1481) and then, after having been delivered by their general Roberto Malatesta from a Neapolitan invasion (1482), turned upon them and eventually laid them under an interdict (1483) for refusing to desist from the hostilities which he had himself instigated. He relied on the co-operation of Ludovico Sforza, who speedily forsook him, and vexation at having peace forced upon him by the princes and cities of Italy is said to have hastened his death (Aug. 12, 1484).

In 1475 Sixtus instituted the office of the Immaculate Conception for Dec. 8; in 1478 he formally annulled the decrees of the Council of Constance; by a brief of Jan. 1482 he condemned abuses in the Spanish Inquisition; and in April 1482 he canonized St. Bonaventura. He granted many privileges to the Mendicant Orders, particularly to his own Franciscans. The most praiseworthy side of his pontificate was his munificence as a founder or restorer of useful institutions and as a patron of letters and art. He established and richly endowed the first foundling hospital, built and repaired numerous churches, constructed the Sistine chapel (1473–81) and the Sistine bridge, improved church music and instituted the Sistine choir, commissioned paintings on the largest scale. pensioned men of learning (notably Bartolomeo Platina) and. above all, immortalized himself, from 1471, as the second founder of the Vatican library. These great works, however, were not accomplished without grievous taxation. Annates were increased and simony flourished.

See J. Burckhardt, *The Civilization of the Renaissance in Italy,* Eng. trans., new ed. (London. 1951); L. Pastor, *History of the Popes,* vol. iv, Eng. trans. (London, St. Louis, Mo., 1894); E. Frantz, *Sixtus IV. und die Republik Florenz* (Regensburg, 1880). (X.)

SIXTUS V (Felice Peretti), pope from 1585 to 1590, was born at Grottainmare in the march of Xncona, near Montalto, on Dec. 13. 1521. Brought up in poverty. he entered a Franciscan monastery in 1533. He early showed rare ability as a preacher and as a dialectician. Sent to Rome in 1552, he attracted the attention of the future popes Paul IV (Caraffa) and Pius V (Ghislieri). He was appointed inquisitor general in the Venetian republic in 1557 but became involved in disputes and had to leave (1560). Sent to Spain with the legation under Cardinal Boncompagni (later Gregory XIII) in 1565, he conceived a strong dislike for Boncompagni and hurried back to Rome on the accession of Pius V, who made him vicar apostolic of the Franciscans and bishop of Sant' Agata de' Goti in 1566 and cardinal on May 17, 1570. Henceforth, as cardinal, Peretti was known by the name of Montalto. During the pontificate of Gregory XIII he lived in retirement, occupied with the care of his villa and with his studies (the first volume of his edition of the works of St. Amhrose appeared in 1580). Yet he did not neglect to follow the course of affairs, though carefully avoiding every occasion of offense. This discreetness contributed not a little to his election to the papacy on April 24, 1585.

The terrible condition in which Gregory XIII had left the states of the church called for prompt and stern measures. Against the prevailing lawlessness Sixtus proceeded with an almost ferocious severity, bringing thousands of brigands to justice by proceeding with vigour against their supporters among the powerful nobility. Within a short time the country was again quiet and safe, but Sixtus had made many enemies. He turned next to financial reform. By the sale of offices: by the creation of new *monti* (loans) and by levying new taxes, he accumulated a vast reserve: which he kept against certain specified emergencies, such as a crusade or the defense of the Holy See. He moreover pursued an active economic policy by regulating food prices and by encouraging agriculture and the production of wool and silk. Immense sums were spent on public works and buildings, yet Sixtus ended his reign as one of the richest princes in Europe, having begun it with an almost penniless treasury.

It is because of his achievements in reforming the central administration of the church that Sixtus must be reckoned as one of the greatest popes. By the bull *Postquam terris* (Dec. 3, 1586) the college of cardinals was given its definitive form, its number being limited to 70. The secretariat of state was reorganized, and in Jan. 1j88 the entire administrative system of the curia was overhauled. The number of congregations was increased to 15, of which 6 dealt with secular administration and the other 9 with spiritual matters. It was through the machinery thus established that the decrees of the Council of Trent were effectively enforced. In particular, Sixtus insisted that the decrees regulating residence and investiture be strictly observed. So he must be counted as one of the founders of the Counter Reformation. His intervention in doctrinal affairs was not so happy. He had good grounds for supposing that the commission appointed to prepare a revised edition of the Vulgate, which had benefited enormously by his injection of a spirit of urgency into its deliberations, had not sufficiently considered the practical problems created by their work of scholarship. His reaction was typical: he rejected the work of the commission and took the whole task into his own hands. After 18 months of intense application, he produced the *editio Sixtina* in May 1590. But his revision was far too hurried and far too conservative, and the opportunity afforded by its numerous printer's errors was taken to postpohe promulgation. Sixtus' death then intervened, and his edition was eventually abandoned. By the same event, Robert Bellarmine's book on doctrinal controversies was saved from official condemnation and the Society of Jesus from a drastic revision of its constitution.

In his political relations with foreign princes, Sixtus was faced by a dilemma. Distrusting Philip II of Spain, he viewed with misgiving the extension of Philip's power but was obliged to abet him as Henry III of France showed himself ever less able to hold his own between the pro-Spanish party of the Guises and the Huguenots under Henry of Navarre and as Elizabeth of England, whose personality Sixtus greatly admired, was an obstinate heretic. Thus he excommunicated Henry of Navarre (1585), promised subsidies for a Spanish invasion of England and denounced Henry III after the coup against the Guises. In the last months of his life. however, he saw the hope that Henry of Navarre would make good his claim to the crown of France (as Henry IV) and be converted to Catholicism. Sixtus could then begin to withstand the demands of Philip's immediate ambition, confined as this was to France since the defeat of the Armada. Negotiating still both with Philip's and with Henry's envoys, he died on Aug. 27, 1590.

Posterity ranks Sixtus one of the greatest popes. He was hasty, obstinate, severe, autocratic; but his mind was open to large ideas, and he threw himself into his undertakings with an energy and determination that often compelled success. Few popes can boast of greater enterprise or larger achievements.

See J. A. von Hübner, *Sixte-Quint*, 3 vol. (Paris, 1870; new ed., 1882; Eng. trans. by H. E. H. Jerningham, *Sixtus V*, 2 vol., London, 1872); H. Balzani, *Sisto Quinto* (Geneva, 1913). (I. F. B.)

SIXT VON ARMIN, FRIEDRICH (1851–1936), German general, was born at Wetzlar, Nov. 27, 1851. He took part in the war of 1870–71 and was severely wounded at St. Privat. After having occupied different positions on the general staff, he was appointed in 1903 director of the general department of war in the Prussian War ministry, and in 1911 general in command of the 4th army corps at Magdeburg. During World War I he led his corps as a part of the 1st and of the 6th army; he was appointed in 1917 commander in chief of the 4th army in Flanders, where he succeeded, in the spring offensive in 1918, in taking Armentières and the Kemmel hill. At the close of the war he retired from the army.

SKAGERRAK, the arm of the North Sea which gives access to the Cattegat and so to the Baltic. It is about 140 mi. long and 75 mi. broad. On the Danish shore, which is low and beset with sandbanks, the strait is shallow. Towards the steep Norwegian coast its deepest part is found. 2,6j8 ft.

For the currents, temperature and salinity of the water, etc., *see* NORTH SEA. For battle, *see* JUTLAND, BATTLE OF.

SKAGWAY, a town of Alaska, U.S., situated at the north end of Lynn canal, a deep and narrow arm of the sea thrust far up between picturesque mountain ranges, in 59° 28′ N. and 135° 20′ W., is at the head of navigation in the waters of southeastern Alaska. Skagway owes its importance to being the seaward terminus of the White Pass and Yukon railway. This road, built in the years 1898–1900, extends up the valley of the Skagway river to the summit of White pass, 20 mi., crossing there the international boundary and continuing thence down on the Canadian side 91 mi. to Whitehorse, head of navigation on the Yukon.

Historically, it is of interest as the landing place of large quantities of supplies and many thousands of people during the struggle of 1897–98 (known as the Klondike rush) to reach the newly discovered rich deposits of gold in the upper (Canadian) Yukon.

SKANDERBEG or **GEORGE CASTRIOTA** (1403–1468), the national hero of the Albanians, "ranked by Sir William Temple among the seven chiefs who have deserved, without wearing. a royal crown," was of Serbian origin. The founder of the family of Castriota was a certain Branilo, who mas governor of Kanina in 1368, and whose grandson, Giovanni, lord of Mat and Vumenestia, married Voisava Tripalda, daughter of a Serbian magnate. The offspring of this union was George Castriota. Thus. as the Albanians gave to Greece several leaders of her War of Independence, Serbia furnished the chief figure of their struggle for freedom. George's uncle had, however, married an heiress of the leading Albanian clan of Thopia and thus acquired. together with the fortress of Kruje. some of that family's influence. Born in 1403, George was 11 years old when the Turks began to occupy Albania. and, while the castle of Kruje became the seat of a Turkish governor, he was sent as a hostage to Constantinople. Educated there as a Moslem he received the Turkish name of Iskander ("Alexander"). applied to him by Byron in *Childe Harold*, with the title of bey—subsequently abbreviated by his countrymen into Skanderbeg. Like Albanians in later times, he rose to eminence in the Turkish service; he was promoted to the government of a *sanjak*, and for many years fought for his Turkish masters against Venetians and Serbs, till! in 1443, while serving in the Turkish army which had been defeated by Janos Hunyadi's troops near Nish, he heard that his native land had risen against the Turkish garrison.

Then, at the age of 40, he realized that his mission was to free Albania, and the rest of his life was devoted to that object. Seizing Kruje by stratagem, he made it his capital, proclaimed himself a Christian, and gathered the wild Albanian clansmen about him. His personal influence was increased by his marriage with Andronica. daughter of Arianites Comnenus, a prominent Albanian chief, who had vainly endeavoured to drive out the Turks. The other chiefs rallied round his standard; the Montenegrins, whose ruler, Stephen Crnojevich, was his brother-in-law. came to his assistance. and at a gathering of the clans at the Venetian colony of Alessio he was proclaimed Captain General of Albania. Venice, then mistress of the Albanian coast as far south as Durazzo, at first regarded him as a rival, but subsequently took him into her pay as an ally against the common foe. The pope and the king of Naples helped the Albanian cause, as fellow Christians and neighbours, and the latter, mindful of the claims of the Neapolitan Angevins beyond the Adriatic, received the homage of the Albanian champion. But Mohammed II, partly by working upon the proverbial jealousy of the other Albanian chiefs, partly by force of arms, temporarily eliminated him, and in 1461 concluded with him a ten years' armistice.

But long before it elapsed, Skanderbeg, at the instigation of Pius II, broke it, with fatal results. That pope's projected crusade was prevented by its author's death; Skanderbeg, abandoned by his western allies, was left to fight singlehanded against the great sultan, who himself in 1466 besieged Krujë. The fortress held out, but Skanderbeg went to seek help from Pope Paul 11 in Rome, where a lane near the Quirinal still commemorates his name and visit. Returning. he died in the Venetian colony of Alessio on Jan. 1;, 1468. whereupon the Turks easily conquered Albania, except Krujë, ceded by his son to Venice, and the other Venetian possessions. His son Giovanni and other Albanian chiefs emigrated to southern Italy, and his posterity formed part of the considerable Albanian colonies there; in modern times a self-styled Castriota claimed the Albanian throne on the ground of his alleged descent from the national hero.

Skanderbeg's grave in the church of St. Nicholas at Xlessio was opened by the Turks, who touched his bones with superstitious reverence and wore them as amulets; but the ruins of the castle which he built on Cape Rodoni remain. the Mirdites still wear mourning for him, and the independent Albania of to-day has placed his image on some of her postage stamps. He has been made the subject of a Latin poem by de Bussières, an Italian poem by Signora Sarrocchi, and an English tragedy. *Scanderbeg: or Love and Liberty,* by Whincop (1747). Gen. Wolfe wrote that "he exceeds all the officers, ancient and modern, in the conduct of a small defensive army." His resistance to the Turkish advance helped Christendom, but did not save Albania—a country too small and too much divided by the clan system to stand against a powerful Turkey. (W. M.)

SKARA BRAE, the most perfect Stone Age village in Europe, was embalmed under a sand dune on the shore of the Bay of Skaill on the Atlantic coast of Mainland Island. largest of the Orkneys. Scot. Exposed by a great storm in 1851, four buildings were excavated during the 1860s by William Watt, of Skaill house. After another storm in 1926 further excavations were conducted by the ancient monuments branch of the ministry of works, that had assumed guardianship of the monument. supervised from 1928 to 1931 by V. G. Childe, of the University of Edinburgh. Before 1939 the age of the site and the cultural status of its builders remained uncertain, but in that year excavation by Walter G.

PHOTOGRAPH, J. ALLAN CASH

EXCAVATED DWELLING AT SKARA BRAE

Grant at a contemporary village, Rinyo, on Rousay, established that the dwellings of Skara Brae were built before the first people to use bronze in Great Britain, the "Beaker folk," reached Orkney, and so belonged to the New Stone Age (of Orkney, of course).

Though the dwellings at Skara Brae are built of undressed slabs of stone from the beach, put together without any mortar, the drift sand that filled them immediately after their evacuation preserved the walls in places to a height of 8 ft. (but unfortunately not the roofs). Moreover, because of the absence of trees on the island, articles of furniture that would normally be carved in perishable wood had to be made of stone and have, therefore, survived. At the same time the dwelling explored in 1928 was found exactly as it had been left by its occupants who had been forced to abandon it in precipitate haste by a violent storm. The village consisted of several one-roomed dwellings, each constructed on the same plan. Each is a rectangle with rounded corners, the largest measuring 21 ft. by 20 ft. square. Entering through a narrow doorway only 4 ft. high that could be closed by a stone slab held in place by a sliding bar, the visitor finds in the centre of the room a rectangular fireplace still filled with peat ash. Behind it against the rear wall stands an erection of two tiers of stone shelves precisely like a modern dresser. On either side of the central hearth are enclosures of stone slabs exactly similar to the fixed beds of planks built in the 19th century in Norwegian peasant houses, that on the right being always the larger. Tall uprights of stone at the corners like bed posts served to support some sort of canopy. In the wall above the bed are recesses that must have served as keeping places for personal possessions. Sunk in the floor are several cubical boxes lined with stone slabs and luted with clay along the joints, evidently designed to hold some sort of liquid. One or more small cells in the thickness of the walls open off the main room. Beneath its floor a slab-lined drain runs to debouch into a main sewer.

At the moment of its abrupt desertion the village had consisted of seven or eight such huts linked together by paved alleys. By this time six huts had been put artificially underground by banking round them midden consisting of sand and peat ash stiffened with dung and other refuse, and the alleys had become tunnels through this midden roofed with slabs. On the west (the east end has been destroyed by the sea) the main tunnel gave through a doorway, identical in design with those of individual dwellings, onto an open space paved with slabs, but unroofed. A hut, entered from this space and standing free of the general midden-heap cover. differed to some extent in arrangement and furniture from the rest; it contained a kiln where the dresser should have stood and had been used for the manufacture of chert implements. The whole residential complex was drained by a built sewer into which the drains from individual huts discharged.

The inhabitants of the village lived mainly on the flesh and presumably the milk of their herds of tame cattle and sheep. on limpets and other shell fish, supplemented exceptionally by red deer, wild boar, seal and whale. There is no positive evidence that they cultivated any cereals or that they spun and wove wool or other material. Presumably they dressed in skins. Bone tools suitable for preparing and piercing such skins were very numerous, while large pins made of narwhal ivory. whalebone or the penis-bones of seals could be used for fastening them. Peat was regularly burned as fuel, while fire may have been made by striking nodular haematite against flint or chert. For their equipment the villagers relied exclusively on local materials. Axheads, or rather adz blades, were made of stone sharpened by grinding and were sometimes attached to their handles with the aid of perforated sleeves of stag's antler. Knives were made by splitting beach pebbles along their bedding planes. The bones of cattle and sheep served for the manufacture of awls, needles, fabricators and various tools of uncertain use probably employed in dressing hides. Vessels were made of pottery. Though the clay was exceedingly coarse and included large grits, and the firing was not sufficient to convert it into pottery right through, most vessels were quite richly decorated with elaborate patterns in relief formed by applying to the surface strips and pellets of clay. Vessels were also made out of the vertebrae of hales and blocks of sandstone.

No weapons at all were found at Skara Brae unless some unique objects carved out of hard volcanic stone were so used. These include balls covered with pyramidal spikes and other spikey forms, all carved with great accuracy. As ornaments the villagers wore pendants and beads made out of the marrow bones of sheep, the roots of cows' teeth (the nerve canal serving as a string hole), the teeth of killer whales and boars' tusks.

Nearly 1,000 finished beads were found together in one cell, and unfinished beads in all stages of manufacture lay about the hut floors. Red, yellow and white pigments contained in little paint pots of stone or cetacean bone were presumably used in painting the person. Games were played with dice of walrus ivory and uith knucklebones.

The skeletons of two old women, buried together doubled up, were found in a cist under the wall of the hut discovered in 1928 and have been interpreted as a foundation sacrifice. Watt had previously discovered a skeleton in a niche beside the main alley, but the village cemetery has not been identified. The two old women must have stood about 5 ft. 2 in. in height, not much, if anything, below the average of the female stature prevailing in the mid-20th century. Both had suffered from osteoarthritis. The leg bones show peculiarities due to habitual squatting. The skulls are just dolichocranial (index 74.5).

A number of stones in the walls of the huts and alleys have been roughly scratched with lozenges and similar rectilinear patterns.

Beneath the walls of the huts just described the foundations of older huts were discovered in 1930. In plan and furniture these agreed precisely with the former and the relics on their floors were of the same kind as those described above. The pottery from the lower levels was adorned with incised as well as relief designs. Among these was the true spiral represented on one sherd—the only example of this pattern in pottery known in prehistoric Britain.

See V. G. Childe, *Skara Brae: Pictish Village in Orkney* (1931), *Scotland Before the Scots* (1946). (V. G. C.)

SKAT, a game of cards, much played in Germany and by people of German origin throughout the world. It is an elaboration of *Schafkopf* (sheepshead), a Wendish game believed to date at least to the middle 1700s. In 1811 a resident of Altenburg who had newly learned *Schafkopf* carried it into the local tarok club, where it was modified by the addition of features from tarok and kalabrias. The very name of the game is a tarok term, derived from the Italian *scartare,* "to discard," or *scatola,* a "place of safekeeping." In the earliest writings, the game is spelled "scat." Much of the early development of skat is credited to F. F. Hempel, an advocate in Altenburg. The first book on it was published by his cousin, J. F. L. Hempel, in 1848. After a long period of experimentation, the game was codified by a congress of more than 1,000 skat players, convened at Altenburg on Aug. 7, 1886. Subsequent modifications chiefly concerned the use of the skat (widow) and elimination of the game *frage.*

Skat is very popular in some sections of the United States. There are hundreds of skat clubs and large tournaments are played for prizes. Laws of the game are promulgated by the North American Skat league and do not in all respects conform to the procedure of play in Germany.

Skat is played by three players with a pack of 32 cards. Each receives ten cards and t o are dealt face down for a skat (widow). The players bid by numbers, in multiples of two, and the high bidder then names his game. In the game tournee the trump suit is fixed by a card turned from the skat—it may be a grand (only knaves are trumps) if a knave is turned. Solo is played without help of the skat, and the player may name a suit or grand. Gucki is a grand using the skat. Null is a bid to take no tricks, at no trumps. Ramsch is played only if all three players pass, the object being to win fewest points in tricks, with knaves trumps.

The bidding and scoring values of the games are determined by their base values times the sum of all due multipliers. The multipliers arise from various sources—points won in play. prediction or announcement as to this outcome, and matadors, which are top trumps in unbroken sequence.

To make his bid, the player must take a majority of the 120 card points: each ace 11, ten 10, king 4, queen 3, knave 2. Except in ramsch, the other two players combine in temporary partnership to try to defeat him.

A modem variant, *Räuber Skat,* popular in club play but not in tournaments, eliminates the game tournee. Instead, the high bidder always has the option of taking the skat or of playing without it. In the latter case, handplay, he earns an extra multiplier.

See Walter J Zarse, *Sheepshead and Skat* (1935) ; "The Official Rules of the North American Skat League," in *The Official Rules of Card Games* (1946). (G. MH.)

SKATE: *see* RAY.

SKATE SAILING: *see* ICE SKATING.

SKATING: *see* ICE SKATING; ROLLER SKATING.

SKEAT, WALTER WILLIAM (1835–1912), English philologist whose greatest work in pure philology was his etymological dictionary, was born in London on Nov. 21, 1835, and educated at King's college school, Highgate grammar school and Christ's college, Cambridge, of which he became a fellow in July 1860. In 1878 he was elected Ellington and Bosworth professor of Anglo-Saxon at Cambridge. His work on Middle English literature includes the three parallel texts of *Piers Plowman* (1886), the Oxford edition of Chaucer (6 vol., 1894), with a supplementary volume of *Chaucerian Pieces* (1897), and important editions for the Early English and Scottish Text societies. His *Etymological English Dictionary* was published in 4 parts, 1879–82 (revised and enlarged, 1910). In the publications of the English Dialect society he had a hand as the founder of the society and afterward its president.

Skeat died at Cambridge on Oct. 7, 1912.

SKEET SHOOTING: *see* TRAPSHOOTING AND SKEET SHOOTING.

SKEGNESS, a seaside resort in Lincolnshire, Eng.; 131 mi. N. by E. from London by Eastern region railway. Pop. (1951) 12,539. Since 1873, it has attracted excursionists. and possesses good hotels and a pier. There are broad, firm sands.

SKELETON, INVERTEBRATE. The function of the skeleton is to provide a more or less rigid framework upon which the muscles can react. In many invertebrate animals no such framework exists; the necessary rigidity is provided by the hydrostatic pressure of the body fluids acting upon a soft and pliable integument. This is seen in caterpillars and, to a lesser extent, in soft worms and in mollusks, where the necessary pressure is maintained by the steady contraction of an interlacing sheet of superficial muscles, the so-called turgor muscles. The muscles which move the body are attached to the integument, which is made rigid by this internal pressure. The firmness of some invertebrate animals is maintained by a mechanism similar to that in many plants; the individual cells which form the body wall are more or less distended by water to give some degree of rigidity. But in many invertebrates rigid skeletal materials are deposited either on the outer surface of the body or within the cells. In some animals these rigid structures do not give attachment to the muscles but merely provide a protective armour.

It is usual to classify skeletal structures as external (exoskeleton) or internal (endoskeleton). But the one type merges with the other, even within the same animal; and in many examples of what appears to be an exoskeleton. the hard material is laid down inside the cells which form the outer covering.

The invertebrate skeleton is exceedingly varied as to the material of which it is composed and as to sites in which the hard substance is deposited. These variations cut across the ordinary classification of animals. In the Protozoa, for example, there are all grades between soft forms such as *Amoeba,* forms with a semisolid pellicle such as *Paramecium,* and forms with a cuticle, which may be proteinaceous as in *Monocystis* or composed of cellulose as in the plantlike flagellates. Other protozoa have definite shells, which may be composed of protein with various foreign bodies incorporated in it, or of siliceous plates, or of lime as in most Foraminifera, or of cellulose as in the resting stages of Mycetomycetes (Mycetozoa). The Radiolaria have an internal lattice of silica laid down inside the cell, a kind of endoskeleton.

Other groups show a similar variation. Some sponges deposit needlelike spicules of calcium carbonate in the jelly (mesogloea) beneath the outer epithelium; others produce spicules of silica held together by a horny substance termed spongin; and yet others have a skeleton of spongin alone and no spicules. Similarly, among coelenterates, there are Hydrozoa which have a horny perisarc protecting the polyps, and others with an external calcareous skeleton. Actinozoa show the same diversity. In *Alcyonium* (deadman's-fingers) the skeleton is mainly internal, consisting of spicules of calcium carbonate in the mesogloea. In the red coral of commerce (*Corallium*) the spicule-bearing cells migrate inward and build up a central skeleton. In the common reef-building corals the calcareous skeleton is secreted by that part of the ectoderm which forms the basal disc. This secretory process is continuous so that the polyp raises itself progressively upon a growing stem of lime.

In the echinoderms the calcareous deposits are laid down in the mesoderm. They may be so scattered that they merely serve to impart a leathery consistency to the skin (as in holothurians); or they may form well-articulated ossicles united by muscles and thus serve as a typical internal skeleton (as in the arms of brittle stars or Ophiuroids); or they may be set closely together to form a rigid armour (as in the sea urchins). Many sea urchins have projecting spines on which the epidermis has been worn away so that the calcareous substance is exposed.

The shell of mollusks is an example of an external skeleton. It is secreted by the ectodermal epithelium of the mantle, and consists of an outer layer of the horny substance conchiolin, an intermediate prismatic layer composed of calcite, and a smooth inner layer (the nacreous layer). also composed mainly of calcium carbonate. The first two layers are secreted by a marginal band of cells, so that the shell grows at its outer margin. The nacreous layer is secreted by the general surface of the mantle and is the material of which pearls are formed around foreign bodies introduced into the mantle cavity.

The exoskeleton attains its most elaborate forms in the arthropods (crustaceans, insects, etc.). Many soft invertebrates, such as worms and mollusks. secrete a protective layer of slime or mucus over the surface of the integument. In the arthropods a solid substance termed chitin forms the basis of the exoskeleton. Chitin is related chemically to mucus. It consists of a nitrogen-containing carbohydrate (a polysaccharide, polyacetyl glucosamine) intimately associated with protein. If the protein component is removed from natural chitin there remains a material, often called pure chitin, the physical properties of which are very similar to those of the cellulose of plants.

Natural chitin forms a cuticle which is tough but distensible and not rigid. It exists in this state in the integument of caterpillars. which, as noted above, have a hydraulic type of skeleton dependent on internal turgor. It exists in this soft state also in the joints of the limbs or between one segment of the body and the next. But in most arthropods the segments of the body or of the limbs are in the form of rigid plates that form a true exoskeleton linked to adjacent segments by flexible membranes. The hard material responsible for this change in the chitin is termed sclerotin, and the hardening process is called sclerotization.

The chemical nature of sclerotization is not fully understood, but it is certainly closely related to the hardening of proteins by tanning. Substances capable of causing tanning (notably certain quinones) are almost certainly produced in the cuticle of arthropods during the hardening process. The resulting product (sclerotin) is a kind of natural plastic. In its horny consistency it closely resembles keratin, both are cross linked or polymerized proteins, but the chemical nature of the linkage is different in the two substances. It is probable that other skeletal proteins in invertebrates, such as the spongin of sponges and the conchiolin of mollusks, are also tanned proteins allied to sclerotin.

In many crustaceans (crabs, lobsters, etc.), much of the cuticle is rendered hard by the incorporation in its substance of lime in the form of aragonite or calcite. But sclerotin is actually harder than calcite, and those parts of crustaceans which need to be of maximum hardness, such as the mandibles and the tips of the claws, are in fact composed of sclerotin. The hardest parts of insects are often the darkest; the hardening and darkening processes are closely associated chemically.

Besides functioning as a skeleton, the cuticle of terrestrial arthropods must act as a waterproof covering in order to prevent these small animals from drying up. This waterproofing is effected by the secretion of a layer of crystalline wax on the surface layer of the cuticle. Such a wax layer, if freely exposed, would be excessively fragile. It is commonly protected by a thin layer of cement substance poured over its surface by small dermal glands. Other glands may discharge quantities of wax, lac and other products upon the surface of the insect.

The cuticle of arthropods is the product of a single layer of epidermal cells; indeed cytoplasmic processes from these cells (so-called pore canals) penetrate far into the cuticle, so that it is really a living structure. It can undergo endless modifications of form to produce sensory hairs, pigment-bearing scales, claws, wings and other kinds of tools. In some insects it shows brilliant metallic colours that result from the presence of some periodic structure in the cuticle (multiple thin plates or ridges) which gives rise to interference. In order that the arthropod may grow, the old cuticle is shed from time to time, after a new and larger cuticle has been laid down beneath it. This process is termed molting or ecdysis. Until the new cuticle hardens, the arthropod is in a very vulnerable condition. See also ARTHROPODA; SKELETON, VERTEBRATE.

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SKELETON, VERTEBRATE. In many animals and in all vertebrates, the general form of the body is maintained by means of certain elements that are hardened to form a skeleton. This persists after death for a variable length of time after the rest of the body has disintegrated. In higher vertebrates, the skeleton is rendered more rigid and permanent by the formation of bone. In many animals the shape and relative positions of the various parts of the skeleton determine the general body form.

In most invertebrates, the skeleton is on the surface to form a protection as well as a supporting framework, and is called an exoskeleton. In vertebrates there is an internal or endoskeleton, and the exoskeleton is either greatly modified or completely suppressed. In the following account the human skeleton is treated as an example of the mammalian skeleton. There are brief supplementary reviews of skeletal development and of the comparative osteology of vertebrates. For the skull and exoskeleton, see SKULL and SKELETON, INVERTEBRATE.

This article is divided into the following sections:

I. Vertebral or Spinal Column
II. Thoracic Skeleton
III. Appendicular Skeleton
  A. Upper Limb
  B. Lower Limb
  C. Sesamoid Bones
IV. Development of the Skeleton
V. Comparative Anatomy
VI. Comparative Anatomy of the Appendicular Skeleton

I. VERTEBRAL OR SPINAL COLUMN

The vertebral column (also known as the backbone or spine) consists of a series of vertebrae connected together by thick elastic intervertebral discs and by other ligaments (see fig. 1). The column lies in the middle of the back of the neck and trunk and is surmounted by the cranium. Each vertebra, with certain exceptions. consists of a thick anterior part, the body, and a posterior part. the neural arch (see fig. 2).

The paired nerves connected with the spinal cord emerge on each side of the vertebral column between successive vertebral bodies and neural arches. The bodies, with the intervertebral discs, form the weight-bearing portion of the vertebral column. The neural arches form partial protection for the spinal cord and for the proximal parts of the lower spinal nerves. Each neural arch consists primarily of two cylindrical pedicles, projecting backward from the body, and two flattened laminae, which meet in the midline posteriorly. At the junction of each pedicle and lamina, there is a laterally directed transverse process, and vertically disposed superior and inferior articular processes (pre- and postzygapophyses). The superior articular processes of one neural arch articulate with the inferior articular processes of the arch above at a synovial joint. A spinous process projects backward from the fused laminae and can be felt under the skin.

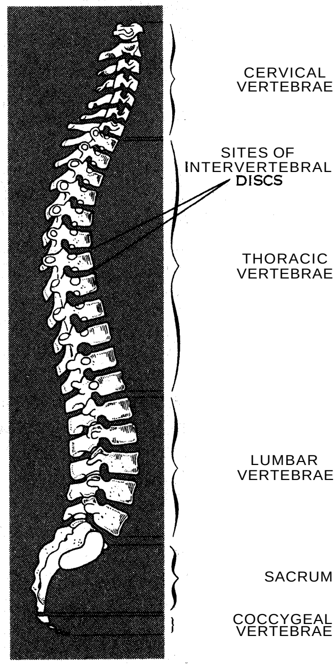


FIG. 1.—LATERAL VIEW OF THE VERTEBRAL COLUMN

In the young child, the vertebral column consists of 33 separate vertebrae. In the adult, some of these are fused together, so that there are only 26 separate bones. The vertebrae are grouped from above downward according to position into cervical, thoracic, lumbar, sacral and coccygeal. For the human infant, the number of vertebrae in each group is expressed in the formula C_7, Th_{12}, L_5, S_5, Coc_4, but in the adult the five sacral vertebrae have fused to form a single triangular bone, the sacrum, and the four coccygeal to form the coccyx.

Vertebrae. — The cervical vertebrae are distinguished by the presence of a foramen in the transverse process. These foramina, excepting that of the 7th vertebra, are in succession traversed by the vertebral artery carrying the blood to part of the brain. The 1st cervical vertebra, or atlas, is atypical in that it has no body but is in the form of a ring. On each side of it there is a thick mass of bone by which it articulates above with the occipital bone of the skull and below with the 2nd vertebra, the axis. The body of the latter is surmounted by a stout, toothlike odontoid process, which is regarded as the body of the atlas. This process forms a pivot round which the atlas moves, with the skull, when the head is turned from side to side.

The typical thoracic vertebrae (1st to 9th) are distinguished by the presence, on each side of their body, of two small, smooth articular surfaces or facets for articulation with the head of a rib. In addition, these vertebrae have an articular facet on each transverse process for the tubercle of a rib. The body of the 10th thoracic vertebra, however, articulates only with one rib. In the case of the 11th and 12th vertebrae, there are articular facets on the body but not on the transverse processes.

The lumbar vertebrae have neither foramina in the transverse processes nor articular facets on the bodies. The bodies are massive in order to transmit the weight of the trunk.

The sacrum is a large triangular bone formed by the fusion of five vertebrae; with the two hipbones, it forms the pelvis. The anterior (or pelvic) surface of the sacrum is concave and is marked by four transverse lines which indicate the sites of fusion of the original five sacral elements. On each side of the fused bodies there are foramina for the transmission of the anterior divisions of the upper four sacral nerves. The convex posterior surface shows four rudimentary spinous processes, and on each side of these are two rows of tubercles representing the articular processes and the transverse processes. Between the rows of tubercles four pairs of foramina transmit the posterior divisions of the sacral nerves. The part of the sacrum lateral to the foramina is known as the lateral mass. The upper lateral aspect of this mass presents an L-shaped articular surface for articulation with the corresponding hipbone. Posterior to the articular surface, the lateral mass is rough, for the ligaments that attach the sacrum to the hipbone. The human sacrum is broader in proportion to its length than that of other mammals, so that great solidity is given to the lower part of the spine; this breadth is probably correlated with the firmness of the sacrum's articulation with the hipbones, as an adaptation of the spine to man's erect posture. The sacrum is broader in women than in men and hence the whole pelvis is wider.

The coccyx consists of four rudimentary vertebral bodies fused together and, in the adult, commonly joined to the sacrum. The first body has a pair of small projections which are the vestiges of the neural arch.

Articulated Vertebral Column. — The vertebrae are held firmly together by a number of strong ligaments. The main ligaments are the intervertebral discs, the anterior and posterior longitudinal ligaments between the bodies, and the ligamentum flavum betueen the laminae. The intervertebral discs form flexible connections between the bodies of adjacent vertebrae from the axis above to the sacrum below. Each disc consists of fibrocartilage which encloses a central mass, the nucleus pulposus. The fibrocartilage is firmly attached to the adjacent vertebrae, whereas the nucleus pulposus is a semifluid structure acting as a shock absorber and can be deformed by pressure. Occasionally, the pressure developed in the nucleus pulposus is so great that the surrounding fibrocartilage ruptures and the nucleus protrudes.

The articulated vertebral column forms the central axis of the skeleton and supports the weight not only of the head and trunk but also of the upper limbs. It gives attachment to the muscles that move the column itself and to other muscles that move the head and limbs.

The vertebral column of an adult in the ordinary standing position exhibits curves in the sagittal (anteroposterior) plane of the body (see fig. 1), and minor curves in the coronal (transverse) plane. In the infant at birth, there are two primary sagittal curves concave forward which meet at the sacrovertebral junction. The lower curve involves the sacrum and coccyx, the upper affecting the remainder of the vertebral column. When the infant begins to lift up its head, a secondary sagittal curve, convex forward, develops in the neck region, and when the child begins to walk, a further secondary sagittal curve convex forward is developed in the lumbar region. In the adult spine, therefore, there is a series of alternating convex and concave curves formed in adaptation to the erect posture of man. As a result of these curves the weight of the body is transmitted to the sacrum with the least expenditure of muscular effort. The curves in the coronal plane are not constant; the frequent convexity to the right has been attributed to the greater use of the right arm.

Movements of the vertebral column are: (1) forward bending, known as flexion, and the opposite movement, extension; (2) lateral bending, known as lateral flexion; and (3) rotation, which occurs about an axis passing vertically through the bodies of the

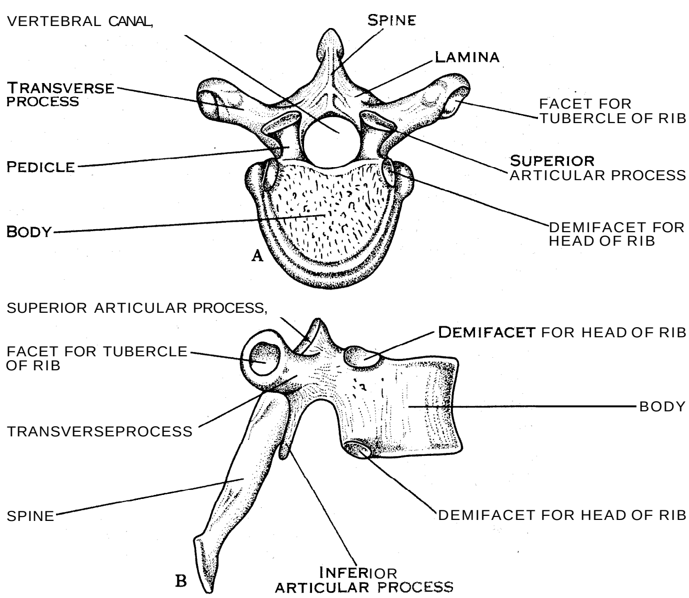


FIG. 2.— TYPICAL THORACIC VERTEBRA SEEN FROM ABOVE (A) AND FROM THE SIDE (B)

vertebrae concerned. The range and kind of movements show great variations in the different parts of the column. They are greatest in the cervical region, at the thoracolumbar junction and at the lumbosacral junction. The limits of movement are determined by the planes of the joints between the articular processes, by the flexibility of the intervertebral discs and by the extensibility of the muscles and ligaments. In the thoracic region movements of the vertebral column are more restricted because the ribs and costal cartilages resist distortion.

II. THORACIC SKELETON

The thoracic skeleton consists of the thoracic part of the vertebral column, the ribs with their costal cartilages and the sternum. The bodies of the vertebrae project into the thoracic cavity from behind so that there is a recess of the cavity on each side of them.

The sternum or breastbone consists of three parts—an upper, the manubrium; a middle, the body; and a lower. the xiphoid process (see fig. 3). The anterior and posterior surfaces of the body are marked by transverse lines, indicating its division into four originally distinct segments. Each lateral margin of the sternum presents seven notches for articulation with the seven upper costal cartilages; at each side of the upper margin of the manubrium is a depression where the clavicle articulates; the xiphoid process remains cartilaginous up to a late period in life.

Most skeletons have 12 pairs of ribs, which articulate behind with the thoracic region of the vertebral column. Occasionally cervical or lumbar ribs are present. From the vertebral column the ribs are directed first backward, then downward and forward, to end at a lower level by joining the costal cartilages. The upper seven ribs are attached to the sternum by their costal cartilages and are called true ribs. The lower five ribs are called false ribs. The cartilages of the 8th, 9th and 10th ribs do not reach the sternum directly but join the cartilages of the ribs immediately above. The cartilages of the 11th and 12th ribs have no anterior attachments, and these ribs are known as floating ribs.

A typical rib (from 3rd to 9th) consists of head, neck and shaft. The head articulates with two adjacent vertebral bodies. A short neck separates the head from a tubercle, articulating with a transverse process. Beyond that the shaft curves round the side of the thorax to the costal cartilage.

III. APPENDICULAR SKELETON

The upper and lower limbs in man resemble one another in their general plan, but differ greatly in their detailed structure and in their mode of attachment to the trunk. Their functions also have undergone pronounced modifications; the upper limbs have been freed from supporting the body weight and have become prehensile organs, whereas the lower limbs have to be used not only to propel the body but also to act as struts to prevent it from falling forward during locomotion. Each limb is attached to the axial skeleton by means of a bony girdle; that of the upper limb is called the shoulder (pectoral) girdle, and that of the lower limb the pelvic girdle. The shoulder girdle, consisting of the clavicle and scapula (see fig. 3, 4), has considerable mobility on the trunk; its sole skeletal connection with the trunk is through the articulation of the clavicle with the upper end of the sternum at the sternoclavicular joint. There is a wide range of free movement of the upper limb on the shoulder girdle, and this is supplemented by movements of the girdle on the trunk. The movements at the shoulder joint can take place about an infinite number of axes. Specific names are given for these movements, such as flexion, extension, abduction, adduction, rotation and circumduction.

The lower limb articulates with the hipbone. This is firmly connected with the sacrum to form the pelvic girdle (see fig. 3, 4), which acts as a single skeletal unit in all ordinary body movements. It is through the hipbone that the weight of the trunk is transferred from the sacrum to the head of the femur. Conversely, the pelvis transmits to the trunk the forces that arise from action of the lower limb. Movements at the hip joint, like those at the shoulder joint, take place about a number of axes; the movements, however, are more limited. Certain of them are distinguished by names. The forward movement of the thigh relative to the pelvis is called flexion, the backward movement extension. The movement of the limb toward the midline of the trunk is called adduction, the movement away from it abduction. Medial and lateral rotation of the limb can also occur, and the combination of all the movements is called circumduction.

Each of the limbs consists of three segments—proximal, intermediate and distal.

The proximal segment in both arm and leg contains one long bone, the humerus in the arm and the femur in the leg.

The intermediate segment consists of two bones, the radius and ulna in the forearm and the tibia and fibula in the leg (see fig. 5). The articulation of the intermediate with the proximal segment in each limb is hingelike; the joint is termed the elbow in the upper limb and the knee in the lower limb. Axial rotation (rotary movement) is fairly extensive at the knee except when the leg is completely straightened (extended) but is negligible at the elbow. The movements possible in the intermediate parts of the two limbs differ considerably; rotation, known as pronation and supination, can take place within the forearm by a movement between the radius and the ulna, but in the lower limb no comparable movement is possible.

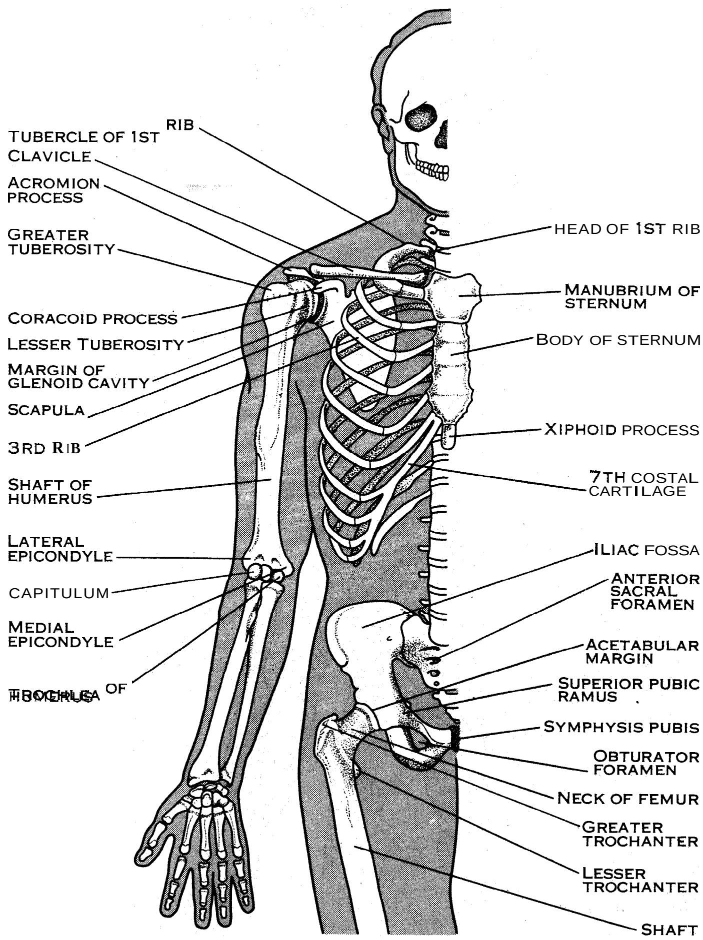


FIG. 3.—ANTERIOR VIEW SHOWING RIGHT HALF OF SKELETON OF THE TRUNK AND UPPER LIMB

The distal segments of the upper and lower limbs consist respectively of the hand and foot. These comprise: (1) a series of small bones, called the carpus or tarsus; (2) five elongated bones, metacarpals or metatarsals, each of which supports (3) a digit, finger or toe. Each digit has three phalanges; the thumb and great toe are exceptional in having only two. The articulation of the carpus with the radius and ulna, known as the wrist joint, allows movements round a transverse axis (*i.e.*, movements producing flexion and extension of the hand) and round an anteroposterior axis permitting abduction and adduction of the hand. The movements at the articulation of the tarsus with the tibia and fibula, known as the ankle joint, are almost restricted to a hingelike flexion and extension. In the foot there is a considerable range of movement between certain of the tarsal bones. The movement that turns the sole of the foot to face inward is known as inversion, while the movement by which it can be turned outward is known as eversion. These movements permit the sole of the foot to adapt itself to the surface contour on which it rests.

There is a general resemblance between toe and finger movements, but the joint at the base of the thumb between the first metacarpal and the adjacent carpal bone (trapezium) permits a variety of movements which is lacking in the big toe. At the metacarpophalangeal, metatarsophalangeal and interphalangeal joints, hingelike flexion and extension movements take place. The movements are freer in the hand than in the foot.

A. Upper Limb

The upper limb consists of the shoulder region, the arm, the forearm and the hand.

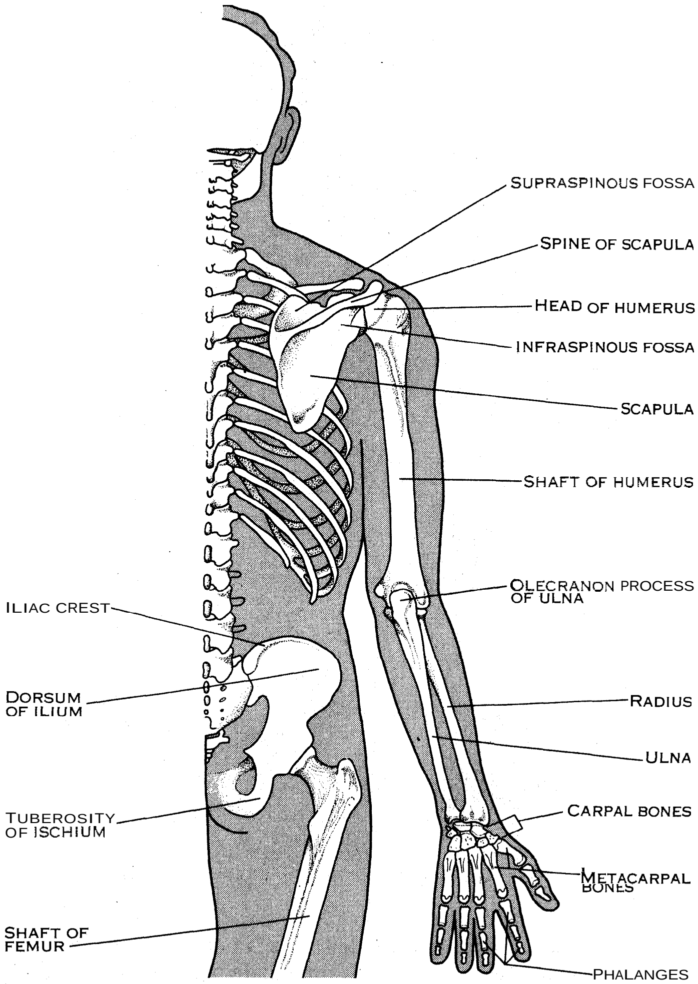


FIG. 4.— POSTERIOR VIEW SHOWING RIGHT HALF OF SKELETON OF THE TRUNK AND UPPER LIMB

Clavicle.—The clavicle, or collarbone, is an elongated bone which extends horizontally from the upper end of the sternum outward, to articulate with the acromion of the scapula (see fig. 3). It presents a strong sigmoidal curve, and is slender in the female but robust in muscular males. Its sternal end is thick; its acromial end, flattened from above downward, has an articular surface that meets a corresponding surface on the acromion. Strong ligaments connect the ends of the clavicle with the sternum and 1st rib and with the acromion and coracoid process of the scapula. The shaft gives attachment to muscles of the shoulder girdle.

Scapula. — The scapula, or shoulder blade, lies upon the upper part of the back of the chest, between the levels of the 2nd and 8th ribs. It is triangular in outline. Its anterior surface, which is concave, faces the ribs. Its posterior surface is crossed obliquely by a prominent ridge, the spine, which subdivides this aspect of the bone into a supraspinous and an infraspinous fossa. The spine and these two fossae give attachment to muscles which act in rotating the arm. The spine arches forward to end in the broad flat acromion by which the scapula articulates with the clavicle. To the margins of the scapula are attached muscles which participate in moving or fixing the shoulder as demanded by the prehensile movements of the upper limb. Of the three angles of the scapula, the outer is thickened and presents the shallow glenoid fossa, which articulates with the head of the humerus to form the shoulder joint. Overhanging the glenoid fossa is a beaklike projection, the coracoid process.

Humerus. — The humerus is a typical long bone, and as such presents a shaft and two expanded ends. The upper end possesses a hemispherical head with a smooth surface which articulates with the glenoid fossa of the scapula; where head and shaft merge, two tubercles are found, to which are attached rotator muscles which arise from the scapular fossae. Between the tubercles is a groove which carries the long tendon of the biceps muscle. The shaft of the humerus is three-sided in section above, but flattened and expanded below. A broad, shallow groove winds round the back of the bone, lodging the radial nerve. The lower end of the bone consists of articular and nonarticular regions. The lateral articular region, the capitulum, articulates with the head of the radius, and the medial, the trochlea, articulates with the ulna. The nonarticular regions have projections, the medial and lateral epicondyles; each is surmounted by a supracondylar ridge. The medial epicondyle and ridge give attachment to the muscles that pronate the forearm and flex it and the fingers; the lateral epicondyle gives origin to muscles which participate in supination and in extension of the wrist and fingers.

Radius. — The radius, the lateral bone of the forearm, conforms to the type of a long bone. The upper extremity, or head, which is disc-shaped, articulates above with the humerus; the margin of the disc articulates with the ulna and with the annular ligament. The head of the bone is joined to the shaft by a neck, below which is a tuberosity into which the biceps muscle is inserted. The shaft of the radius affords attachment for muscles which act upon the fingers and the wrist. Its sharp inner margin gives attachment to the interosseous membrane, which forms a partition between the structures of the front and back of the forearm, affording surfaces for muscle attachments. The lower, or distal, end of the radius is much broader than the proximal end, and is marked posteriorly by grooves that lodge the muscle tendons passing to the back of the hand. From its outer margin a pointed styloid process projects downward. The inner margin of the distal extremity has a smooth concave surface for articulation with the lower end or head of the ulna, and its broad concave lower surface articulates with the scaphoid and lunate bones of the wrist.

Ulna. — The ulna is the long bone on the medial side of the forearm. Its proximal end is subdivided into two strong processes by the trochlear notch, the smooth surface of which articulates with the humerus. The lower, or coronoid, process is rough, receiving the insertion of the chief flexor of the forearm, the brachialis muscle, whereas the upper and posterior process, the olecranon, gives insertion to the powerful extensor of the forearm, the triceps muscle from the back of the arm. Immediately behind the trochlear notch on the lateral side of the ulna is the radial notch for articulation with the margin of the head of the radius. The shaft of the bone has three surfaces giving attachment to muscles which act upon the wrist and fingers and in the movements of both pronation and supination. The sharp lateral margin of the shaft gives attachment to the interosseous membrane. The lower end, or head, of the ulna, much smaller than the upper, has a styloid process and an articular surface, the lateral surface of which meets the lower end of the radius. The lower part is in contact with a fibrocartilage which binds the ulna to the radius and separates the distal end of the former from the wrist joint.

The ulna. much more than the radius, establishes the hinge joint at the elbow. The radius, although entering into this joint, is involved, functionally, less with the arm than with the hand with which it alone articulates. By muscular action the radius revolves about the stationary ulna, carrying the hand in the movement called twisting the wrist. When the palm faces for ard in supination, the radius and ulna are parallel. When it faces backward in pronation, the radius crosses obliquely over the ulna.

Hand. — The hand consists of the carpus or wrist, the metacarpus or palm and the five digits individually named. Anatomists describe it with the palm turned to the front, and with its long axis in line with the long axis of the forearm.

The carpal or wrist bones, eight in number, are arranged in two rows. Named in order from the radial to the ulnar side, the proximal row comprises the scaphoid, lunate, triquetral and pisiform hones, and the distal row the trapezium, trapezoid, capitate and hamate bones.

The metacarpal bones are five in number. They are miniature long bones. The metacarpal of the thumb is the shortest. and diverges outward from the rest; its carpal extremity is saddle-shaped for articulation with the trapezium. Its shaft is somewhat flattened, and its distal end is smooth and rounded, articulating with the first phalanx of the thumb. The bases of the other metacarpal bones articulate with the trapezoid, capitate and hamate bones; the distal end or head of each articulates with the proximal phalanx of a finger.

The five digits of the hand are distinguished by the names of pollex or thumb, index, medius, annularis and minimus. The skeleton of the thumb consists of two phalanges while that of each finger has three. Each phalanx is a miniature long bone.

The carpal bones are firmly connected together, yet permit siight movements that are essential in the mechanism of the hand as a prehensile organ. The palmar contour of the wrist skeleton is like a gutter, bridged over by a dense ligament that makes it into a tunnel through which pass blood vessels, nerves and tendons for the fingers. The thumb enjoys great range and variety of movement, a human characteristic made possible in part by the conformation of the base of its metacarpal with the trapezium. The other carpometacarpal joints permit only slight motion, in contrast with the free movement of the fingers.

B. Lower Limb

The lower limb consists of the hip region, the thigh, leg and foot. The bone of the hip (the innominate bone, or os coxae) forms the pelvic girdle by articulating behind with the side of the sacrum, and by arching forward to articulate with the opposite bone in the midline at the symphysis pubis.

The hipbone is a large irregular plate which forms the lateral and anterior wall of the pelvis. In early life it is made up of three separate elements — ilium, ischium and pubis — which unite about the 18th to the 20th year into a single bone. At the site of junction of the three elements there is a cup-shaped depression, the acetabulum, for the head of the femur (see fig. 3, 4). From the acetabulum the ilium extends upward and laterally, the ischium downward, the pubis forward and medially. Below the acetabulum is a large opening, the obturator foramen, bounded by the pubis, the ischium and the ilium.

Ilium. — The ilium is a broad, bony plate, the lower, narrower part of which enters into the formation of the acetabulum, whereas the upper, expanded part presents an elongated free margin, the sinuous crest of the ilium. This crest affords attachment to the broad muscles that form the wall of the abdominal cavity. The external or lateral surface of the ilium gives origin to the muscles of the buttock. The internal surface is hollowed out anteriorly and gives origin to the iliacus muscle, which flexes the thigh. Posteriorly the ilium has an L-shaped surface articulating with the side of the sacrum in the sacroiliac joint.

Pubis. — The pubis consists of a body and two rami and is therefore somewhat U-shaped. The body is the flattened portion adjacent to the symphysis, and has an outer and an inner surface. The upper ramus passes backward to become continuous with the ilium; the lower ramus is continuous aith the ramus of the ischium.

Ischiurn. — The ischium also is somewhat U-shaped. One extremity (the upper) completes the acetabulum, whereas the lower is united with the inferior ramus of the pubis, and together these form the lower boundary of the obturator foramen. The conjoined rami afford origin to the adductor muscles that act in drawing the thigh toward the middle line. The upper, posterior branch is a stout bone which gives origin to the powerful hamstring muscles of the back of the thigh. The spine of the ischium separates the greater from the lesser sciatic notch. In the sitting position the body rests on the tuberosity of the ischium.

Pelvis. — Through articulation of the two hipbones with each other at the pubic symphysis, and with the sides of the sacrum behind, the osseous walls of the cavity of the pelvis are formed. This cavity is subdivided into a major (false) and a minor (true) pelvis. The true pelvis encloses a short, wide canal and possesses a superior opening. or inlet, a cavity and an inferior opening, or outlet. The false pelvis consists of the iliac fossa of each side above the level of the inlet of the true pelvis. Because of the inclination of the pelvis, the upper part of the sacrum is nearly ten centimetres higher than the upper margin of the pubic symphysis. The female pelvis is distinguished from the male by certain sexual characteristics. The bones are more delicate and the ridges and processes for muscular attachment are less prominent. The depth is less. the inlet more nearly circular, the pubic arch wider, the distance between the ischial tuberosities greater and the acetabulum smaller in the female than in the male. In addition, the pelvis is broader and its capacity greater, and this contributes to the greater breadth of the hips in women. The greater capacity of the female pelvis affords room for expansion of the uterus during pregnancy and for the passage of the child at the time of birth.

Femur. — The femur is the longest bone in the body. At its upper extremity is the smooth hemispherical head, articulating with the acetabulum. Supporting the head is a strong, elongated neck which extends downward and outward to join the shaft. At the junction of neck and shaft two processes or trochanters are situated. To the lateral, or greater, trochanter are attached muscles that rotate the thigh; into the lesser trochanter is inserted the iliopsoas muscle, a flexor of the thigh. The neck of the femur in the adult forms an angle of about 125° with the shaft. The shaft is almost cylindrical at its centre, but it is expanded above and below. Its front and sides give origin to the extensor muscles of the leg; behind, there is a long ridge, the linea aspera, into which are inserted the adductor muscles of the thigh. The lower end of the femur is adapted to the upper surface of the tibia and presents a large, smooth, articular surface, the anterior portion forming a trochlea or pulley for the patella (see fig. S). The lower and posterior part, subdivided into two convex condyles, moves upon the condyles of the head of the tibia. In the deep fossa between the femoral condyles are attached the cruciate ligaments that control and limit movements at the knee joint.

Patella. — The patella, or kneecap, is a triangular, flattened, sesamoid bone developed in the tendon of the great extensor muscles of the leg. Its anterior surface and sides are rough, giving attachment to tendinous fibres; its posterior surface is smooth, and enters into the formation of the knee joint by articulating with the anterior part of the lower end of the femur.

Tibia. — The tibia is the medial and larger of the two bones of the leg (see fig. 5). The femur moves and rests upon its upper end, and through it the weight of the body in the erect position is transmitted to the foot. Its upper extremity (head) is broad and expanded into two condyles, the lateral one bearing inferiorly a small articular facet for the head of the fibula. Superiorly, the two condyles have nearly flat surfaces. articulating with the condyles of the femur. The two condyles are separated by an intermediate rough surface, from which an intercondyloid eminence projects; standing opposite the intercondylar fossa of the femur, this eminence affords attachments to the interarticular cruciate ligaments and the meniscoid cartilages of the knee. These cartilages are movable rings which help to compensate for the flatness of the condylar articular surfaces by making shallow sockets for the femoral condyles The shaft of the tibia is three-sided. Its medial surface is subcutaneous and forms the shin (see fig. 5). Its lateral and posterior surfaces give origin to muscles which move the foot. The anterior margin is the sharp ridge of the shin, and terminates superiorly in a tubercle into which the great tendon of the extensor muscles of the leg is inserted. The lateral margin of the bone gives attachment to the interosseous membrane of the leg. The lower end of the tibia, smaller than the upper, is prolonged into a broad process, the medial malleolus, which forms the inner prominence of the ankle. The lower end of the tibia articulates with the talus.

Fibula. — The fibula is the long, slender bone buried in the muscles of the lateral side of the leg (see fig. 5). The upper end, or head, articulates with the lateral condyle of the tibia. The

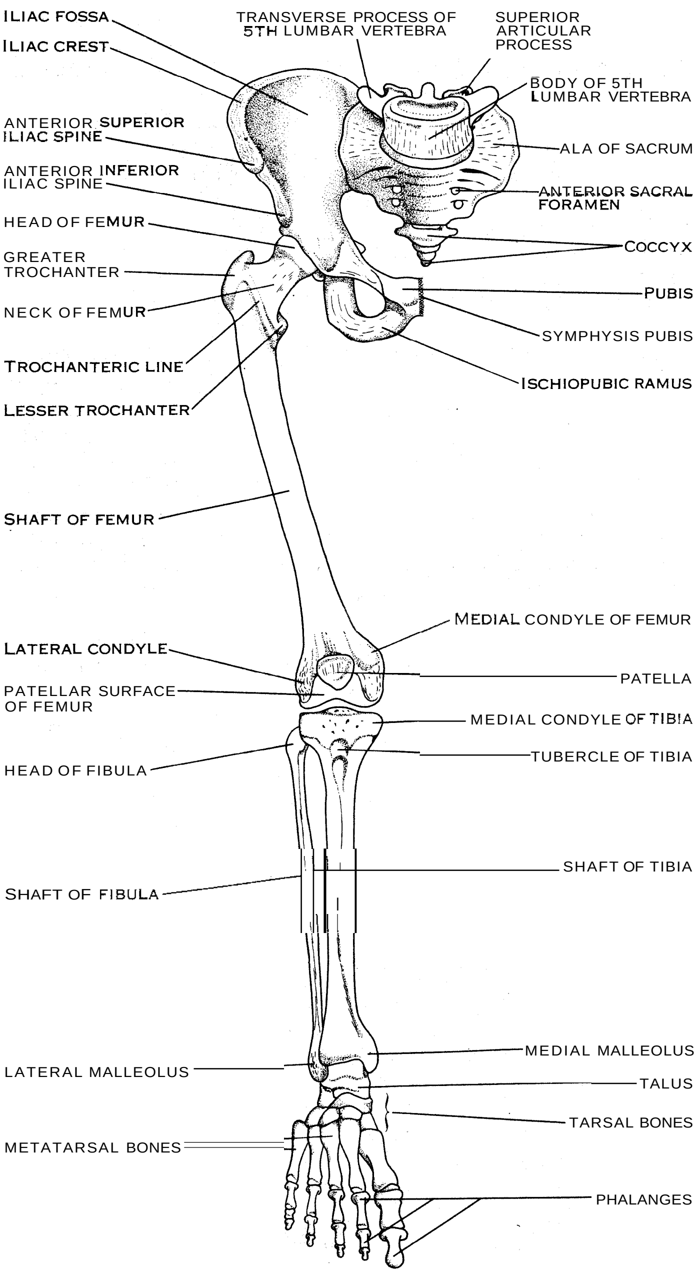


FIG. 5. — ANTERIOR VIEW OF SKELETON SHOWING RIGHT HALF OF THE PELVIS AND RIGHT LOWER LIMB

shaft is four-sided and gives attachment for many muscles. Separating the anterior from the medial surface is a slender ridge giving attachment to the interosseous membrane. The lower end expands into a strong process, the lateral malleolus, forming the lateral prominence of the ankle and presenting a smooth medial surface articulating with the talus. Behind this is a rough surface where the strong ligaments that bind the tibia and fibula together are attached.

Foot.—The foot consists of the tarsus, the metatarsus and the five fret digits, or toes (see fig. 5). The human foot is placed in the prone position, with the dorsum or back of the foot directed upward. The axis of the foot is at about a right angle to the axis of the leg, and the great toe, or hallux, corresponds to the thumb.

The bones of the tarsus, or ankle, seven in number, are arranged in three transverse rows—a proximal, consisting of the talus and calcaneus; a middle, consisting of the navicular; and a distal, composed of the first, second and third cuneiform bones and the cuboid bone. The tarsal like the carpal bones are short and, with the exception of the cuneiforms, which are wedge shaped, are irregularly cuboidal. The dorsal and plantar surfaces are rough for the attachment of ligaments except those of the talus which, since it is mortised between the bones of the leg and the calcaneus, presents articular surfaces on its dorsal and plantar surfaces as well as on its sides.

The posterior portion of the calcaneus projects backward to form the prominence of the heel. With this exception the tarsal bones have articular surfaces upon their anterior and posterior surfaces. Their lateral and medial surfaces are also articular, excepting the lateral surfaces of the calcaneus and cuboid, which form the lateral or outer margin, and the medial surfaces of the calcaneus, navicular and first cuneiform, which form the medial or inner margin of the tarsus.

The metatarsal bones and phalanges agree in number and in general form with the metacarpal bones and the phalanges in the hand. The bones of the great toe are more massive than those of the other digits, and this digit, unlike the thumb, does not diverge from the other digits but lies almost parallel with them.

C. Sesamoid Bones

In addition to the bones described above, certain supernumerary bones are present in certain tendons of the muscles of the hand and foot; these are known as sesamoid bones.

IV. DEVELOPMENT OF THE SKELETON

The skeleton is developed from the embryonic mesoderm. so it is necessary to refer briefly to the origin of this tissue. At about the 15th day after fertilization of the ovum, when the embryo consists of a bilaminar disc with layers called ectoderm and endoderm, a longitudinal thickening appears in the posterior part of the embryonic disc as the result of multiplication of the ectodermal cells. This thickening, called the primitive streak, gives rise to the notochord and to the mesoderm. The primitive streak is comparable to the blastopore of lower vertebrate embryos. The axis of the embryo is first laid down by the formation of a cylindrical mass of cells, the notochord, proliferated from the primitive (Hensen's) node at the anterior end of the primitive streak. The notochord lies ventral to the developing central nervous system and forms the first supporting structure for the developing embryo.

In fishes such as the shark, cartilaginous vertebrae are formed round the notochord and to some extent compress it. Nevertheless, it persists as a continuous structure through the length of the vertebral column. In the higher vertebrates, including man, the notochord is a temporary structure which persists only as a minute canal in the bodies of the vertebrae and in the central part of the nucleus pulposus of the intervertebral discs.

While the notochord is being laid down, cells proliferate from the sides of the primitive streak. These form the mesoderm, which spreads out as a sheet on each side and, as a result of migration and multiplication of cells, soon comes to occupy most of the space between the ectoderm and the endoderm on each side of the notochord. The mesodermal sheets soon become differentiated into: (1) a mass lying on each side of the notochord (paraxial mass) which undergoes segmentation into hollow blocks, the mesodermal somites; (2) a lateral plate which becomes separated into an outer layer, the somatopleuric mesoderm, against the future body wall, and an inner layer, the splanchnopleuric mesoderm, against the endoderm of the future gut; (3) an intermediate mass, the nephrogenic cord, which gives rise mainly to the urinary apparatus.

The segmentation of the paraxial mesoderm is a fundamental feature of the development of the vertebrates. The axial skeleton and associated structures develop from part of the somite, while the appendicular skeleton arises from the somatopleuric mesoderm of the lateral plate. Each somite differentiates into: (1) a lateral and superficial plaque, the dermatome, giving rise to the integumentary tissue; (2) a deeper lateral mass, the myotome, which gives origin to the muscles; and (3) a medial ventral mass, the sclerotome. The sclerotomic cells from each pair of somites migrate medially until they meet in the middle line round the notochord to separate it from the neural tube dorsally and from the aorta ventrally. The sclerotomic tissue retains its original segmentation and becomes condensed to form the forerunner or blastema of the body of the future vertebra. From each posterolateral half of the condensation extensions pass backward and eventually meet posteriorly round the neural tube to form the blastema of the neural arch of the vertebra. In the interspaces between adjacent myotomes of each side, an extension from each sclerotomic mass passes laterally and forward to form the costal or rib element. It is only in the thoracic region that the costal elements develop into the definitive ribs. In the other regions the costal elements remain rudimentary. As early as the seventh week of fetal life (the embryo being approximately 18 mm. in length), the mesenchymal blastema of the future vertebra becomes chondrified; *i.e.*, the mesenchymal cells are converted into cartilage cells. In this cartilaginous vertebra, ossification centres appear about two weeks later, and the cartilage is gradually replaced by bone. The mesenchyme of the primordia of the ribs also undergoes chondrification and later ossification. In the thoracic region, where costal elements are best developed, a cartilaginous sternal bar is formed in relationship with their anterior or growing ends.

The appendicular skeleton begins to develop in the primitive limb bud at the fifth week of fetal life in the core of mesenchyme derived directly from the unsegmented somatopleuric mesoderm. This mesenchyme becomes condensed to form the blastemal masses of the future limb bones. By the seventh week of fetal life, the mesenchyme has become transformed into the cartilaginous precursors of the individual bones (except in the case of the clavicle). The cartilaginous models determine the general shape and relative size of the bones, and there is convincing evidence from experimental investigations that the shape of the bones of higher vertebrates is determined by intrinsic factors inherent in the tissues and that extrinsic influences are concerned with providing the proper conditions for maintaining the normal structure once development has begun.

The first mesenchymal condensations of the appendicular skeleton are in the region of the future girdles, and those for the shoulder girdle appear a little earlier than those for the pelvic girdle. The mesenchymal condensations for the other bones of the limbs appear in a proximodistal sequence.

Ossification of Bone.—The ossification of bone is usually described as occurring by two different methods—endochondral (in cartilage) and intramembranous (in membrane), but in each case the fundamental process is the same since the cells that are responsible are identical.

All the bones of the skeleton (excluding certain of the skull bones and the clavicle) are developed in cartilage; *i.e.*, by endochrondral ossification. It must be emphasized that there is no direct transformation of the cartilage into bone. The cartilage of the model becomes calcified and is then removed by a process of erosion and replaced by bone (see Bone; Connective and Supporting Tissues: Anatomical Types of Connective Tissues: Bone).

V. COMPARATIVE ANATOMY

Just as in the embryonic development of man the notochord forms the earliest structure that stiffens the embryo, so in the animal kingdom it appears before the true vertebral column is evolved. In the ascidians or sea squirts (Urochordata) the notochord is present in the larval stage, in the tail region only, disappearing after the animal's metamorphosis to the adult form. In amphioxus (Cephalochordata) the notochord is permanent and extends the whole length of the animal.

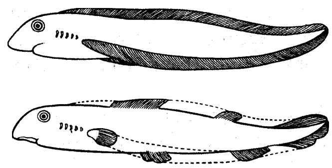
In the lampreys (Cyclostomata) the notochord and its sheath persist throughout life, and in the adult lamprey (Petromyzon) rudimentary cartilaginous neural arches are found. Among the bony fishes, the sturgeon (Acipenser) has a persistent notochord with fibrous sheath upon which appear the paired cartilaginous dorsal neural arches and ventral hemal arches. The modern shark (*Scyllium*) possesses a vertebral column composed of cartilaginous, partly calcified, centra which have their origin within the sheath of the notochord, causing its partial absorption.

The vertebrae of the salmon and cod (Teleostei) are completely ossified; each centrum develops in the sclerotomic mesoderm outside the notochordal sheath (perichordal development).

A vertebra of a modern tailed amphibian (*e.g., Ambystoma*) is in one piece, and the neural and hemal arches are in continuity with the centrum. In general, a vertebra is formed from the sclerotomic tissue of two somites, the tissue from the posterior part of one somite joining that from the anterior part of an adjacent one. Articulation between neural arches of adjacent vertebrae is by special articular processes (zygapophyses). The first vertebra of the amphibian vertebral column, the atlas. presents a pair of sockets on the anterior surface of the centrum. These sockets articulate with the two condyles of the skull. The second vertebra does not differ from those following.

In living reptiles the vertebrae are completely ossified. The neural arch has a spinous process and pre- and postzygapophyses; at the junction of arch and centrum there is a facet for articulation of the head of a rib. Groups of vertebrae can be distinguished; for example, the cervical vertebrae can be recognized, as the neck is differentiated from the body. The atlas, in the form of a ring, lacks a centrum, and articulates with the single condyle of the skull by a facet on the anterior surface of the ventral bar of the ring. The second vertebra, the axis, possesses a centrum which articulates anteriorly with the odontoid process; this process is the dissociated centrum of the atlas and lies within the ring of the latter in contact with its ventral bar. The costal elements of two sacral vertebrae unite the pelvic girdle with the axial skeleton. In the tail region hemal arches are found enclosing the caudal artery and vein. In some species the hemal arches are separate and are called chevron bones. A special feature of the caudal vertebrae in the lizard is the transverse division of the centra, adapted to the shedding of the tail. The fibrocartilaginous intervertebral discs uniting the centra of crocodiles have been identified as representing intercentra (interpreted as ossifications in the hypochordal bars). Ribs are present in the cervical, thoracic and lumbar regions, and in the tortoises they fuse with the cervical vertebrae. The more cranial thoracic ribs are attached to the stemum through cartilaginous sternal ribs; the other ribs do not reach the sternum. In the crocodiles and the lizardlike *Sphenodon*, a spur from each thoracic rib overlaps the next rib behind and is known as an uncinate process. These processes are developed in connection with the origin of the external oblique muscle of the abdomen. The ventral elements of some of the hinder ribs of crocodiles lie unattached in the intersections (inscriptiones tendineae) of the rectus and internal oblique muscles and are known as abdominal ribs. The sternum may be calcified but is seldom ossified in the reptiles. In the lizards it is a cartilaginous plate articulated with the coracoid processes of the pectoral girdle and with the anterior thoracic ribs. The sternum is absent in the turtles and in the snakes; in the crocodiles it is a wide plate joined by the coracoids and by two pairs of ribs.

The skeletons of modern birds show reptilian features with some specialized adaptations to their bipedal locomotion and power of flight. Between the bodies of the vertebrae are intervertebral discs. The neck is very movable, and with its variation in length the number of cervical vertebrae ranges from 25 in the swan to only 9 in some of the small birds. The tendency for the vertebrae to fuse in certain regions is a characteristic of birds. The two true sacral vertebrae become secondarily fused with adjacent lumbar vertebrae, and indirectly even with thoracic, to constitute a synsacrum. This fuses with the ilium of the pelvic girdle, making a rigid support for the posterior part of the bird's body. The caudal vertebrae are fused into a single bone, the pygostyle, that supports the tail. The stemum is a very large bone standing like a shield in the front of the chest. In flying birds (Carinatae) a median keel, the carina, projects ventrally, providing additional surface for the attachment of the pectoral muscles that move the wings. The nonflying ostrich-like birds have a keelless. raft-like sternum.



FROM WILDER'S HISTORY OF THE HUMAN BODY

FIG. 6.— DRAWING ILLUSTRATING THE THEORY OF ORIGIN OF THE MEDIAN AND PAIRED FINS OF THE FISH AS THE RESULT OF THE PER- [illegible] MEDIAN AND LATERAL FIN FOLDS

In mammals, the vertebral centra articulate by means of intervertebral discs of fibrocartilage. Epiphyseal bony plates formed on the generally flat ends of the centra are characteristic of mammals; they are rudimentary in the duck-billed platypus and in the sea cows. Regional differentiation in the mammalian backbone is marked. The number of vertebrae in each group, excepting the caudal, is moderately consistent with few exceptions. Some exceptions to the group averages may be cited. Whereas 7 cervical vertebrae are the rule, there are 9 or 10 in the three-toed sloth and only 6 in the two-toed sloth and the manatee. The thoracic vertebrae commonly number 13 or 14, although they vary from 9 in some whales to 24 in the two-toed sloth. The average number of lumbar vertebrae may be taken as 6; there are but 2 in the duck-billed platypus and 21 in the dolphin. Rib elements are fused to the transverse processes of the cervical vertebrae, and in the lumbar vertebrae they form the so-called transverse processes. There is an increase in the number of vertebrae that compose the sacrum. The sacrum consists of the true sacral vertebrae fused to form a single bone. In the early developmental stages of human embryos the beginnings of the hipbones lie opposite those segments of the spinal column that go to form the lower lumbar and upper sacral vertebrae. As development proceeds, the sacroiliac joints become established between the hipbones and the upper sacral vertebrae; the sacrum, derived from the 25th to the 29th vertebrae inclusive, becomes a single bone by their fusion. The whales and sea cows lack a sacrum, although vestiges of a pelvis occur. In some anteaters the posterior sacral vertebrae are fused with the ischium through ossification of the sacrotuberous ligament. The sacrum of some armadillos consists of 13 vertebrae, caudal vertebrae having become fused with it. The cervical vertebrae of some whales are fused together. The centrum of the atlas of most mammals fuses with that of the axis and projects from it as the dens, but in the duck-billed platypus it is a separate bone as it is in reptiles. The spinous processes of the thoracic vertebrae, excepting the last. point caudally and those of the lumbars generally point cranially; at the transitional zone between these groups the spines of one or two thoracic vertebrae are upright and the name anticlinal is given to them. Lying ventral to the intervertebral discs in some mammals (whales, pangolin) are paired ossicles, the intercentra, homologous with the anterior arch of the atlas. The tail vertebrae vary in number from none in the bat to 49 in the pangolin.

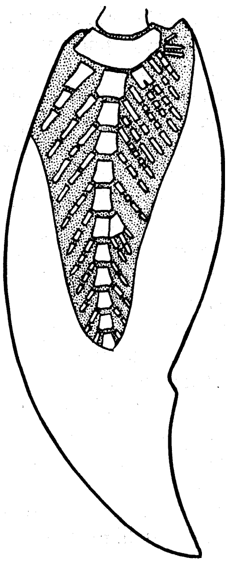
The ribs in mammals correspond in number of pairs to the number of thoracic vertebrae. The tubercle articulates with the transverse process; the head of the rib with the capitular facets of two vertebrae, that with which the tubercle articulates and the one anterior to it. The ribs of some whales articulate only with the transverse processes of the vertebrae. The ventral ends of the ribs join the costal cartilages, the relations of which follow, with minor variations, the pattern described for the human skeleton. Sternal ribs, connecting the more anterior vertebral ribs with the sternum. may be cartilaginous, calcified or ossified. The mammalian sternum is composed of several pieces—the presternum anteriorly, followed by the mesosternum, made up of a number of segments, and a terminal single xiphisternum. The sternum of the rorqual whale and of the manatee is a single bone.

VI. COMPARATIVE ANATOMY OF THE APPENDICULAR SKELETON

The paired appendages or limbs are not found in ancestral vertebrates and are not yet present in the living cyclostomes or jawless vertebrates. Appendages make their first appearance during the early evolution of the fishes. Usually two pairs of appendages are present and consist of fins (ichthyopterygium) in the fishes and limbs (cheiropterygium) in land vertebrates. Each appendage includes not only the skeletal elements within the free portion of the limb but also the basal supporting structure, the limb girdle. This portion of the appendage lies partly or wholly within the trunk and forms a stable base for the fin or limb. Each girdle consists of ventral and dorsal masses and in lower fishes these are composed of cartilage; in bony fishes and in land vertebrates the masses become more or less completely ossified.

The anterior appendages, the pectoral fins or forelimbs, articulate with the pectoral girdle, which is situated just caudal to (behind) the gill region in fishes and in a comparable position at the junction of the neck and thorax in land vertebrates.

The posterior appendages, called pelvic fins or hindlimbs, articulate with the pelvic girdle: which is situated in the trunk region usually just cranial to (in front of) the anus or cloaca. It is by way of the girdles that the weight of the body in land vertebrates is transmitted to the limbs. As the hind limb is usually of greater importance in weight bearing, especially in bipedal vertebrates, it articulates with the vertebral column by means of the costal elements of the sacral vertebrae. The vertebrae to which the pelvic girdle is attached usually fuse to form the sacrum. In fishes, however, since the posterior appendages usually do not support the body weight but are used only in l'ocomotion, a sacrum as such does not develop.

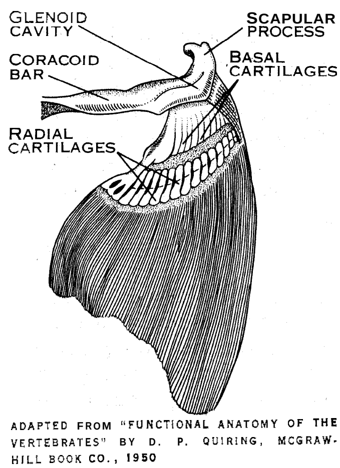


FROM NILS HOLMGREN IN "ACTA ZOOLOGICA," ALBERT BONNIERS FÖRLAG, STOCKHOLM

FIG. 7.— PECTORAL GIRDLE OF THE LUNGFISH (CERATODUS) SHOWING A CENTRAL ARCHIPTERYGIUM WITH LATERAL RAYS

The origin of paired fins has been much debated and many theories have been put forward in explanation. In the most probable theory, the fin-fold theory, the paired limbs are derived from the local persistence of parts of a continuous fold which, in ancestral vertebrates, passed along each side of the trunk and fused behind the anus into a single fin (see fig. 6[A] and 6[B]). The primitive paired fins were attached to the body by a broad base and carried no weight. Their main function, it would appear, was to act as horizontal stabilizing keels which tended to prevent rolling movements and possibly also fore and aft pitching. It is generally agreed that the limbs of tetrapods (land vertebrates) have been evolved from the paired fins of fishes and have become organs for propulsion. They are thought to have their ancestral counterpart in the fins (see fig. 7) of certain extinct lobe-finned fishes (Crossopterygii). The coelacanth is a living example of this group.

Limb Girdles.—The skeleton of the primitive fin consists of a series of endoskeletal rods each of which undergoes subdivision into a series of three or four pieces. The proximal (*i.e.*, nearer to the trunk) or basal pieces tend to fuse into larger pieces. The most cranial (anterior) of the basal pieces fuses across the middle line with its fellow of the opposite side to form a primitive girdle in the form of a cartilaginous bar. The more distal or radial pieces persist to form the dermal fin rays.



ADAPTED FROM "FUNCTIONAL ANATOMY OF THE VERTEBRATES" BY D. P. QUIRING, MCGRAW-HILL BOOK CO., 1950

FIG. 8.—LEFT PECTORAL GIRDLE AND LIMB OF AN ELASMOBRANCH

Pectoral Girdle.—Fishes.—In the dogfish the pectoral girdle consists of a U-shaped endoskeletal cartilaginous inverted arch with its ends extending dorsally. The crosspiece of the "U" forms the coracoid bar, the ends passing dorsally on each side to form the scapular processes. At the junction of the coracoid with the scapular process is an articular region or glenoid fossa for articulation with the basal cartilages of the fin (see fig. 8).

In all other major groups of vertebrates the pectoral girdle is a composite structure consisting of the endoskeletal structures to which secondary dermal components are added as the result of ossification of dermal elements. These become ossified to form dermal bones.

In bony fishes such as the lungfishes, sturgeon and coelacanths, the main element added is a vertically placed structure, the cleithrum, which supports the scapula (see fig. 9). The cleithrum may be joined by a supracleithrum, which in turn is surmounted by a posttemporal element, so that the shoulder girdle is connected with the otic region of the skull.

The most ventral of the added dermal bones are the clavicles, which unite below the gill chamber with each other or with the sternum. In the holostean fishes (*e.g.,* gar pike) and in the teleosts (*e.g.,* salmon and codfish) the clavicle is lost, leaving only the cleithrum.

Amphibians.—In tailed amphibians such as newts and salamanders the dermal elements of the pectoral girdle have been completely lost and only the endoskeletal parts remain; they have reverted mainly to being cartilaginous bars. This retrogression is probably the result of their adaptation chiefly to an aquatic

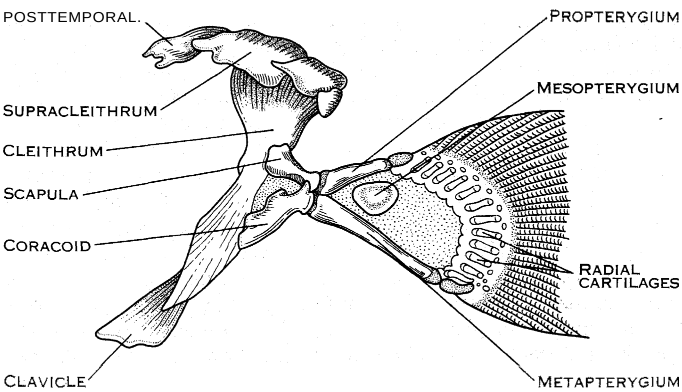


FIG. 9.— RIGHT SHOULDER GIRDLE OF TELEOST FISH

mode of life where less support by the girdles is required. The ventral part of the girdle forms the coracoid and the dorsal part the scapula; the latter is the only part which becomes ossified, and only a rudimentary sternum is developed.

In the frog, the pectoral girdle consists of a dorsally placed, ossified scapula, to the end of which is joined an incompletely ossified plate, the suprascapula. The precoracoid and coracoid are quite distinct, the former being cartilaginous and overlaid by an investing dermal bone, the clavicle.

Reptiles.—In most reptiles there is a primary girdle for the forelimb, consisting of a scapula and a single coracoid. The pectoral girdle of the lizard consists of bones formed in cartilage; the scapula and the large coracoid, participating in the glenoid cavity, and the dermal, membrane bones, the clavicle and interclavicle, the latter being a single T-shaped bone, with the stem in the midline and in contact with the sternum. The curved clavicles articulate with each other at their medial ends. The cartilaginous suprascapula is present.

In the alligator the pectoral girdle consists of a stout dorsal scapula and a well-developed precoracoid. Clavicles are absent, but there is a well-developed midventral dagger-shaped interclavicle.

Birds.—In birds the pectoral girdle is essentially similar to that found in the reptiles. The precoracoid forms a stout bar which reaches to the sternum. The wishbone, or furcula, is formed from the dermal part of the girdle and consists of two clavicles united together in the middle line by the interclavicle. The Carinatae (birds with a keeled sternum) have a sabre-shaped scapula and a stout coracoid joined together by ligaments, where the glenoid cavity for articulation with the humerus is located. The coracoid is jointed to the sternum; at its dorsal end is the acrocoracoid process. The furcula stands in front of the coracoids, its ends connected by ligaments with the acrocoracoid and with the rudimentary acromion process of the scapula. The girdle of the nonflying ostrichlike birds is little developed, being represented by an ankylosed scapula and coracoid.

Mammals.—Among mammals, the monotremes have two coracoids, articulating medially with the presternum and laterally with the scapula, which enter into the formation of the glenoid cavity. An interclavicle (episternum) and an investing clavicle resembling these bones in reptiles are also present. The clavicle articulates with the acromion of the scapula. In the opossum the scapula has a spine ending in the acromion, with which the clavicle articulates. A much-reduced coracoid fuses with the scapula and does not meet the sternum. The scapula of the placental mammals has a spine ending, generally, in an acromion, and the body of the bone is triangular. In mammals which use the forelimb for support in standing, the vertebral margin is the shortest and the long axis of the scapula runs from it to the glenoid cavity; but in those whose forelimb is used for prehension, such as the primates, or for flight, such as the bats, the vertebral margin is elongated and the distance from it to the glenoid cavity is decreased, so that the long axis is parallel with that of the body instead of being transverse. In the placental mammals, the coracoid, although developing independently, has dwindled to a beaklike process, and fuses with and becomes part of the scapula and does not articulate with the sternum. There has occurred a change in the structure of the pectoral girdle, from its form in animals in which the fore part of the body is propped up on the forelimbs when the coracoid is functional, as in reptiles, to a form in pronograde mammals by which the fore parts are suspended between the two scapulae by the serratus anterior muscles. These spring from the ribs and are inserted into the vertebral margin of the scapula.

The clavicle is present generally in those placental mammals that have prehensile forelimbs (primates, many rodents and marsupials and others), or whose forelimb is adapted for flying (bats). In many mammals it is suppressed, as in cats, or absent, as in whales, sea cows and hoofed animals.

Pelvic Girdle.—Fishes.—The pelvic girdle of the elasmobranch fishes consists of a curved cartilaginous puboischial bar or pair of bars lying transversely in the ventral part of the body anterior to the cloaca; projecting dorsally on each side is an iliac process. Connected with it is a basal cartilage carrying a series of radialia, the skeleton of the paired pelvic fins. The pelvic girdles of many bony fishes are situated far forward near the gills.

Amphibians.—There are marked variations in the form of the pelvic girdle in the amphibians. In the frog the three parts of the hip bone (ilium, ischium and pubis) are present. The pubic elements, however, remain wholly cartilaginous. The hip bone is characterized by the great length and forward extension of the ilium. The girdle is connected with the costal element of one vertebra, thus establishing a sacral region of the vertebral column. The acetabulum is situated at the junction of the three elements.

Reptiles.—The pelvic girdle of some reptiles has a loose connection with the spine. In most reptiles, the ilium is joined to two sacral vertebrae. Both the pubic and the ischial parts usually meet in the ventral symphysis, from which a cartilage or bone, the hypoischium, projects backward to support the margin of the cloacal orifice, and another, the epipubis, projects forward. In a few snakes vestiges of a pelvis and of a limb skeleton appear.

Birds.—In most birds the ilium extends forward and backward and is fused with the many vertebrae which form a synsacrum. The slender ischia and pubes do not form symphyses except in the ostrich.

Mammals.—In most mammals the ilium articulates with the sacrum and the pubes meet in a symphysis anteriorly. A cotyloid bone, formed in the cartilage in the bottom of the acetabulum, is usually found. The symphysis pubis is not present in certain mammals (*e.g.,* moles). In monotremes and marsupials, the mar-

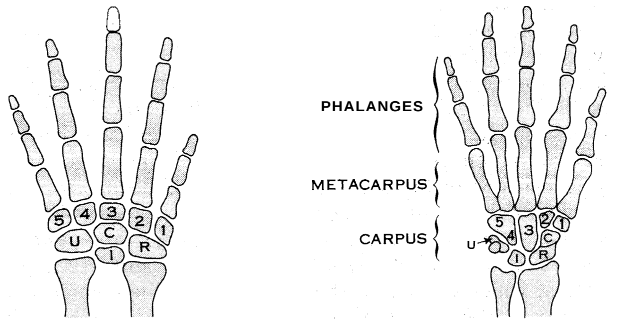


FIG. 10.— DISTALSEGMENT OF FORELIMB OF (A) PRIMITIVE CARPUS AND (B) HUMAN CARPUS
Key: R = radiale, I = intermedium, U = ulnare, C = centralia, 1–5 = carpalia

supial bones that support the pouch have been regarded as part of the epipubis.

Limbs.—Fishes.—The pectoral fin of the elasmobranchs has basal cartilages articulating with the shoulder girdle and carrying a number of radial cartilages consisting of varying numbers of short segments beyond which are delicate fin rays (see fig. 8).

The proximal segment of the pelvic fin of sharks is supported by a single basal cartilage and by one or two radialia. In the pectoral fin of the living crossopterygian fish Polypterus, three elements constitute the proximal segment of the fin, bony rods named pro- and metapterygium on the margins and an intermediate cartilage partly ossified, the mesopterygium (see fig. 9).

Other Vertebrates.—In the land vertebrates, many modifications have occurred in the appendages as a result of the transformation of the fins from balancing organs to weight-bearing propulsive levers. Limbs with digits replace the paired fins. The position of the limbs undergoes progressive changes in adaptation to new conditions. The skeleton of the free limb of the land vertebrate is divisible into three segments.

The proximal segment consists of a single bone, known as the humerus in the forelimb and as the femur in the hindlimb. The humerus articulates by its rounded head with the glenoid cavity of the scapula and by condyles with the bones of the forearm. Its shaft is usually twisted and presents ridges and tuberosities for the attachment of muscles. In many species the distal expanded end is perforated by epicondylar foramina. Foramina are characteristic of the humerus of most reptiles; an entepicondylar foramen is characteristic in some. These foramina are absent in crocodiles. The humerus of flying (carinate) birds, like many of their bones, is hollowed out and contains air. It is short and has, next to the head, a large tuberosity for the insertion of wing muscles. Epicondylar foramina are absent. In nonflying (ratite) birds, the skeleton of the wing is greatly reduced. The entepicondylar foramen is widely distributed among mammalian orders and seems to be linked, in part, with the prehensile limb, as is suggested by its presence in cats and absence in dogs and in the hoofed animals. The entepicondylar foramen transmits the median nerve and brachial artery. The supracondylar process sometimes found in man is a vestige of the boundary of the foramen.

The femur is essentially a cylindrical structure with expanded ends. At the proximal end, for articulation with the acetabulum, is the rounded head, and near it there are usually two elevations, trochanters, for the attachment of muscles. The occurrence of three trochanters is characteristic of certain mammals; *e.g.,* horse and rhinoceros. Distally, the femur expands into two condyles for articulation with the tibia. In many types there is an articular facet on the lateral surface for the head of the fibula.

The typical skeleton of the next segment contains two bones, radius and ulna in the forelimb and tibia and fibula in the hindlimb. In the forelimb, the radius is anterior or preaxial, and the ulna postaxial in the adjustment of the limb for support and locomotion on land. The radius and ulna are fused in some amphibians, for example, in the tailless amphibians (as frogs and toads), and are separate in others, for example, in the urodeles, as they are in all of the reptiles. The ulna is the stouter bone in the bird's wing and supports the secondary feathers. In pronograde mammals the radius is fixed in pronation; that is, the forelimb is rotated so that the shaft of the radius crosses in front of that of the ulna. The radius transmits the aeight of the fore part of the body to the forefeet; whereas it is the ulna that makes the elbow joint with the humerus, and into its proximal end are inserted the flexor and extensor muscles of the forelimb.

Tibia and fibula are separate in urodeles, united in tailless Amphibia. In land reptiles the tibia, the larger bone of the leg, articulates with both condyles of the femur and with the tritibiale of the ankle; the fibula articulates with the postaxial femoral condyle and with the tritibiale and fibulare. The tibia of birds is long but the fibula reduced. In mammals the fibula is generally reduced. It may be fused with the tibia and excluded from the knee joint.

The distal segment of the limb comprises the carpus, metacarpus and phalanges in the upper limb, and the tarsus, metatarsus and phalanges in the lower limb. In a typical limb there are five digits (fingers or toes) which contain the phalanges.

The carpus and tarsus of the higher vertebrates are probably derived from a primitive type by the fusion or suppression of certain of its elements. The bones of a generalized carpus (or tarsus), as that of a tortoise and certain other reptiles, are in three transverse rows: a proximal row of three, named radiale (or tibiale), intermedium and ulnare (or fibulare); a distal row of five carpalia (or tarsalia), numbered one to five from the radial (or tibial) margin; and an intermediate row of one or two centralia.

In many of the urodele amphibians (*e.g.,* salamanders) the carpus is generalized. In the frogs and toads, however, it is more specialized, only six carpals being present, the third, fourth and fifth carpalia having probably fused with either or both centralia. In birds the radiale and ulnare are distinct, but the distal bones are fused with the metacarpus to form a carpometacarpus. In mammals various examples of fusion and suppression occur. In man the radiale forms the scaphoid; the intermedium, the lunate; the ulnare, the triquetral; the pisiform, an ulnar marginale, represents the remains of an extra digit, which may, however, be simply a sesamoid bone. The trapezium and trapezoid are carpalia 1 and 2, the capitate is derived from carpal 3; whereas carpalia 4 and 5 have fused to form the hamate. An os centrale is present in the carpus of many monkeys. In mammals the number of digits varies but the number of phalanges in each digit present usually corresponds with that of man. In some species, however, the phalanges are more numerous, as when the limb is modified to form a paddle —*e.g.,* in the whales.

The tarsus of urodele amphibians has the typical composition; in the frogs and toads the intermedium is absent; two long bones are identified as tibiale and fibulare. Among the reptiles there is much variation in the composition of the tarsus. Generally the hinge of the ankle is intratarsal, the row of tarsalia being distal to the hinge. In most living reptiles the tibiale and intermedium fuse to form the talus. In birds the ankle hinge is of the reptilian pattern in being intratarsal. The three tarsal cartilages of the embryo fuse to form the talus, which fuses with the tibia forming

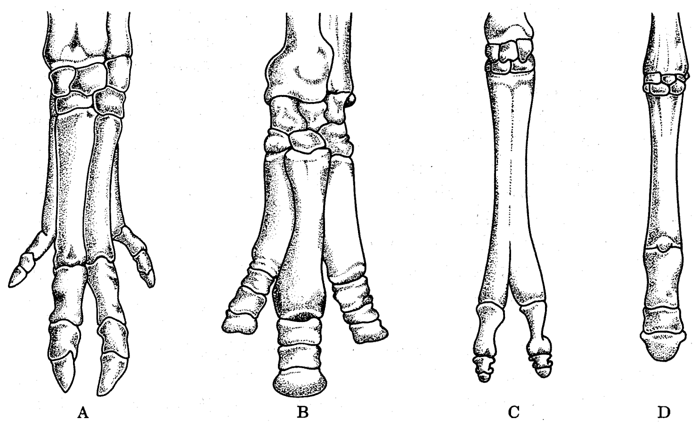


FIG. 11.—LEFT FOREFEET OF UNGULATES: (A) PIG, (B) RHINOCEROS, (C) CAMEL, (D) HORSE

the tibiotarsus. The tarsalia fuse with the ends of the united metatarsals to make a tarsometatarsus. In the mammalian tarsus the talus is generally composed of the fused tibiale and intermedium, but in some a centrale is included to form a tritibiale. The ankle hinge is not intratarsal, but located between the bones of the leg and the first row of tarsal bones—tibia and talus usually.

With the suppression of digits, which occurs among certain mammals, a rather frequent order of sequence occurs (*see* fig. 11). The pollex (or first) is the first to go, then the minimus (or fifth), index (or second) and annularis (or fourth). Thus, among the even-toed ungulates (artiodactyls), for example, in the pig and hippopotamus, the pollex has disappeared and the other four digits are present, although the second and fifth are much reduced. In the camel only the third and fourth digits persist and are of equal importance. Among the odd-toed ungulates (perissodactyls) the right digit is dominant and the others reduced to mere rudiments or splints as in the horse.

See also BONE; CARTILAGE; CONNECTIVE AND SUPPORTING TISSUES; JOISTS AND LIGAMENTS; MUSCLE AND MUSCULAR SYSTEM.

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SKELTON, JOHN (*c.* 1460–1529), English poet, is variously asserted to have belonged to a Cumberland family and to have been a native of Diss in Norfolk. He is said to have been educated at Oxford. He certainly studied at Cambridge, and he is probably the "one Scheklton" mentioned by William Cole (manuscript *Athen. Cantabr.)* as taking his M.A. degree in 1484. In 1490 Caxton writes of him, in the preface to *The Boke of Eneydos Compyled by Vyrgyle,* in terms which prove that he had already won a reputation as a scholar. "But I pray mayster John Skelton." he says, "late created poete laureate in the unyversite of Oxenforde, to oversee and correct this sayd book . . . for him I know for suffycyent to expomne and englysshe every dyffyculte that is therein. For he hath late translated the epystlys of Tulle, and the boke of dyodorus siculus, and diverse other works . . . in polysshed and ornate termes craftely . . . I suppose he hath drunken of Elycons well." The laureateship referred to was a degree in rhetoric. Skelton received in 1493 the same honour at Cambridge.

Skelton found a patron in the pious and learned countess of Richmond, Henry VII's mother, for whom he wrote *Of Mannes Lyfe the Peregrynacioun,* a translation. now lost, of Guillaume de Deguilleville's *Pèlerinage de la vie humaine.* An elegy "Of the death of the noble prince Kynge Eduarde the forth," included in some of the editions of the *Mirror for Magistrates,* and another (1489) on the death of Henry Percy, 4th earl of Northumberland, are among his earliest poems. In the last decade of the century he was appointed tutor to Prince Henry (afteruard Henry VIII). He wrote for his pupil a lost *Speculum principis,* and Erasmus, in dedicating an ode to the prince in 1500, speaks of Skelton as "unum Britannicarum literarum lumen ac decus." In 1498 he was successively ordained subdeacon, deacon and priest. He seems to have been imprisoned in 1502, but no reason is known for his disgrace. Two years later he retired from regular attendance at court to become rector of Diss, a benefice which he retained nominally till his death.

Skelton frequently signed himself "regius orator" and poet laureate, but there is no record of any emoluments paid in connection with these dignities. His parishioners thought him, says Anthony a Wood, more fit for the stage than for the pulpit. He was secretly married to a woman who lived in his house, and he had earned the hatred of the Dominican monks by his fierce satire. He was censured by Richard Nix, bishop of the diocese, and appears to have been temporarily suspended.

After his death a collection of farcical tales, no doubt chiefly. if not entirely, apocryphal, gathered round his name—The *Merie Tales of Skelton.* During the rest of the century he figured in the popular imagination as an incorrigible practical joker. His sarcastic wit made him some enemies, among them Sir Christopher Garnesche or Garneys, Alexander Barclay, William Lilly and the French scholar. Robert Gaguin (*c.* 1425–1502). Earlier in his career he had found a friend and patron in Cardinal Wolsey, and the dedication to the cardinal of his *Replycacion* is couched in the most flattering terms. But in 1522, when Wolsey in his capacity of legate dissolved convocation at St. Paul's, Skelton put in circulation the couplet:

> Gentle Paul, laie doune thy sweard
> For Peter of Westminster hath shaven thy beard.

In *Colyn Cloute* he incidentally attacked Wolsey in a general satire on the clergy, but *Speke, Parrot* and *Why Come Ye nat to Courte?* are direct and fierce invectives against the cardinal who is said to have more than once imprisoned the author. To avoid another arrest Skelton took sanctuary in Westminster abbey. He was kindly received by the abbot, John Islip, who continued to protect him until his death on June 21. 1529.

In his *Garlunde of Laurell* Skelton gives a long list of his works, only a few of which are extant The garland in question was uorked for him in silks. gold and pearls by the ladies of the countess of Surrey at Sheriff Hutton castle, where he was the guest of the duke of Norfolk. The composition includes complimentary verses to the various ladies concerned, and a good deal of information about himself.

But it is as a satirist that Skelton merits attention. *The Bowge of Court* is directed against the vices and dangers of court life. He had already in his *Boke of the Thre Foles* drawn on Alexander Barclay's version of the *Narrenschiff* of Sebastian Brant, and this more elaborate and imaginative poem belongs to the same class. Skelton, falling into a dream at Harwich, sees a stately ship in the harbour called the *Bowge of Court,* the owner of uhich is the Dame Saunce Pere. Her merchandise is Favour; the helmsman Fortune; and the poet, who figures as Drede (modesty), finds on board Favell (the flatterer). Suspect. Harvy Hafter (the clever thief), Dysdayne, Ryotte. Dyssymuler and Subtylte, who all explain themselves in turn, until at last Drede, who finds they are secretly his enemies. is about to save his life by jumping overboard, when he wakes. Both of these poems are written in the seven-lined Chaucerian stanza. but it is in an irregular metre of his own that his most characteristic work was accomplished.

The Boke of Phyllyp Sparowe, the lament of Jane Scroop, a schoolgirl in the Benedictine convent of Carowe near Norwich, for her dead bird, was no doubt inspired by Catullus. It is a poem of about 1,400 lines with many digressions. We learn what a wide reading Jane had in the romances of Charlemagne, of the Round Table, the Four Sons of Aymon and the Trojan cycle. Skelton finds space to give his opinion of Chaucer, Gower and Lydgate. He seems fully to have realized Chaucer's value as a master of the English language. Gower's matter was, he said, "worth gold." but his English antiquated. The verse in which the poem is written, called from its inventor "Skeltonical," is here turned entirely to whimsical use. The lines are usually six-syllabled, but vary in length, and rhyme in groups of two, three, four and even more. It is not far removed from the old alliterative English verse, and well fitted to be chanted by the minstrels who had sung the old ballads.

For its comic admixture of Latin Skelton had abundant example in French and Low Latin macaronic verse. He makes frequent use of Latin and French words to carry out his exacting system of frequently recurring rhymes. This breathless, voluble measure was in Skelton's energetic hands an admirable vehicle for invective, but it easily degenerated into doggerel. By the end of the 16th century he was a "rude rayling rimer" (Puttenham, *Arte of English Poesze),* and at the hands of Pope[1] and Warton he fared even worse. His own criticism is a just one:

> For though my ryme be ragged,
> Tattered and jagged,
> Rudely rayne beaten,
> Rusty and moughte eaten,
> . . . .
> It hath in it some pyth.

[1]Pope said: "Skelton's poems *are* all low *and bad, there* is nothing in *them* that is worth *reading" (Spence,* **Anecdotes, p.** *87).*

Colyn Cloute represents the average country man who gives his opinions on the state of the church. There is no more scathing indictment of the sins of the clergy before the Reformation. He exposes their greed, their ignorance, the ostentation of the bishops and the common practice of simony, but takes care to explain that he writes in defense of, not against, the church.

The charge of coarseness regularly brought against Skelton is based chiefly on *The Tunnynge of Elynoure Rummynge,* a realistic descriptibn in the same metre of the drunken women who gathered at a well-known alehouse kept by Elynour Rummynge at Leatherhead, not far from the royal palace of Nonsuch. "Skelton Laureate Against the Scottes" is a fierce song of triumph celebrating the victory of Flodden. "Jemmy is ded And closed in led, That was theyr owne Kynge," says the poem; but there was an earlier version written before the news of James IV's death had reached London.

This, which is the earliest singly printed ballad in the language, was entitled *A Ballade of the Scottysshe Kynge,* and was rescued in 1878 from the wooden covers of a copy of *Huon de Bordeaux.* "Howe the douty Duke of Albany, lyke a cowarde knight" deals with the campaign of 1523, and contains a panegyric of Henry VIII. To this is attached an *envoi* to Wolsey, but it must surely have been misplaced, for both the satires on the cardinal are of earlier date.

Skelton also wrote three plays, only one of which survives. *Magnificence* is one of the best examples of the morality play. It deals with the same topic as his satires, the evils of ambition; its moral, "how suddenly worldly wealth doth decay," being a favourite one with him. Thomas Warton in his *History of English Poetry* described another piece, *Nigramansir,* printed by Rynkyn de Worde in 1504, and dealing with simony and the love of money in the church; but no copy is known to exist, and some suspicion has been cast on Warton's statement.

Illustration of the hold Skelton had on the public imagination is supplied from the stage. A play (1600) called *Scogan and Skelton,* by Richard Hathway and William Rankins, is mentioned by Henslowe. In Anthony Munday's *Downfall of Robert, earl of Huntingdon,* Skelton acts the part of Friar Tuck, and Ben Jonson in his masque, *The Fortunate Isles,* introduced "Skogan and Skelton in like habits as they lived."

Very iew of Skelton's productions are dated, and their titles are here necessarily abbreviated. Wynkyn de Worde printed the *Bowge of Court* twice. *Divers Balettys and dyties solacious devysed by Master Skelton Laureat,* and *Skelton Laureate agaynste a comely Coystroune . . .* have no date or printer's name, but are evidently from the press of Richard Pynson, who also printed *Replycacion against certain yong scolers,* dedicated to Wolsey. *The Garlande or Chapelet of Laurell* was printed by Richard Faukes (1523); *Magnificence, A goodly interlude, . . .* probably by John Rastell about 1533, reprinted (1821) ior the Roxburghe Club. *Hereajter foloweth the Boke of Phyllyp Sparowe* was printed by Richard Kele (1550?), Robert Toy, Antony Kitson (1560?), Abraham Veale (1570?), John Walley, John Wyght (1560?). *Hereafter foloweth certaine bokes compyled by mayster Skelton . . .* including "Speke, Parrot," "Ware the Hawke," "Elynoure Rummynge" and others, was printed by Richard Lant (1550?), John King and Thomas March (1565?), and John Day (1560). *Hereafter foloweth a litle boke called Colyn Cloute* and *Hereafter . . . why came ye nat to Courte?* were printed by Richard Kele (1550?) and in numerous subsequent editions. *Pithy, plesaunt and profitable workes of maister Skelton, Poete Laureate. Nowe collected and newly published* was printed in 1568, and reprinted in 1736 A scarce reprint of *Elinour Rummin* by Samuel Rand appeared in 1624.

See the Rev. Alexander Dyce, *The Poetical Works of John Skelton; With Notes and Some Account of the Author and His Writings,* 2 vol. (1843). A selection of his works was edited by W. H. Williams (London, 1902). *See* also Arthur Koelbing, *Zur Charakteristik John Skeltons* (Stuttgart, 1904); F. Brie, "Skelton Studien" in *Englische Studien,* vol. 38 (Heilbronn, 1877, etc.); *A.* Rey, *Skelton's Satirical Poems . . .* (Berne, 1899); A. Thümmel, *Studien über John Skelton* (Leipzig-Reudnitz, 1905); *G.* Saintsbury, *History of English Prosody,* 3 vol. (1906–10); A. Kolbing in the *Cambridge History of English Literature,* vol. iii (1909).

SKENE, ALEXANDER JOHNSTON CHALMERS (1837–1900), U.S. surgeon, who contributed to theory, practice and teaching in gynaecology during the latter part of the 19th century. was born at Fyvie, Scot., on June 17, 1837. He first studied medicine at King's college, London. When he was 19 Skene went to America, studied medicine in Toronto, Ont.. in 1860 and at the University of Michigan, Ann Arbor, 1861–62, and received his M.D. degree from the Long Island (N.Y.) College Hospital medical school in 1863. He was an assistant surgeon in the volunteer corps of the Union army in 1863, and in 1864 began to practice in Brooklyn, N.Y.

His teaching career began in the same year when he was appointed adjunct professor at the Long Island College Hospital medical school, becoming professor of gynaecology in 1872 and dean in 1886. He also taught gynaecology at the New York Post-Graduate hospital (1883–86). In 1884 he opened his own sanitarium in Brooklyn with W. M. Thalon, and in 1899 Skene's Hospital for Self-Supporting Women.

He was a founder of the American Gynecological society, of which he was president in 1886–87, and of the International Congress of Gynecology and Obstetrics, of which he was honorary president in 1896.

In 1880 his discovery of the urethral glands named for him established his reputation internationally. The inflammation of these glands, skeneitis, and an instrument for examining them, the skeneoscope, were also named for him. He devised 31 medical and surgical instruments, notably Skene's catheter. As a surgeon and teacher he established important operative procedures.

He wrote more than 100 medical articles, served as editor for various general and specialized medical journals, and wrote numerous medical textbooks, including *Diseases of the Bladder and Urethra in Women* (1878), *Treatise on Diseases of Women, for the Use of Students and Practitioners* (1888), and *Medical Gynecology* (1895). He also wrote a novel, *True to Themselves* (1897), and was a sculptor, several of his works being on exhibit at the Kings County Medical society.

Skene died on July 4, 1900, at his country home in the Catskills at Highmount, N.Y. A bust of Skene was ,preserved in Prospect park. Brooklyn.

SKENE, WILLIAM FORBES (1809–1892), Scottish historian and antiquary, was the second son of Sir Walter Scott's friend, James Skene (1775–1864), of Rubislaw, near Aberdeen. In 1832 he became a writer to the signet, and shortly afterward obtained an official appointment in the bill department of the court of session, which he held until 1865. His early interest in the history and antiquities of the Scottish Highlands bore its first fruit in 1837, when he published *The Highlanders of Scotland, Their Origin, History and Antiquities.* His chief work, however, is *Celtic Scotland, a History of Ancient Alban* (3 vol., Edinburgh, 1876–80), perhaps the most important contribution to Scottish history written during the 19th century. In 1881 he became historiographer royal for Scotland. He died in Edinburgh on Aug. 29, 1892.

The most important of Skene's other works are: editions of John of Fordun's *Chronica gentis Scotorum* (Edinburgh, 1871–72); of the *Four Ancient Books of Wales* (Edinburgh, 1868); of the *Chronicles of the Picts and Scots* (Edinburgh, 1867); and of Adamuan's *Vita S. Columbae* (Edinburgh, 1874); an *Essay on the Coronation Stone of Scone* (Edinburgh, 1869); and *Memorials of the Family of Skene of Skene* (Aberdeen, 1887).

SKEPTICISM. Extreme skeptics deny that the human mind can attain knowledge. Total skeptics extend this denial to all kinds of claims to knowledge. But even the original Greek school of skeptics included few, if any. who were not partial or moderate: the former allowed that certain kinds of claims to knowledge were valid; the latter refrained from dogmatic denials of the possibility of knowledge and merely advised suspense of judgment. This restraint was more in harmony with the etymology of the word "skeptic," which is derived from the Greek word *skeptesthai,* "to examine." Dogmatic denials of the possibility of knowledge are always difficult to substantiate, and sometimes they seem to imply knowledge of the existence of the very things which are said to be unknowable.

Differences within the Greek school of professed skeptics have caused uncertainty about the classification of philosophers outside the school. Evidently a skeptic need not be dogmatic. But if a philosopher shows moderate skepticism it may not be a systematic doctrine. but perhaps only an attitude of mind. It may even be unconscious, and possibly the philosopher himself would repudiate the suggestion that he was a skeptic. For if partial skepticism is allowed it is by no means clear what kind of claims to knowledge must be admitted by everyone who is not a skeptic. Consequently the title "skeptic" has no agreed application, and its use reveals as much about the person who applies it as about the person to whom it is applied. For instance, skepticism about ordinary claims to knowledge is quite a different thing from skepticism about the claims of speculative philosophers, so that ordinary people and speculative philosophers are likely to disagree in their diagnoses of skepticism. Also, the same people who apply the word pejoratively to the rejection of their own claims to knowledge at other times may use it as a term of praise to point the contrast with credulity or superstition. However, most systematic skeptics, who stand at the centre of these extensions of their title, do have one tendency in common: they are reluctant to allow claims to knowledge about anything beyond the claimant's own immediate reactions; and consequently systematic skepticism has often been closely associated with some radical forrn of empiricism.

Greek skepticism passed through three stages. The school was founded by Pyrrho toward the end of the 4th century B.C. Next, in the 3rd and 2nd centuries, its ideas were absorbed, extended and modified by the philosophers of the Middle Academy and of the New Academy. Finally, it was revived as an independent school by Aenesidemus in the 1st century B.C. and carried on by Menodotus, Sextus Empiricus and others in the next two centuries.

Pyrrho's chief interest was ethics. He taught that, since knowledge is unattainable. the only way to achieve happiness is to practise suspense of judgment. He appears to have formulated this moral precept without any reservations. So he was neither a total nor an extreme skeptic. Perhaps it was the definiteness and simplicity of his moral teaching which enabled his follower Timon to claim that his philosophy did not conflict with common sense. Pyrrho's skepticism was directed chiefly against the dogmatic speculative theories on which the Epicureans and Stoics based their moral doctrines. However, skeptics who begin by attacking the recondite theories of philosophers often end by colliding with common sense, and Pyrrho's skepticism was not confined to philosophers' claims to knowledge.

The skeptical teaching of Pyrrho's school was taken over by Arcesilaus, the founder of the Middle Academy, and worked out in a more systematic way. This development was continued by Carneades, who founded the New Academy. Both were interested in epistemology for its own sake, unlike Pyrrho, who took it up because of its bearing on ethics. They produced a sustained and thorough criticism of the theory of knowledge which had been elaborated by the Stoics. But their work was not entirely negative. For though Carneades denied the possibility of knowledge. he offered a substitute: he admitted that judgments may have different degrees of probability.

The new skeptical school founded by Aenesidemus owed much to the nork of the Middle and New Academies. It was systematic and self-conscious and classified the arguments which it inherited under ten headings (tropoi). Aenesidemus also took over the criticism of the powers of reason, which had been begun by his predecessors, and carried it much further. This inevitably raised a methodological problem: if reason is unreliable, the philosophical arguments which support this conclusion are themselves unreliable. This difficulty was usually evaded by a simile: the skeptic's arguments would be compared, perhaps, to fire, which consumes both its fuel and itself. Such comparisons are hardly adequate to remove the difficulty; what was needed was some way of distinguishing, as Kant did. between legitimate and illegitimate uses of reason. But the lack of any such distinction did not halt the attack on reason. Deductive reasoning was declared invalid, and inductive reasoning was submitted to a criticism which on many points anticipated Hume's views on causation. The conclusions of inductive arguments were rejected if they could not in principle be checked by observation. Even those which merely moved from phenomena to phenomena were said to yield something less than certainty. But at this point skepticism was tempered by the school's interest in medicine. This they regarded not as a science but as an art (techne), based on repeated and careful observation of the phenomena, never claiming absolute certainty and never postulating unobservable causes. In an instructive passage Sextus commends the grammar which children learn but condemns abstruse theories about the nature of the letters and their origin. Evidently his views on empirical matters were practical. cautious and positivistic. but not obviously skeptical. However, some philosophers would detect skepticism even here, on the ground that inductive arguments involve more than Sextus allows.

Outside the school of professed skeptics the attribution of the title is highly debatable, except in the case of the Middle and New Academies, which stood consciously within the skeptical tradition. But when the historian of ideas considers philosophers outside this continuous Greek tradition, it is as if he had moved out of harbour into the open sea. However, it is just this move which is most likely to lead to some understanding of the nature of skepticism.

Michel de Montaigne is often classified as a skeptic because, in his Essais, he discussed every question in a detached and critical way. He certainly was not an extreme skeptic. But almost all philosophers have something of Montaigne's spirit. So. if Montaigne counts as a moderate skeptic, as no doubt he should, few philosophers have entirely lacked moderate skepticism, even in the Middle Ages. which constituted in some ways the least skeptical of all periods in the history of thought.

However, the rather more extreme forms of skepticism are perhaps worth diagnosing. But here too a great range of variation is encountered. Skepticism about a particular human faculty can be used by two different philosophers to support two entirely different conclusions. This is not altogether surprising, since the same doubt can be associated and contrasted with different certitudes. Plato impugned the reliability of the senses and claimed that the intellect could apprehend a transcendent world of "forms." Sextus rejected all speculation about transcendent reality, took over the Greek corpus of arguments against the senses and accepted medicine as something less than science. Sextus' combination of skepticism about the senses with empiricism is not as inconsistent as it might appear to be. For it is possible to try to allow for sources of error in perception and so to claim that it provides an adequate basis for probable conclusions.

Even Berkeley (*Principles* of *Human* Knowledge, 1710), who maintained that perception yields information only about the sensations of the perceiver, sincerely believed that this did not make him a skeptic. In this he was not entirely unjustified. For, if sensations are the only direct objects of perception (which not everyone would admit), it is not clear how the existence of anything beyond them could be validly inferred. Moreover, Berkeley claimed that material objects were merely collections of sensations in the minds of human beings and God, and this theory might well seem to be less skeptical than any theory which treats sensations as clues to the existence and nature of objects which are never directly perceived.

Berkeley's investigation of perception raises two connected questions about the nature of skepticism. When a philosopher says, not that a certain kind of thing exists but is unknowable. but that it does not exist. is he a skeptic? If. for instance. God's existence is denied. there is no doubt that this is true skepticism. But if a philosopher can plausibly claim that ordinary empirical judgments, nhen they are correctly construed, do not commit the speaker to belief in the existence of a certain type of thing, then the denial that these things exist is not obviously skeptical. This raises the second question. which is a question about the relation between ordinary judgments and philosophical doctrines: how is it possible to decide whether a philosopher's account of what ordinary judgments imply is correct? Many would say that Berkeley does not give a correct account of what ordinary perceptual judgments imply. But it is not easy to adjudicate in cases like this, if only because ordinary people do not often consider such matters deeply. Yet, until this question is decided. it is impossible to say whether a philosophical doctrine like Berkeley's is skeptical or not; unless. of course, the analysis of ordinary judgments is abandoned and the question is decided by appeal to some speculative theory.

Skepticism about the powers of reason can also lead in diverse directions. It led Sextus to pare donn all ambitious claims to knowledge. leaving only the probable results of strictly empirical inquiries, shorn of all theoretical superstructure. It took Pascal, in his *Pensées,* to an entirely different conclusion: the impotence of reason seemed to him to leave all science open to doubt and to show up by contrast the reliability of religious faith. The difference between the sciences which these two had in mind probably explains their divergent estimates of the bearing of skepticism about reason on the claims of scientists. Clinical medicine is largely concerned with symptoms, probabilities and happy diagnoses, whereas applied mathematics is rigorous and theoretical.

Hume, who was also a skeptic about the powers of reason, gave a much more subtle account of science *(Treatise of Human Nature,* 1739; and *Dialogues Concerning Natural Religion,* 1779). Like Sextus, he condemned all theories which postulate unobservable causes behind the phenomena. Like Sextus too, he believed that reason, working on the results of observation, could not possibly establish any contingent general statements. For reason can establish only a priori statements (on this point he was more liberal than Sextus). Contingent general statements are believed not on rational grounds but only because continued observation of a conjunction of events has produced a habit of expectation. Such expectations are based on feeling and not on reason, and no justification of feeling is possible. It is merely an ultimate fact that human beings have this feeling. So there are two central propositions in Hume's philosophy: matters of fact cannot be established purely by a priori reasoning; they can only be established in a precarious way by nonrational inference; or else, perhaps, by direct observation. But even direct observation was not left unscathed by Hume. By an elaborate argument he sought to prove that no rational account of perceptual judgments is possible, and here too he fell back on feeling. Human beings, he said, are so constituted that they must believe in the existence of material objects beyond their sensations even though they can give no rational account of this belief.

Hume's account of inference inevitably seems skeptical to speculative philosophers. For it confines a posteriori inference to phenomena, and it declares a priori inference incapable of yielding new factual conclusions. However, when it is judged at the bar of common sense, it is not so easy to see how it should fare. Hume himself often said that, judged by these standards, it was skeptical, but it is not clear that he was right. Admittedly his refusal to allow that a posteriori inference is rational conflicts with ordinary ideas and linguistic usage. But on the other hand ordinary people might well rest fairly content with his account of the evidence which supports such inferences. For contingent general statements are based ultimately on the observed conjunctions of events, and it is not obvious that they assert anything more than that these conjunctions have always held and will always hold. No doubt the theory needs qualifying and modifying in various ways if it is to fit the facts exactly. But it is doubtful if ordinary people would agree with the much larger complaint of Hume's philosophical critics, that his theory altogether fails to account for the necessity of contingent general statements. However, Hume's theory of inference, like Berkeley's theory of perception, goes far beyond the point to which ordinary people carry the analysis of their judgments. Consequently it is not easy to estimate their reactions to the theory, or, in particular, whether they would call it skeptical.

However, it is possible to detect a pattern in the development of such difficult cases and so to understand why they are difficult. The ordinary person makes judgments which he does not analyze. Some philosophers hold that these judgments commit him to hypotheses which transcend the available evidence. Then other philosophers, allegedly skeptics, react by saying that they commit him to nothing beyond the bare phenomena. The controversy proceeds by a kind of diastole and systole. Perhaps neither the expanding nor the reducing theories are correct, but rather something intermediate. In any case this pattern of philosophical controversy explains why it is so difficult to decide whether reducing theories like Hume's are, from the point of view of the ordinary person, skeptical.

Kant thought that Hume's theory was skeptical, and he tried, in his *Critique of Pure Reason,* to work out a theory of knowledge which would be acceptable to an empiricist and yet free from what he thought was skepticism. At the same time he wished to curtail the speculative flights of reason. What he had in mind was not so much the speculative hypotheses which philosophers sometimes reach in the course of analyzing ordinary judgments, but rather the elaborate deductive systems of the metaphysicians of the 17th century. He called his own philosophy critical, to distinguish it both from what he regarded as skepticism and from what he regarded as dogmatism. This word "critical" is close to the etymology of the word "skeptic," in fact closer than the popular connotation of skeptic. The whole field would be easier to survey if Kant's distinction between criticism and skepticism had always been observed. As it is, the word "skeptic" usually covers both. However, even Kant's use of the word is not free from ambiguities. It can mean one who denies that something exists, or one who allows that it exists but maintains that its nature cannot be known, or one who claims that a whole area of so-called knowledge is vitiated by inconsistencies. Hume's theory of perception belongs to this third type.

Kant believed that human reason imposes certain categories on the raw material of experience which somehow comes from things in themselves. Phenomena are the result of this operation. Causality is one of the categories. So, if a philosopher doubted the validity of causal inferences, as Kant thought that Hume did, he could be answered by the contention that causality is already an ingredient in phenomena as we know them. This illustrates the positive part of Kant's philosophy: reason is rehabilitated in the sphere of phenomena. Kant's negative teaching was that reason cannot extend its operation beyond phenomena. For instance, any attempt to use the category of causality to reach some speculative conclusion would inevitably lead to contradictions; the apparatus of reason, having no material to work on, would cease to function properly.

In spite of Kant's intention there is an element of skepticism in his system. Ostensibly it is critical and only seeks the limits of the powers of reason. But it gives these limits in terms which imply awareness of the existence of things in themselves. It is hard to see how Kant can consistently allow this awareness of the existence of things in themselves. However, since he does allow it and since at the same time he denies the possibility of any kno ledge of the nature of things in themselves. he is on this point a skeptic. On the other hand, he was not in the least skeptical about the possibility of knowledge of what he called phenomena.

Kant used the term "phenomenon" in a neutral way that did not imply an unfavourable contrast with things in themselves. Most of his idealist followers thought that this was an inconsistency and rejected the hypothesis of things in themselves. Some rejected even the claim that phenomena are knowable, supporting this rejection with arguments very like those which Kant had used to show that things in themselves are unknowable. They tried to establish that there are latent contradictions even in quite ordinary claims to knowledge. This kind of dialectical argument, which they inherited from Kant and adapted to a more subversive use, had existed in antiquity and had often been used to undermine the beliefs of ordinary people in just this way. Hume's treatment of perception is an example of this kind of reasoning, but it is as old as Zeno. It produces a special kind of skepticism, which is conspicuous in the writings of 19th-century idealists and was taken to the extreme limit by F. H. Bradley *(Appearance and Reality,* 1893), who found that all claims to knowledge are self-contradictory.

This kind of skeptic does not deny that things of a certain kind can be known to exist; nor does he admit that they exist but deny that their nature can be known: instead he maintains that parts, or perhaps even the whole, of what is alleged to be knowledge cannot be knowledge since it contains hidden contradictions. The first two of these three kinds of philosophical skepticism rely on analogies with ordinary situations in which people refrain from claims to knowledge, perhaps misleading analogies, but at least intelligible ones. This third kind of skepticism is more difficult to understand. A pragmatist would ask how anything which works so well as science could possibly be self-contradictory. An idealist such as Bradley would reply by introducing the doctrine of degrees of reality. What the scientist discovers cannot be perfectly real, since it contains contradictions, but nevertheless it is not sheer illusion, since successes can be achieved even on lower levels of reality. But the scientist must appreciate that he is on a lower level and must not make any claims about ultimate reality, which is the domain of the metaphysician. This kind of system is, from the point of view of the ordinary person, skeptical, and skeptical in a very peculiar way. But the philosophers who build such systems would say that they give every claim to knowledge its due and would confine the title "skeptic" to those who reject transcendent reality.

These speculative adventures inevitably produced reactions in the 19th century. Both pragmatists and positivists defended science and common sense against these dialectical attacks and professed themselves at least agnostic about transcendent reality. However, their defense of science was often associated with very reductive theories, similar to Berkeley's and Hume's, and this controversy provides yet another example of the perennial pattern of extreme contraction alternating with extreme expansion. Also agnosticism about transcendent reality is a difficult position to maintain because, if it is really true that ordinary judgments commit people to belief in transcendent reality, agnosticism about transcendent reality is strictly inconsistent with the claim to understand and accept ordinary judgments.

These two weaknesses in the empiricist reaction were not irremediable. The pragmatists investigated the meaning of scientific statements in a sympathetic way and claimed that they contained no contradictions and did not point to any transcendent reality. They also investigated the meaning of other kinds of empirical statements and tried to give a comprehensive criterion of meaningfulness. Their work was carried on by the logico-analytic school in the 20th century; and, though it sometimes produced reductive theories, this did not always happen. When it did happen, it was not because there is any good reason why theories about the meaning of empirical statements should be reductive, but rather because the logico-analytic school inherited the tradition of Berkeley and Hume and because in any case extreme reaction is natural.

G. E. Moore, Bertrand Russell and Ludwig Wittgenstein were the three most important philosophers of this school. Its attitude to speculative philosophy was critical rather than skeptical because when its members rejected speculative theses, it was on the ground not that they were false but that they were meaningless, or at least involved misuse of language. However, if the idealist attack on empirical statements is to be classified as a kind of skepticism, then it might be correct to call the logico-analytic philosophers skeptics because of their attack on speculative philosophy. For, though the objects of the two attacks were different, their methods, the detection of contradictions and the diagnosis of meaninglessness, were very similar. But, if the word "skeptic" is used pejoratively, it is important to remember that there is a certain presumption in favour of common sense. The logico-analytic school did not merely rest on this presumption: it tried to show that both the apparent contradictions in ordinary empirical statements and the apparent meaningfulness of speculative theses are the results of illusions; *cf.* particularly Moore's "Defence of Common Sense," in *Contemporary British Philosophy,* 2nd series (1925); and Russell's *Mysticism and Logic* (1918).

Two different tendencies can be detected in the writers of this school. Some of its adherents tried to give a single criterion of meaningfulness which would cover all ordinary statements and exclude those of speculative philosophers. In this way they hoped to evade the difficulty which Kant had failed to evade, the difficulty of limiting knowledge without implying some awareness of what lies beyond the limit. For if statements about what lies beyond the limit could be shown to be meaningless, the inconsistency would be avoided. This systematic attempt to delimit the sphere of meaning was made in Wittgenstein's *Tractatus Logico-Philosophicus* (1921), which was closely related to Russell's work in logic. Its weakness was that it set up scientific statements as the type to which all meaningful statements must conform. This places it in the tradition of the 19th-century pragmatists and positivists. In fact some of the philosophers who tried to work out these ideas of Wittgenstein in more detail called themselves logical positivists. The other tendency within the school was a reaction against any attempt to give a systematic account of meaning. Every type of ordinary statement should be examined separately and judged by its own standards. This tendency begins in the writings of G. E. Moore. It also appears in the later writings of Wittgenstein, who added the corollary that, if speculative philosophers are wrong in thinking thnt their statements mean something, this too should be established by a detailed examination of each individual case. This tendency, judged by ordinary standards, was obviously not skeptical. In fact it was a vindication of common sense in which many speculative philosophers would detect credulity.

There are many reasons why the diagnosis of philosophical skepticism will always be debatable. Greek skepticism had many facets, and outside the Greek school different philosophers show different combinations of these facets. However, when the word "skeptic" is used about the rejection of particular claims to knowledge on ordinary grounds the difficulties are less formidable. In such cases both the claimant and the rejector will usually be appealing to similar standards: they will differ in their application of these standards; and they may also differ about the force of the word "skeptic," whether it is pejorative, commendatory or neutral. These complications need to be unraveled, but the task of unraveling them is comparatively easy. But when philosophers question whole departments of knowledge, they are really questioning the standards which are ordinarily taken to be reliable within these departments. At the same time they frequently offer different, stricter standards and sometimes make strange new claims to knowledge of their own. This enormously widens the scope of the debate and makes it very hard to decide which philosophers are skeptics, which dogmatists and which merely critical. It might appear that this question could be safely settled only by a philosopher who adopted the standpoint of common sense. But even here the difficulties do not end. In fact the greatest difficulty of all is to understand the intricate relations between ordinary beliefs and philosophical doctrines. For few philosophers entirely abandon ordinary beliefs. Even those who do not analyze them sympathetically usually recast them and let them stand in an altered form. And there is no simple way of deciding when justice has been done.

For theological skepticism *see* AGNOSTICISM.

BIBLIOGRAPHY.—On the Greek skeptics *see* E. Bevan, *Stoics and Sceptics* (1913); M. M. Patrick, *The Greek Sceptics* (1929). *See* further the bibliographies of the separate articles in this encyclopaedia on the philosophers mentioned above. (D. F. P.)

SKIBBEREEN, a market town of County Cork, Ire., on the Ilen about 3 mi. from its estuary, 53 mi. S.W. of Cork by road. Pop. (1956) 2,202. The river is navigable for small vessels to Skibbereen, and for larger ones to Old Court on the estuary. Trade is in corn and other agricultural produce and there is sea and river fishing. The district suffered much in the famine of 1847 and many were buried in the graveyard adjoining the ruined Cistercian cell of Abbeystrowry (1 mi. W.).

Skibbereen is the seat of the Roman Catholic bishopric of Ross, which comprises part of west County Cork. The procathedral was built in 1826.

SKIING, a way of moving over snow wearing a pair of long flat runners called skis attached to the shoes or boots. It is practiced for recreational, competitive or utilitarian purposes. On the level or on slight grades, the skier uses a gliding gait; downhill he slides effortlessly over the snow, turning to avoid obstacles, to slacken speed or to change direction; special steps are used in climbing steeper slopes. Ski jumping is usually performed on hills of varying size especially designed for the sport.

Skis were first used in northern countries for utilitarian purposes, in order to get from one place to another, for hunting and in warfare, and they are still so used. Recreational skiing was a natural outgrowth of such uses. In the Americas and in western Europe the sport developed chiefly as downhill skiing.

At first, only the mountain railways and aerial cable cars of the Alps were available for the uphill transportation of skiers. In the early 1930s, many new devices were designed and built for this purpose, including chair lifts, T-bar tramways, gondola lifts and in the United States and Canada rope tows, as well as many additional aerial tramways. These greatly promoted the popularity of skiing, for they made possible four or five times as much downhill skiing in a day as when the skier had to climb uphill. In the Scandinavian countries and eastern Europe touring and cross-country skiing developed as the more popular sports. Competitive skiing comprises the Nordic (or classic) events, cross-country racing and jumping; and the Alpine events, downhill (or straight) racing, slalom (zigzag downhill racing) and giant slalom (see *Competitive Skiing,* below).

EQUIPMENT

The Ski.—The three chief types of skis, downhill, jumping and cross-country, have certain characteristics in common. They are pointed, turned up and usually slightly wider at the front (the tips or shovel) and are squared at the rear (or heel). They are thickest in the mid-section, under the foot, thinnest just before the ends, and are built with a slight arch, or camber, so as to distribute the skier's weight along the length. Over the years skis have been refined in their shape and camber and in precision of stiffness. The design is graceful and functional.

The downhill ski normally varies in length according to the height and weight of the user. It is about three inches in width, and for the average adult man about seven feet long, although much shorter skis have enjoyed some vogue in Europe. They were formerly fashioned from one piece of wood, usually hickory, but later laminated constructions also were used. After 1950, plastic running surfaces were introduced to increase speed and durability and skis of metal, usually with a wood or plastic core, became increasingly popular. The downhill ski typically has a shallow groove running longitudinally along the centre of the bottom (or sole); this imparts directional stability. The skis also have sharp edges of steel along the undersurface, in order to bite into hard snow or ice.

Jumping skis are longer, wider, thicker and heavier and ordinarily have three grooves in the bottom. They have no steel edges.

Cross-country skis are narrower and lighter in weight than downhill skis and often are made of woods other than hickory. They have one groove but no metal edges.

Other Equipment.— For downhill skiing, the skier wears close-fitting, heavy leather boots with extremely stiff soles in order to exercise precise control over his skis. His boots are firmly attached to the skis by bindings which are made almost exclusively of metal, with steel cables supplanting the crude straps used in the 1930s. So-called safety or release bindings were developed to free the skier's foot in case of severe falls. For jumping, and especially for cross-country, a lighter and more flexible boot is used, with a special binding which allows the heel to be raised.

For downhill and cross-country skiing a light pole, or stick, of metal or wood, about four feet long, is carried in each hand. These aid the skier in pushing himself along on the level, and in climbing. They also are used in maintaining balance when running downhill and to assist in turning. Each stick has a wrist strap at the top and a ring, or wheel, near the bottom, which prevents the point from sinking too deeply into the snow. Various waxes are used on the bottoms of skis to prevent snow from sticking to them, to reduce friction or to aid in climbing. For the latter purpose, strips of sealskin or plush are sometimes strapped to the bottoms in order to grip the snow.

The refinements in ski equipment after World War II were accompanied by a great increase in the proficiency of the average recreational or competitive skier, so that he skis as well or better than the most skillful performers of a generation ago. As the parallel (slideslipping) technique supplanted the earlier stemmed (Christiana) turns, speed and maneuverability were greatly increased.

Appeal of Skiing.— The sensation of downhill skiing is similar to the sensation of flight. Its popular appeal is attested to by the rapid growth of the sport in all parts of the world where there is snow and hilly or mountainous country. This is true both of competitive and of recreational skiing. Two of the chief attractions of the sport are the fact that the snow conditions to be coped with are of infinite variety and constantly changing, and the fact that there is virtually no limit to the degree of skill that can be developed. In downhill skiing, skill consists largely in being able to run steadily at high speed and to turn with agility and precision on all kinds of snow and terrain, whether bumpy, steep or wooded.

HISTORY

The oldest ski that has been found, at Hoting in Sweden, is believed to be at least 4,500 years old. The oldest pictorial representation of skiing is a carving on a rock found at Roedoey, Tjoetta, in northern Norway, dating from about 2000 B.C., which is preserved in the Norwegian ski museum. However, some sort of skis or skilike snowshoes were probably used long before these times in regions where men found them useful in order to travel, hunt or carry on warfare in snow-covered country. Procopius, the Byzantine historian, mentions a race of "Skridfinns," that is, gliding Finns, in apparent contrast to the Finns who did not glide.

Military Skiing.— Skis were probably used for military purposes as early as they were used for ordinary travel. In 1199, Saxo, the Danish historian, described how the Finns waged war on skis, and in the following year, King Sverre sent out a company on skis to reconnoitre before the battle of Oslo. In World War I, when the Austrian-Italian front ran through the Alps, and during the Russian invasion of Finland in 1939–40, much use was made of ski-equipped mountain troops.

Development of Skiing as a Sport.— Although there is a record of a military ski competition in Oslo in 1767, the real beginnings of skiing as a competitive sport were in Norway 100 years later and in California about 1870. The famous Holmenkollen, Nor., jumping meeting began in 1892. In 1888 Fridtjof Nansen led a party across Greenland on skis, dragging sledges. His book, *Paa Ski Over Grönland,* exerted a great influence on the development of skiing throughout Europe. It was at this time the first skis were imported into the Alps and the Black Forest of Germany.

As the sport spread, both proficiency and equipment developed rapidly. Because the terrain in the Alps was steeper and more difficult, a new skiing technique was needed. The erect, Norwegian Telemark and Christiana style was gradually supplanted by an Alpine way of skiing downhill and turning. This found its first complete and practical expression in the Arlberg system developed by Hannes Schneider, of St. Anton, Aus. The Swiss ski schools carried on these methods. Since 1936, the leading ski racers of the Alpine countries have had a great influence on technique, culminating in the new official Austrian system of teaching the *wedeln* turns.

The principal architects of Alpine skiing were Mathias Zdarsky and Col. Bilgeri of Austria; Hans Klopfenstein and Col. Iselin of Switzerland; W. Paulcke and Henry Hoek of Germany; and Sir Arnold Lunn and Vivien Caulfeild of Great Britain.

COMPETITIVE SKIING

Downhill races are run on defined courses of a length, steepness and difficulty appropriate to the skill and endurance of the entrants. For men's Olympic and world's championship events, a vertical descent of at least 2,625 ft. is prescribed, with sufficient steep and difficult terrain. Such courses may be between one and one-half and three miles long, although some races are considerably longer. Average speed of the winners is usually between 40 and 50 m.p.h. In 1955 a speed of 109 m.p.h. was unofficially recorded on a short prepared course in Chile by Ralph Miller of the United States:

For a slalom race the course is defined by gates consisting of pairs of poles with flags, between which the runner must pass. The course is carefully set so as to test the skill and judgment of the competitor. For Olympic and world championship events the men's course must have a vertical drop between 650 and 975 ft. and for other international races between 390 and 650 ft. Sixty to seventy-five gates are usual, although up to 100 gates are sometimes included. For less skilled groups, courses are shorter and less difficult. The Arlberg-Kandahar race rotates between Mürren, Switz., St. Anton, Aus., Chamonix, France, Sestrière, Italy, and Garmisch-Partenkirchen, Ger., and is the oldest open international event decided on the results of a downhill and a slalom, having been first run in 1928.

The giant slalom has characteristics of both the downhill and the slalom. The gates are set wider and farther apart, the length of the course approaches that of the downhill and the average speeds achieved are between those of the two other Alpine events. Because of the persistent efforts of Sir Arnold Lunn, who devised the modern slalom race, the International Ski federation recognized downhill racing in 1930, and the first downhill and slalom world's championships were held in Miirren in 1931.

The best Alpine competitors have come from Austria and the other western European countries. American women have won several world championships.

Cross-country races (also called Langlauf and *Dauerlauf*) are held over rolling terrain. The standard distances are 15, 30 and 50 km. for men, and 10 km. for women, although the Vasa race in Sweden is 56 mi. long. A variation of the cross-country race is the relay, in which four men each run a 10 km. course, or three women a 5 km. course.

Jumping competitions are held on carefully graded and prepared hills, classed according to size as 100-m., 80-m., 70-m., etc. The approach, or inrun, often starts on a scaffold, or tower; down it the jumper in a crouched position accumulates speed until he reaches the take-off, where he leaps outward, upward and forward. The best competitors lean far over toward the points of their skis in order to minimize wind resistance and to get an aerodynamic lifting effect to increase the length of their jump. The landing is made on the steep landing hill in a more upright position with the shock of contact taken up by the knees. After the slope levels off, the jumper stops by turning on the outrun. The performance is decided half by the distance covered and half on form, as marked by the judges, on the basis of a complicated set of style marks.

The best jumpers and cross-country runners have come from the Scandinavian countries, Finland and eastern Europe.

A combination of the results of the downhill and slalom is called the Alpine combined event, and the jump and cross-country together are called the Nordic combined. Skijoring, in which the skier is pulled by a horse, is little practiced.

ORGANIZATION OF THE SPORT

The International Ski federation (FIS) was founded, and the first winter Olympic games were held in Chamonix, in 1924, but with Nordic ski events only. The Alpine events were included for the first time in 1936, in Germany.

The first ski club in the United States was the Ishpeming (Mich.) Ski club, founded in 1900. The Ski club of Great Britain began three years later. The first intercollegiate ski meet, between McGill, Dartmouth and Montreal, was held in Quebec, at Shawbridge, in 1914.

The basic skiing organization is the local club, which is composed of individuals. In the United States, most clubs are members of one of the seven regional associations (or divisions) which compose the National Ski Association of America. The latter, along with the national associations of the 35 other skiing nations throughout the world, compose the FIS, which sets the rules for and sanctions international competitions in all forms of the sport, and engages in other co-ordinating activities.

SKI-MOUNTAINEERING

Skis have been used in winter mountaineering since the 1890s. The first important expedition was the incomplete traverse of the main massif of the Bernese Oberland by a German party, including W. Paulcke. Two of this party were killed two years later in an avalanche, the first fatal accident on skis. Most of the great ski-mountaineering successes of the following ten years, Monte Rosa, Mont Blanc, Matterhorn and Finsteraarhorn were scored by Germans, but the Swiss soon took an active part, as did the British, Italians and French. See WINTER SPORTS; OLYMPIC GAMES.

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SKIMMER, an aquatic bird of the family Rynchopidae, unique in having a bill with the lower mandible much longer than the upper and compressed to knifelike thinness. The birds fly low over the water, the mandible just immersed, as though skimming the surface, whence the name. However, it is debatable whether most of their food is secured in this manner.

There are three species: the black skimmer. Rynchops nigra, of the Americas; R. *flavirostris* of Africa; and R. *albicollis* of India. They frequent coastal waters and large rivers, and their other habits resemble those of their close relatives, the terns (*q.v.*). (A. L. RD.)

SKIN, the covering (or integument) of an animal, as distinguished from the internal parts. In animals with backbones (vertebrates) skin is complex in structure and is a vital organ in that some of its functions are essential for the maintenance of life. In all vertebrates the skin consists of two major layers. The richly cellular. relatively thin outer layer. deriving from the embryonic ectoderm, is called the epidermis; the thicker and tougher inner part, of mesodermal origin, which is largely composed of fibrous connective tissue, is called the dermis, cutis or corium.

Skin in Lower Vertebrates. — Before considering in detail the skin of man. the integuments of various classes of vertebrates will be briefly surveyed in the order of their position on the evolutionary scale.

Cyclostomes.—In the lamprey the surface of the skin is smooth, with no scales. Gland cells producing slime are mixed with the epithelial cells, as in most aquatic vertebrates.

Elasmobranchs.—Among the elasmobranchs, sharks have a very tough skin. Over it are scattered denticles or placoid scales, each with a pulp cavity, around the edge of which is a layer of odontoblasts. These cells secrete the dentine or calcareous material of the scale Outside the dentine is the enamel secreted by the overlying ectoderm. Usually the denticles pierce through the ectoderm, after which no more enamel can be added.

Fishes. — The dominant fishes of the modern era are teleosts, characterized by scales, which are internal structures in that they are covered by skin. The epithelium of a trout's epidermis provides the animal with an inert covering of keratin. The scales lie in the dermis as thin, overlapping. bony plates with the exposed part bearing the pigment cells. The bone of the scale is deposited in a series of rings, since its growth is not constant but occurs rapidly in spring and summer and hardly at all in winter; the age of the fish can be determined from these rings.

Amphibia.—All existing amphibia of the terrestrial vertebrates have skin that is moist and used for respiration. Its outer layers are cornified, a character typical of land vertebrates. In the adult frog the epidermis is renewed at intervals by a process of molting, which is under control of the pituitary and thyroid glands. The wartiness of the skin of toads is due to local thickenings that are of interest in considering the origin of feathers and hair. Both mucous and poison glands derived from the epidermis are present in the skin of amphibia. The secretion of the poison glands generally does not harm human skin; when swallowed it produces nausea and an action on the heart similar to that of digitalis.

Reptiles. — The skin of reptiles is dry and contains few or no glands. The outer division is horny or scaly and is shed in flakes; bony plates may be present in the dermis, especially over the head. Many reptiles have elaborate colour patterns, which may change from time to time, as in the chameleon, and thus serve for concealment.

Birds. — Birds are characterized by having feathers appended to a thin, loose, dry skin. The only gland is the oil-excreting uropygial or preen gland located at the base of the tail. It is especially well developed in aquatic birds. Feathers are the major keratinous structures. but scales like those of reptiles are present on the legs and feet and sometimes elsewhere. The bill and claws are also specialized scalelike structures and may be molted. Nerve endings are present throughout the skin. The feathers perform two main functions, heat insulation and flight; in addition, they provide sensation. protective coloration and sexual display. The same follicle produces many generations of feathers, which may differ in type as the bird matures. The feathers are provided with muscles at the base that control their position. important in flight and in heat loss, and with nerve fibres in the papilla that make them organs for the sensation of touch. They are not spread uniformly over the body but are localized in tracts separated by bare areas.

Mammals. — The presence of hair appended to the skin (even though the area may be extremely small) is a requisite for classification within the group. In addition to hairs, which include both the long tactile bristles or vibrissae and the smaller hairs more generally distributed over the body, horns, claws, hoofs, nails and glands may be found as skin appendages. The armadillo is the only living mammal that has a true bony exoskeleton.

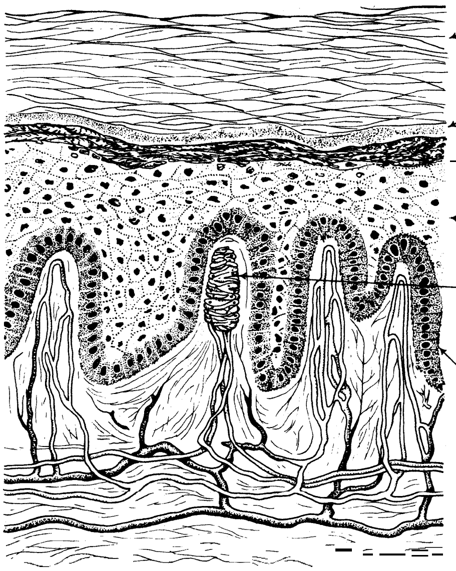

FIG 1 — VERTICALSECTION OF EPIDERMIS AND PAPILLAE OF CORIUM

Horns are of three kinds. The antlers found in members of the deer family are true bone with a covering of very vascular skin (velvet), which disappears soon after growth is completed The antlers are shed annually and are replaced rapidly. The small horns of giraffes are also bony structures though permanent The horns of ruminants are hollow cases of hardened epidermis that fit over a bony core and are permanent except in the pronghorn, which sheds its horns periodically The horns of the rhinoceros are a mass of hairlike horny fibres, which grow from dermal papillae and are cemented together by cells. Claws and nails are found in the dorsal aspect of the distal phalanges of the digits, whereas hoofs extend across the end and reach the plantar surface as well; all three represent specially thickened parts of the epidermis.

Skin in Man. — The skin of man, from the surface to the point where the dermis merges with the usually adipose subcutaneous tissue layers varies in thickness from less than one millimetre on the eyelids to three millimetres or more on the interscapular area palms and soles It is elastic and presents a smooth, soft, pliable surface broken by intersecting lines, folds, ridges and tiny pores The more or less parallel, closely set, fine ridge patterns of palmar and plantar skin are characteristic for each individual and form the basis for the widely used fingerprint system of personal identification

Epidermis — The average thickness of the epidermis is only about 0 1 mm, although on the palms and soles, or where subjected to rubbing or pressure, it may be 10 to 15 times thicker, largely because of the greater thickness of its outermost, cornified layers The epidermis can be differentiated into several distinct layers (see fig 1) The deepest layer, which rests on the dermis, is called the stratum gerrninativum (or basal-cell layer) and consists of a single layer of columnar epithelial cells arranged in regular palisade fashion Interspersed betueen and slightly below the cells of this layer, along the junction betueen it and the dermis, is a network of melanin pigment-forming cells (melanocytes) having many slender, branchlike, cytoplasmic extensions; these extensions communicate with one another as well as extend between the cells of the deeper portions of the epidermis, to which they can transfer melanin pigment. There are about 1,000 to 3,000 melanocytes in each square millimetre of skin.

The layer above the basal cell layer is called the stratum mucosum, spinosum or prickle-cell layer. This layer is several cells thick; its cells have irregular polyhedral shapes, and they appear to be connected with one another by numerous microscopic intercellular bridges, spines or prickles. In the next layer, the stratum granulosum, which is from two to four cells thick, the cells become flattened and diamond shaped, and a granular material, keratohyalin. appears in their cytoplasm. The next layer, the stratum lucidum, is not always apparent. Where well developed it appears as a clear, homogeneous line in microscopic cross-sectional preparations. It contains a lipid-resembling substance called eleidin. The major barrier against the passage of water and salts through the skin lies at the level of the stratum lucidum. The most superficial layer. the stratum corneum. consists usually of 10 to 20 layers of very flat, dead, dry, keratinized cells, which adhere to one another tightly except nearest the surface, where they are continually shed as microscopic flakes

Cell division in the epidermis takes place in the basal cell layer and in the lover layers of the prickle-cell layer. As a result of such proliferation, cells are continuously pushed toward the surface, and as they move outward in this fashion they undergo a sequence of changes in which they die and their proteins become transformed into the tough, chemically inert, fibrous protein called keratin There are no blood vessels in the epidermis, which therefore has to receive its nutrition from tissue fluids that diffuse through the spaces between the intercellular spines of the stratum mucosum.

Dermis — The dermis, or coriurn, has an outer thin, relatively loose, papillary layer adjoining the epidermis and an inner thick, dense, reticular layer that blends into the subcutaneous connective tissue Papillae of the outer layer (from about 40 to 140 per square millimetre. depending on the region) are tiny. fingerlike processes that fit into sheathlike sockets in the overlying epidermis. The papillae carry capillary vascular loops and also may contain specialized sensory nerve endings A thin layer of mucoprotein cement substance lies at the junction between the corium and the epidermis.

Most of the structural material of the corium consists of the fibrous proteins collagen and elastin. When suitably treated by a process called tanning, these tough, elastic, fibrous materials as found in the coriurn of animal skins make commercial leather. Boiling of collagen fibres partially hydrolyzes them to give rise to gelatin Electron microscopic examination of collagen fibres reveals them to be composed of bundles of very fine fibrils showing a characteristic regular pattern of cross striations The fibrous components of the coriurn are imbedded in a complex matrix of ground substance consisting of mucopolysaccharides as well as proteins, water and miscellaneous dissolved substances. This ground substance has important functions in regulating the diffusion of material through the coriurn

The fibres of the corium run in all directions, but predominantly in the plane of the body surface and parallel to the lines of tension and compression of the skin in ordinary movements. A round puncture wound becomes elliptical after withdrawal of the instrument, and a linear incision gapes more widely if it is transverse to the prevailing fibres The corium is well supplied mith blood vessels and nerves. Striated muscle extends into the dermis about the face and neck to permit facial movements such as those that give expression to emotions Smooth muscle is widely distributed in the coriurn in the form of thin bundles attached to hair follicles. Their contraction elevates hairs to a more erect position and produces "goose flesh."

Cutaneous Appendages. — The cutaneous appendages in man consist of pilosebaceous units, sweat glands and nails.

The nails are platelike, translucent, keratinous structures that grow over the ends of all digits from specialized, proximal epidermal matrices or nail roots; these extend to the distal edge of the lunula, a moon-shaped whiter area often visible at the base of the nail plate. Nails consist of densely compacted, highly cornified, dead epithelial cells containing only remnants of degenerated nuclei. The distal edges of the nails are free, and on the fingers serve to assist in the manipulation of small objects as well as for scratching. Six to seven months are required for a newly generated portion of nail to be pushed over the nail bed to reach the distal free edge.

Eccrine sweat glands occur throughout the skin of man in large numbers, although in many other mammals they occur only on the foot pads. Each eccrine sweat gland is an independent, slender, blind tubule about 20 μ in diameter and consists of two cell layers, an inner epithelial lining (either secretory or ductal in type) and an outer myoepithelial layer of more or less contractile cells. The secretory portion of the gland lies coiled in a ball-like structure in the lower dermis or upper subcutaneous tissue. From there the duct follows a slightly spiral course through the dermis and then a much more tightly spiral course through the epidermis and especially the stratum corneum to open in a tiny sweat pore. The total number of sweat glands in man is over 2,000,000, with an estimated total tubular length of about eight miles. These glands actively secrete sweat, a thin. watery fluid containing salts and other solutes found in blood plasma but in individual concentrations often much lower or higher than in plasma. For example, urea is about twice as concentrated in sweat as in plasma, while glucose occurs in sweat only in trace amounts.

Sweat secretion is subject to various controlling mechanisms, chief among which is the secretory innervation of these glands by nerve fibres of the sympathetic nervous system. Under extreme conditions of heat as much as eight litres of sweat may be produced per day by an adult man. The fluid and salts lost in this manner must steadily be replaced if the man is to survive. The chief function of sweat secretion in man is the regulation of body temperature by means of evaporative cooling. Sweat also helps maintain normal hydration of the outer layers of the skin, and on the palms its moisture enhances the grip. Sweating of the palms and soles is particularly influenced by nervous activity in higher brain centres and becomes profuse under conditions of mental or emotional tension.

Pilosebaceous units are found densely distributed in almost all parts of the skin (fig. 2). Each unit consists of a hair follicle with its hair and its appended sebaceous gland and erector muscle. In the axillae, perineal and pubic regions, and about the nipples, apocrine sweat glands are also appended to the pilosebaceous units. These glands, which open into the pilosebaceous canal, have a complex, branched, tubular structure with lumina about ten times larger than those of eccrine sweat glands. Their mode of secretion also differs from that of eccrine glands in that part of the cytoplasm of the secretory cells is pushed off in the process (decapitation secretion). Apocrine secretion is an opalescent fluid that under bacterial action gives rise to odorous substances partly responsible for unpleasant body odours.

Sebaceous glands are multilobulated structures 0.2 to 2 mm. in diameter with short ducts that open into the necks of the hair follicles. These glands excrete a highly complex mixture of lipids? called sebum, which diffuses upward in the follicle, impregnates the hair and surrounding horny layers of the skin to participate in forming the greasy skin surface film. This film helps maintain normal pliability of the skin by retarding loss of water from the horny layer, delays absorption of many foreign substances and contains substances that are protective against exogenous infections. In the process of sebum formation, germinative cells in the periphery of the gland proliferate, and as the maturing cells move toward the centre of the gland, discrete droplets of lipid progressively accumulate in their cytolasm. Finally, these cells burst and liberate the enclosed lipid material.

Hair, in man. has little functional value when compared with its role in fur-bearing animals. Nevertheless, human hair and hair growth have considerable cosmetic and general biological interest. Hair filaments are dead, thin, flexible, shafts of highly keratinized epithelial cells developing within slanting tubular invaginations of the epidermis—the hair follicles. The deepest portion of each follicle is enlarged to enclose a vascular papilla, projecting from the dermis into the bulb. The epithelium immediately above and around this papilla is the germinative matrix for the hair. There are great individual and regional variations in types and distribution of hair. On the scalp, where hair is usually densest and longest, the average total number of hairs is between 100,000 and 150,000. Hair is continually shed and renewed by the operation of alternating cycles of growth, rest, dedifferentiation and renewal of growth of the hair follicle and its associated structures. This cyclic activity is intrinsic in the individual pilosebaceous units. The average life of different varieties of hair varies from $4\frac{1}{2}$ months for downy hairs to three to five years for long scalp hairs. Caucasoid scalp hair grows approximately 1 cm. per month and reaches an average length of 60 to 75 cm.

***Skin* Functions.**—Human skin has primarily protective, sensory and body-temperature-regulating functions. Furthermore, vitamin D (the antirachitic vitamin) is produced in the epidermis when the skin is exposed to sunshine. There are also absorptive, secretory and excretory, and respiratory functions of the skin. The integument serves as a remarkably effective protective barrier against a wide range of potentially injurious chemical, physical and biological factors. Since it is nearly waterproof it enables the relatively fluid body to exist in dry air, to be immersed in fresh water without becoming swollen and in salt water without becoming shrunken. The keratinized layers of the skin, which are practically inert chemically and are poor conductors of heat and electricity, also serve, together with melanin pigment, as an effective screen against potentially harmful amounts of ultraviolet radiation. Body temperature regulation is achieved by virtue of the extensive vascular plexuses distributed in the skin and by the cooling effect of sweat evaporation from its surface. Sensory functions are carried out through a rich variety of nerve endings, which bring the primary sensory modalities of touch, heat, cold and pain into consciousness from discrete receptor points in the skin. Total body respiration, as well as excretion of metabolic wastes, is aided by the skin only slightly. Most substances are very poorly absorbed through intact skin except in the gaseous state. Materials readily soluble in both lipid and water are generally better absorbed than those soluble in only one or the other.

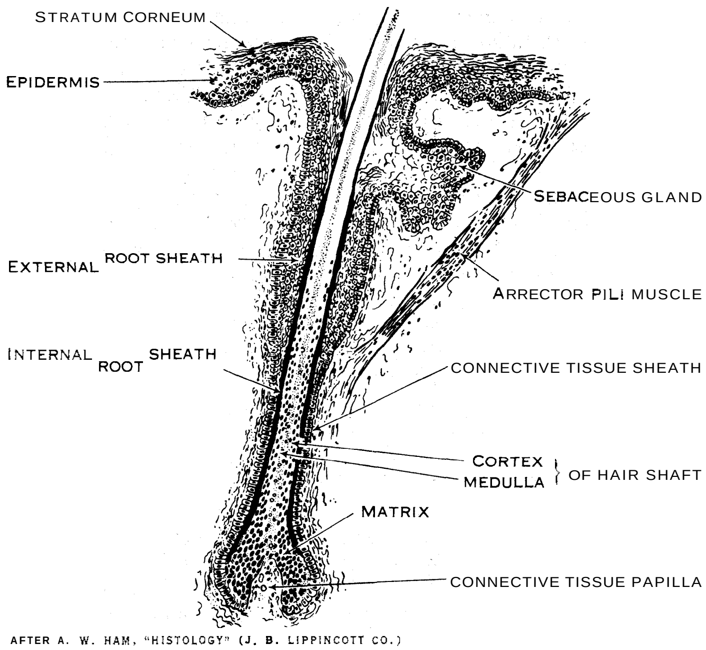

FIG. 2.— DIAGRAM OF A HAIR FOLLICLE CUT IN LONGITUDINAL SECTION

See also SKIN DISEASES; SKIN. SENSORY FUNCTIONS OF; and articles on such related subjects as HAIR; PERSPIRATION; ANIMAL HEAT; etc.

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(A. L. Lz.)

SKIN, SENSORY FUNCTIONS OF. Sensory nerve impulses from the skin are employed either in keeping the "mind" informed of the relationship between the body and its immediate surroundings, or in the control of mechanisms for counteracting the effect of changes in the physical conditions within or at the surface of the skin. The sensory functions of the skin are not concerned solely with conscious experience related to common sensation; *i.e.,* touch, warmth, cold and pain sensibility.

This complex role can be demonstrated in many ways; for instance, if a beam of invisible (infrared) heat energy is transferred to the skin at a suitable rate, a report of warmth is evoked; the temperature of the skin surface starts to rise, at first rapidly, then more slowly until a steady state is reached, despite the fact that heat is still being transferred to it at virtually the same rate. The new state of equilibrium is brought about by reflex action. The sensory impulses evoke a discharge of motor impulses which result in a local increase in the blood flow, thus enabling the heat to be removed as fast as it is received. As soon as the surface temperature of the skin stops rising, the sensation of warmth is no longer perceived despite the fact that the skin is still being irradiated.

By contrast, if the experiment is repeated, using a much greater rate of heat transfer, the subject will almost instantaneously withdraw from the path of the beam and a report of pain will be made even though the actual rise in temperature of the skin surface has not been particularly large.

These observations make it clear, among other things, that the conscious experience evoked by stimulation of the skin is conditional both upon the physical characteristics of the stimulus and upon the conditions prevailing within the skin itself at the time of stimulation. In other words, in respect of heat transfer, the skin does not behave like a thermometer, for the number of impulses reaching the central nervous system from the skin does not merely reflect alterations in the physical state of the environment but also depends upon the changes brought about in the skin itself.

Further, even if the nerve impulses reaching the central nervous system from the skin do not vary, the conscious experience evoked depends upon the precise conditions prevailing in the central nervous system at the time of stimulation. Stimuli which consistently evoke reports of pain in a subject at rest may fail to reach consciousness when the same person is absorbed in a game of chess.

Although the sensory functions of the skin are not limited to arousing conscious experiences, these are of the more immediate interest, primarily because of their well-known relationship to disease and also because more is known about them than about most of the other sensory functions of the skin.

Physical Background of Common Sensibility.—It was formerly believed that the skin contained a mosaic of discrete nerve tertninations divided into four species, each of which was specialized structurally and functionally to serve one of the primary modalities of common sensation (*i.e.,* touch, warmth, cold and pain).

This concept probably arose directly from the necessary codification of common experience into convenient abstract terms. Moreover, it proved to be a useful working hypothesis, for it led to the recognition that impulses which evoke pain travel up to the brain in a different part of the spinal cord from those transmitting detailed tactile information. More critical and refined work, however, has yielded observations which cannot be reconciled with the data upon which this hypothesis was erected.

Anatomy of the Cutaneous Nerve Terminals.—The greater part of the human body in both sexes is covered with hairy skin, although the hairs in certain zones are so fine that they cannot be seen without the aid of a lens. Indeed. the only zones where hairs are entirely absent are the palms of the hands, the soles of the feet and certain exposed mucous membranes, such as those of the lips, the anus and parts of the external genital organs. In hairy skin there are only two kinds of nerve termination: (1) compact basketlike networks surrounding the necks of the follicles through which the hair shafts pass and (2) diffuse arborizations of fine filaments which intermingle extensively with one another and end freely and at random among the various tissue elements in the skin. In hairless zones, compact nerve entanglements of diverse shapes and sizes, often enclosed within cellular capsules, take the place of the basketlike networks around the hairs, but it is not possible to classify them taxonomically into sharply demarcated groups.

These observations strike at the roots of the hypothesis upon which the mechanism of cutaneous sensibility was originally erected. For it is clear that over the greater part of the body there are only two types of nerve terminal to subserve four sensory modes. Further, since it is unlikely that the stimulation of hairs arouses in conscious experience sensations unrelated to touch, the diffuse arborizations (which incidentally are impossible to distinguish from one another on anatomical grounds) must be related, among other things, to the conscious experiences reported as warmth. cold and pain.

Pattern of Innervation of the Skin.—It has been demonstrated that individual nerve terminals do not have private lines of communication passing directly to the central nervous system. On the contrary, each parent nerve subserves many terminals which are evenly scattered over a relatively large area by means of a mazelike network of nerve fibre bundles in the skin itself. Indeed, the arrangements are such that random destruction of up to one-quarter of the parent nerve fibres in a sensory nerve trunk (a bundle into which parent nerves are gathered as they pass between the skin and the spinal cord) results in degeneration of a small proportion of nerve terminals evenly scattered throughout the area of skin subserved by the whole trunk. Moreover. the subject is usually quite unaware of any alteration in the sensory capacity of the skin involved; certainly none can be detected by the use of such test objects as needles and wisps of cotton wool.

Although little quantitative information concerning the pattern of innervation of human skin had been obtained by the late 1950s, the innervation of the hairs in the skin of the rabbit ear had been analyzed in some detail, and comparative studies leave no doubt that hairs are innervated on the same principle in man. Briefly, there are around 100.000 hairs in the rabbit ear but no more than 5,000 nerves to innervate them. Yet even the smallest hair is supplied by at least 2 parent nerves, "guard hairs" by as many as 20, an average hair by 6. Each parent nerve supplies on the average 120 hairs sparsely scattered over relatively large areas, in some cases extending over as much as one-half of the ear. It has also been found that an individual hair is subserved by parent nerve fibres of slightly different thickness which conduct impulses at different speeds so that they reach the spinal cord at different times. In addition to this, the hairs themselves are so grouped that it is virtually impossible to stimulate a single hair in isolation, unless it be a large guard hair (which is subserved by many parent axons, by any form of naturally occurring stimulus. Thus, any significant stimulus must result in a highly complex spatiotemporal pattern of impulses reaching the cord. The sensory experience evoked must therefore be the result of the integration of this pattern of impulses with other incoming patterns, the transfer of the new pattern which emerges to higher centres where further integration probably takes place, and the final transfer of resulting activity to circuits responsible for perception.

In the case of the rabbit, it has been calculated that these peripheral arrangements require fewer parent nerve fibres to carry an equivalent amount of information as compared with the system envisaged in the original hypothesis, which assumed that each terminal in the skin had a private line of communication with the central nervous system. A corollary of this is the negligible effect on sensory acuity caused by destruction of up to one-quarter of the parent fibres in any part of a sensory nerve trunk passing between the skin and the spinal cord. Focal disturbances of sensation within the area supplied are not encountered.

Density of Innervation.—This varies considerably from place to place over the body surface. The skin of the back of the trunk for example, is not subserved by so many parent nerve fibres as the skin covering the face and the extremities, particularly that covering the palms of the hands and soles of the feet. On the other hand, the nerve terminals which end freely within such sparsely innervated areas of skin are almost as numerous as (though they are finer than) those in more densely innervated zones.

Skin which is supplied by a large number of parent nerve fibres is generally capable of resolving fine details in the configuration of the environment. For instance, the skin covering the finger pads, as is well known, can be used by blind people for reading by the Braille system. Pain evoked from lavishly innervated areas, such as the face, is always reported as being more intense, and it certainly is more prone to cause fainting than that evoked by the same stimulus from less densely innervated areas of skin.

The effect of stimulation on conscious experience is not, however, always directly proportional to the density of innervation of the area concerned. The foreskin and mucous membranes of the glans penis and clitoris are among the most lavishly innervated surfaces of the body, in terms of both parent nerves and the density and size of their terminal ramifications. Yet these regions are virtually "silent" as compared with those covering the trunk when the same stimulus is used. Moreover, the sensation evoked is peculiarly uninformative, both as regards the position and clarity of image which is perceived. Despite this apparent insensitivity, it is known that a large outburst of activity follows stimulation of the monkey's glans penis with a wisp of cotton wool even when the animal is fully anesthetized. Division of cutaneous nerve fibres in this region (*i.e.*, circumcision) evokes pain of greater intensity than that which follows an incision of comparable length through skin covering the body elsewhere.

From this it can only be concluded that the nature of the conscious perception evoked by naturally occurring stimuli (short of severe injury) in these zones is not dependent upon the sensory impulses evoked but solely upon the state of the nerve cells upon which they project; these may be either in the spinal cord or elsewhere. Experience suggests that it is such as to prevent the majority of impulses reaching the level of consciousness except upon specific occasions. This arrangement is in contrast to that obtaining elsewhere, for preoccupation of the mind usually results in preventing sensory impulses from reaching consciousness, not in raising them to a higher level of consciousness.

Specificity of **Nerve** Terminations in the Skin.—It is accepted that the nerve terminals related to hairs and compact nerve terminals help to keep the "mind" informed of the relationship between the body and its immediate surroundings. It is, then, of more than passing interest to find that such endings, as well as the spinal tracts associated with them, are absent in aquatic animals whose watery environment is relatively homogenous and where such information is presumably less necessary to survival. It is not known whether hairs can be stimulated in such a way that nerve impulses specifically related to the terminals evoke reports of pain. Pulling on a hair is usually considered to involve diffuse nerve endings, for vibratory impulses are invariably ineffective in this respect. However, in certain pathological conditions in which the pattern of the discharge from hairs in a given area is disturbed, the sensations evoked by their stimulation are referred to as "unpleasant" and at times "painful," but the subject always adds that sensations are not of the kind he experiences in everyday life and he is unable to describe them adequately. In this connection, it is perhaps significant that tactile stimulation in man under local anesthesia of the spinal pathways conducting the impulses from hairs (and other proprioceptive organs; *i.e.*, impulses from deeper structures) gives rise to a report of intolerable pain.

More is known concerning the specificity of diffuse nerve endings, although the evidence concerning their precise function in human skin is indirect. Clearly, it is possible that, despite their lack of anatomical differentiation, close interrelationship and complex patterned arrangement, they may be highly specific from a functional point of view.

Unfortunately, there is no known area of skin subserved solely by nerves which end diffusely. They are invariably accompanied by nerves which form compact terminals of one kind or another, which may affect the sensory experience they evoke. On the other hand, the transparent covering of the eye, the cornea, does contain only diffuse nerve endings. It is true that it is structurally unlike skin, but it is highly significant that when it is suitably stimulated, reports in each of the four primary modalities are invariably evoked. Fortunately, the microscopic anatomy of the cornea varies little from animal to animal, including man. Moreover, it is a relatively uncomplicated tissue in that it contains neither blood vessels nor nerves having other than sensory functions. Experimental observations in the cat, then. are likely to reflect conditions in man; and in the cat it has been shown that one and the same nerve ending discharges impulses along its parent nerve when the cornea is stimulated by objects which in man evoke reports related to each of the four sensory modes. The amount of activity evoked by a particular stimulus varies from ending to ending. Moreover, different stimuli evoke different patterns of activity from the same ending. For instance, light touch evokes a short, high-frequency outburst in the case of all active terminals. Injury (pain) evokes a prolonged outburst, the frequency of which depends upon the degree of damage which has been inflicted. Thermal stimuli usually evoke a discharge with a sharp rise and fall in frequency. In the case of some terminals, the activity evoked by warmth is far greater than that evoked by an equivalent amount of cold and vice versa; in the case of others, the responses evoked by either warmth or cold stimuli are indistinguishable. More rarely, while tactile and injurious stimuli evoke activity from the terminal, thermal stimuli are ineffective. These observations strongly suggest that stimuli having different physical characteristics evoke different patterns of activity from nerve endings, the specificity being due to their varied environmental conditions. Certain activity patterns which are intimately concerned with the preservation of the organism from environmental hazards are recognized and made linguistically explicit for the purposes of collective security.

Conclusions.—The anatomical configuration and environmental arrangement of the cutaneous nerves and their terminals are such that it is probable that the great majority of stimuli encountered in everyday life evoke a unique space-time pattern of activity which is projected onto the central nervous system. Here the impulse pattern is first integrated with other incoming impulse patterns. The resulting pattern either increases, decreases or has no effect on the excitatory state of the neurons to which these impulses project. The result is usually to set up yet another impulse pattern, which is projected to yet another set of sensory cells where further reanalysis ensues until at last the impulses are perceived as a sensation localized in the skin. The pattern on its way to the brain may become dissipated or transformed at each relay station, the degree of transformation depending upon the excitatory state of the station and the number of sensory impulses which converge upon it at a given time. There are no groups of specially modified terminals in the skin reporting by private lines the local state in respect of four clear-cut modalities. On the contrary, the amount of information available from the periphery is far more complex and varied. The particular information which dictates activity can be divided into four sensory modalities, but this selection is made in the central nervous system as the result of learning. As everyone knows, pain is not a single entity, but acts as a warning signal. It has innumerable forms, many of which can be used in the diagnosis of specific disease processes. Pain ordinarily follows when an unusually large and prolonged series of impulses from the skin or sensory relay station converge onto the circuits responsible for conscious experience. Warmth and cold can be regarded as preliminary warnings, informing the organism of impending danger. Touch evoked from diffuse endings, such as that produced by an insect crawling over the skin, can also be regarded as a warning signal which puts the organism in an alert state against a possible bite.

The skin innervation in lower vertebrates (teleost fish) and in Amphioxus exhibits a pattern resembling that in the cornea of most vertebrates and in human skin. Moreover, the sensory functions of the skin in these animals appear analogous; the integument of Amphioxus can transmit centrally a variety of stimuli resulting from changes in its environment, which alert the animal and enable it to evade injury. *See* also NERVE; NERVE CONDUCTION; NERVOUS SYSTEM; SENSATION. (A. G. M. W.)

SKIN DISEASES. The human skin is subject to a large number of diseases, some of them inconsequential, others chronic and productive of prolonged partial or total disability, and others associated with internal medical diseases of varying seriousness. At mid-20th century, much less basic research had been done on the skin than on other organs of the body such as the liver, kidney, gastrointestinal tract, etc. Although the cause of some skin conditions was definitely known and the treatment reasonably precise and effective, there remained a large number for which no cause had definitely been established and for which the treatment was empiric and relatively unsatisfactory.

The skin is a highly complex organ, with accessory glands of various types. It is the largest organ of the body. The functions which the normal skin carries out admirably may be summarized as follows:

(1) It regulates body temperature through convection of heat and the evaporation of sweat. In persons with decreased or absent functioning of a large proportion of sweat glands, marked intolerance to a warm environment may be noted, and this is the commonest cause of acute heat prostration or a more chronic disabling condition known as tropical asthaenia.

(2) It protects the body from many harmful external agents in various ways. The complex nerve structure in the skin warns promptly of excessive heat or cold, and of mechanical injury. In persons in whom this nerve mechanism is disturbed, marked injury to the skin may be produced before the individual is aware of it. This occurs in some forms of leprosy, and in certain other conditions in which structural damage to nerve endings or nerve trunks has occurred. The normal skin has a remarkably effective method of protecting itself against prolonged exposure to sunlight in the form of a precise mechanism to lay down melanin pigment, which produces tanning. In some persons with deficient capacity to produce pigment in the skin, such as those with very blond or redhead complexions, this deficiency may lead to repeated severe sunburn, and eventually to more permanent changes such as warty keratoses and skin cancer. The skin, through its corneous upper layer, normally has a remarkable ability to withstand the effects of chemical agents, both acids and alkalis. In the normal human skin there is a tendency to build up an increased thickness of horny tissue rapidly in response to repeated mild to moderate injury. The most common example of this is an ordinary callus.

The intact healthy skin also possesses a remarkable resistance to bacteria. The number of bacteria normally on the skin surface is large; by scrubbing the hands and forearms for 15 minutes with soap and water, anywhere from 1,000,000 to 20,000,000 or more bacteria may be removed. These bacteria are ordinarily not capable of producing disease, and are known as the normal resident flora. If the skin is subjected to prolonged harmful influences, such as excessive moisture, or chronic dermatitis or eczema, or an injury, marked decrease in the self-disinfecting property of the skin may occur.

(3) Another essential function of the skin is the maintenance of an adequate amount of lipoid or fatty substances on its surface, and within the structure of the skin itself. An oily film is maintained by the sebaceous glands. The complex nature of the fatty substances and waxes within the skin itself is poorly understood, but deficiencies rapidly become apparent in dryness and cracking of the skin, particularly during cold weather, and a decreased resistance to chemical substances such as soap. This disturbance of lipoids within the skin is frequently congenital, and becomes more severe in old age. In the skins of some individuals, there is an excessive secretion of oil from the sebaceous gland, and this leads to acne and to an increased tendency to superficial infection.

Diseases of the skin, and also marked general disturbances, may be produced by excessive sweating. Sweating is produced mainly by two types of stimuli, a warm environment or nervous tension. In excessive sweating caused by heat, provided there is opportunity for the sweat to evaporate, no damage ordinarily results. However, if evaporation is prevented, and the surface of the skin is kept wet for long periods of time, resistance to infection by bacteria and by fungi is greatly reduced. If sweating is prolonged, a large amount of salt may be lost, and it is necessary for the individual to take increased amounts of salt by mouth. Sweating caused by nervous tension occurs principally on the hands and feet rather than on the body, and is a common source of itching and of various chronic eruptions in these areas. In prickly heat, there is an obstruction to the free flow of sweat onto the surface of the skin, and the sweat excreted piles up within the tissues. This may produce marked itching and inflammation. Although prickly heat had been recognized as a common disease of the skin for centuries, it was only during World War II that it was discovered that prickly heat was due to a blockage of the sweat ducts, either because of some preceding disease of the skin or a mild injury such as that produced by the application of adhesive tape.

The skin possesses a marked resistance to absorption of chemicals. Such absorption as does occur is principally through the hair follicles and the sebaceous glands. This is the reason that common eruptions such as poison ivy dermatitis rarely appear on the palms of the hands, where there are no hairs.

Definite figures on the comparative incidence of various skin diseases were difficult to obtain prior to World War II. However, the carefully compiled medical records of enormous numbers of patients in the armed forces showed that skin diseases were a very significant source of disability. In statistics from various U.S. and British military hospitals throughout the world, patients admitted because of a disease affecting the skin accounted for from 4% to 20% of the total number of patients. The varying percentages were dependent on several factors. A tropical climate increases the incidence of skin diseases greatly; these are not usually exotic tropical infections, as commonly supposed, but severe forms of common skin conditions such as dermatitis, eczema, prickly heat and fungus or bacterial infections. Diphtheria infections of the skin, rarely seen in temperate climates, become a significant problem in tropical areas. Parasitic infestations such as scabies, which was widely prevalent in England and on the continent during World War II, produced much disability. From the southwest Pacific area, the number of U.S. soldiers returned to the United States because of skin diseases frequently exceeded all other classifications with the exception of neuropsychiatric disorders, and throughout the war were in excess of soldiers returned home because of battle injuries.

Diseases of the skin may be classified in several ways. There are those which arise solely within the skin and remain confined to it, such as superficial fungus infections. In other diseases, particularly bacterial infections, actual spread of the infection or absorption of toxic agents may produce disease of internal organs. It has been shown, for instance, that superficial bacterial infections of infants and children may sometimes be the source of chronic kidney disturbances. Another large group of skin diseases is composed of those in which the skin changes are an expression of an internal medical disease of varying significance. This includes such contagious diseases as scarlet fever, measles and chicken pox, and more or less common serious infections such as tuberculosis of the skin, lupus erythematosus, early and late phases of syphilis, leprosy, various diseases of the blood-forming organs such as leukaemia, Rickettsial infections such as Rocky Mountain spotted fever and typhus, cutaneous manifestations of various types of internal cancer, deep fungus infections such as coccidioidomycosis (San Joaquin Valley fever), etc.

The most common diseases of the skin are the following:

Acne vulgaris.—This disease is so common during adolescence as to be almost a normal physiologic process (70%–80%). Coincident with the development of secondary sex characteristics during puberty, there occurs an increased activity of the sebaceous or oil glands of the skin. Some of these glands become plugged, with the formation of blackheads. The ends of these plugs of cheese-like sebaceous material become black through chemical changes, not because of dirt. The lesions, as might be expected, occur where sebaceous glands are present in the greatest numbers, on the face and upper portions of the trunk. In severe cases of acne, inflammatory lesions may resemble boils, and sometimes produce rather severe scarring. The primary disturbance, however, is not that of a bacterial infection, and treatment with antibacterial agents such as penicillin is usually not effective. While a tendency to acne ordinarily subsides within a year or two as the patient passes through adolescence, some patients have persistent recurrent lesions for many years. In addition to the progressive scarring which such lesions may produce, rather marked psychoneurotic changes may occur because of the young patient's continued concern about his or her pimply appearance, and the production of new scarred areas. While very mild acne does not require treatment, patients with repeated inflammatory lesions deserve understanding competent medical attention. Lotions and drying creams containing sulphur, resorcin and other agents are often quite effective Attention to the diet in regard to foods which seem to produce more acne lesions is essential. though it is important not to restrict the diet of growing children and young adults to the point where it may produce loss of weight and possible injury to general health. Although the basic changes in acne are known to be produced by normal changes in the endocrine glands, treatment with various endocrine substances is usually not effective. X-ray therapy is sometimes used, but should be employed only after other less drastic methods of treatment have failed, and under conservative expert direction of a physician trained and experienced in the treatment of skin diseases with X-rays.

Superficial Fungus Infections. — The two most common types of superficial fungus infections are ringworm of the scalp, occurring predominantly in children, and ringworm of the feet (athlete's foot) and groin (jock-strap itch) occurring principally in adults. Prior to World War II, ringworm of the scalp was seen almost entirely in larger metropolitan centres among children living under poor economic and hygienic conditions. In 1942–44 a marked increase in the number of cases was noted, and this seemed to reach a peak about 1949–50. The disease is apparently transmitted most frequently by barber's clippers, contaminated hats, combs and brushes. direct contact and the backs of theatre seats. Some children are apparently immune. Two types of infections are noted, those due to animal fungi, which may also be found in cats, dogs and other animals, and those due to human fungi. which apparently affect man only. The infection tends to get well spontaneously, but may persist for several months to two or three years or longer in the case of some fungi. The only certain method of treatment is to produce temporary loss of the infected hair by means of X-rays, but this method of treatment is tedious and difficult to carry out, and even under the most expert administration carries a slight risk of some permanent loss of hair. At mid-century, no entirely satisfactory method of local treatment had yet been developed.

Superficial fungus infections of the feet are very common, occurring in 60% to 80% of persons of college age. The disease is a penalty of civilization, and does not occur in races accustomed to going barefoot. The primary site of involvement is almost always between the toes, but spread to other areas may be noted, particularly in warm climates. The symptoms consist of itching and burning, and the appearance of small to large vesicles or blisters, with fissuring, denuded areas of skin and secondary bacterial infection. The diagnosis of a fungus infection of the feet should always be confirmed by laboratory studies. The organisms may be cultured, or may be demonstrated by a simple stain, the Hotchkiss-McManus method, which was first adapted for this purpose in 1950. Fungus infections of the feet are frequently confused with other conditions, such as reactions to various components of shoes, bacterial infection or excessive sweating. It is probably true that more harm than good results from many methods of treatment of fungus infections, because they are too strong, and produce increased irritation. There is no completely satisfactory method of treatment in the sense of killing off the responsible fungi without damaging the skin. Good foot hygiene is of the greatest importance, and this includes thorough removal of soap and drying of the skin after bathing, wearing of aerated shoes during warm weather, avoidance of the wearing of rubber-soled shoes in susceptible individuals and the regular use of a drying dusting powder. Foot baths for prevention are probably useless.

Bacterial Infections constitute another major type of skin diseases. These may occur suddenly and acutely on normal skin, as in impetigo, which is caused by staphylococci and streptococci. This infection is extremely contagious among infants, but not particularly contagious among adults. The availability from about 1935 of an increasing number of antibacterial substances such as sulfonamides, penicillin, etc., greatly increased the efficiency of treatment. Secondary bacterial infection of irritated skin, such as that resulting from fungus infections or from eczema, occurs quite frequently.

When the infection is principally around the hairs, folliculitis or boils may be noted, and such infections may be extremely chronic and recurrent, even with the most modern methods of treatment.

Dermatitis and Eczema. — A dermatitis is any type of inflammation of the skin not caused by an infectious agent, and may result from an extremely wide variety of substances. Eczema is, essentially, a chronic dermatitis, and in some types there may be a marked familial history of various allergic diseases such as eczema, asthma, hay fever, hives, etc. Dermatitis may commonly result from an external source, such as poison ivy. There are literally thousands of natural and synthetic chemicals which are capable of sensitizing the human skin. Dermatitis from numerous external contactants is a significant source of disability in industry. It is entirely possible for a person who has worked with a particular chemical for months to many years to become sensitive to it rather abruptly. In the treatment of dermatitis from external contacts, determination of the responsible substance or group of substances is essential. However, this may be extremely difficult at times. Other types of dermatitis or eczema result from substances which are circulating through the blood stream, and which produce inflammation of the lower layers and blood vessels of the skin. These may be substances which are inhaled, such as pollens or dust, or foods or drugs which are taken by mouth, or reactions to fungus or bacterial infections elsewhere on the body. In this group of more or less chronic eruptions, psychosomatic and emotional factors play an important role, and may perpetuate the itching and inflammation of the skin long after the original cause has been determined.

Parasitic Infestations. — A wide variety of insects regard the human animal as an attractive food or habitat. Biting insects such as mosquitoes, flies, chiggers and ticks produce local reactions in the skin varying from a small hive to a large blister. Some insects are capable of transmitting serious infections such as malaria, Rocky Mountain spotted fever and typhus. Various species of lice infect the scalp (pediculosis capitis), the groin (pediculosis pubis — crab lice) and the body (pediculosis corporis). Adequate hygiene and the availability of antiparasitic agents such as DDT have 'made lice infestations almost completely preventable. Infestation of the clothing, which occurred with great frequency among troops in R'0rld War I, was almost unknown in troops in World War II who were supplied with DDT powder.

Another common infestation is by the *Acarus scabiei*, which produces scabies. Under conditions which produce poor hygiene and crowding of the population. such as those encountered in the British Isles during the air raids of World War II, scabies may become epidemic. Transmission occurs principally by skin to skin contact, and not to any great extent through wearing apparel and bedding. The damage is chiefly produced by the female *Acarus*, which burrows along the upper layers of the skin in warm, protected areas of the body. She lays her eggs within the skin, and is capable of producing considerable inflammation and marked itching, the latter being noted particularly while the patient is in bed. If the infestation is undetected, marked secondary infection may occur from scratching. Treatment is highly effective if properly carried out, the principal useful compounds being sulphur and benzyl benzoate. A great rise in the incidence of scabies may be expected under conditions of war, and returning troops spread the infestation among the civilian population.

Virus Infections. — In addition to generalized infections caused by various viruses, certain virus infections may remain localized principally on the skin. These include warts, cold sores (herpes simplex), shingles (herpes zoster) and molluscum contagiosum. Warts are extremely common. They may vary in number from 1 to 100 or more on an individual. and can be spread from one part of the body to another. In moist areas, the lesions may be very large and exuberant in growth (venereal warts). When warts occur on the sole of the foot (plantar wart), considerable pain and disability may result. Warts may appear or disappear for no apparent reason. In children particularly, they may be successfully treated by psychotherapy (Pennsylvania-Dutch hexing). There is no chemical which specifically kills the virus of warts, and methods of removal such as application of cauterant compounds or the use of electrosurgical methods are employed. X-ray or radium therapy is sometimes used. but the effect is unpredictable and there is grave danger of late untoward changes if the method is used inexpertly or to excess.

Herpes simplex usually occurs about the mouth, but may be encountered on any other area of the body, sometimes recurrently in exactly the same place. Once the infection is acquired, the virus apparently remains in the skin indefinitely and may be reactivated by various factors such as a cold, excessive exposure to sunlight, some drugs and foods, menstrual periods and nervous or emotional tension. In infants, the initial infection with herpes simplex may be a serious disease, and adults with active cold sores should be careful not to transmit the infection to babies. There is no satisfactory treatment other than the application of soothing drying preparations.

Herpes zoster or shingles is caused by the same virus as that of chicken pox. The virus affects the skin and nerve structures. and may at times be accompanied or followed by severe neuralgic pain, especially in older patients, When the process involves nerves reaching the eye, severe visual damage may result. Molluscum contagiosum is a much less common virus infection resembling warts to some extent, and occurring principally in children.

Psoriasis. — This is a rather common and extremely persistent disease of the skin, with raised red areas having a characteristic silvery scale. The cause is completely unknown. Various types of treatment have temporary palliative effects. The best method of treatment is ordinary natural sunlight. The disease ordinarily is not accompanied by any change in general health, though arthritis may be noted in some patients.

Dandruff. — The term "dandruff," a mild form of seborrhoeic dermatitis, simply indicates a moderate to excessive increase in the scaling of the scalp. One type is seen in persons whose skins are generally dry, though the most common type is in persons whose skins tend to be oily, and who may have had some acne during adolescence. In children, ringworm infections of the scalp may be mistaken for ordinary dandruff in mild cases. A brief examination with a special lamp equipped with the Wood's glass is ordinarily adequate to determine whether or not ringworm is present. It is not generally believed that seborrhoeic dermatitis is directly responsible for loss of hair, though in some individuals it may seem to be contributory. The basic cause of dandruff is not well understood, and treatment is therefore largely empiric. At mid-20th century no infectious agent had been proved to be responsible.

Hives. — Urticaria or hives is a local and usually transitory oedema of the skin produced by the release of a substance resembling histamine. The simplest example of a hive is the reaction resulting from an ordinary mosquito bite. Extensive hives may result from the eating of some food to which the patient is allergically sensitive. Various drugs, including penicillin particularly, may give rise to extensive and persistent urticaria. In some patients with chronic urticaria, the cause may be exceedingly difficult to determine. Psychosomatic influences frequently play a role. The various antihistaminic drugs are useful for producing temporary disappearance of hives.

Pigmentation Disturbances. — The enzymatic mechanisms concerned in pigmentation of the skin are well understood, but the factors which produce disturbances of these mechanisms, with resultant increase or loss of pigmentation, are not well understood. Vitiligo is a fairly frequent disturbance, in which the skin loses its power to produce melanin pigment. The loss of pigment may affect only a small area, but patients are sometimes seen in whom almost all the skin is affected. In persons with dark skins, the cosmetic changes may be very marked. As a rule, there is no underlying disturbance of general health. Vitiligo produces some disability, however, because the affected skin does not tan in response to exposure to sunlight, and the vitiliginous areas sunburn very easily.

Skin Cancer. — Cancer of the skin is one type of cancer in which possible cure approaches 100% if the precancerous or cancerous condition of the skin is recognized early, and if adequate treatment is applied. This statement does not apply, however, to malignant moles or melanoma. Cancer of the skin may be divided into two main types, basal cell epitheliomas (rodent ulcer) and prickle or squamous cell epitheliomas. Basal cell epitheliomas are ordinarily slow growing, and do not spread by metastasis, that is, through the lymphatics or blood stream to other parts of the body. Basal cell epitheliomas commonly arise from some accessory structure of the skin, principally the hair follicles or sebaceous gland. They spread slowly by extension, and if the lesion is recognized when it is small, surgical removal by complete excision, or electrosurgical methods, or treatment with X-rays is ordinarily curative. Squamous or prickle cell carcinoma is a more malignant type of skin cancer which may spread to neighbouring lymph nodes and other structures quite rapidly. This type is usually preceded by a long-standing precancerous lesion, usually a senile keratosis. It is therefore important to recognize and remove such lesions before they have become truly malignant. Cancer of the lip is ordinarily of the squamous cell type, and occurs much more frequently in smokers than in nonsmokers. At the time of removal of any lesion of the skin which may be malignant, it is of extreme importance to determine the exact nature of the changes microscopically, by means of a biopsy. In some instances, a lesion which looks quite benign externally may be found to be of highly malignant character, and more radical removal or X-ray treatment may be necessary.

Certain chronic stimuli are known to promote degenerative changes in the skin which may result in cancer. By far the most important of these is excessive exposure to sunlight. This is well shown by the fact that cancer of the skin is much more common in areas where there is a high proportion of sunlight, and in individuals whose work keeps them in sunlight a great deal (farmers and sailors). Persons whose skins do not tan are far more susceptible to untoward late changes from excessive sunlight. While some exposure to natural sunlight is beneficial and healthful, persons who are addicted to baking and bronzing their skin excessively and repeatedly are inviting senile changes which may result in cancer. Another stimulus which may in later years result in cancer is overexposure to X-ray or to radium. If used expertly and conservatively, these agents are reasonably safe, but overexposure may lead to atrophic changes which frequently result in a highly malignant type of skin cancer. Some chemicals, such as pitch and tar, encountered in certain occupations, may result in an increased incidence in skin cancer.

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SKIN DIVING is the most ancient diving technique and undoubtedly has been practised since the time man learned to swim. By strict definition, the term skin diving applies only to "natural" diving, that is, without the use of any underwater breathing apparatus. This method is employed by pearl and sponge divers in many parts of the world. After the end of World War II, the term skin diving came to include, in addition to natural diving, diving with self-contained underwater breathing apparatus (SCUBA). The basic difference between this type of equipment and conventional diving gear is that with the former there are no connections between the diver and the surface, the breathing gas being carried in tanks strapped to the diver's body. Thus, the self-contained (or "free") diver propelling himself by swimming gains a tremendous advantage in mobility over his counterpart dressed in the conventional suit and helmet who must walk upright much encumbered by his heavy equipment and connected with the surface by a lifeline and air hose. The traditionally outfitted diver, however, derives a degree of security from his unlimited supply of air and more protective suit that for certain missions may more than outweigh the great advantage in mobility he must concede the free diver.

Both types of equipment have a distinct place in diving. The major factors governing the choice of apparatus are depth and duration of the dive and the degree of mobility required. Deep dives of long duration nearly always dictate the use of the suit and helmet. If mobility is an important consideration, however, and especially if the terrain is rough or obstructed. the use of self-contained equipment may be indicated. While SCUBA generally is inadvisable for dives deeper than 130 ft., useful work has been accomplished at much greater depths, and several descents to more than 300 ft. have been made by free divers.

Self-contained equipment falls into two categories: open-circuit and closed-circuit. While both systems were developed before 1880, they were refined for military applications during World War II. Thereafter they gained widespread acceptance by both professionals and amateurs. The first popular open-circuit SCCBA was developed in 1943 by J. Y. Cousteau and E. Gagnan. It was called the "Aqua-Lung," a trade name that often has been applied erroneously to all SCUBA. Open-circuit units consist essentially of two parts: an air reservoir made up of from one to three cylinders charged with the breathing mixture (usually compressed air) to a pressure of from 150 to 200 atm., and a demand regulator which feeds air through a hose and mouthpiece to the diver at ambient pressure when he inhales. Some regulators incorporate a second hose which returns the exhaled gas to the regulator where it is discharged directly into the water through a one-way valve. others exhaust through a similar valve at the side of the mouthpiece. All these systems release gas into the water upon exhalation. causing an intermittent discharge of bubbles.

The closed-circuit SCUBA (also called oxygen rebreathers or regenerative systems) releases no bubbles into the water except during ascent, and, therefore, in spite of certain severe limitations, has found extensive military use where the consideration of stealth is paramount. These units consist essentially of three parts: (1) a relatively small steel cylinder charged with the breathing gas (usually pure oxygen) to a pressure of from 150 to zoo atm.; (2) a cannister of soda lime or other carbon dioxide absorbent into which exhaled gas passes for removal of carbon dioxide; and (3) a breathing bag which acts as a reservoir for oxygen at ambient pressure between the cylinder and inhaling hose. Closed-circuit systems using pure oxygen are limited in depth to 30 ft. Prolonged respiration of a pure oxygen atmosphere at greater pressure ultimately results in convulsion and unconsciousness. Closed-circuit units are suitable for use only by specially trained and experienced free divers.

Other than the breathing apparatus, equipment used in self-contained diving is identical to that required for skin diving: rubber swim fins shaped like duck feet are used for propulsion and the ordinary flutter kick is standard technique; a face mask covering eyes and nose and fitted with a flat glass pane permits underwater vision; in cold waters, a tight-fitting and flexible protective rubber suit is worn, usually necessitating the use of a weight belt to restore neutral buoyancy. Further accessories include depth gauge and wrist watch (both niandatory in deep SCUBA diving), knife, compass, "snorkel" (a short breathing tube with a mouthpiece) and self-inflating rescue device.

See also DIVING APPARATUS.

See *Submarine* **Medicine Practice,** prepared **by** the Bureau of Medicine, U S Department of the Navy (1956). (P R GL.)

SKINNER, OTIS (1858–1942), U.S. actor, who played hundreds of roles in all parts of the world in a career extending over more than 60 years, was born in Cambridge. Mass., June 28, 1858, the son of a minister. His first stage appearance was at the Philadelphia museum in 1877 in *Woodleigh.* After tuo years in the stock company at the Walnut Street theatre in Philadelphia, Skinner made his New York debut at Niblo's Gardens, Sept. 4, 1879 in The *Enchantment.* During the next five years he developed a classical repertory and a successful acting style, first with Ednin Booth, at Booth's theatre, and then, for three years, with Lawrence Barrett. In 1884 he joined Augustin Daly's company at Daly's theatre, remaining with it for four years. He made his London debut in 1886 with Daly's company, playing at the Strand theatre. After two years with the Booth-Modjeska company, he became, in 1892, leading man opposite Helena Modjeska. In 1903 he starred with Ada Rehan. In addition to his Shakespearean roles, Skinner's chief successes were in *Kismet,* which he played between 1911 and 1914, and *Blood and Sand* (1921), in which he played the matador, Juan Gallardo. Skinner was active in the theatre until his death on Jan. 4, 1942. He was the author of *Footlights and Spotlights* (1924) and *Mad Folk of the Theatre* (1928).

Skinner's daughter, CORNELIA OTIS SKINNER (1901–), actress and monologist, was also the author of many sketches, a play, *Captain* Fury, verse and light essays. (S. W. H.)

SKINNER'S CASE, the name usually given to the celebrated dispute between the house of lords and the house of commons over the question of the original jurisdiction of the former house in civil suits.

In 1668 a London merchant named Thomas Skinner presented a petition to Charles II asserting that he could not obtain any redress against the East India company. which, he asserted, had injured his property. The case was referred to the house of lords, and Skinner obtained a verdict for £5,000. The company complained to the house of commons which declared that the proceedings in the other house were illegal. The lords defended their action, and after two conferences between the houses had produced no result the commons ordered Skinner to be put in prison on a charge of breach of privilege; to this the lords replied by fining and imprisoning Sir Samuel Barnardiston, the chairman of the company. Then for about a year the dispute slumbered, but it was renewed in 1669, when Charles II advised the two houses to stop all proceedings and to erase all mention of the case from their records. This was done and since this time the house of lords has tacitly abandoned all claim to original jurisdiction in civil suits.

SKINS: *see* HIDE.

SKIPPON, PHILIP (d. 1660), English soldier, was born at West Lexham, Norfolk. At an early age he adopted the military profession and in 1622 was serving with Sir Horace Vere in the Palatinate. He took part in most of the battles and sieges of the time in the Low Countries. At the sieges of Breda in 162j and 1637 he mas wounded, and under his old commander, Lord Vere, he was present when Bois-le-Duc ('s Hertogenbosch) and Maestricht were attacked in 1629.

A veteran of considerable experience, Skippon returned to England in 1639, and was appointed to a command in the (Honourable) Artillery company. In Jan. 1642 Skippon was made commander of the City troops. He was not present at Edgehill, but he cheered his raw militiamen at Turnham green, in the face of the king's victorious army. The earl of Essex. the lord general of the parliament forces, made Skippon his major general, a post which carried with it the command of the foot and the duty of arranging the line of battle. In Sept. 1644 Essex' desertion at Lostwithiel left Skippon in command; compelled to surrender without firing a shot, he bore himself with calmness and fortitude in this adversity *(see* CIVIL WAR, ENGLISH). Soon after the second battle of Newbury (Oct. 27) he became major general of the New Model army. In this capacity he supported Sir Thomas Fairfax. its commander in chief, as loyally as he had supported Essex, and at Naseby refused to quit the field although dangerously wounded.

He took part in the negotiations bet een parliament and the army in 1647 and was named one of Charles I's judges, though he took no part in the king's trial. Under the Commonwealth he held office, military and civil, but ceased to influence events. He was a member of Oliver Cromwell's house of lords, and was universally respected and beloved. He died in March 1660. Skippon was a deeply religious man, and wrote several books of devotion for the use of soldiers. (R. B. WM.)

SKIPTON, a market town and urban district in the Skipton parliamentary division of the West Riding of Yorkshire, Eng., on the Leeds and Liverpool canal, 43 mi. E. of York by road. Pop. (1961) 12,988.

Lying in the hilly district of the upper valley of the Aire where it is joined by the Eller Beck from the north, it is the nodal town of the Craven gaps, the lowest ways through the Pennines between Trent and Tyne, and so has become an important route centre and the principal market town of Craven. Weekly sales of cattle and sheep take place.

During the middle ages the Craven gaps were the chief routes through the Pennines along rvhich the Angles, and later the Danes, moved westward. and Skipton was the capital of Craven. At the Norman conquest, it became part of the possessions of Earl Edwin and mas granted to Robert de Romille, who built the castle in the 11th century. It was taken by the parliamentary forces in 1645 after a three-year siege, partly demolished in 1648. restored by Lady Anne Clifford in 1657–58 and now consists chiefly of the gateway with its two round towers and an original Norman arch to the inner court. In the grounds are the remains of the castle chapel. The parish church of the Holy Trinity, mainly Perpendicular, was also partly destroyed during the Great Rebellion but has been restored. The grammar school was founded in 1548.

There are rayon and silk factories in the town and a large limestone quarry nearby.

SKOBELEV, MIKHAIL DIMITRIEVICH (1843–1882), Russian general, was born near Moscow on Sept. 29, 1843. After graduating as a staff officer at St. Petersburg he was sent to Turkestan in 1868 and, with the exception of an interval of two years, during which he was on the staff of the grand duke Michael in the Caucasus, remained in central Asia until 1877. He commanded the advanced guard of General Lomakine's column from Kinderly Bay, in the Caspian, to join General Verefkin, from Orenburg, in the expedition to Khiva in 1874. and, after great suffering on the desert march, took a prominent part in the capture of the Khivan capital. Dressed as a Turkoman, he intrepidly explored in a hostile country the route from Khiva to Igdy, and also the old bed of the Oxus. In 1875 he was given a command in the expedition against Khokand under General Kaufmann. For his great services he was promoted to be major general and appointed the first governor of Fergana. In the Turkish War of 1877 he seized the bridge over the Sereth at Barborchi in April, and in June crossed the Danube with the 8th corps. He commanded the Caucasian Cossack brigade in the attack of the Green Hills at the second battle of Plevna. He captured Lovtcha on Sept. 3, and distinguished himself again in the desperate fighting on the Green Hills in the third battle of Plevna. In command of the 16th division, he took part in the investment of Plevna and also in the fight of Dec. 9. when Osman Pasha surrendered, with his army. In January 1878 he crossed the Balkans in a severe snowstorm. defeating the Turks at Senova, near Schipka, and capturing 36,000 men and 90 guns. Dressed in white uniform and mounted on a white horse, and always in the thickest of the fray, he was known and adored by his soldiers as the "White Genera!." He returned to Turkestan after the war. and in 1880 and 1881 further distinguished himself in retrieving the disasters inflicted by the Tekke Turkomans, captured Geok-Tepe, and, after much slaughter, reduced the Akhal-Tekke countn to submission. He was advancing on Askabad and Kalat i-Nadiri when he was disavowed and recalled. He was given the command at Minsk. in the last years of his short life he engaged actively in politics, and made speeches in Paris and in Moscow in the beginning of 1882 in favour of a militant Panslavism. predicting a desperate strife between Teuton and Slav. He was at once recalled to St. Petersburg. He was staying at a Moscow hotel, on his way from Minsk to his estate close by, when he died suddenly of heart disease on July 7, 1882.

SKOKIE, a residential and light industrial village of Cook county, in northeastern Illinois, U.S., is on the northern edge of Chicago and west of Evanston. Called Niles Center until 1940, Skokie was first settled in 1834 and attracted a colony of settlers from Luxembourg. By the time of its incorporation in 1888 the trading centre was known primarily for its greenhouse industry, started during the previous decade.

In the late 1920s a development boom occurred in the community following the extension of service by the Chicago and North Western and the Chicago, North Shore and Milwaukee railroads. The depression of the 1930s halted the growth of the village but World War II began a great influx of industry. The community nevertheless retained much of its earlier residential character, and residential and commercial building (including extensive shopping facilities) increased sharply in the postwar years. in the decade 1950–60 the population increased from 14,832 to 59,364. (For comparative population figures see table in ILLINOIS: *Population.*)

The village adopted a council-manager form of government in 1957. (AR. C. H.)

SKOPAS: see SCOPAS.

SKOPLJE (SKOPJE), the capital of Macedonia, Yugos. (Turkish *Üsküb*). It lies on a fertile plain, with the Vardar running through it, and is completely encircled by a Turkish cemetery. Pop. (1961) 161,993, comprising Serbs, Albanians, Turks, Bulgars and a few gypsies. The agricultural production of the district includes maize, oats and barley, and silkworm culture is extensively carried on. There is an important opium market and Skoplje is the distributing centre for a very large area. At the outbreak of World War I it possessed a steam flour mill, a brewery, distilleries, tanneries, braid, soap, horseshoe and sugar factories, and was the centre of the silver filigree industry. Antimony, saltpetre and veins of pure magnesite are found in the district.

The principal buildings are the citadel, the palace of the former Turkish governor, a Roman aqueduct. many churches and mosques. The second urban Serbian school in Macedonia was opened there in 1830. and the first Macedonian newspaper published there in 1908. Skoplje is strategically the most important point in Macedonia, and perhaps in the Balkans. several main arteries of communication, and four railways, converging upon it. Its fall in 1941 decided the German victory in the Balkans. The town came under Bulgarian occupation.

The name is derived from *Scupi*, an ancient town whose ruins lie near by, and which was destroyed by an earthquake in 518, and rebuilt by Justinian. In the 13th century Skoplje was taken by King Milutin of Serbia and made his capital, and his successor, Stephen Dushan was crowned there in 1346, and composed his famous code.

SKOULOUDIS, STEPHEN (1836–1928), Greek statesman, a Chiot, was born an Ottoman subject, in Constantinople in 1836. He founded the Banque de Constantinople. and after retiring from business lived in Athens and became a Hellenic subject. He was several times elected member of the Greek chamber (1879 and 1892–1906). He was appointed minister in Spain in 1883, and minister of marine in the Trikoupis cabinet of 1892. As minister for foreign affairs in the Ralli cabinet of 1897, his knowledge of the Turks enabled him to exert his influence on the terms of peace after the war of 1897. He then resigned office. and retired into private life until 1912, when Venizelos obtained his appointment on the delegation to meet the Turks in London. In Nov. 1915 he became prime minister, in succession to Zaïmis. Soon after his appointment he announced his policy of benevolent neutrality. The confidence of the Allies was, however. shaken by his reported intention, at the instigation of German ministers. to disarm Serbian troops who were being forced into Greek territory by the German and Bulgarian advance, and the commercial blockade of Greece by the Allies (Nov. 18) mas followed by an ultimatum which Skouloudis accepted. After six months' continued effort to satisfy both sides in the world conflict. Skouloudis resigned on June 19, 1916, shortly after the evacuation of Fort Rupel by the Greek garrison. A charge of treasonable correspondence was afterward brought against him, but was not proved. He died on Aug. 20. 1925.

SKRAM, PEDER (c. 1500–1581), Danish senator and naval hero, born between 1491 and 1503, at his father's estate at Urup near Horsens in Jutland. He first saw service in the Swedish war of Christian II at the battle of Brannkyrka, 1518, and at the battle of Uppsala two years later he saved the life of the Danish standard-bearer. For his services he was rewarded with an estate in Norway. During "Grevens Fejde," or "the Count's War," Skram was sent by the Danish government to assist Gustavus Vasa, then in alliance with Christian III against the partisans of Christian II, to organize the untried Swedish fleet; and Skram seems, for the point is still obscure, to have shared the chief command with the Swedish Admiral Måns Some. Skram greatly hampered the movements of the Hanseatic fleets who fnught on the side of Christian II, captured a whole Lubeck squadron off Svendborg, and prevented the revictualling of Copenhagen by Lubeck. But the incurable suspicion of Gustavus I minimized the successes of the allied fleets throughout 1535. Skram's services were richly rewarded by Christian III. As a senator he contributed to the victory of the Danish party over the German in the councils of Christian III. In 1555, feeling too infirm to go to sea, he resigned his post of admiral; but when the Scandinavian Seven Tears' War broke out seven years later, the new king, Frederick II, offered Skram the chief command. He put to sea in August 1562, and compelled the Swedish admiral, after a successful engagement off the coast of Gotland, to take refuge behind the Skerries. He was superseded at the end of the year by Herluf Trolle. Skram was twice (1565–1568) unsuccessfully besieged by the Swedes in his castle of Laholm, which he and his wife defended with great intrepidity. Skram died at Urup on July 11, 1581.

Skram's audacity won for him the nickname of "Denmark's dare-devil," and he contributed perhaps more than any other Dane of his day to destroy the Hanseatic dominion of the Baltic. His humanity was equally remarkable; he often imperilled his life by preventing his crews from plundering.

See Axel Larsen, *Dansk-Norske Heltehistorier* (Copenhagen, 1893).

SKRZYNECKI, JAN ZYGMUNT (1787–1860), Polish general, organised the Polish army at the revolution of 1830. After his defeat by Diebitsch at Ostrolenka he had to resign his command. He took refuge at Cracow, where he died.

SKRZYNSKI, ALEXANDER, COUNT (1882–1931), Polish statesman, was born at Zagorzany, Galicia. Educated at Cracow and Munich, he entered the diplomatic service in 1906 and was appointed secretary to the ambassador to the Holy See in 1910. When the World War broke out he was secretary to the Austro-Hungarian Ambassador in Paris. After a short military service at the beginning of the War, he completed his studies for the Bar, receiving the degree of Doctor of the Law at the University of Vienna. When the new Polish State was established, he was appointed Polish Minister Plenipotentiary at Bucharest, and later succeeded in concluding a Polish-Rumanian political treaty in 1921. In Dec. 1922, after the murder of Narutowicz, the first international President of the Republic, Skrzynski became Minister of Foreign Affairs. He threw himself energetically into the task of settling all open questions, inaugurated a pacific policy based on the final stabilisation of frontiers and gained the necessary confidence of the Powers. When a Cabinet of the Right was formed in May 1923, Skrzynski thereby lost office, and he was appointed in the following month Polish delegate to the League of Nations. In Aug. 1924 he again became Minister of Foreign Affairs in the Grabski Cabinet.

By a number of conventions, the regulation of the British and American debts, the concordat with the Vatican, the rapprochement with Czechoslovakia, Skrzynski strengthened Poland's international position, taking an active part in the League of Nations in elaborating the scheme for the Geneva Protocol and in securing settlement of the Danzig disputes in a manner favourable to Poland. He tried to disarm the suspicions of Moscow as to the new configuration of Europe by receiving Chicherin at Warsaw (Sept. 1924). In the negotiations in connection with the German proposals with regard to the Locarno Pact (1925), Skrzynski sought to reconcile Polish interests with the general scheme of the conference, and signed an arbitration agreement with Germany and also a convention with France in accordance therewith. After the fall of Grabski's Government Nov. 13, 1925, Skrzynski was entrusted with the formation of a government by Wojciechowski, the President of the Republic, and with the participation of the Socialists formed a coalition cabinet in which he himself was Prime Minister and Minister of Foreign Affairs, In May 1926, however, the Socialists seceded from the Cabinet on account of the refusal of their financial proposals, which involved inflation. After the Pilsudski *coup d'état* of that month Skrzynski remained in retirement. See also POLAND.

SKUA, sea-birds forming the genus *Stercorarius* of the *Laridae* (see GULL). Except during the breeding season, when they obtain their own food, the skuas live almost exclusively by preying upon gulls, which they compel to disgorge what they have caught. For this purpose they are swift of flight, powerfully armed and endowed with great courage. The largest species, equalling a herring gull (Larus argentatus) in size, is *S.* skua, the great skua or bonxie. The plumage is dark brown above, lighter beneath, with a patch of white at the base of the primaries. It breeds in the Faeroes. Shetlands, and Iceland, laying its two dark olive eggs in a nest in the heather. Out of the breeding season it occurs all over the north Atlantic. *S.* antarcticus, the Port Egmont hen, from the Pacific, closely resembles it. Maccormick's skua (S. maccormicki) breeds on the Antarctic continent, where it plunders the penguin colonies.

The Arctic or Richardson's skua (S. crepidatus) is interesting as showing great variety in the colour of the underside from dark to white, with a thin dark collar. In the Arctic, skuas nest only in years when food is plentiful. The skuas have a remarkable injury-feigning performance to lure intruders from the nest. If this does not succeed, they swoop at the intruder's head. Some species may strike severe blows. American ornithologists assign three of the skuas, which they call jaegers, to the genus *Stercorarius:* the pomarine jaeger (S. *pomarinus*), the parasitic jaeger (*S. parasiticus*), and the long-tailed jaeger (*S. longicaudus*).

SKULL. The skull is the skeleton of the head. It comprises the brain case and the facial skeleton, which includes the upper and lower jaws. The function of the skull, apart from providing for the suspension of the jaws, is to protect the delicate brain (*q.v.*) and the organs of special sense, the nose, the eye and the ear. The skull is poised on the first or atlas vertebra through a joint which permits nodding movements of the head. Rotation of the head is carried out by movement of the atlas around the axis of the so-called odontoid peg of the second or axis vertebra. The following account of the human skull considers its structure, the infant skull, evolution of the skull and the skull in anthropology.

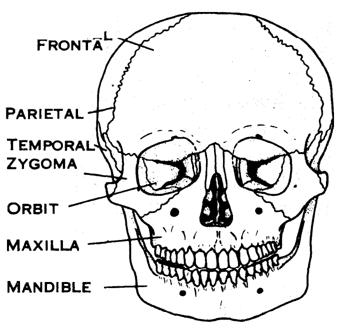


FIG. 1.—ADULT HUMAN SKULL FROM THE FRONT

Structure. — The adult human skull (seen from the front in fig. 1) has a dome-shaped brain case, the walls of which are composed of a number of flat bones —the frontal over the forehead and the parietals and temporals at the sides. The bones of the cranial vault are joined to each other at the sutures, which are actually fibrous joints and are shown in the figure as irregular lines between the bones. They serve in the young skull to join the bones together rigidly yet allow a slight degree of movement between them. This arrangement also confers some elasticity on the skull, enabling it to withstand blows of considerable force. The sutures become progressively and slowly obliterated by the formation of a bony union between the individual bones, this process beginning in the young adult skull and being advanced by the time of middle age.

The human forehead is smooth and almost vertical and there is not a well-developed brow ridge such as occurs in many great apes. The orbits or eye sockets, roughly quadrilateral in shape, face forward and slightly outward; this position of the eyes in man is of great importance since it permits an overlap of the visual fields that makes true stereoscopic or binocular vision possible. This overlap of the visual fields is also favoured by the great reduction of the snout and nose area in the human skull. In the horse the eyes are placed far over on the sides of the head. The orbits of the human skull are bounded at the outer edge by the zygomatic bone. The orbital cavities are conical in shape and taper as they are traced deep into the skull. At the apex of the orbit are several holes through which the nerves to the eye and to the eye muscles gain entrance to the orbit. The bones forming the interior walls of the orbit are thin and delicate; those of the roof and floor are more solid.

In the centre of the face may be seen the external orifice of the nasal cavities. The bridge of the nose is made by the flat nasal bones and the rest of the nasal orifice is bounded by the maxillary bones, one on either side. The external projection of the nose on the face of a living person is due almost entirely to cartilaginous structures that are not properly a part of the skull. The greater part of the nasal cavities lies deeply buried within the skull; some of the bony structures within it may be seen in fig. 1. On the outer wall of each nasal cavity are two scrolls of bone, the turbinate bones, not shown in the figure. In life the scrolls are covered by a thick mucous membrane which is believed to assist in warming the incoming air before it passes into the lungs.

In the mid line between the nasal cavities is the bony nasal septum or partition. The maxillary bones, one on either side, make up the main mass of the upper jaws and carry 16 teeth in the adult. Internally the maxillary bones are hollowed out to form the maxillary sinuses, which are lined with mucous membrane continuous with that of the nose. The mandible is the skeleton of the lower jaw; like the maxilla it bears 16 teeth. There are 2 incisors, 1 cuspid, 2 premolars (or bicuspids) and 3 molars on each side in each jaw, making a total of 32. The holes in the frontal, maxillary and mandible bones provide for the exit of branches of the trigeminal nerve passing to the skin of the face.

When the skull is seen from the side *(see* fig. 2), bones making up the vault of the skull include the frontal, the parietal, the sphenoid, the temporal and the occipital. At the outer margin of the orbit the zygomatic bone (Gr. *zygon,* "yoke") sends backward a prolongation which meets a similar process of the temporal bone to form the zygomatic arch. The space between the zygomatic arch and the side of the brain case allows the powerful temporalis muscle to gain attachment to the mandible; its function is to close the mouth. Note the position of the external auditory canal or ear hole. Its walls are made up chiefly by a tubular bone, the tympanic. A spicule (splinter) of bone projecting down from the base of the skull from a point just behind the tympanic bone is the styloid process (Gr. *stylos,* "pillar"). A fibrous band or ligament is found in the living person attached above to the tip of the styloid process and below to the hyoid bone. The ligament is indicated by dotted lines in fig. 2. The hyoid bone is further discussed below, in the section *Evolution of the Skull.* Behind the external auditory canal is a bulging area of bone called the mastoid process. It is a typical feature of the human skull and

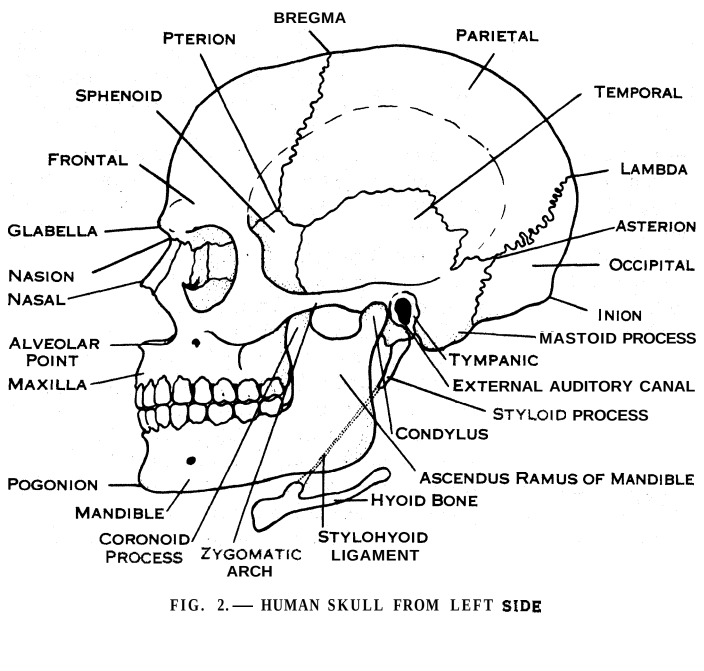


FIG. 2.— HUMAN SKULL FROM LEFT SIDE

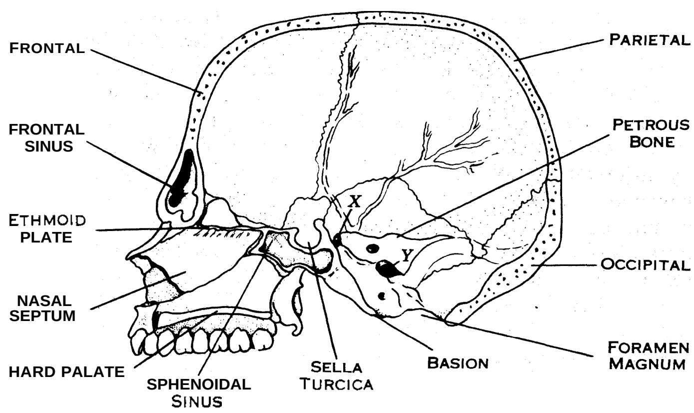


FIG. 3.— HUMAN SKULL IN SECTION FROM INNER SIDE

contains many small cavities or air cells continuous with the cavity of the middle ear. These cells are readily infected and may give rise to serious trouble.

The shape of the mandible can be recognized more clearly from the side. It consists of a horizontal body which carries the teeth on its upper surface and an ascending ramus (Lat. *ramus,* "oar"). At the upper margin of the ramus are two prominences, one in front called the coronoid process (Lat. *corona,* "crown") and one farther back called the condylus (Lat. *condylus,* "knuckle" or "joint"). The condylus is rounded and coated with cartilage in life. It fits into a depression in the undersurface of the temporal bone to form with it a movable joint, the temporomandibular joint, which permits opening and closing of the mouth and also side to side movement as in chewing.

Certain terms of anthropological interest are included in fig. 2. Of special note are the pterion (Gr. *pteron,* "wing") at the junction of the frontal, the parietal and the sphenoid bones. The conformation of the sutures at this point is very distinctive in the human skull and is of interest when comparing the human skull with that of a closely related species such as the anthropoid apes. From the surgeon's standpoint the pterion is of importance as a landmark since it more or less overlies the large middle meningeal artery on the inside of the skull. This artery is frequently torn as a result of a severe blow on the side of the head, giving rise to a characteristic train of symptoms possibly ending in death if the resulting hemorrhage is not arrested.

A section through the middle of the skull shown in fig. 3 serves to illustrate some important features of the interior of the skull. The relative thinness of the bones of the vault of the skull overlying the brain is evident. In a young person the bones in this area consist of three layers, an inner and outer table of compact bone with a middle layer of bone marrow. The latter layer is called the "diploe" (Gr. *diploos,* "double") and disappears with advancing age. When a blow is administered to the skull the inner table is apt to be more severely damaged than the outer table and sharp spicules (slivers) of bone may be driven into the brain. Moreover, since the dome of the skull is somewhat elastic, at least in the young person, by virtue of its sutural pattern, the force of the blo may be transmitted around to the base of the skull producing a fracture there.

The brain has an additional protection in the dura mater (Lat., "hard mother") which is a tough fibrous envelope within the skull itself. Associated with the dura mater are numerous large veins of exceptionally wide calibre. These dural veins are known as the cranial venous sinuses and are not to be confused with the air sinuses within such bones as the maxilla. The inner surface of the skull also bears a sutural pattern and sinuous grooves mark the course and branching of the middle meningeal artery.

The base of the skull is made up from front to back by the frontal, ethmoid, sphenoid and basioccipital bones. The base supports the superincumbent weight of the brain which is further protected by the development of fluid-filled spaces or "cisterns" between it and the base of the skull; it is thus supported, as it uere, on a fluid cushion. There are large air sinuses within the frontal bone above the nasal cavity and a similar excavation, the sphenoidal air sinus, exists within the body of the sphenoid. All these are continuous with the cavity of the nose. Behind the frontal bone is the ethmoid bone (Gr. ethmos, "a sieve"). In the floor of the skull the ethmoid forms a perforated plate through which pass the nerves to the nose. It also has an upward projection, the crista galli (Lat. "coxcomb"), and a downward projection which forms the upper part of the bony septum of the nose. The upper surface of the sphenoid bone is hollowed out to form the sella turcica or "Turkish saddle" in which the pituitary gland lies. This important gland, on which the proper functioning of all the other endocrine glands depends (see ENDOCRINOLOGY), is thus situated in a most inaccessible and invulnerable place in the skull. For this reason, its surgical approach presents many difficulties.

A massive wedge of bone in the floor of the skull, called the petrous bone (Gr. *petra*, "rock"), is the hardest bone in the body. It houses the organ of hearing. On the inner side of the petrous bone is a hole for the passage of the auditory nerve to the ear. There is a large circular hole in the floor of the skull called the foramen magnum (Lat., "big hole") through which the medulla oblongata of the brain and the spinal cord are continuous with each other. The great internal carotid artery gains access to the skull at the point indicated by X (fig. 3) and the great internal jugular vein leaves the skull at the point indicated by Y.

It has been noted that the ethmoid bone takes part in the formation of the nasal septum. The rest of the septum consists of the vomer (Lat., "a plowshare") and the maxillary bones. The hard palate in the roof of the mouth is made up of the maxillary bones and the palatine bones.

The Infant Skull. — The skull of a newborn baby is illustrated from the left side in fig. 4. The skull at this stage shows clearly the multiple bones in the brain case. These bones are uidely separated by sutures which thus confer great flexibility on the skull and permit overriding of the bones upon each other during the process of birth. The size of the facial skeleton is very small relative to the brain case. The maxillary bones are very small, a fact due to the absence of teeth except in rudimentary form and to the absence of the maxillary air sinuses. The mandible is distinctly different in shape from that found in the adult in that there is almost no angle between the body and the ramus. There is no mastoid process and the external auditory canal is absent. The canal develops after birth by bony extensions from the tympanic ring.

In certain areas the sutures between the bones of the brain case are very wide. At such points the baby's skull presents localized areas of relative softness and weakness. These are called the fontanels, the most important of which is at the bregma (where the frontal and parietal bones adjoin at the top of the skull). Others are found at the lambda (where the parietal and occipital bones adjoin at the rear of the skull) and at the pterion and asterion (where the temporal, parietal and occipital bones adjoin on the side of the skull).

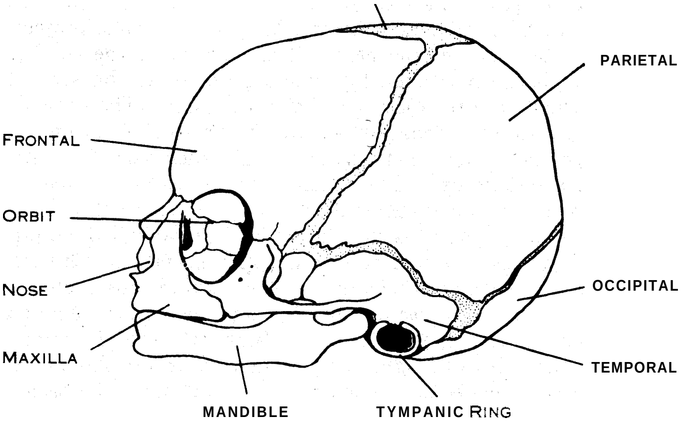
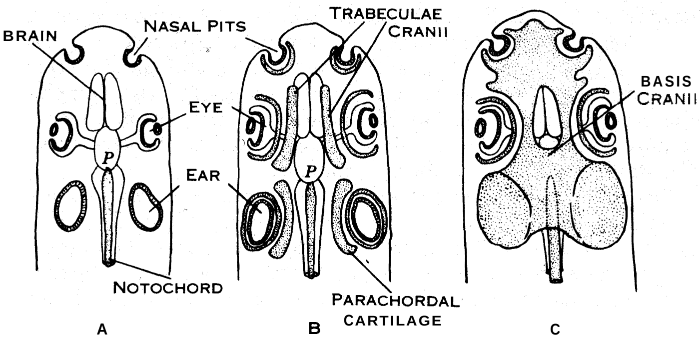


FIG. 4. — SKULL OF NEWBORN INFANT FROM LEFT SIDE



AFTER "HISTORY OF THE HUMAN BODY" BY H. H. WILDER; HENRY HOLT & CO., N.Y., 1909

FIG. 5. — DIAGRAMS SHOWING THREE STAGES IN THE EVOLUTION OF A SKULL: (A) HEAD OF A HYPOTHETICAL PREVERTEBRATE ANIMAL: (B) LATER STAGE OF ANIMAL WITH VERTEBRAL COLUMN; AND (C) VERTEBRATE WITH PRIMITIVE SKULL

Evolution of the Skull. — In order to facilitate an understanding of the way in which the mammalian skull is built up, a brief survey of the evolution of the skull will be presented. The head of a hypothetical animal which may have preceded the vertebrates is illustrated in fig. 5(A). The head already possesses a well-developed brain and also special sense organs, namely, two nasal pits, two eyes and two ears, the latter being concerned only with balance. Instead of a bony vertebral column there is a semirigid rod called the notochord which traverses the full length of the animal below the spinal cord and ends in front just behind the pituitary gland (P in fig. 5[A]). At a later stage in the evolution of the skull (fig. 5[B]) certain additions are made to the head. Cartilaginous envelopes are formed around the special sense organs, investing these partially in the case of the nasal pits and the eyes and completely in the case of the ears; these coverings are known as the special sense capsules.

In addition, the need for added rigidity is met by the development of two rods of cartilage on either side, the trabeculae carnii in front and the parachordal cartilages at the back of the head. At a still later stage (fig. 5[C]) a general consolidation of the cartilaginous elements of the primitive skull takes place by the fusion of the trabeculae cranii and the parachordal cartilages into a single cartilaginous skull base (basis cranii) and the fusion of this in turn nith each of the special sense capsules. Further extensions of the cartilaginous skull also take place above the brain. This sequence of events in the evolution of the skull can be deduced with a fair degree of confidence since it is essentially what takes place in the development of the human embryo and indeed in the embryos of all vertebrates.

Speculation about the skull becomes fact with the conditions present in the skulls of a large group of modern fish having cartilaginous skeletons, the Elasmobranchii. These primitive fish, which include the sharks and rays. have skulls essentially similar to that depicted in fig. 5(C). The next stage in the evolution of the skull is the appearance of added protection for the head in the form of bony plates or scutes (Lat. *scutum*, "shield"). The living primitive fish the Ganoidei have this armour plating over the head and some of the body. These fish include the sturgeon, the garpike and the bowfin. The bony plates of the skull are actually developed from the connective tissues of the skin and are called dermal bones. There are many of these bony plates in the skull region, and their names, which include the frontals. parietals, temporals and many others, have become familiar through study of the human skull.

The dermal skull bones become extremely numerous in the bony fish known as Teleostei, which include most of the ordinary fish. A striking feature of the dermal bones in all vertebrates above the fish is their development not on the surface of the head but deep in the connective tissues under the skin. This is the uay they develop in the human embryo.

Meanwhile important changes have occurred in the cartilaginous skull lying inside the outer skull of dermal bones. Centres of bone formation appear within the basis cranii and the special sense capsules and convert them into solid bone. This change is foreshadowed in the Elasmobranchii and is well advanced in the Teleostei. At the same time there are varying degrees of fusion between the dermal bones and between these and the underlying basis cranii and special sense capsules. In essence this completes the story of the evolution of the skull. There is, however, an infinite variety in the detailed arrangements of the elements of the skull in different groups of animals.

There remains to be considered the so-called visceral skeleton. This includes the jaws and the hyoid apparatus (see fig. 2). In the fish the gills are supported by cartilaginous bars, the branchial or visceral arches. The upper jaw consists of a plate of cartilage, the palatoquadrate bar; the lower jaw consists of Meckel's cartilage. The jaw joint is formed between the quadrate and the articular cartilages, which are merely the hind ends respectively of the palatoquadrate and of Meckel's cartilages.

In the Ganoidei and Teleostei new dermal bones are laid down around the cartilages of the jaws; the articular and quadrate cartilages continue to form the jaw joint. In higher vertebrates there are profound modifications in the visceral skeleton of the skull. A new joint is developed between the dermal lower jaw and the temporal bone. The quadrate and articular cartilages are thus no longer necessary. They do not disappear, however, but are apparently transformed into the small bones of the ear, the quadrate becoming the incus or anvil bone and the articular becoming the malleus or hammer bone.

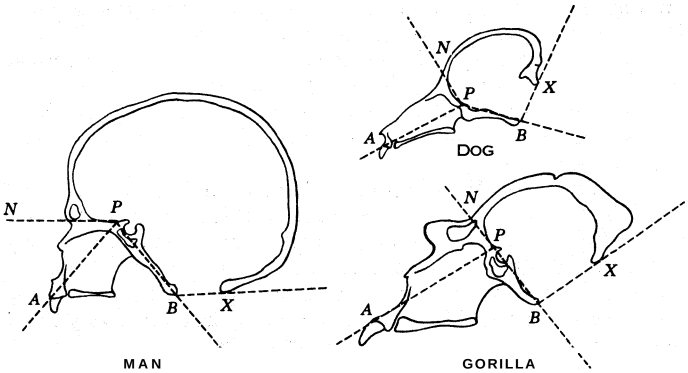
The remaining gill arches of the fish also become greatly modified with the disappearance of the gills and the development of lungs. The second and third gill arches become transformed into the hyoid bone together with the styloid process and the stylohyoid ligament (see fig. 2). The stapes or stirrup-bone of the ear appears to be developed from the second arch. The remaining arches become modified in man as the cartilaginous framework of the larynx or voice box.

The human skull, then, may be regarded as consisting essentially of an inner skull, very ancient from the evolutionary point of view, which includes the base of the skull and the special sense capsules; and an outer, more recent skull, made up of the so-called dermal bones. The dermal bones are typically found in the dome of the skull, the face and the mandible. In the first situation they have proved extremely plastic in adapting themselves to the enormous development of the brain that characterizes man.

The **Skull** in Anthropology. — The skull occupies a key position in the study of fossil remains for a number of reasons. Whereas the bones of the limbs give important information about the mode of progression and the posture of the individual when alive, the skull gives unique information about the intellectual development of the individual. Moreover, the conformation of the teeth and jaws gives some insight into dietary habits. Certain parts of the skull, due to their compact and durable nature, notably the mandible and the teeth, are apt to be preserved over the centuries. The student of fossilized remains who wishes to establish their possible affinities with man must keep clearly in mind exactly what criteria make a skull typically human. Doing so necessitates a thorough knowledge of the many natural variations of the skull in different groups and races of mankind. Some of the distinctly human features are reviewed below.

The capacity of the brain case is relatively and absolutely large in the human skull in all known races. When the capacity is less than 1,350 c.c. the skull is called microcephalic; a skull with a capacity of 1,350–1,450 c.c. is designated as mesocephalic; a capacity of over 1,450 c.c. is characteristic of a macrocephalic skull. Another characteristic feature of the human skull is the smooth, almost vertical forehead, lacking the pronounced brow ridges found in many apes and certain extinct forms of man. There is a marked concavity above the cuspid (or canine) tooth in, the upper jaw, the canine fossa, which is absent or is replaced by a convexity in apes and in extinct man. The mandible is characterized by a definite angle between the ramus and the body. The condylus of the jaw joint is also typical. The bony prominence of the chin is also a distinctive human trait, as is the absence of a shelf of bone at the back of the chin known as the simian shelf, found in all apes but generally absent in the mandible of early man. The mastoid and tympanic region and certain sutural areas, such as the pterion, also serve to distinguish the human from the anthropoid skull.

Of particular significance in this respect is the poise of the skull on the end of the vertebral column. To illustrate this a series of sections of the skull of a man, of a gorilla and of a dog are shown in fig. 6. Certain planes of reference are indicated in dotted lines. Thus the plane of the foramen magnum (BX) is horizontal in the human skull, slightly inclined to the horizontal in the gorilla and almost vertical in the dog. This indicates that in man, who is truly an erect animal, the skull is perfectly balanced on the top of the spine. In the gorilla this is not so and powerful muscles are developed at the back of the neck to counterpoise the huge weight of the face with its massive jaws. In the dog, which walks on all fours, the skull is held at right angles to the axis of the spine (BX). Other angles, indicated in fig. 6, may be of value in establishing that a skull is not anthropoidal. The sphenethmoidal angle (NPB) is drawn by projecting a line (PN) forward in the plane of the ethmoid plate from a point just behind this plate known as the prosphenion (P) and another line (PB) from the latter point passing through the axis of the base of the skull to



DRAWN FROM "MORPHOLOGY AND ANTHROPOLOGY" BY W. L. H. DUCKWORTH: CAMBRIDGE UNIVERSITY PRESS, 1915

FIG. 6.— FACIAL ANGLES IN THE SKULLS OF A MAN, DOG AND GORILLA

the front of the foramen magnum (B). The difference in this angle in the skulk of man, gorilla and dog is striking. In man the plane of the ethmoid plate has been rotated downward and forward. a change associated with the enormous development of the frontal lobes of the brain believed to be correlated with his unique intellectual powers. The sphenomaxillary angle (APB), determined by adding a line (PA) from the prosphenion to the alveolar point *(A)* just above the upper incisor teeth, indicates that there has been a striking reduction in the projection of the face or snout area in man together with some rotation of the maxillary area downward.

Certain cranial indices can be calculated from measurement of the diameters of the skull that can be carried out with some precision. The length of the skull is the distance from the glabella (the mid-point between the two brow ridges) and the most projecting point at the back of the head. The breadth of the skull is the distance between the most projecting points at the side of the head, usually a little above and behind the ear. The cephalic index is the breadth × 100 divided by the length. An index of less than 75, indicating a long. narrow skull when seen from the top, is characteristic of a dolichocephalic (Gr. dolicho, "long") skull and is found among native Australians and the Kaffirs. An index of between 75 and 80 is characteristic of the so-called mesaticephalic or oval skull found among Europeans and the Chinese. An index of over 80, indicating a broad, short skull, is observed in a brachycephalic (Gr. brachys, "short") skull which is common among Mongolians and the Andaman Islanders. Other cranial indices are the index of height and the gnathic or alveolar index. The former is calculated as the height of the skull from the basion (front of the foramen magnum) to the bregma (see fig. 2) × 100 divided by the breadth. The latter is reckoned as the basialveolar length (from basion to alveolar point, see fig. 6) × 100 divided by the basinasal length (from basion to nasion [root of the nose]) and gives a measure of the degree of prognathism or snout projection of the skull.

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SKULL, SURGERY OF. Fractures of the vault of the skull may occur without the bone being driven in to compress the brain, and in such cases their existence may be revealed only after death. But if there is also a severe scalp wound the line of fracture may be traced in the bare bone as a thin red crack. The patient with a suspected fracture of the skull is put to bed in a dark, quiet room, and is watched. It may be that the crack has extended across a bony groove in which an artery is running, and, the artery being torn, hemorrhage may take place within the skull and symptoms of compression of the brain may supervene.

Compression of the brain may be the direct and immediate result of a head injury. a piece of the vault of the skull being driven in, and a local or a general paralysis of muscles being at once observed. In addition to the muscular paralysis, there may be insensibility, laborious breathing, dilated pupils that do not react to light. In such cases the treatment is trephining.

Fractures of the base of the skull are always serious, in that they may run across important nerves and large blood vessels; passing through the roof of the nose, or the ear, they may communicate with air cavities. Thus. the dangers of sepsis are added to those of concussion or compression of the brain. Fractures of the base of the skull are often associated with bleeding from the nose, mouth or ear, or with extravasation of blood over the eyeball. Facial paralysis is the result of the line of fracture passing across the bony channel in which the seventh or facial nerve is running. When the fracture passes across the temporal bone and the middle ear and ruptures the membrane of the tympanum. not only blood may escape from the ear. but an apparently unlimited amount of cerebrospinal fluid. When the fracture extends through the anterior part of the base of the skull this same clear fluid may escape from the nose. In both cases its appearance implies that the dura mater has been lacerated and the subdural space opened.

Concussion of the brain (stunning) may result from a blow upon the head or from a fall from a height. The symptoms may be those of mere giddiness and a feeling of stupidity, which may quickly pass off, or they may be those of severe shock (*see* SHOCK). The person may die from the concussion, or he may slowly or quickly recover. As a rule, the pupils react to light. One of the first signs of returning consciousness is that the person vomits, and after this he gradually comes round. As a result of the injury, however, he may remain irritable, liable to headache or to lapses of memory. See also NERVOUS SYSTEM, SURGERY OF.

SKULLCAP (*Scutellaria*), the common name for a numerous genus of herbs and subshrubs of the mint family (Labiatae, *q.v.*), comprising about 200 species of nearly world-wide distribution. They have numerous blue, violet, yellow, scarlet or white flowers, borne in opposite pairs or in axillary or terminal, slender. one-sided spikelike racemes. The corolla has a long tube, dilated at the throat and surmounted with two unequal lips, the upper usually entire and the lower notched. The persistent calyx bears a conspicuous protuberance on the upper lip, giving it a helmetlike appearance, whence the common name.

Besides the common skullcap. which is found across the continent, about 2; other species occur in North America. Two species occur in the British Isles, the common or marsh skullcap (S. *galericulata*), with handsome violet-blue flowers, and the lesser skullcap (S. *minor*).

SKUNK, a North American carnivorous mammal, belonging to the family Mustelidae and noted for its evil smell arising from a secretion of the anal glands. This is under the control of the animal, which can propel the yellow liquid to a distance of 8 or 12 ft. The common skunk (Mephitis mephitis) inhabits North America from Hudson bay to Texas. About the size of a cat, though more heavily built. it has black fur, usually with two streaks of white on the back. The muzzle is long and pointed, the tail long and bushy. Insects form its staple diet, but it will also eat mice. eggs, frogs and carrion, and occasionally rob hen roosts. The skunk evinces little dread of man or other animals, and its normal gait is a walk. No animal attacks it knowingly, and its leisurely gait and conspicuous coloration well advertise its disagreeable properties. During very severe weather the animal hibernates. Four to seven young are brought forth each spring. Several other forms inhabit Central and South America.

THE COMMON SKUNK

The skunk lives in dens or burrows, and is chiefly nocturnal in its habits. Since colonial times it has been trapped and sometimes reared for its valuable fur.

SKUNK CABBAGE (*Symplocarpus* joetidus), a fleshy herbaceous plant of the arum family, Araceae, so called because of its fetid odour and large leaves, native to eastern North America and northeastern Asia. It grows in swampy places and in very early spring (March or sometimes February) it sends up from thick rootstocks grotesque, swollen, shell-like, purple-brown spathes, each enclosing many small flowers borne in a short thick cluster. These are soon followed by numerous ovate leaves: one to three feet long, and later by large globular masses of fleshy berries. The similar western skunk cabbage (*Lysichiton*) occurs in western North America.

SKY, the apparent covering of the atmosphere. the overarching heaven (M.E. skie, "cloud"; O.E. *skua,* "shade"; connected with an Indo-European root *sku,* "cover," whence "scum," Lat. *obscurus*, "dark." etc.).

The Colour **of the** Sky.—It is a matter of common observation that the blue of the sky is highly variable, even on days that are free from clouds. The colour usually deepens toward the zenith and also with the elevation of the observer. It is evident that the normal blue is more or less diluted with extraneous white light, having its origin in reflections from the grosser particles of foreign matter with which the air is usually charged. Closely associated with the colour is the polarization of the light from the sky. This takes place in a plane passing through the sun, and attains a maximum about 90° therefrom. Cnder favourable conditions more than half the light is polarized.

As to the origin of the normal blue, very discrepant views have been held. Some writers, even of good reputation. have held that the blue is the true body colour of the air, or of some ingredient in it such as ozone. It is a sufficient answer to remark that on this theory the blue would reach its maximum development in the colour of the setting sun. It should be evident that what we have first to explain is the fact that we receive any light from the sky at all. Were the atmosphere nonexistent or absolutely transparent, the sky would necessarily be black. There must be something capable of *reflecting* light in the wider sense of that term.

A theory that received much support in the past attributed the reflections to thin bubbles of water, similar to soap bubbles, in which form vapour was supposed to condense. According to it, sky blue would be the blue of the first order in Newton's scale of colours. The theory was developed by R. Clausius (*Pogg. Ann.* vols. 72, 76, 88), who regarded it as meeting the requirements of the case. It must be noticed, however, that the angle of maximum polarization would be about 76° instead of 90°.

Apart from the difficulty of seeing how the bubbles could arise, there is a formidable objection, mentioned by E. W. Briicke (Pogg. *Ann.* 88. 363), that the blue of the sky is a much richer colour than the blue of the first order. Briicke also brought forward an experiment of great importance, in which he showed that gum mastic, precipitated from an alcoholic solution poured into a large quantity of water, scatters light of a blue tint. He remarks that it is impossible to suppose that the particles of mastic are in the form of bubbles. Another point of great importance is well brought out in the experiments of John Tyndall (Phil. *Mag.* [4], 137, 388) upon clouds precipitated by the chemical action of light. Whenever the particles are sufficiently fine, the light emitted laterally is blue in colour and, in a direction perpendicular to the incident beam, is completely plane-polarized.

The dependence of the amount of scattering upon the wave-length of the light can be settled in the case of very small particles by an application of the method of dimensions. The particle acts as a centre for a radiating beam. The amplitude of the light sent out by it at a distance R varies inversely as R; it is also proportional to the volume of the particle when this is small compared with the wave-length of the light. Thus the ratio of the scattered to the incident *intensity* varies as $\frac{V^2}{R^2}$; that is a quantity whose dimensions are those of the fourth power of a length. The ratio of intensities must, however, be a pure number; and since the wave length X is the only other linear quantity that can be concerned, the ratio must also depend on the inverse fourth power of X.

Lord **Rayleigh's** Theory.—A more detailed investigation was conducted by the third Lord Rayleigh (Phil. Mag. XLI., 107, 275) based on an elastic-solid theory of light. This enquiry showed that both the intensity and the polarization could be satisfactoriiy accounted for on such a theory, if (and only if) the vibrations are perpendicular to the plane of polarization and the difference between the substance of the particles and that of the surrounding medium is one of density only.

Later (Phil. Mag. XII. 81–101, 1881) Rayleigh examined the question from the point of view of the electromagnetic theory in which the particles are treated as dielectric spheres. Maxwell's equations can be applied exactly in the case of vanishingly small spheres. The azimuth of the electric displacement travelling in any direction in the scattered wave is at right angles to that direction and is in the plane containing the scattered ray and the azimuth of the incident displacement; further the intensity is proportional to the square of the sine of the angle between these two lines. It follows that when this angle is zero the scattered light in the given direction is zero. This occurs in the direction at right angles to the incident ray. Thus, in this case, if unpolarized light is incident the light scattered at right angles is completely polarized.

According to either theory, sunlight in penetrating through the earth's atmosphere should fall off according to an exponential law for each colour.

In order to test the theory Rayleigh compared the blue light of the sky taken from near the zenith with sunlight diffused through white paper. For different wave-lengths the ratios calculated from the formula are given together with observed values for comparison:—

Fraunhofer line	C	D	b_3	F
Calculated	25	40	63	80
Observed	25	41	70	90

It appears that the sky light when compared with that diffused through white paper was bluer than that required by theory; but this may possibly arise from yellowness of the paper or from the yellowness of the sunlight when it reaches us compared with its colour at higher levels.

A much more important calculation has reference to the size and number of the particles concerned in the production of the blue of the sky. Since the light scattered by each particle is proportional to the square of its volume the total amount scattered per unit volume depends not only upon the quantity of matter therein but upon its fineness of division 'also. Assuming that the molecules of the air are the effective scatterers Rayleigh in 1899 calculated (taking Maxwell's value 19×10^{18} for the number of moletules per unit volume of a gas at standard pressure and temperature) that sunlight should diminish to $\frac{1}{e}$ of its value in passing through a distance of 83 kilometres in normal air. This value might agree roughly with the visibility of Mount Everest from Darjeeling but Rayleigh considered that it implied too high a visibility since there is certainly suspended matter to be reckoned with as well. Small particles of saline or other matter (including organic germs) must play a part and to them may be attributed much of the bluish haze by which the moderately distant landscape is often suffused.

American Investigations.—In recent years considerable attention has been paid to this question in America where advantage could be taken of the remarkable clearness and dryness of the air above Mount Wilson in California. F. E. Fowle in these investigations has obtained values of the transparency coefficients for zenith observations for 30 different wave-lengths between $0{\cdot}34\ \mu$ and $2{\cdot}24\ \mu$ (μ = one millionth of a metre). The logarithms of the observed coefficients were plotted as ordinates against the corresponding quantities of precipitable atmospheric moisture as abscissae. The curves which were very nearly straight were extrapolated to zero moisture so as to obtain the transparencies for perfectly dry air. From these values for dry air the number of molecules per c.c. was calculated by means of Rayleigh's formula. The value obtained was $2{\cdot}7\times10^{19}$, while the best value obtained by Millikan by other methods is $2{\cdot}705\times10^{19}$. The conclusion drawn from this result is that for the clear air above Mt. Wilson the scattering is almost entirely due to the molecules of air themselves. (Fowle, *Astroph.* J. 1914.)

Tyndall's Residual Blue.—The experiments of Tyndall upon precipitated clouds have been mentioned. When the precipitated particles are very fine, the light dispersed in a perpendicular direction is sky-blue and fully polarized. At a further stage of their growth the particles disperse in the perpendicular direction a light which is no longer fully polarized. When quenched as far as possible by rotation of a nicol prism, it exhibits a residue of a more intense blue colour; and further it is found that the direction of the most nearly complete polarization becomes inclined to the direction of the primary rays.

Electromagnetic Theory.—A discussion of these and other questions upon the basis of the electromagnetic theory of light is given in the Phil. Mag., 1881, 12, p. 81. Here we must be content with a statement of some of the results. So long as the particles are supposed to be very small and to differ little from their environment in optical properties, there is little differencebetween the electric and the elastic solid theories. Whatever may be the shape or size of the particles, there is no scattered light in a direction parallel to the primary electric displacements. In order to render an account of Tyndail's "residual blue" it is necessary to pursue the approximation further, taking for simplicity the case of spherical shape. We learn that the light dispersed in the direction of primary vibration is not only of higher order in the difference of optical quality, but is also of order k^2c^2 in comparison with that dispersed in other directions, where c is the radius of the sphere, and $k=2\pi/\lambda$. The incident light being white, the intensity of the component colours scattered in this direction varies as the inverse eighth power of the wave-length, so that the resultant light is a rich blue.

As regards the polarization of the dispersed light as dependent on the angle at which it is emitted, we find that although, when terms of the second order are included, the scattered light no longer vanishes in the same direction as before, the peculiarity is not lost but merely transferred to another direction. The angle θ through which the displacement occurs is measured backwards, *i.e.*, towards the incident ray, and its value is given by

$$\theta=\frac{\Delta K}{K}\,\frac{k^2c^2}{25}, \qquad (23)$$

AK being the difference of dielectric constants.

Experiments upon this subject are not difficult. In a darkened room a beam of sunlight (or electric light) is concentrated by a large lens of 2 or 3 ft. focus; and in the path of the light is placed a glass beaker containing a dilute solution of sodium thiosulphate (hyposulphite of soda). On the addition, well stirred, of a small quantity of dilute sulphuric acid, a precipitate of sulphur slowly forms, and during its growth manifests exceedingly well the phenomena under consideration. The more dilute the solutions, the slower is the progress of the precipitation. A strength such that there is a delay of 4 or 5 minutes before any effect is apparent will be found suitable, but no great nicety of adjustment is necessary.

Polarization. — In the optical examination we may, if we prefer it, polarize the primary light; but it is usually more convenient to analyze the scattered light. In the early stages of the precipitation the polarization is complete in a perpendicular direction, and incomplete in oblique directions. After an interval the polarization begins to be incomplete in the perpendicular direction, the light which reaches the eye when the nicol is set to minimum transmission being of a beautiful blue, much richer than anything that can be seen in the earlier stages. This is the moment to examine whether there is a more complete polarization in a direction somewhat oblique; and it is found that with θ positive there is, in fact, a direction of more complete polarization, while with θ negative the polarization is more imperfect than in the perpendicular direction itself.

The polarization in a distinctly oblique direction, however, is not perfect, a feature for which more than one reason may be put forward. In the first place, with a given size of particles, the direction of complete polarization indicated by (23) is a function of the colour of the light, the value of θ being 3 or 4 times as large for the violet as for the red end of the spectrum. The experiment is, in fact, much improved by passing the primary light through a coloured glass. Not only is the oblique direction of maximum polarization more definite and the polarization itself more complete, but the observation is easier than with white light in consequence of the uniformity in the colour of the light scattered in various directions. If we begin with a blue glass, we may observe the gradually increasing obliquity of the direction of maximum polarization; and then by exchanging the blue glass for a red one, we may revert to the original condition of things, and observe the transition from perpendicularity to obliquity over again. The change in the wave-length of the light has the same effect in this respect as a change in the size of the particles, and the comparison gives curious information as to the rate of growth.

But even with homogeneous light it would be unreasonable to expect an oblique direction of perfect polarization. So long as the particles are all very small in comparison with the wave-length, there is complete polarization in the perpendicular direction; but when the size is such that obliquity sets in, the degree of obliquity will vary with the size of the particles, and the polarization will be complete only on the very unlikely condition that the size is the same for them all. It must not be forgotten, too, that a very moderate increase of dimensions may carry the particles beyond the reach of our approximations.

The fact that at this stage the polarization is a maximum, when the angle through which the light is turned *exceeds* a right angle, is the more worthy of note, as the opposite result would probably have been expected. By Brewster's law this angle in the case of regular reflection from a plate is *less* than a right angle; so that not only is the law of polarization for a very small particle different from that applicable to a plate, but the first effect of an increase of size is to augment the difference.

Sunset **Colours.**—The simple theory of the scattering of light by small particles suffices to explain not only the blue of the zenith, but the comparative absence of small wave lengths from the direct solar rays and the brilliant orange and red coloration of the setting sun and of the clouds illuminated by its rays. The hyposulphite experiment here again affords an excellent illustration. But we must not expect a simple theory to cover all the facts. It is obvious that the aerial particles are illuminated not only by the direct solar rays but also by light dispersed from other parts of the atmosphere and from the earth's surface. On this and other accounts the coloration of the sky is highly variable. The transition from blue to orange or red at sunset is usually through green, but exceptional conditions may easily disturb the normal state of things. The brilliant sunset effects observed in Europe after the Krakatoa eruption may naturally be attributed to dust of unusual quality or quantity in the upper regions of the atmosphere.

To illustrate further the complications that arise when the particles are not infinitely small it may be mentioned that if the solution of hypo prepared as above be observed for a longer time it becomes more opaque as a result of the growth of the sulphur particles and afterward becomes more transparent again even though kept well stirred; and further that in this last stage it transmits blue more than red and consequently scatters red more than blue. This is a complete reversal of the blue-sky effect. (Keen and Porter, *Roy. Soc. Proc. A. 89*, 370, 1914.) A similar phenomenon had previously been observed by Capt. W. de W. Abney and by W. Ritz. Abney says in connection with certain suspensions of silver bromide in collodion: "In some cases I obtained it in such a state which, when viewed by transmitted light, appeared of a sky-blue colour inclining to green." (Abney, *Phil. Trans. Roy. Soc.*, pt. ii, p. 653, 1880; W. Ritz, *Comptes Rendus 143*, 167, 1906.) This phenomenon is well known to preparers of emulsions for photographic plates.

Related to abnormalities of colour we may expect to find corresponding abnormalities in polarization. Of this nature are the neutral points, where the polarization changes character, observed by F. J. D. Arago, J. Babinet and Sir D. Brewster for an account of which reference may be made to Mascart, *Traitk d'optique.* (R.; *A.W.* Po.)

SKYE, the largest island of the Inner Hebrides, Inverness-shire, Scot. From the mainland it is separated by the Sound of Sleat, Kyle Rhea, Loch Alsh and the Inner sound, and from the Outer Hebrides by the Minch and Little Minch. At Kyleakin, on the western end of Loch Alsh, the channel is only about $\frac{1}{4}$ mi. wide, and there is a ferry. The length of the island from southeast to northwest is $48\frac{1}{2}$ mi., but its coast is deeply indented, so that no part of the interior is more than 5 mi, from the sea. It has a total area of 670.3 sq.mi. The population was 23,082 in 1841, 9,908 in 1931 (or 10.3 to the sq.mi.) and 8,632 in 1951.

The chief arms of the sea are Lochs Snizort and Dunvegan in the north, Loch Bracadale in the west, Lochs Scavaig and Eishort in the south and Loch Sligachan in the east. The jagged mass of the Cuillin hills (Coolins) dominates the view whether by land or sea. Their highest point is Sgurr Alasdair (3,309 ft.) and at least six other peaks exceed 3,000 ft.

To the north of Loch Slapin stands the grbup of Red hills of which the highest points are Ben Caillich and Beinn Dearg Mor and near Loch Ainort rises Ben Glamaig. About 8 mi. N. of Portree is the curious basaltic group of the Storr, consisting of pinnacles and towers, the most remarkable of which, the Old Man, forms a landmark for sailors.

Most of the land is moor and hill pasture but during the first half of the 20th century there was a considerable development in agriculture. The crofting system was still general at mid-20th century and while more crops were grown, the climate appeared to be better adapted for sheep and cattle. In 1953 there were approximately 104,284 sheep and 11,000 cattle on the island. The farms and small holdings were stocked principally with Black-faced sheep although there were also Cheviot stocks. The condition of the crofters, which was pitiable in the extreme, was greatly improved by the Small Landholders (Scotland) acts 1886–1911, and in later years by the introduction of the government subsidies for cattle, potatoes and, until mid-20th century, sheep. The introduction of grants for various purposes enabled the black houses to be replaced principally by houses built of brick or concrete. With the opening in 1952 of the Storr Lochs hydroelectric power scheme, approximately 95% of the houses were supplied with electricity. The many ejections between 1840 and 1880 and the emigration that followed were mainly responsible for the serious decline of the population.

While the railheads at Kyle of Loch Alsh and Mallaig make the mainland markets accessible, road transport is extensively used. The fishing industry, which was at one time the mainstay of the population, declined during the first half of the 20th century. Whisky is distilled at Carbost. At Loch Cuithir, 4 mi. N. of Storr, work on the extensive diatomite deposits was restarted and in 1953 a factory, in which the raw material is processed, was opened at Uig. An afforestation scheme led to the reopening in 1953 of one of the 18 forestry schools closed as a result of the depopulation of the island.

The inhabited isles off the coast of Skye are mainly situated near the eastern shore. Of these the principal is Raasay, 13 mi. long by about $3\frac{1}{2}$ mi. at its widest. Off its northwestern shore lies the isle of Fladda. To the north of Raasay is Rona (seal island, from the Gaelic *ron,* a seal), $4\frac{1}{2}$ mi. long with a maximum breadth of $1\frac{1}{4}$ mi. The island is now unoccupied except for the lighthouse keepers whose families were removed to Portree in 1952. Scalpay, immediately south of Raasay, has a hill of 1,298 ft. The other isles are Pabay, Ornsay and Soay. The islanders of Soay mere evacuated in 1953 to Mull where they were established on new holdings by the department of agriculture for Scotland.

Portree (pop. of parish 1,766), the capital, lies at the head of a fine harbour about the middle of the eastern seaboard. Steamers run daily to and from Mallaig and Kyle of Loch Alsh. There is a factory for tweeds, tartans and other woolens. During the cattle sales, held twice a year, large numbers of sheep and cattle are transported to the railhead at Kyle of Loch Alsh. The name Portree was derived from the fact that James V landed there during his tour of the western Highlands. The place thus became, in Gaelic, Port-an-Righ (the king's harbour).

It was to Portree that Flora Macdonald (1722–90) conducted Prince Charles Edward when he escaped from Benbecula. The sheriff's courthouse is situated in Portree.

Among other places in Skye associated with the Young Pretender are Prince Charles's point near Monkstadt, where he landed with Flora Macdonald, and Kingsburgh, on the eastern shore of Loch Snizort. The castle of the Macleods of Macleod, on a rocky promontory at Dunvegan. was erected in the 9th century and is reputed to be the oldest continually inhabited house in Scotland. The MacCrimmons, the famous race of hereditary pipers, hailed from this quarter of Skye and mere attached to the Macleods of Dunvegan. At Duntulm is the ruined castle of the Macdonalds. another of the great clans of Skye chieftains. There is also much of archaeological interest in Skye. (J. Pp.)

SKYSCRAPER: see ARCHITECTURE.

SLAG. A waste substance of many kinds formed during smelting operations. Thus, in the blast furnace, limestone is charged with the coke and iron ore to form with the ash of the fuel and the gangue of the ore a lime silicate or slag which is run out of the furnace liquid, taking with it the sulfur. Blast furnace slags are of variable composition, the quantity of limestone used varying with the nature of the ore. In the basic process of steel manufacture, which employs phosphoric ores, the resulting slag, rich in phosphorus (as soluble calcium phosphates) is known as "basic slag" and forms a very valuable manure. See IRON AND STEEL; METALLURGY: Basic Steel.

SLANDER: see LIBEL AND SLANDER.

SLANG, an informal and colloquial variation of or addition to standard speech. It may be a variation in any element of a language — in its sounds ("atta dirl"). in its stress ("positively"), in its intonation ("Is that so?"), in its syntax ("We was robbed"); but it is in vocabulary ("spiv") and meaning ("She's a peach") that slang is commonest.

Slang is formed by normal linguistic processes found in all living languages, processes such as compounding ("low-down," "sob-stuff"), word clipping ("pro," "mike," "pix"), abbreviation ("O.K.," "v.i.p.," "snafu," "q.t."), onomatopoeia ("boom," "whiz," "bang"), generalization of proper names ("bobby," "guy," "real McCoy"), borrowing from dialects and foreign languages ("vamoose," "savvy," "pronto," "loco") and extension of meaning by analogy ("Park your hat," "He got pickled").

Slang and Society. — People belonging to the same social group — of the same trade, profession, hobby, age or social position — tend to behave in the same way. This behaviour influences not only the clothes they wear but also the language they use. The language of a social group, particularly its slang, is one of several forms of behaviour that keep the group distinct from other groups. As a verse writer has aptly put it, "The chief use of slang/Is to show that you're one of the gang" (R.D.C. in the New Statesman and Nation, London. Nov. 16. 1946).

One of the commonest social groupings is that of people who work together. Students have their "lab" and their "gym." Secondhand car dealers have their "creampuffs" (excellent cars) and their "dogs" (dilapidated ones). For an order of poached eggs on toast a waitress may tell the cook to "drop two on." To a television producer a poor show may be a "wart." A circus "geek" (conditioned freak) can use a "stick" (decoy) to attract a "tip" (prospective customer); but this is not the same sort of tip that a hotel porter might expect from a "front" (inexperienced traveler). A professional flyer may wear a "brain bucket" (crash helmet) in case he has to "buy a farm" (crash); but his "soup" (horsepower) has nothing to do with the "soup" (nitroglycerin) of the professional safe-cracker. "Cat" does not refer to the same thing in the underworld as it does in the jazz world. Yet both underworld and jazz slang formed the basis of much of the "teen talk" of the 1950s.

Some social conditions are more favourable than others to the creation of slang. Excitement, crowding and the sudden regrouping of people for a particular purpose, as in wartime, may result in the formation of a large number of slang words. This goes on from person to person, from ally to ally and from one side to the other. All the participants learn things about the others, and all come out with larger vocabulariee. Forceful expressions by the thousand are created and used by members of the armed forces. "Big Bertha" is remembered as the nickname of the long-range German cannon in World War I, immortalizing Bertha Krupp of the munitions family. The innocent-sounding "pineapple" of the same war was a hand grenade with markings suggestive of the fruit. World War II added another type of grenade, the "Molotov cocktail," and a vast new vocabulary of slang including such words as "blitz," "doodlebug" and "walkie-talkie." The Korean war also had its slang; Korean soldiers were known as "gooks" and as "ROKs."

A few slang expressions have spread far beyond their original linguistic boundaries. This is the case of "O.K.," the international sign of approval. Originally an American term, it has become a household word in languages throughout the modern world. There are a number of theories on the origin of this popular expression. One is that it stands for the nickname "Old Kinderhook." meaning Martin Van Buren. eighth president of the United States, who was born and died at Kinderhook, N.Y. It was used by his supporters as early as 1840, and within a few years acquired its present meaning.

How Slang Develops. — The witticism of a single person may be enough to launch a new slang form. The novelty may produce a response so effective that it is taken up by others and soon becomes widespread. The more it is used, the more popular it becomes, especially if it is used by associates or admired persons. But after much use the novelty wears off, and the expression, having no special effect and therefore no further function, dies out. If, however, the older form or its central meaning has in the meantime gone out of fashion, the slang expression may remain in use as the normal form. This was the case when the Latin word testa (earthen pot), used jocularly to describe the head of a baldheaded man, supplanted the normal word *caput* and later became the usual form for head in Italian (testa) and in French (*tête*). Similarly. gamba ("hoof"). the Latin slang word for leg, became the standard word for leg in both French (*jambe*) and Italian (gamba), the latter being the word from which "gam" in modern American slang was most probably derived.

When literary men in the 17th century wrote about the "common people" they often used a Latin expression, mobile *vulgus,* meaning the fickle or movable crowd. Sometimes in writing this was abbreviated to mob. vulg. Later the vulg. was dropped, and careless writers began to use mob. alone, still pronouncing it in full, *mobile.* The next step was to say simply *mob,* which was considered shockingly low and regarded as the crudest type of slang. The usage persisted, and in the 18th century "mob" became tolerated in conversation, although not in writing. Early in the 19th century came another promotion, and the word, at long last, entered the ranks of standard English. A similar process was responsible for about 2% of English "dictionary" words; such words as "trip," "bet," ".donkey," "shabby," "chap," "bore," "cab" and "kidnap" were once condemned as slang.

Some words may remain as slang for centuries, neither disappearing nor becoming part of the standard vocabulary Such is the case of the medieval "booze," the Elizabethan "rook" (verb) and the 18th-century "swop." The same applies to certain expressions such as "dead as a doornail," which was used in the 14th century and may have been old even then. In the 16th century Shakespeare, in *Twelfth Night,* wrote "laugh yourselves into stitches." In the 17th century George Fox, founder of the Quakers, wrote about a professional man who had "done his stuff," proving early currency for another expression still in use.

Yet for every slang expression that has lived, hundreds of others have died. "Gamp" was once the usual slang name for an umbrella. It was named after a large, bulging umbrella carried by Sairey Gamp, a character in Charles Dickens' *Martin Chuzzlewit,* published in 1844. In the latter part of the 19th century it became a well-established colloquialism, but it was hardly important enough to last.

It is in the area of fundamental emotions that slang is most changeable and most productive The slang of approval ("swell," "nifty," "bong," "zorch," "the end." "real dizzy") and disapproval ("phooey," "nuts," "boloney," "hogwash," "balderdash." "poppycock") may change within a generation. So may the words for woman and girl ("skirt." "biscuit," "swan"). and these are usually numerous in any generation. When a young man refers to his sweetheart as his "soul mate," his "steady." his "main dish," his "heavy" or his "onliest" he has hardly made a beginning; he could use a different expression every day for three years and still have words left over for variety. It is the same with money, which has unconventional synonyms by the bookful, including such picturesque terms as "berries," "cabbage," "chink," "ducats," "honey," "jack," "mazuma," "potatoes," "simoleons," "spondulics" and "wampum." The expression "to die" seems much too commonplace; a person is said to "drop off," "fade out," "go to grass," "go under," "go up," "go west," "kick the bucket," "ring down the curtain," "shuffleoff" or "push the clouds." with probably a thousand variations. A person suffering from the effects of drinking to excess is said to be "afloat," "blowed," "boozy," "cockeyed," "corned," "disguised," "fractured." "groggy," "high as a kite," "ratty," "stewed," "vulcanized" or "zigzag." The idea of stealing is expressed in slang in many forms, some of them with a disarming suggestion of innocence, such as "promote," "salvage," "rustle" and even "liberate." Other synonyms. ranging all the way from "annex" and "appropriate" to "souvenir" and "freeze onto," would easily exceed the thousand mark. The same may be said of all fundamental words, the ones first used by children and by "primitive" people. They seem to seek synonyms—humorous. satirical, poetical, euphemistic or merely roughly descriptive—in slang.

Catch Phrases.—Catch phrases, more or less related to slang, are of many kinds, ranging from the whimsical and witty to the meaningless and inane. Popular catch phrases in the 19th century included "Who stole the donkey's bed?" addressed to men wearing straw hats; "What a tail our cat has," a bantering reference to a woman's new dress; "Does your mother know you're out?" a supposedly funny remark of wide application. Many 19th-century examples were based on music-hall songs, as "Where did you get that hat?"; "Shoo, fly, don't bother me"; and "A hot time in the old town tonight." A similar specimen in the 20th century, "Yes, we have no bananas," might very well have invited the retort "and no sense." Catch phrases still come and go, and still will bear study, for they tend to reveal the processes, mental or emotional, of the people who utter them.

Artificial Types.—Since one of the functions of slang is to prevent members of other groups from understanding what is said, it is not surprising that attempts have been made to create systems of slang to function as secret languages. These include such artificial types as rhyming slang, back slang and centre slang. Rhyming slang was used by certain Cockney groups as early as 1840; it spread to the Australian underworld and in the 1950s became popular among the young "teddy boy" gangs in London and other English cities. In rhyming slang a wife becomes "trouble and strife," a road a "frog and toad" and a suit a "whistle and flute." This becomes even more secret when the rhyming word is omitted, whereby a road becomes a "frog," a suit a "whistle," a hat a "tit for" (tat) and mouth a "north" (and south). Back slang consists in saying a word backward with any alteration necessary to make it more pronounceable. In this way a game becomes an "emag," a market a "tekram," drunk "kennurd" and police "slop." In centre slang, the first syllable of the slang word is formed from the first vowel of the standard word and the consonant that follows it; the other syllables may be made in a number of ways, either with fixed or free suffixes. To call a man a fool in centre slang, such terms as "oolfoo," "oolerfer" and even "hoolerfer" could be used.

National Slang.—Since about half the world's English-speaking people are citizens of the United States, it is not surprising that world English shows traces of American influence. This influence, which tends to create variety but not disunity, extends into the field of slang. The Americanizing process has been aided by radio and films; but it should be pointed out that communication is a two-way street and that Americans have not been slow to import "Briticisms."

A study of the lists of American and British slang appended to this article will show that the line between the two is becoming increasingly tenuous. Australian and New Zealand slang, of which lists are also given, are relatively independent of outside influence, European or American.

On the continent of Europe, slang was being recognized as early as the 12th century and studied at least as early as the 15th, when François Villon used it and probably added to it in some of his immortal ballades. A generation later. in Germany, Martin Luther wrote a preface to the 1529 edition of *Liber Vagatorum (Book of Vagabonds)* and gave his views on the vocabulary of vagabonds' slang featured in that work. Villon and Luther had one thing in common—they were both writers, and writers recognized, then as now. the strong human appeal of certain types of slang.

Attitudes Toward Slang.—Some writers have condemned all slang, especially that of hostile classes. They have called it vulgar, corrupted, uncultured, secret and false, the dialect of the rabble, of beggars, of gypsies and of thieves. Others have praised slang as creative activity. In England the critic G. K. Chesterton said that "all slang is metaphor." In the U.S. the semanticist S. I. Hayakama called slang "the poetry of everyday life." According to the scientific view, slang in itself is neither good nor bad. It is part of the natural growth of language. A living language must continually change. and some of the changes first appear as slang. Some slang makes the language capable of new and delicate shades of meaning or adds vividness, clarity and directness to everyday expressions. Other slang expressions are vague in meaning, cover too much ground or duplicate better conventional vocabulary. The use of slang is sometimes quite appropriate in informal writing, but it is usually out of place in formal, scientific or academic writing.

Reasons for Studying Slang.—When Elisha Coles issued his *English Dictionary* in 1676, he explained the inclusion of a number of slang words and expressions by saying, " 'Tis no Disparagement to understand the Canting Terms: It may chance to save your Throat from being cut, or, (at least) your Pocket from being pick'd." Reasons less ominous impel the modern student, who knows that from slang much can be learned about the history, customs, fashions, the very thoughts of people far away or long ago. The study of unconventional speech is of immense value to authors and playwrights.

Bibliography.—For practical purposes, books regarding slang can be divided into two classes, early (virtually unobtainable) and modern (1900 to date). The latter include a few popular works, such as the

Dictionary of Slang and Unconventional English, 4th ed. (New York, 1952) by Eric Partridge, or his *Dictionary of the Underworld, British and American* (New York, London, 1950). In *American Thesaurus of Slang* by Lester V. Berrey and Melvin Van den Bark, 2nd ed. (New York, London, 1953), the words and expressions, though not individually defined, are minutely classified and indexed. H. L. Mencken's *The American Language,* 4th ed. (New York, 1945), and its two supplements (1945, 1948) contain much lively material on slang. *A Dictionary of Americanisms on Historical Principles* (Chicago, London, 1951), ed. by Mitford M. Mathews, includes many slang expressions, with dated quotations. Current studies, many of them of interest in British circles, appear in the periodical *American Speech* (1925–). Australasian slang is discussed in Sidney J. Baker's *Australia Speaks* (London, 1953) and *New Zealand Slang* (Christchurch, 1941). War slang is represented in *A Dictionary of Forces' Slang, 1939–1945* (Philadelphia, London, 1948) by Eric Partridge, Wilfred Granville and Frank Roberts; also in *Dictionary of Service Slang* (New York, 1944) by P. Kendall. *The Literature of Slang* by W. J. Burke (New York, 1939) is a useful bibliography. Underworld slang is represented in Hyman E. Goldin (ed.), *Dictionary of American Underworld Lingo* (New York, 1950). French slang, from ancient times to the 20th century, is described, classified and indexed in Albert Dauzat's authoritative book *Les Argots* (1929). German slang is likewise discussed and listed in *Wörterbuch der Kunden-und Gaunersprache* (1939) by A. Bertsch. (A. McQ.; W. F. My.)

AMERICAN SLANG

Following is a list of American slang of various periods but still in use after 1957. See also the list of British slang, some of which is used by Americans.

Attaboy (that's the boy), fine!
Back number, superannuated
Balled up, confused; mixed up
Bang up, excellent
Bat, a spree
Bawl out, to rebuke sharply
Beanery, cheap eating place
Beasted, stuck on a date
Beat it, to get out; make a rapid exit
Berry, dollar
Biff, to strike
Big boy, a term of admiration
Big cheese, the "boss" or chief
Big shot, important person
Blah, nonsense; piffle
Blink (on the), out of repair
Blooey (to go), to go to pieces
Blowout, a party
Blurb, publisher's advertisement
Boloney, nonsense
Bonehead, a fool
Boob, a stupid person
Boom, to promote
Boost, a recommendation
Bootlegger, dealer in prohibited liquor
Bottom dollar, last dollar
Brain storm, idea
Break (to make a), *faux pas*
Break even, to come out of a game neither winner nor loser
Breaks (to get the), to be in luck
Buck, dollar
Buddy, close companion
Bug out, get away quickly
Bull, police
Bull (throwing the), boasting
Bulldoze, to intimidate; to bully
Bum, vagrant
Bum's rush (to get the), to be thrown out
Bunk, nonsense; rubbish
Butt in, interfere
Buttinski, one who interferes or intrudes
Call-down, a rebuke
Call down (to), to correct
Can, to discharge; to throw out
Canned music, music which is played by mechanical means
Can you beat it?, equivalent to "Did you ever?"
Caught with the goods, caught in the act
Chase yourself, get out
Cheap skate, a poor spender
Chesty, puffed up; vain
Chicken, cowardly
Chicken feed, small money
Chink, a Chinese
Cinch (also "lead-pipe cinch," and hence shortened to a "pipe"), a sinecure
Classy, handsome; stylish; chic
Clip joint, business place with dishonestly high prices
Clock watcher, a lazy worker
Cook with gas, get somewhere
Crab, to spoil, as to "crab an act"
Crack, a shot; figuratively as a "dirty crack"—a mean hit
Cuckoo, crazy
D.D.T., drop dead twice
Dead beat, worthless fellow
Doggy, stylish
Doll-up, to dress up
Dope. the facts in a situation; also drugs, as heroin; stupid person
Double-cross, to betray
Dough, money
Down and out, at the end of one's resources
Drag, influence
Drop dead, expression of contempt
Duck out. to escape
Easy, gullible; easily duped
Easy mark, a dupe
Eats, food; a meal
Fade-out, to disappear; take quick leave
Fall down on, to fail at
Fall for, to be infatuated with
Fanny, the buttocks
Fiend, an enthusiast
Fifty-fifty, equally divide
Fire, to dismiss from a position
Fixin's, trimmings; extras, as at a meal
Fizzle, a failure
Flat tire, a deflated scheme; dull person
Flophouse, a cheap lodging
Fourflusher, one who promises without performing
Frame (to), to fabricate evidence
Frame-up, a trumped-up piece of evidence
Freeze out, to force out
Fresh, impertinent
Gaff. chaffing; "standing the gaff," standing the pace
Gate crasher, one who enters without paying admission or without invitation
Get away with, to carry through an action undetected
Get down to brass tacks, deal with the bare facts
Get lost, go away
Get one's goat, try one's patience
Get one's hooks on, get hold of
Get solid, to establish standing
Get the bulge, gain an advantage
Get the gate, be discharged
Get wise to, become aware of
G.I., an enlisted man; also (army) government issue; (naval service) galvanized iron
Gink, chap
Gin mill, a saloon
Giveaway (usually "dead giveaway"), betrayal
Go (to make a), to succeed
Go-getter, a practical, energetic person
Going some, doing very well
Goon, a hired ruffian
Go over big (to), to succeed
Graft, illegal profit
Grand, a thousand dollars
Gravy, profit
Greble, unpopular girl
Grouch, a sour, peevish person
Grunt, restaurant check
Guff, nonsense
Gumshoe, to proceed surreptitiously
Guy, fellow, as, a regular guy
Gyp, to cheat
Hang (to get the), to understand
Hard-boiled, callous
Hash house, cheap eating place
Hick, a country bumpkin
High-brow, intellectual (n. or *adj.)*
Highjacker, a bandit
Hitch, ride, sometimes stolen, on a passing vehicle
Hit the hay, go to bed
Hobo, tramp
Hock, to pawn; in hock, in pawn
Hogwash, nonsense
Hold on, wait a minute!
Hooey, bunk; nonsense
Hoosegow, a jail
Hophead, narcotics addict
Horn in, to intrude
Hot air, exaggerated statements
Hot dog, exclamation of approval
Hunch, presentiment
Hurry wagon, a police patrol
Ice, diamonds
I'll say, I agree
I'll tell the world, "I'll say as much"
In had, under disfavour
Inside dope, confidential information
Jack, money
Jack up, to remind; to jog
Jag, drunken spree; "to have a jag on," to be drunk
Jalopy, a broken-down automobile
Jerk, a silly person
Jinx, hoodoo
Jitney, a five-cent piece
John, a toilet
Joint, an establishment, as a dance hall, restaurant, etc.
Josh, to tease; to banter
Joy ride, a reckless ride
Juke box, an automatic record player
Junk, anything poor in quality; narcotics
Kale, money
Keep your shirt on, keep cool
Kick, to complain
Kid (*v.*), to tease
Knock, condemn or criticize
Lemon, undesirable person or thing
Let down, to desert without warning
Let up, to cease
Light out, to depart
Line (to get a line on), to gather information about
Lit, inebriated
Live wire, energetic person
Loaded, drunk
Lounge lizard, man who haunts bars for flirtation
Low-brow, uncultured
Low-down (*n.*), all the important information
Lulu, something superior
Mae West, an inflatable life jacket
Main squeeze, the chief
Make (on the), intent on profit
Make a getaway, escape
Make the grade, accomplish the task in hand
Melon (financial term), distribution of unusual dividend
Mick, an Irishman
Miss out, to let an opportunity slip by
Mitt camp, palm-reading concession
Mixer, one who meets all types of persons easily
Moll, a gangster's girl friend
Monkey business, foolish trifling
Moocher, a beggar; cadger
Moonshine, privately (generally illicitly) distilled whisky
Nail, to arrest; to catch at a critical moment
Neck, to embrace
Nerve, impudent cheek
N G., no good
Nothing doing, no chance whatever
Not on your life, certainly not
Not with it, badly mistaken
Nut, idiot
Nutty, very enthusiastic about; crazy
Old stuff, out of date
Once-over (also called the double-O), careful scrutiny
On the bum, in a low state; spoiled; damaged
On the spot, exposed to danger
Outfit, a group of people, especially a business organization
Pan out, to result
Pass out, lose consciousness
Pass up, to let slip
Peeved, annoyed
Pen, prison
Pep, energy; vim
Petting, amorous fondling
Phoney, bogus; not genuine
Pickled, intoxicated
Picnic, an easy task
Pie-eyed, intoxicated
Piffled, half intoxicated
Pinch, arrest
Pipe, an easy task
Pix, moving pictures; cinema
Playboy, a free spender
Played out, exhausted
Poker face, expressionless
Pull, influence
Pull off, to initiate and carry through a plan
Punch, vigour
Punk, utterly worthless; young hoodlum
Push, a crowd
Pussyfoot, to proceed cautiously
Put across, to accomplish by one's own effort
Put over, to accomplish
Put over on, to impose on
Put the skids under, get rid of
Put-up job, a conspiracy
Put wise, to acquaint with the facts in a situation
Queer (*v.*), to compromise; damage
Quitter, a faintheart

Raunchy, sloppy; off colour
Razz, to heckle, to make fun of
Real McCoy, genuine article
Regular fellow (or guy), agreeable or "good" person
Ritzy, stylish
Road hog, an inconsiderate motorist
Rod, revolver
Root, to shout for
Roughhouse, a disorderly affair
Roughneck, rowdy
Rough up, to treat harshly
Rubberneck, a sight-seer; a curious person
Rube, a rustic
Salve, flattery
Sand, grit; iourage
Sap, a brainless person
Scoff joint, restaurant
Screwy, crazy
Shake a leg, move on
Shine (take a shine to), to become suddenly fond of
Shoestring (on a), with a very little capital
Shoot! Go ahead!
Showdown, an accounting
Side-step, to evade
Simp, simpleton
Sinker, a doughnut
Sit in with, join with
Size up, to make a rapid estimate oi
Skin, cheat (*n.* and *v.)*
Slob, an untidy, careless person
Slush, sentimentality
Smacker, a dollar
Small-time stuff, unimportant
Smoke eater, a fireman
Snafu, a mess (situation normal, all fouled up)
Snap, sinecure
Snooty, supercilious; critical
Snow, cocaine
Soap opera, a serial drama in radio or television
Sob sister, a woman reporter who writes oversentimentally
Sock, a severe blow
Soft soap, flattery
Souse, a habitual drinker
Sparkler, diamond
Squeal, to betray an accomplice
Steady, fiance (both sexes)
Steep, exorbitant
Step on it, hurry up
Step out, go out on pleasure
Stork, stay up late drinking
Strike oil, to make money
Strong-arm, violent
Stuck on, infatuated by
Stuff, the (as "that's the stuff"); the real thing
Stung, taken in; cheated
Stunt, trick, usually acrobatic
Swat, to hit; also a blow
Swear off, to stop drinking
Take a powder, go away
Take for a ride, to kill
Take the rap, accept the punishment
Talk turkey, to speak frankly
Tear. a wild spree
Tickle the ivories, play the piano
Tip, a hint
Tip off, to inform
Toney, aristocratic
Tummy, stomach
Up and coming, promising
Vip (also V.I.P.), very important person
Walkover. an easy task
Water wagon (to go on the), to stop drinking
Whale (as a "**whale of a show**"), a splendid specimen
Whiz, a wonder
Willies (the), an attack of "nerves"
Wirepuller, a person who contrives for his own ends
Wisecrack, smart remark
Wow, a great success
Yellow, cowardly
Yellow streak, a vein of cowardice
Yen. a yearning
Yock, a horselaugh, a guffaw
(H. L. M.; A. McQ.; W. F. MY.)

BRITISH SLANG

Following is a list of British slang expressions of various periods still in use after 1957; see also the list of American slang, some of which is used by Britons.

Bag, to appropriate
Bally, imprecatory epithet
Ballyhoo, excessive praise
Barnacle, a good job, easily got
Bean, head
Beat the band, be very good
Bill?;, a simpleton
Bird, girl
Bob. a shilling
Bobby-dazzler, anything flashing or brightly coloured
Bone, to steal
Booze, liquor
Boss, "to boss," mess up something; "a boss shot," a futile effort
Bounce, bragging; boasting
Brass, impudence, "brazen-face"; money
Cackle, to tell a secret
Cantab, Cambridge undergraduate
Carrots, a red-haired person
Char, a task; work of any kind
Chink, money
Chit, child
Chuck a dummy, to faint
Claret, blood, as "tap his claret," make his nose bleed
Cold tea, brandy
Copper, a policeman
Corker, a very good thing or person
Cove, a man; fellow
Crackers, eccentric; mad
Cut a dash, make a display
Dab, an expert
Dace, twopence
Daddy, a backer; protector
Darbies, handcuffs
Dive, to pick a pocket; a low eating house, dance hall, etc.
Dubber, a lock picker
Duds, clothes
Dumb, stupid
Fag, a cigarette
Fib, to beat
File. to rob
Fin, hand
Fly, smart; clever; shrewd
Flyers, shoes
Fresh (to get), to be cheeky; to become audacious
Game, gamey; lame
Gob, the mouth
Grinders, teeth
Half seas over, almost drunk
Heave, to rob
Hedge, to make secure a desperate bet
Hooch, whisky; liquor
Hoof it, to walk
Jabber, useless chatter
Jailbirds, prisoners
Lag, a convict
Lid, a hat
Lift, to steal
Loon, a fool
Lubber, a heavy, dull fellow
Lugs, the ears
Muck, filth; worthless stuff
Mum, silent
Nab, a hat, cap or a head; to take
Nark, a police spy
Nix, nothing
Nob, the head
Old, epithet of endearment
Old Harry, the devil
Old Nick, the devil
Pal, a friend; companion
Peepers, eyes
Phiz (or phyzog), face
Pickled, drunk
Pinch, to steal; to arrest
Pins, legs
Poke, a bag or sack
Pong, to stink; also a bad smell
Prig, a thief; to steal
Pug, a boxer
Ramp, a swindle
Ratty, angry
Reach-me-downs, a suit of ready-made ill-fitting clothes
Ready, ready money; cash
Ripper, something excellent
Rub out, to kill
Rum, queer; strange
Sack, a pocket; "to get the sack," to lose one's job
Scab, a scoundrel
Scout, a watchman
Scrounge, obtain illicitly
Shark, a sharper; trickster
Shaver, a young boy
Sitter, something easy to do
Slyboots, a seemingly silly but subtle fellow
Snaffle, to appropriate
Sock, a pocket; to beat
Split, inform against someone
Sponge, to "sponge on someone," to live or drink at another's cost
Tanner, a sixpence
Topping, excellent
Tuck in, to eat heartily
Wangle, obtain by cunning
Whack, a share; **to share out**
(A. McQ.; W. F. MY.)

CANADIAN SLANG

Much American and British slang is understood in different parts of Canada (population, almost 16,000,000 in 1957). More than three-quarters of the slang used in Canada is American; the remainder is made up of British slang (old and new) and Canadian localisms of which the following are samples:

Bangbelly, bread and molasses pudding
Banker, fishing vessel
Bennett buggy, automobile drawn by horses
Beveraged, licensed to sell liquor
Blue ruin, gin
Clinkerbells, icicles
Colony house, pigsty
Dog's nose, beer mixed with **gin**
Dolly varden, cup
Devil-dodger, parson
Forty-rod. strong whisky
Gob-stick, spoon or fork
Gridiron, U.S. flag
Hard-rock, rough, uncouth person
Herring choker, Maritimer, esp. from Nova Scotia
Hydro, electric power commission
Jig, day's work
Liveyer, Newfoundlander
Mountie, member of the Royal Canadian Mounted Police
Nitchie, native Indian
Pea soup, French Canadian
Prairie oyster, raw egg yolk in whisky or hot sauce
Pump-sucker, nondrinker
Salt chuck, ocean
Scouch, stew
Solomon gouse, pork and cabbage
Spotted dog, raisin pudding
Storms, storm windows
(W. F. MY.)

AUSTRALIAN SLANG

In proportion to Australia's population (less than 10.000.000 in 1957) and history (since 1788), its slang is probably the most vigorous linguistic growth of its kind in the world. More than 10.000 Australianisms have been listed; representative examples:

Abo, aboriginal; aborigine
Art union, a lottery, the prizes of which are in kind, not money
Aussie, Australia; an Australian
Backblocks, sparsely inhabited inland areas
Bail up, to hold up and rob; to corner
Banker, a flooded river running banks high
Barrack, to shout or jeer at opponents; also, barrack for, to support; barracker, a partisan
Berley, small pieces of food scattered on water to attract fish
Billabong, a quasi-oasal river bend
Billy, a tin can used for boiling tea and cooking; also, billycan
Binghi, an aboriginal; also, boong, blackfellow
Block (do one's), to become angry or excited
Blow-in, a newcomer
Bludge, to impose on; whence, bludger
Blue, a summons; an error; a fight
Bluey, a swagman's bundle; also called a swag, drum or matilda
Board, the floor of a shearing shed
Bombo, cheap wine; also called plonk
Bone, to direct a ceremonial "death curse" against a person; also point (sing) a bone
Bonzer, good, excellent
Borak at (poke), to jeer at; make fun of
Bowyang, a strap or string fixed below the knees of a worker's pants to keep the cuffs off the ground
Boxer, a bowler hat
Brumby, a wild horse
Bucker, buckjumper, a refractory horse
Buckley's chance, no chance at all
Bullocky, a bullock driver
Bumper, a cigarette butt; "not worth a bumper," worthless
Bung (to go), to peter out, to die
Burl (give it a), to make an attempt at
Bush. forestlands; the inland country in general; also, "go bush." to decamp or hide; "bushed," confused; "bushranger," an outback bandit
Cat (whip the), to cry over spilt milk
Chloe (drunk as), extremely

drunk
Chromo, a prostitute
Chyack, impudence; cheek
Cobber, a friend
Cockatoo, a small farmer; also, cocky
Cockeye Bob, a wild gale in northwest Australia
Cooee, a penetrating cry; also verb
Cossie, a swimming costume
Cow, an objectionable person or thing
Crack hardy, to put on a brave face against misfortune
Crook, ill; worthless; "go crook," to become angry
Cut out, to complete a task
Damper, bush bread baked in ashes or a camp oven
Dead ring of, exactly similar to
Deaner, a shilling
Digger, an Australian soldier
Dillybag, a native bag made of grasses or fur twisted into cord
Dingo on (someone), to betray
Dinkum, true; honest; also, "dinky die," "fair (square) dinkum"
Do a perish, almost to die for want of a drink
Doover, a thingumbob
Dreaming, any source of native legend-
Drop one's bundle, to become panicky
Duffer, a cattle thief; whence, duffing
Fizgig, a police informer
Fossick, to search for surface gold; to look for something; whence, fossicker
Full as a goog, completely full; extremely drunk
Furphy, a baseless rumour or canard
Game as Ned Kelly, highly reckless or courageous
Gin, a native woman
Graft, hard work
Gumtree (up a), in a quandary
Guyver, tall talk; affectation
Hard case, a reckless or amusing person
Hatter, a man who lives and works alone
Haven't a skerrick, to be penniless
Haven't the bolter's, to have no chance at all of success
Hop, a policeman; also John Hop
Humpy, a hut; a small shack
In smoke, in hiding
Jackeroo, a young station hand, learning sheep or cattle farming
Jacko, a kookaburra; also, jack, jackass
Jimmy Woodser, a solitary drinker
Joey, a young kangaroo; a baby; a lie
Jumbuck, a sheep
Keep nit. to mount guard while some illegal activity is afoot; also, to cockatoo
Kidstakes, pretence; foolery, nonsense
Lair, a flashily dressed youth; "lairy," flashily or showilv dressed
Larrikin, a street tough or hoodlum
Larry (happy as), completely happy
Lolly, a sweetmeat
Lubra, a young native woman
Lurk, a scheme; racket; also, dart, rort
Maoriland, New Zealand; also, Enzed, Pig Islands, Shakey Isles
Merino (pure), first class in quality
No good to gundy, worthless
Nohoper, a person who has no prospects of success
Nuggety, short; thickset; sturdy
Offsider, a helper or companion
Old identity, an old, noted inhabitant of a locality
Oscar, money; ready cash
Outback, the inland country or bush
Paddock, any fenced area of land
Pastoralist, any farmer engaged in the primary industries
Perform, to curse luridly; to give way to temper
Plonk, cheap wine
Poddy, a hand-fed calf
Point, to take unfair advantage of another; to loai; to malinger
Pommy, an English-born person
Possie, a place or position
Push, a gang or clique
Put the hard word on, to lodge an urgent demand
Putty (up to), worthless
Rafferty rules, no rules at all
Ratbag, an eccentric person
Ready up, to conspire; to fake; as a noun, a conspiracy, a "stew"
Reff, reffo. a refugee from Europe
Removalist, a person or firm engaged in shifting household effects
Ridge, excellent, genuine
Ringer, the fastest shearer in a woolshed; any expert
Ropeable, angry; savagely ill-tkmpered
Rough as bags, unpolished; crude
Rouseabout, a handy man on a sheep or cattle station
Rouse on, to upbraid; reprove
Run, a large farm for sheep or cattle
Sandy blight, a form of ophthalmia
Scale, to ride on a tram, train or bus without paying
Shanghai. a catapult
Sheila, a girl
Shicer, shyster; a swindler or crook
Shicker, intoxicating liquor; whence, "shickered," drunk
Shivoo, a spree; party
Shout, to stand treat
Silvertail, a social figure; a social climber
Slygrog, liquor sold illegally; also, a place where such liquor is sold
Smoodge, to make love to; to curry favour
Snags, sausages; also, snorks, snorkers
Sool on. to incite
Southerly buster, a wild wind or gale from the south
Squatter, the owner of a large sheep or cattle station
Squib, a coward
Station, as for "run"
Stickybeak, an inquisitive person
Stoush, to hit; thrash; as noun, violence
Sundowner, a tramp of indolent habits
Swag, see Bluey; swagman, swagger, swaggie, a tramp
Swy, as for "two-up"
Tassie, Tasmania; a Tasmanian
Tinny, extremely lucky
Tipslinger, a race tipster
Top end, far north Australia; whence, "topender," a resident of the far north
Tote, a totalizator or pari-mutuel
Trot (a good), a sequence of successes; "bad trot," a sequence of failures
Tucker, food
Two-up, a gambling game played with two pennies
Urger, a race tipster; a trickster's confederate
Waddy, a stick or club
Wake-up (a), an alert person
Waler, whaler, an idolent tramp; especially, Murrumbidgee waler
Walkabout (go), to travel; wander
Wallaby (go on the), to wander in the outback
Waltz matilda, to go on the tramp
Weekender, a week-end holiday residence
Whacko! an ejaculation of pleasure
Whinge, to complain; grouse; whence, whinger, whinging
White ant (to), to undermine or sabotage
Willy willy, a wild storm of tornadic type
Wog, a germ; parasite; small insect
Woolshed, the building on a run or station wherein sheep shearing takes place
Woop Woop, the (hypothetically) most rustic of all rustic townships
Wowser, a puritanical fanatic; bluestocking
Yabber, to talk; chatter
Yacker, work
Zack, sixpence
Ziff, a beard

NEW ZEALAND SLANG

Most of the terms listed under Australian slang are known in New Zealand (population less than 3,000,000 in 1957). Some of the following, all of which originated in New Zealand, are also common to both countries.

All Blacks, New Zealand representative footballers
Batch, a small shack or cottage; "batcher," one who lives alone
Bot, a cadger or parasite
Box of birds, happy; in full health
Enzed, New Zealand; "Enzedder," a New Zealander
Fire in the fern, trouble; smouldering discontent
Half-pie, worthless
Have the wood on, to have an advantage over
Hoot, money
Kai, food
Kit, a shopping basket
Over the fence, unreasonable
Pakeha, a white man
Pie at, expert at; efficient
Wahine, a woman
Whare, a small shack or cottage

(S. J. Br.)

SLATE, in geology, fine-grained argillaceous or clayey metamorphic rock which cleaves or splits readily into thin slabs having great tensile strength and durability. Some other rocks that occur in thin beds are improperly called slate because they can be used for roofing and similar purposes. True slates do not, as a rule, split along the bedding, but along planes of cleavage, which may intersect the bedding at any angle, usually, in the case of good roofing slates, at high angles. The original material was a fine clay, sometimes with sand or volcanic dust, and the bedding of the sediment as originally laid down may be indicated by alternating bands, differing in colour or in lithological character, sometimes to be seen on the cleavage faces of the slates. Cleavage is a superinduced structure, the result of pressure acting on the rock at some time when it was deeply buried beneath the earth's surface. On this account slates are found chiefly among the rocks of the older geological systems, although some occur in regions where comparatively recent rocks have been folded and compressed as a result of mountain-building movements in the earth's crust.

In thin sections for microscopic examination, slates show much colourless mica in small, irregular scales, which in the best average about 2,000 to the inch in breadth and 6,000 to the inch in thickness. Green chlorite in flakes is also usually abundant, the principal other ingredient being quartz, in minute lens-shaped grains. In colour, slates may be black, blue, purple, red, green or gray; dark slates usually owe their colour to carbonaceous material or to finely divided sulfide of iron, reddish and purple varieties to the presence of oxide of iron in the form of hematite and green varieties to the presence of much chlorite.

Slates are made or split from quarried blocks about three inches thick. A chisel, placed in position against the edge of the block, is lightly tapped with a mallet; a crack appears in the direction of cleavage, and slight leverage with the chisel serves to split the block into two pieces with smooth and even surfaces. This is repeated until the original block is converted into 16 or 18 separate "slates," the thickness of which depends upon many circumstances, such as quality of rock, size required and purpose for which it is to be used, the average thickness of a roofing tile of the best kinds of slate being about $\frac{1}{6}$ in. The slates are afterward trimmed to size, either by hand, in which case they are cut between a fixed sharp edge and a movable knife acting on the principle of a paper cutter, or by means of machine-driven rotating knives.

Slate is sold both as dimension slate and crushed slate (granules and flour). Dimension slate is used mainly for electrical panels, laboratory table tops, roofing and flooring and blackboards. Crushed slate is used on composition roofing, in aggregates and as a filler. Principal production in the United States is from Pennsylvania and Vermont; lesser quantities are quarried in Maine, New York, Virginia, Georgia, Arkansas and California. North Wales provides most of the slate used in the British Isles. See also STONE. (F. J. N.; F. J. P.)

SLATIN, SIR RUDOLF CARL VON (1857–1932), Anglo-Austrian soldier and administrator in the Sudan, was born on June 27, 1857, at Ober St. Veit near Vienna. At the age of 17 he made his first journey to the Sudan, reaching Khartum by the Nile route in Oct. 1875 in company with Theodor von Heuglin (*q.v.*). Thence he went through Kordofan to Dar Nuba, exploring the mountains of that region. He returned to Khartum in consequence of a revolt of the Arabs against the Egyptian government. There Slatin met Emin (Emin Pasha) and with him purposed visiting Gordon at Lado, Gordon at that time being governor of the equatorial provinces. Slatin, however, was obliged to return to Austria without accomplishing his desire, but Emin went to Lado, and at Slatin's request recommended the young traveller to Gordon for employment in the Sudan. In 1878, while Slatin was serving as a lieutenant in the crown prince Rudolf's regiment in the Bosnian campaign, he received a letter from Gordon inviting him to the Sudan, of which country Gordon had become governor general. Slatin arrived at Khartum in Jan. 1879. After a brief period during which he was financial inspector, Slatin was appointed mudir (governor) of Dara, the southwestern part of Darfur, a post he held until early in 1881, when he was promoted governor general of Darfur and given the rank of bey. While administering Dara, Slatin conducted a successful campaign against one of the Darfur princes in revolt, and as governor of Darfur he endeavoured to remedy many abuses. He had soon to meet the rising power of the mahdi Mohammed Ahmed (*q.v.*). Early in 1882 the Arabs in southern Darfur were in revolt. With insufficient resources and no succour from Khartum, Slatin gallantly defended his province. Though victorious in several engagements he lost ground. His followers attributing his nonsuccess to the fact that he was a Christian, Slatin nominally adopted Islam. But all hope of maintaining Egyptian authority vanished with the news of the destruction of Hicks Pasha's army, and in Dec. 1883 Slatin surrendered, refusing to make any further sacrifice of life in a hopeless cause. In the camp of the mahdi an attempt was made to use him to induce Gordon to surrender. This failing, Slatin was placed in chains, and on the morning of Jan. 26, 1885, an hour or two after the fall of Khartum, the head of Gordon was brought to the camp and shown to the captive. Slatin was kept at Omdurman by the khalifa, being treated alternately with savage cruelty and comparative indulgence. At length, after more than 11 years' captivity, he was enabled, through the instrumentality of Sir Reginald (then Major) Wingate of the Egyptian intelligence department, to escape, reaching Egypt in March 1895.

In a remarkable book, Fire and Sword *in the* Sudan, written in the same year and issued in English and German in 1896, Slatin gave not only, as stated in the subtitle, "a personal narrative of fighting and serving the dervishes," but a connected account of the Sudan under the rule of the khalifa. Raised to the rank of pasha by the khedive, Slatin received from Queen Victoria the C.B. He served as staff officer in the campaigns of 1897–98 which ended in the capture of Omdurman and was made a K.C.M.G. and in 1906 was ennobled by the emperor of Austria. He was inspector general of the Sudan from 1900 to the outbreak of World War I. His mastery of Arabic and his profound knowledge of the land and peoples proved invaluable in the work of reconstruction. In 1907 he was made an honorary major general in the British army, and in 1912 was made G.C.V.O. During World War I he presided over the Austrian Red Cross for the Aid of Prisoners of War. He died Oct. 4, 1932.

SLATING: see ROOF.

SLAUGHTERHOUSE or ABATTOIR. The slaughtering of meat animals is conducted in many ways. The farmer slaughters a single animal or a few animals depending on the needs of his family. Some retail butchers slaughter a few animals, but usually only that number which is sufficient to supply their retail trade. These slaughtering operations are frequently conducted under quite primitive conditions. Slaughtering on a wholesale basis with a volume slightly larger than the retail butcher and ranging to the capacities of large packing plants such as those located in Chicago brings into the picture the conventional slaughterhouse or abattoir. The types of slaughterhouses vary according to the volume of slaughtering operations conducted and the degree of governmental control exercised over them in a particular community.

Slaughterhouses have been a factor in the public meat supply from antiquity. Whenever, with the increase of populations, man congregated in large communities, slaughter of food animals on a wholesale basis was a natural development. Even governmental control of slaughterhouses goes back to Roman days. In Europe the slaughterhouse has continued to be largely a local institution. Its size and capacity have been determined primarily by the local needs. Moreover, its method of functioning depends to a large extent on the kind of local governmental control exercised over it. Denmark is a good example of a European country in which slaughterhouses function at the local level. That is, they are usually just large enough to satisfy the local demand for meat. Furthermore, it is required in that country that all meat offered for sale must have been produced in an abattoir which comes under governmental supervision. Under these conditions well-equipped and properly supervised slaughterhouses function at their best in providing a public meat supply.

By contrast with the European slaughterhouse whose production supplies primarily the local need, in the United States large slaughtering centres have developed in which are located slaughterhouses that ship their products to all the states in the union. This developed quite naturally because the large livestock-producing areas are several hundreds of miles from the large meat-consuming sections of the country. The history of the development of these large slaughterhouses in the United States has an interesting aspect in relation to governmental control of their slaughtering and meat-processing operations. Whereas the governmental control of slaughterhouse operations in Europe has been principally a local concern, in the United States by virtue of large meat packing concerns doing a nation-wide business, the meat inspection control is exercised by a federal agency.

Other factors of importance which are entitled to consideration in understanding the slaughterhouse development in the U.S. are connected with the development of rail transportation. The advent of the refrigerated railroad car made it possible to slaughter meat animals many hundreds of miles from the localities in which the meat is to be consumed. Large slaughterhouses in Chicago, for example, receive carloads of livestock which come from the western plains many hundreds of miles away. They ship in refrigerated cars carcasses produced from these animals as far as the eastern seaboard to the large centres of population there. An efficient utilization of many by-products of the slaughtering operations has been one of the results of slaughtering large numbers of animals in a single plant. There has been production in large volume of such materials as fertilizer, soap, soap fats, hair, animal casings, hides, skins, bone products, pharmaceutical products and many technical products. Many interesting adjustments in the slaughtering operation have been made from time to time to accomplish an efficient production of large quantities of meat. So-called moving chain conveyor production which has become an important factor in many other industries is reputed to have originated on the slaughtering floors of these large establishments. This development also has its personal interest. Butchers in slaughterhouses at one time were highly trained craftsmen who efficiently and with some artistry conducted all the dressing operations on a carcass. Today, with the moving chain conveyor operation, the dressing of a carcass has been separated into a number of simple, easily learned functions which are divided among a number of men, each doing his small specialized part.

Structure. — A properly planned slaughterhouse requires a considerable area of ground and should have ready access to railroad facilities and to the public highway. This calls for a location outside of the metropolitan area but still close enough to it to ensure an adequate labour supply.

Livestock pens should be large enough to hold a considerable supply of animals. This is necessary so that as the livestock are unloaded from railroad cars or trucks they may be driven into comfortable holding pens where they can be fed and watered and rested. The pens are paved and drained so that they can be cleaned and washed down regularly. An ample supply of water is piped throughout the pen area for watering purposes and so that during the hot summer months the livestock can be sprinkled regularly to avoid their becoming overheated. Cleanliness in the livestock pens avoids their becoming a nuisance and also aids materially in maintaining clean conditions in the slaughtering department. Livestock may bring a considerable quantity of debris onto a slaughtering floor from unclean pens.

The slaughtering department is the hub of all operations; therefore, it is planned carefully to make certain that its facilities and equipment are adequate to handle the intended production. Different species of animals are handled with equipment specialized for the particular purpose. Furthermore, the flow of dressing operations must be smooth and orderly to assure efficiency of production and the maintenance of sanitary conditions. Wherever possible, handling is done mechanically rather than manually. The slaughtering department is usually located on the second- or third-floor level. The livestock are driven up a long, inclined ramp to the slaughtering floor. With the slaughtering department at the top level it is possible to provide abundant light and ventilation. The additional and probably more determining consideration is the fact that with the slaughtering operations being conducted at the top level, the products, both edible and inedible, may gravitate to the lower levels where they are given their final preparation.

The animal as it reaches the slaughtering department consists of a combination of edible and inedible products. The properly done slaughtering operation succeeds in separating efficiently the edible parts from the inedible parts, at the same time avoiding any contamination of the products which are prepared for human consumption. From the removal of the hide to the separation from the carcass of such parts as intestines, bladder and the like, a strict regard is given to maintaining the cleanliness of the edible portions. For example, the hide is removed without permitting its outside surface to contact the carcass and as soon as it is removed it is dropped through an opening in the floor into a chute which conveys it directly to the hide cellar. Furthermore, this chute is so vented as to direct any odours to the outside air. Those inedible portions of the carcass which are rendered into soap fats and fertilizer are separated from the edible portions of the carcass by skilled operators using specialized equipment, and these inedible materials are conveyed by chute or other mechanical means to the inedible-rendering department.

The inedible-rendering department is entirely separate from the other departments of the slaughterhouse. This is necessary so that the edible products may in no way be subjected to any possible contamination. Even the loading dock of the inedible-rendering department is entirely separate from the dock which is used to load out meats and other edible products. The inedible-rendering department is constructed with floors and walls of impervious material which can be washed down thoroughly and the floors are sloped to drains so as to facilitate this cleanup. The equipment is adequate to handle the volume expeditiously; *i.e.,* there are sufficient rendering tanks which are provided with odour-control devices.

While turning out a properly dressed carcass in the slaughtering department, the organs removed from the body cavities must be taken care of. These are handled in what is called the viscera-separating department, which is immediately connected with the slaughtering department. This viscera-separating department is so equipped that the various organs can be separated from each other without contamination. Sausage casings are a product of this department.

The edible products which include the dressed carcasses, livers and other edible organs, are conveyed to the refrigerators. The body heat is removed promptly from these edible meat products. The carcasses are hung spaced from overhead rails, and the edible organs are either spread out on trays or hung individually from hooks on racks. Since proper chilling determines to a great extent the quality of the edible products as they are subsequently shipped from the plant, the refrigeration facilities must be adequate for the volume of production. This applies both to the amount of refrigeration space and the temperature maintained in those areas.

Water Supply. — An abundant supply of water is piped to all operating departments. That used in the slaughtering and other departments where edible products are handled must be clean and potable. The outlets must be numerous and so located that both hot and cold water under good pressure are available wherever needed. Hot water is particularly important for cleanup in the slaughtering department, because cold water will not cut the fat which is always present to some extent in the debris that accumulates in connection with the dressing operation. This cleanup is progressive during the operation, so that the department may be kept clean at all times.

It is sometimes difficult and usually quite expensive to obtain potable water in the large amounts necessary for properly operating the inedible-rendering department and the condenser lines in the refrigeration system. Also, frequently nonpotable water is the only supply available in amounts adequate for fire control. When nonpotable water is used for these purposes, no lines carrying this water pass through edible-product departments and there are no cross connections between the potable and nonpotable water systems.

The slaughterhouse employees are furnished dressing-room and laundry facilities. The lockers provided for them are adequate to accommodate their working clothes and equipment. Their outside garments are of washable material, and they are laundered regularly. The dressing rooms in which the lockers are located are separated from adjoining toilet rooms by tight, full-height walls or partitions. The toilet rooms are not entered directly from workrooms. The intervening dressing room serves as a ventilated vestibule between the toilet rooms and the edible products departments. In addition to the toilet facilities, which are sufficient for the number of employees at a particular plant, showers are also provided.

Sewage Disposal. — The sewage lines from floor drains and other affluents from edible-product departments are separate and apart from sanitary sewage lines. These lines enter the main sewer separately. This avoids the contamination which would result in edible-products departments should there be any stoppage in the sanitary sewage lines. Also, it is the usual practice for sewage from operating departments to be passed through catch basins where the fat is salvaged. The fat rises to the surface in these catch basins, is skimmed off regularly, and taken to the inedible-rendering department. The catch basins are drained and washed out daily.

Meat Inspection. — The slaughterhouse, however well-laid out and equipped, requires the supervision of government inspection to assure its being maintained in a sanitary condition and to ensure the clean handling of meat and meat products for human consumption. The animals before slaughter must be examined by a government inspector to eliminate from food channels all those that are unfit. Also, each carcass at the time of slaughter must be examined by the inspector to search out all diseased and otherwise unfit carcasses and parts. To facilitate examination of the live animals, the pens are so arranged and lighted as to permit the inspector to pass among the animals and examine them at rest and while moving about. The animals which are suspected of being unfit for meat production are segregated and placed in a pen provided for the purpose. These animals are again examined and those considered unfit are taken directly to the inedible-rendering department where they are destroyed under the supervision of the inspector. Since only a few instances of disease occurrence in animals can be detected in the inspection of the live animal, each carcass is examined during the dressing operation immediately after slaughter. Equipment provided in the slaughtering department permits the inspector to examine the carcass and its organs. Diseased and otherwise unfit carcasses and parts condemned by the inspector are destroyed under his supervision. Equipment which has been contaminated by condemned material is required to he sterilized, using water at high temperatures.

The manufacturing processes used in preparing meat products also require inspectional supervision. The inspector prohibits the use of harmful preservatives as well as unfit or unclean ingredients generally. The preparation of chopped meat products such as sausages, meat loaves and the like, receives the inspector's close attention to guard against adulteration. Only clean, wholesome meats and other ingredients are permitted to be used, and the proportion of meat to other ingredients is maintained at a level which is consistent with consumer expectancy.

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SLAVE COAST, a term denoting the low-lying deltas and sandbars that stretch for 700 mi. between the Volta river and Mt. Cameroon; used (but now rarely) to distinguish this shore line from the Gold. Ivory and Grain coasts. The name derives from its position as a principal source of African slaves for 350 years. especially the section of it that fronts on the Bight of Benin (Dahomey. Lagos). (D. WH.)

SLAVEIKOV, PENCHO (1866–1912), Bulgarian poet. best known for his epic poem. *Karvava Pessen* ("Song of Blood" [1911–12]) describing the sacrifices of the Bulgarian people in their struggle for independence. He was born in Trevna. Bulg.. on April 27, 1866, the son of P. R. Slaveikov (*q.v.*). He studied literature and philosophy in Leipzig and subsequently held the posts of director of the national library and director of the national theatre in Sofia.

Slaveikov died at Brunate, on Lake Como, Italy, where he retired in poor health in 1911. His remains were transferred to his native country in 1921.

A highly individualistic lyrical poet whose thought was moulded under the influence of the German poets and philosophers of the 19th century. Slaveikov was also inspired by the simple eloquence and realism of Bulgarian folk songs. A collection of folk songs was published posthumously in 1917.

See E. Damiani, "La figura e l'opera di Pencho Slaveikov nella letteratura bulgara," *Riv. di let. slave,* iii (1928). (L. BY.)

SLAVEIKOV, PETKO RACHEV (1827–1895), first modern Bulgarian poet, outstanding writer and politician who played a considerable part in the renaissance of his country by re-establishing the vernacular language in literature. He was born at Trnovo, Bulg.. April 2, 1827. and received there an elementary education. the only one that was possible under Turkish rule. He wished to become a monk but, inspired by Paissi's *History;* decided to fight for the national revival.

A self-educated man, Slaveikov worked from 1843 as a teacher. He also wrote lyrical and patriotic poems (first published in 1852) and spoke against the Turkish oppressors and the spiritual domination of the Greek ecumenical patriarchate.

In 1863 Slaveikov moved to Istanbul where. from 1866, he edited the *Mukedonia,* a Bulgarian political journal. In 1872 the Turks suspended its publication. He was arrested. On his release he returned to Bulgaria, again earning his living as a teacher. After his country's partial liberation he was one of the prominent Liberal members of the national assembly that met at Trnovo in 1878 and the following year was elected its president.

In 1880–81 Slaveikov was minister of education and later minister of the interior in the L. Karavelov government. After the 1881 *coup d'état* he moved to Plovdiv, then in so-called Eastern Rumelia, where he edited the newspaper *Nezavisimost* ("Independence").

Returning to Sofia in 1883, he was a co-publisher of the Liberal newspaper *Trnooska Konstitutsia* (1884–88).

Slaveikov died in Sofia on June 9, 1895.

See P. *R.* Slaveikov, *Izbrani proizvedenya* ("Selected Poems") (Sofia, 1945); E. Damiani, "Il primo poeta bulgaro," *Riv. di let. slave,* II (Rome, 1927).

SLAVERY. It appears to be true that, in the words of Dunoyer. the economic régime of every society which has recently become sedentary is founded on the slavery of the industrial professions. In the hunter period the savage warrior does not enslave his vanquished enemy. but slays him; the women of a conquered tribe he may, however, carry off and appropriate as wives or as servants, for in this period domestic labour falls almost altogether on their sex. In the pastoral stage slaves will be captured only to be sold, with the exception of a few who may be required for the care of flocks or the small amount of cultivation which is then undertaken. It is in proportion as a sedentary life prevails, and agricultural exploitation is practised on a larger scale, whilst warlike habits continue to exist, that the labour of slaves is increasingly introduced to provide food for the master, and at the same time save him from irksome toil. Of this stage in the social movement slavery seems to have been, as we have said, a universal and inevitable accompaniment.

But wherever theocratic organizations established themselves slavery in the ordinary sense did not become a vital element in the social system. The members of the lowest class were not in a state of individual subjection: the entire caste to which they belonged was collectively subject. It is in the communities in which the military order obtained an ascendancy over the sacerdotal, and which were directly organized for war, that slavery (as the word is commonly understood) had its natural and appropriate place. It is not merely that in its first establishment slavery was an immense advance by substituting for the immolation of captives, often accompanied by cannibalism, their occupation in labour for the benefit of the victor. This advantage, recalled by an old though erroneous[1] etymology, is generally acknowledged. But it is not so well understood that slavery discharged important offices in the later social evolution—first, by enabling military action to prevail with the degree of intensity and continuity requisite for the system of incorporation by conquest which was its final destination; and, secondly, by forcing the captives, who with their descendants came to form the majority of the population in the conquering community, to an industrial life, in spite of the antipathy to regular and sustained labour which is deeply rooted in human nature. As regards the latter consideration, it is enough to say that nowhere has productive industry developed itself in the form of voluntary effort; in every country of which we have any knowledge it was imposed by the strong upon the weak, and was wrought into the habits of the people only by the stern discipline of constraint. From the former point of view the freeman, then essentially a warrior, and the slave were mutual auxiliaries, simultaneously exercising different and complementary functions-each necessary to the community. In modern slavery, on the other hand, where the occupations of both parties were industrial, the existence of a servile class only guaranteed for some of them the possibility of self-indulgent ease, whilst it imposed on others the necessity of indigent idleness.

It was in the Roman State that military action—in Greece often purposeless and, except in the resistance to Persia, on the whole fruitless—worked out the social mission which formed its true justification. Hence at Rome slavery also most properly found its place, so long as that mission was in progress of accomplishment. As soon as the march of conquest had reached its natural limit, slavery began to be modified; and when the empire was divided into the several States which had grown up under it, and the system of defence characteristic of the middle ages was substituted for the aggressive system of antiquity, slavery gradually disappeared, and was replaced by serfdom.

We have so far dealt with the political results of ancient slavery, and have found it to have been in certain respects not only useful but indispensable. When we consider its moral effects, whilst endeavouring to avoid exaggeration, we must yet pronounce its influence to have been profoundly detrimental. In its action on the slave it marred in a great measure the happy effects of habitual industry by preventing the development of the

[1]*Servus* is not cognate with *servare,* as has often been supposed, it is really related to the Homeric εἴρερο and the verb ἐίρω, with which the Latin *sero* is to be connected. It may be here mentioned that *slave* was originally a national name; it meant a man of Slavonic race captured and made a bondman to the Germans. "From the Euxine to the Adriatic, in the state of captives or subjects, . . . they [the Slavonians] overspread the land, and the national appellation of the *Slaves* has been degraded by chance or malice from the signification of glory to that of servitude" (Gibbon, *Decline and Fall,* ch. Iv.). The historian alludes to the derivation of the national name from *slava,* glory. *See* Skeat's ***Etym. Dict.,*** *s.v.; see* also SLAVS.

sense of human dignity which lies at the foundation of morals. On the morality of the masters—whether personal, domestic or social—the effects of the institution were disastrous.

GREECE

We find slavery fully established in the Homeric period. The prisoners taken in war are retained as slaves, or sold (*Il.* xxiv. 752) or held at ransom (*Il.* vi. 427) by the captor. Sometimes the men of a conquered town or district are slain and the women carried off (Od. ix. 40). Not unfrequently free persons were kidnapped by pirates and sold in other regions, like Eumaeus in the Odyssey. The slave might thus be by birth of equal rank with his master, who knew that the same fate might befall himself or some of the members of his family. The institution does not present itself in a very harsh form in Homer, especially if we consider (as Grote suggests) that "all classes were much on a level in taste, sentiment and instruction." The male slaves were employed in the tillage of the land and the tending of cattle, and the females in domestic work and household manufactures. The principal slaves often enjoyed the confidence of their masters and had important duties entrusted to them; and, after lengthened and meritorious service, were put in possession of a house and property of their own (Od. xiv. 64). Grote's idea that the women slaves were in a more pitiable condition than the males does not seem justified, except perhaps in the case of the aletrides, who turned the household mills which ground the flour consumed in the family, and who were sometimes overworked by unfeeling masters (Od. xx. 110–119). Homer marks in a celebrated couplet his sense of the moral deterioration commonly wrought by the condition of slavery (Od. xvii. 322).

Historic Period—Sources of Slavery.—It is, however, in historic Greece, where we have ample documentary information, that it is most important to study the system. The sources of slavery in Greece were: (1) Birth, the condition being hereditary. This was not an abundant source, women slaves being less numerous than men, and wise masters making the union of the sexes rather a reward of good service than a matter of speculation (Xen. Oecon. 9. 5). It was in general cheaper to buy a slave than to rear one to the age of labour. (2) Sale of children by their free parents, which was tolerated, except in Attica, or their exposure, which was permitted, except at Thebes. The consequence of the latter was sometimes to subject them to a servitude worse than death, as is seen in the plays of Plautus and Terence, which, as is well known, depict Greek, not Roman, manners. Freemen, through indigence, sometimes sold themselves, and at Athens, up to the time of Solon, an insolvent debtor became the slave of his creditor. (3) Capture in war. Not only Asiatics and Thracians thus became slaves, but in the many wars between Grecian States, continental or colonial, Greeks were reduced to slavery by men of their own race. Callicratidas pronounced against the enslavement of Greeks by Greeks, but violated his own principle, to which, however, Epaminondas and Pelopidas appear to have been faithful. (4) Piracy and kidnapping. The descents of pirates on the coasts were a perpetual source of danger; the pirate was a gainer either by the sale or by the redemption of his captives. If ransomed, the victim became by Athenian law the slave of his redeemer till he paid in money or labour the price which had been given for him. Kidnappers (andrapodistae) carried off children even in cities, and reared them as slaves. Whether from hostile forays or from piracy, any Greek was exposed to the risk of enslavement. (5) Commerce. Besides the sale of slaves which took place as a result of the capture of cities or other military operations, there was a systematic slave trade. Syria, Pontus, Lydia, Galatia, and above all Thrace were sources of supply. Egypt and Ethiopia also furnished a certain number, and Italy a few. Of foreigners, the Asiatics bore the greatest value, as most amenable to command, and most versed in the arts of luxurious refinement. But Greeks were highest of all in esteem, and they were much sought for foreign sale. Greece proper and Ionia supplied the petty Eastern princes with courtesans and female musicians and dancers. Athens was an important slave market, and the State profited by a tax on the sales; but the principal marts were those of Cyprus, Samos, Ephesus and especially Chios.

Employment of Slaves.—The slaves were employed either in domestic service—as household managers, attendants or personal escorts—or in work of other kinds, agricultural or urban. In early Attica, and even down to the time of Pericles, the landowners lived in the country. The Peloponnesian War introduced a change; and after that time the proprietors resided at Athens, and the cultivation was in the hands of slaves. In manufactures and commerce, also, servile gradually displaced free labour. Speculators either directly employed slaves as artisans or commercial and banking agents, or hired them out, sometimes for work in mines or factories, sometimes for service in private houses, as cooks, flute-players, etc., or for viler uses. There were also public slaves; of these some belonged to temples, to which they were presented as offerings, amongst them being the courtesans who acted as hieroduli at Corinth and at Eryx in Sicily; others were appropriated to the service of the magistrates or to public works; there were at Athens 1,200 Scythian archers for the police of the city; slaves served, too, in the fleets, and were employed in the armies—commonly as workmen, and exceptionally as soldiers.

The condition of slaves at Athens was not in general a wretched one. Demosthenes (In Mid. p. 530) says that, if the barbarians from whom the slaves were bought were informed of the mild treatment they received, they would entertain a great esteem for the Athenians. Plautus in more than one place thinks it necessary to explain to the spectators of his plays that slaves at Athens enjoyed such privileges, and even licence, as must be surprising to a Roman audience. The slave was introduced with certain customary rites into his position in the family; he was in practice, though not by law, permitted to accumulate a private fund of his own; his marriage was also recognized by custom; though in general excluded from sacred ceremonies and public sacrifices, slaves were admissible to religious associations of a private kind; there were some popular festivals in which they were allowed to participate; they had even special ones for themselves both at Athens and in other Greek centres. Their remains were deposited in the family tomb of their master, who sometimes erected monuments in testimony of his affection and regret. They often lived on terms of intimacy either with the head of the house or its younger members; but it is to be feared that too often this intimacy was founded, not on mutual respect, as in the heroic example of Ulysses and Eumaeus, but on insolent self-assertion on the one side and a spirit of unworthy compliance on the other, the latter having its *raison d'être* in degrading services rendered by the slave. Aristophanes and Plautus show us how often resort was had to the discipline of the lash even in the case of domestic slaves. Those employed in workshops, whose overseers were themselves most commonly of servile status, had probably a harder lot than domestics; and the agricultural labourers were not unfrequently chained, and treated much in the same way as beasts of burden. The displeasure of the master sometimes dismissed his domestics to the more oppressive labours of the mill or the mine. A refuge from cruel treatment was afforded by the temples and altars of the gods and by the sacred groves. Nor did Athenian law leave the slave without protection. He had, as Demosthenes boasts, an action for outrage like a freeman, and his death at the hand of a stranger was avenged like that of a citizen (Eurip. Hec. 288), whilst, if caused by his master's violence, it had to be atoned for by exile and a religious expiation. Even when the slave had killed his master, the relatives of the house could not themselves inflict punishment; they were obliged to hand him over to the magistrate to be dealt with by legal process. The slave who had just grounds of complaint against his master could demand to be sold; when he alleged his right to liberty, the law granted him a defender and the sanctuaries offered him an asylum till judgment should be given. Securities were taken against the revolt of slaves by not associating those of the same nationality and language; they were sometimes fettered to prevent flight, and, after a first attempt at escape, branded to facilitate their recovery. There were treaties between States for the extradition of fugitives, and contracts of mutual assurance between individuals against their loss by flight.

Emancipation.—The slave could purchase his liberty with his *peculium* by agreement with his master. He could be liberated by will, or, during his master's life, by proclamation in the theatre, the law courts or other public places, or by having his name inscribed in the public registers, or, in the later age of Greece, by sale or donation to certain temples—an act which did not make the slave a hierodulus but a freeman. Conditions were sometimes attached to emancipation, as of remaining for life or a definite time with the former master, or another person named by him, or of performing some special service; payments or rights of succession to property might also be reserved. By manumission the Athenian slave became in relation to the State a metic, in relation to his master a client. He was thus in an intermediate condition between slavery and complete freedom. If the freedman violated his duties to his patron he was subject to an action at law, and if the decision were against him, he was again reduced to slavery. He became a full member of the State only, as in the case of foreigners, by a vote in an assembly of 6,000 citizens; and even this vote might be set aside by a *graphē paranomōn*. Slaves who had rendered eminent services to the public, as those who fought at Arginusae and at Chaeronea, were at once admitted to the status of citizens in the class of (so-called) Plataeans. But it would appear that even in their case some civic rights were reserved and accorded only to their children by a female citizen. The number of freedmen at Athens seems never to have been great. (*See* further GREECE: *History*.)

Theoretic Views on Slavery.—It is well known that Aristotle held slavery to be necessary and natural, and, under just conditions, beneficial to both parties in the relation—views which were correct enough from the political side, regard being had to the contemporary social state. His practical motto, if he is the author of the *Economics* attributed to him, is—"no outrage, and no familiarity." There ought, he says, to be held out to the slave the hope of liberty as the reward of his service. Plato condemned the practice, which the theory of Aristotle also by implication sets aside as inadmissible, of Greeks having Greeks for slaves. In the *Laws* he accepts the institution as a necessary though embarrassing one, and recommends for the safety of the masters that natives of different countries should be mixed and that they should all be well treated. But, whilst condemning harshness towards them, he encourages the feeling of contempt for them as a class. The later moral schools of Greece scarcely at all concern themselves with the institution. The Epicurean had no scruple about the servitude of those whose labours contributed to his own indulgence and tranquillity. The Stoic regarded the condition of freedom or slavery as an external accident, indifferent in the eye of wisdom; to him it was irrational to see in liberty a ground of pride or in slavery a subject of complaint; from intolerable indignity suicide was an ever-open means of escape. The poets—especially the authors of the New Comedy—strongly inculcate humanity, and insist on the fundamental equality of the slave. The celebrated "homo sum" is a translation from Alexis, and the spirit of it breathes in many passages of the Greek drama. A fragment of Philemon declares, as if in reply to Aristotle, that not nature, but fortune, makes the slave. Euripides, as might be expected from his humanitarian cast of sentiment, and the "premature modernism" which has been remarked in him, rises above the ordinary feelings of his time in regard to the slaves. As Paley says, he loves "to record their fidelity to their masters, their sympathy in the trials of life, their gratitude for kindness and considerate treatment, and their pride in bearing the character of honourable men. · · · He allows them to reason, to advise, to suggest; and he even makes them philosophize on the follies and the indiscretions of their superiors" (compare *Med.* 54; *Orest.* 869; *Hel.* 728; *Ion.* 854; *Frag. Melan.* 506; *Phrix.* 823). (For the Helots in Laconia, see HELOTS.)

ROME

We have already observed that the Roman system of life was that in which slavery had its most natural and relatively legitimate place; and accordingly it was at Rome that, as Blair has remarked, the institution was more than anywhere else "extended in its operations and methodized in its details."

Sources of Slavery.—We must distinguish from the later slavery at Rome what Mommsen calls "the old, in some measure innocent" slavery, under which the farmer tilled the land along with his slave, or, if he possessed more land than he could manage, placed the slave—either as a steward, or as a sort of lessee obliged to render up a portion of the produce—over a detached farm. Though slaves were obtained by the early victories of Rome over her Italian neighbours, no large number was employed on the small holdings of those periods. But the extension of properties in the hands of the patricians, and the continued absences of citizens required by the expanding system of conquest, necessarily brought with them a demand for slave labour, which was increasingly supplied by captives taken in war. Of the number furnished from this source a few particulars from the time of the mature republic and the first century of the empire will give some idea. In Epirus, after the victories of Aemilius Paullus, 150,000 captives were sold. The prisoners at Aquae, Sextiae and Vercellae were 90,000 Teutons and 60,000 Cimbri. Caesar sold on a single occasion in Gaul 63,000 captives. But slavery, as Hume has shown, is unfavourable to population. Hence a regular commerce in slaves was established, which was based on the "systematically-prosecuted hunting of man," and indicated an entire perversion of the primitive institution, which was essentially connected with conquest. The pirates sold great numbers of slaves at Delos, where was the chief market for this kind of wares; and these sales went on as really, though more obscurely, after the successful expedition of Pompey. There was a regular importation to Rome of slaves, brought to some extent from Africa, Spain and Gaul, but chiefly from Asiatic countries—Bithynia, Galatia, Cappadocia and Syria.

There were other sources from which slavery was alimented, though of course in a much less degree. Certain offences reduced the guilty persons to slavery (*servi poenae*), and they were employed in public work in the quarries or the mines. Originally, a father could sell his children. A creditor could hold his insolvent debtor as a slave, or sell him out of the city (*trans Tiberim*). The enslavement of debtors, overwhelmed with usury in consequence of losses by hostile raids or their own absence on military service, led to the secession to the Mons Sacer (493 B.C.). The Poetelian law (326 B.C.) restricted the creditor's lien (by virtue of a *nexum*) to the goods of his debtor, and enacted that for the future no debtor should be put in chains; but we hear of debtors *addicti* to their creditors by the tribunals long after—even in the time of the Punic Wars.

Employment of Slaves.—There were *servi publici* as well as *privati*. The service of the magistrates was at first in the hands of freemen; but the lower offices, as of couriers, servants of the law courts, of prisons and of temples, were afterwards filled by slaves. The execution of public works also came to be largely committed to them—as the construction of roads, the cleansing of the sewers and the maintenance of the aqueducts. Both kinds of functions were discharged by slaves, not only at Rome, but in the rural and provincial municipalities. The slaves of a private Roman were divided betneen the *familia rustica* and the *familia urbana*. At the head of the *familia rustica* was the *villicus*, himself a slave, with the wife who was given him at once to aid him and to bind him to his duties. Under him were the several groups employed in the different branches of the exploitation and the care of the cattle and flocks, as well as those who kept or prepared the food, clothing and tools of the whole staff and those who attended on the master in the various species of rural sports. A slave prison (*ergastulum*) was part of such an establishment, and there were slaves whose office it was to punish the offences of their fellows. To the *familia urbana* belonged those who discharged the duties of domestic attendance, the service of the toilet, bath, table and kitchen, besides the entertainment of the master and his guests by dancing, singing and other arts. There were, besides, the slaves who accompanied the master and mistress out of doors and were chosen for their beauty and grace as guards of honour, for their strength as chairmen or porters, or for their readiness and address in remembering names, delivering messages of courtesy and the like. There were also attached to a great household physicians, artists. secretaries, librarians, copyists, preparers of parchment, as well as pedagogues and preceptors of different kinds — readers, grammarians. men of letters and even philosophers — all of servile condition, besides accountants, managers and agents for the transaction of business. Actors. comic and tragic, pantomimi, and the performers of the circus were commonly slaves, as were also the gladiators. These last were chosen from the most warlike races — as the Samnites, Gauls and Thracians. *Fumiliae* of gladiators were kept by private speculators. who hired them out; they were sometimes owned by men of high rank.

Several special examples and other indirect indications show that the wealthier Romans possessed large *familiae.* This may be inferred from the *columbaria* of the house of Livia and of other great houses. The slaves of Pedanius Secundus, who, in spite of a threatened outbreak of the indignant populace, mere all put to death because they had been under their master's roof when he was murdered, were 400 in number.

Pliny tells us that Caecilius, a freedman of the time of Augustus, left by his will as many as 4.116. The question as to the total number of slaves at Rome or in Italy is a very difficult one, and it is not, perhaps, possible to arrive with any degree of certainty at an approximate estimate. Gibbon supposes that there were in the Roman world in the reign of Claudius at least as many slaves as free inhabitants. But Blair seems right in believing that this number, though probably correct for an earlier period, is much under the truth for the age to which it is assigned. He fixes the proportion of slaves to free men as that of three to one for the time between the conquest of Greece (146 B.C.) and the reign of Alexander Severus (A.D. 222–235). The entire number of slaves in Italy would thus have been, in the reign of Claudius. 20.832.000.

Laws. — By the original Roman law the master was clothed with absolute dominion over the slave, extending to the power of life and death, which is not surprising when we consider the nature of the *patria potestas.* The slave could not possess property of any kind: whatever he acquired was legally his master's. He was. however, in practice permitted to enjoy and accumulate chance earnings or savings, or a share of what he produced. under the name of *peculium.* A master could not enter into a contract with his slave, nor could he accuse him of theft before the law; for, if the slave took anything, this was not a subtraction, but only a displacement. of property. The union of a male and female slave had not the legal character of a marriage; it was a cohabitation *(contubernium)* merely, which was tolerated, and might be terminated at will, by the master; a slave was, therefore, not capable of the crime of adultery. Yet general sentiment seems to have given a stronger sanction to this sort of connection; the names of husband and wife are freely used in relation to slaves on the stage, and even in the laws, and in the language of the tombs. For entering the military service or taking on him any State office a slave was punished with death. He could not in general be examined as a witness, except by torture. A master, when accused, could offer his slaves for the "question," or demand for the same purpose the slaves of another; and, if in the latter case they were injured or killed in the process, their owner was indemnified. A slave could not accuse his master, except of adultery or incest (under the latter name being included the violation of sacred things or places); the case of high treason was afterwards added to these. An accused slave could not invoke the aid of the tribunes. The penalties of the law for crime were specially severe on slaves.

Treatment of Slaves. — Columella, like Xenophon, favours a certain friendliness and familiarity in one's intercourse with his farm slaves. Cato ate and drank the same coarse victuals as his slaves, and even had the children suckled by his wife, that they might imbibe a fondness for the family. But he had a strict eye to profit in all his dealings with them. He allowed the *contubernium* of male and female slaves at the price of a money payment from their *peculium.* Columella regarded the gains from the births as a sufficient motive for encouraging these unions, and thought that mothers should be rewarded for their fecundity; Varro, too, seems to have taken this view. The immense extension of the rural estates *(latijundia)* made it impossible for masters to know their slaves, even if they were disposed to take trouble for the purpose. Effective superintendence even by overseers became less easy; the use of chains was introduced, and these were worn not only in the field during working hours but at night in the *ergastulum* where the slaves slept. Urban slaves had probably often a life as little enviable, especially those who worked at trades for speculators. Even in private houses at Rome, so late as the time of Ovid, the porter was chained. In the *familia urbana* the favourites of the master had good treatment, and might exercise some influence over him which would lead to their receiving flattery and gifts from those who sought his vote or solicited his support. Doubtless there was often genuine mutual affection; slaves sometimes, as in noted instances during the civil wars, showed the noblest spirit of devotion to their masters. Those who were not inmates of the household, but were employed outside of it as keepers of a shop or boat, chiefs of workshops, or clerks in a mercantile business, had the advantage of greater freedom of action. The slaves of the *leno* and the *lanista* were probably in most cases not only degraded but unhappy. The lighter punishments inflicted by masters were commonly personal chastisement or banishment from the town house to rural labour; the severer were employment in the mill *(pistrinum)* or relegation to the mines or quarries. To the mines also speculators sent slaves; they worked half-naked, men and women, in chains, under the lash and guarded by soldiers. Vedius Pollio, in the time of Augustus, was said to have thrown his slaves, condemned sometimes for trivial mistakes or even accidents, to the lampreys in his fishpond. Cato advised the agriculturist to sell his old oxen and his old slaves, as well as his sick ones; and sick slaves were exposed in the island of Aesculapius in the Tiber; by a decree of Claudius slaves so exposed could not be reclaimed by their masters, in case of their recovery.

Though the Roman slaves were not, like the Spartan Helots, kept obedient by systematic terrorism, their large numbers were a constant source of danger. The law under which the slaves of Pedanius were put to death, probably introduced under Augustus and more fully enacted under Nero, is sufficient proof of this anxiety, which indeed is strongly stated by Tacitus in his narrative of the facts. There had been many conspiracies amongst the slaves in the course of Roman history, and some formidable insurrections. The growth of the *latifundia* made the slaves more and more numerous and formidable. Free labour was discountenanced. Cato, Varro and Columella all agree that slave labour was to be preferred to free except in unhealthy regions and for large occasional operations, which probably transcended the capacity of the permanent *familia rustica.* Cicero and Livy bear testimony to the disappearance of a free plebs from the country districts and its replacement by gangs of slaves working on great estates. The worst form of such predial slavery existed in Sicily, whither Mommsen supposes that its peculiarly harsh features had been brought by the Carthaginians. In Sicily, accordingly, the first really serious servile insurrections took place. The rising under Eunus in 133 B.C. was with some difficulty suppressed by Rupilius. Partial revolts in Italy succeeded; and then came the second Sicilian insurrection under Trypho and Athenio, followed by the Servile War in Italy under Spartacus (*q.v.*). Clodius and Milo used bands of gladiators in their city riots, and this action on the part of the latter was approved by Cicero. In the First Civil War they were to be found in both camps, and the murderers of Caesar were escorted to the Capitol by gladiators. Antony, Octavius, and Sextus Pompeius employed them in the Second Civil War; and it is recorded by Augustus on the Monumentum Ancyranum that he gave back to their masters for punishment about 30,000 slaves who had borne arms against the State.

Blair, in comparing the Greek and Roman systems of slavery, points with justice to the greater facility and frequency of emancipation as the great superiority of the latter. No Roman slave, he says, "needed to despair of becoming both a freeman and a citizen." Manumission was of two kinds—*justa* or regular, and *minus* justa. Of *manumissio* justa there were four modes: (1) by adoption, rarely resorted to; (2) by testament, already recognized in the Twelve Tables; (3) by census, which was of exceptional use, and did not exist later than the time of Vespasian; and (4) by vindicta, which was the usual form. In the last method the master turned the slave round, with the words "liber esto," in the presence of the praetor, that officer or his lictor at the same time striking the slave with his rod. The manumissio minus justa was effected by a sufficient manifestation of the will of the master, as by letter, by words, by putting the *pileus* (or cap of liberty) on the slave, or by any other formality which had by usage become significant of the intention to liberate, or by such an act as making the slave the guardian of his children. This extra-legal sort of manumission was incomplete and precarious; even after the lex *Junia Norbana* (A.D. 19), which assimilated the position of those so liberated to that of the Latin colonists, under the name of Latini juniores, the person remained in the eye of the law a slave till his death and could not dispose of his *peculium* by gift or testamentary disposition.

A freedman, unless he became such by operation of law, remained client of his master, and both were bound by mutual obligations arising out of that relation. These obligations existed also in the case of freedmen of the State, of cities, temples and corporations. The freedman took his former master's name; he owed him deference (*obsequium*) and aid (*officium*); and neglect of these obligations was punished, in extreme cases even with loss of liberty. Conditions might be annexed by the master to the gift of freedom, as of continued residence with him, or of general service or some particular duty to be performed, or of a money payment to be made. But the praetor Rutilius, about the beginning of the 1st century B.C., limited the excessive imposition of such conditions, and his restrictions were carried further by the later jurists and the imperial constitutions. Failing natural heirs of an intestate freedman, the master, now patron, succeeded to his property at his death; and he could dispose by will of only half his possessions, the patron receiving the other half. Freedmen and their sons were subject to civil disabilities; the third generation became *ingenui* (full citizens). Thus the slave element tended to merge itself in the general popular body.

It was often a pecuniary advantage to the master to liberate the slave; he obtained payment which enabled him to buy a substitute and at the same time gained a client. This, of course, presupposes the recognition of the right of the slave to his *peculium;* and the same is implied in Cicero's statement that a diligent slave could in six years purchase his freedom. Augustus set himself against the undue multiplication of manumissions. probably considering the rapid succession of new citizens a source of social instability. and recommended a similar policy to his successor. The lex Aelia Sentia (about A.D. 3) forbade manumission, except in strictly limited cases, by masters under 20 years of age or of slaves under 30; and the lex Furia Caninia (about A D 7) fixed the proportion of a man's slaves which he could liberate by testament, and forbade more than 100 being so enfranchised, whatever might be the number of the familia. Under the empire the freedmen rose steadily in influence; they became admissible to the rank of equites and to the senate; they obtained provincial Governments, and were appointed to offices in the imperial household which virtually placed them at the head of administrative departments. (See article on NARCISSUS) Freedmen of humbler rank, on the other hand, filled the minor offices in the administrative service, in the city cohorts, and in the army; and we shall find that they entered largely into the trades and professions when free labour began to revive. They appeared also in literature, *e.g.,* Tiro, the amanuensis of Cicero; Hyginus, the librarian of Augustus; Livius Andronicus, Caecilius, Statius, Terence, Publilius Syrus, Phaedrus and Epictetus.

In the 2nd century of the Christian era we find a marked change with respect to the institution of slavery, both in the region of thought and in that of law. Already the principles of reason and humanity had been applied to the subject by Seneca. But it was in the 2nd century, as we have said, that "the victory of moral ideas" in this, as in other departments of life, became "decisive. . . . Dio Chrysostom, the adviser of Trajan, is the first Greek writer who has pronounced the principle of slavery to be contrary to the law of nature" (Mark Pattison). And a parallel change is found in the practical policy of the State. The military vocation of Rome was now felt to have reached its normal limits; and the emperors, understanding that, in the future, industrial activity must prevail, prepared the abolition of slavery as far as was then possible, by honouring the freedmen, by protecting the slave against his master, and by facilitating manumissions. The general tendency both of the imperial constitutions and of the maxims of the legists is in favour of liberty. The practices of exposure and sale of children, and of giving them in pledge for debt, are forbidden. Diocletian forbade a free man to sell himself. Kidnappers (*plagiarii*) were punished with death. The insolvent debtor was withdrawn from the yoke of his creditor. While the slave trade was permitted, the mutilation of boys and young men, too often practised, was punished with exile and even with death. In redhibitory actions (for the annulment of sales), if a slave were returned to the seller, so must also be his parents, brothers and personae contubernio *conjunctae.* In the interpretation of testaments it was to be assumed that members of the same family were not to be separated by the division of the succession. The law also favoured in special cases the security. of the peculium, though in general principle it still remained the property of the master. The State granted to public slaves the right of bequeathing half their possessions; and private persons sometimes permitted similar dispositions even to a greater extent, though only within the *familia.* Hadrian took from masters the power of life and death and abolished the subterranean prisons. Antoninus Pius punished him who killed his own slave as if he had killed another's. Already in the time of Nero the magistrates had been ordered to receive the slave's complaint of ill-treatment; and the *lex* Petronia, belonging to the same or an earlier period, forbade masters to hand over their slaves to combats with wild beasts. M. Aurelius gave to masters an action against their slaves for any cause of complaint, thus bringing their relation more directly under the surveillance of law and public opinion. A slave's oath could still not be taken in a court of law; he was interrogated by the "question"; but the emperors and jurists limited in various ways the application of torture, adding, however, as we have mentioned, to the cases in which it could previously be appealed to that of the crime of *majestas.* For certain alleged offences of the master the slave could bring an action, being represented for the purpose by an *adsertor.* Emancipation mas facilitated. The power of imposing conditions on testamentary manumissions was restricted, and these conditions interpreted in the sense most favourable to freedom. The emperor could confer liberty by presenting a gold ring to a slave with the consent of the master, and the legal process called restitutio *natalium* made him a full citizen

Influence of Christianity.— The rise of Christianity in the Roman world still further improved the condition of the slave The sentiments it created were not only favourable to the humane treatment of the class in the present, but were the germs out of which its entire liberation was destined, at a later period, in part to arise. It is sometimes objected that the Christian Church did not denounce slavery as a social crime and insist on its abolition. We have seen that slavery was a fundamental element of the old Roman constitution. When the work of conquest had been achieved, it could not be expected that a radical alteration should be suddenly wrought either in the social system which was in harmony with it, or even in the general ideas which had grown up under its influence. The latter would, indeed, be gradually affected; and accordingly, we have observed a change in the policy of the law, indicating a change in sentiment with respect to the slave class, which does not appear to have been at all due to Christian teaching. But the institution itself could not be at once seriously disturbed. The results must have been disastrous, most of all to the slave population itself. Before that end could be accomplished, an essentially new social situation must come into existence. But in the meantime much might be done towards further mitigating the evils of slavery, especially by impressing on master and slave their relative duties and controlling their behaviour towards one another by the exercise of an independent moral authority. This was the work open to the Christian priesthood, and it cannot be denied that it was well discharged. Whilst the fathers agree with the Stoics of the 2nd century in representing slavery as an indifferent circumstance in the eye of religion and morality, the contempt for the class which the Stoics too often exhibited is in them replaced by a genuine sympathy They protested against the multiplication of slaves from motives of vanity in the houses of the great, against the gladiatorial combats (ultimately abolished by the noble self-devotion of a monk) and against the consignment of slaves to the theatrical profession, which was often a school of corruption. The Church also encouraged the emancipation of individual slaves and the redemption of captives. And its influence is to be seen in the legislation of the Christian emperors, which softened some of the harshest features that still marked the institution. But a stronger influence of Christianity appears in Theodosius, and this influence is at the highest in the legislation of Justinian. Its systematic effort is, in his own words, "pro libertate, quam et fovere et tueri Romanis legibus et praecipue nostro numini peculiare est." Law still refused in general to recognize the marriages of slaves; but Justinian gave them a legal value after emancipation in establishing rights of succession. Unions between slaves and free women, or between a freeman and the female slave of another, continued to be forbidden, and were long punished in certain circumstances with atrocious severity. As witness, the slave was still subject to the question; as criminal, he was punished with greater rigour than the freeman. If he accused his master of a crime, unless the charge was of treason, he was burnt. But he could maintain a legal claim to his own liberty, not now merely through an adsertor, but in person. A female slave was still held incapable of the offence of adultery; but Justinian visited with death alike the rape of a slave or freedwoman and that of a free maiden. Already the master who killed his slave had been punished as for homicide, except in the case of his unintended death under correction; Constantine treated as homicide a number of specially enumerated acts of cruelty. Even under Theodosius the combats of the amphitheatre were permitted. if not encouraged. by the State authorities; these sports were still expected from the candidates for public honours. Combats of men with beasts were longest continued; they had not ceased even in the early years of the reign of Justinian. A new process of manumission was now established. to be performer1 in the churches through the intervention of the ministers of religion; and it was provided that clerics could at any time by mere expression of will liberate their slaves. Slaves who were admitted to holy orders, or who entered a monastery, became freemen, under certain restrictions framed to prevent fraud or injustice Justinian abolished the personal conditions which the legislation of Augustus had required to be satisfied by the master who emancipated and the slave who was manumitted, and removed the limitation of number. The liberated slave, whatever the process by which he had obtained his freedom, became at once a full citizen, his former master, however, retaining the right of patronage, the abolition of which would probably have discouraged emancipation.

Transition to Serfdom.—The slavery of the working classes was not directly changed into the system of personal freedom. There was an intermediate stage which has not always been sufficiently discriminated from slavery. We mean the régime of serfdom. In studying the origin of this transitional state of things, four principal considerations have to be kept in view. (1) As Gibbon observes, the completion of the Roman system of conquest reduced the supply of slaves. It is true that, when the barbarian invasions began in the 3rd century, many captives were made, who, when not enrolled in the army, were employed in agriculture or domestic service: but the regular importation was increasingly diminished. This improved the condition of the slave by rendering his existence an object of greater value to his master. It was clearly to the interest of each family to preserve indefinitely its own hereditary slaves. Hence the abolition of the external slave trade tended, in fact, to put an end to internal sales, and the slaves became attached to the households or lands of their masters. (2) The diminished supply of slaves further acted in the direction of the rehabilitation of free labour. A general movement of this kind is noticeable from the 2nd century onwards. Freemen had always been to some extent employed in the public service In private service superior posts were often filled by freedmen; the higher arts—as medicine, grammar, painting—were partly in the hands of freedmen and even of *ingenui;* the more successful actors and gladiators were often freedmen In the factories or workshops kept by wealthy persons slave labour was mainly employed; but free artisans sometimes offered their services to these establishments or formed associations to compete with them. We have seen that free persons had all along been to some extent employed in the cultivation of land as hired labourers, and, as we shall presently find, also as tenants on the great estates. How all this operated we sha!! understand when we examine the remarkable organization of the State introduced by Diocletian and his successors. (3) This organization established in the Roman world a personal and hereditary fixity of professions and situations which was not very far removed from the caste system of the East. The purpose of this was doubtless to resist by a strong internai consolidation the shock of the invasions, to secure public order, to enforce industrious habits, and to guarantee the financial resources of the State. Personal independence was largely sacrificed, but those still more important ends were in a great measure attained. This system, by diminishing the freeman's mastery over himself and his power to determine his occupation, reduced the interval between him and the slave; and the latter on the one hand, the free domestic servant and workshop labourer on the other, both passed insensibly into the common condition of serfdom. (4) The corresponding change, in the case of the rural slaves, took place through their being merged in the order of *coloni* The Roman *colonus* was originally a free person who took land on lease contracting to pay to the proprietor either a fixed sum annually or (when a *colonus partiarius*) a certain proportion of the produce of the farm. Under the emperors of the 4th century the name designated a cultivator who. though personally free, was attached to the soil, and transmitted his condition to his descendants; and this became the regular status of the mass of Roman cultivators. The class of coloni appears to have been composed partly of tenants by contract who had incurred large arrears of rent and were detained on the estates as debtors (obaerati). partly of foreign captives or immigrants who were settled in this condition on the land, and partly of small proprietors and other poor men who voluntarily adopted the status as an improvement in their position. They paid a fixed proportion of the produce (pars agraria) to the owner of the estate, and gave a determinate amount of labour (operae) on the portion of the domain which he kept in his own hands (*mansus dominicus*). The law for a long time took no notice of these customary tenures, and did not systematically constitute them until the 4th century. It was, indeed, the requirements of the fiscus and the conscription which impelled the imperial Government to regulate the system. The coloni were inscribed (*adscripti*) on the registers of the census as paying taxes to the State, for which the proprietor was responsible, reimbursing himself for the amount. In a constitution of Constantine (A D 332) we find the colonus recognized as permanently attached to the land. If he abandoned his holding he was brought back and punished; and anyone who received him had not only to restore him but to pay a penalty. He could not marr, out of the domain; if he took for wife a colona of another proprietor. she was restored to her original locality, and the offspring of the union were divided between the estates. The children of a colonus were fixed in the same status. They and their descendants were retained in the words of a law of Theodosius, "quodam aeternitatis jure," and by no process could be relieved from their obligations By a law of Anastasius, at the end of the 5th century, a colonus who had voluntarily come into an estate was by a tenure of 30 years for ever attached to it. The master (dominus) could inflict on his coloni "moderate chastisement," and could chain them if they attempted to escape, but they had a legal remedy against him for unjust demands or injury to them or theirs. In no case could the rent or the labour dues be increased The colonus could possess property of his own, but could not alienate it without the consent of the master. Thus, whilst the members of the class were personally free, their condition had some incidents of a semi-servile character. They are actually designated by Theodosius, "servi terrae cui nati sunt." And Salvian treats the proposition "coloni divitum fiunt" as equivalent to "vertuntur in servos." This is, indeed, an exaggeration; the *colonatus* was not an oppressive system; it afforded real security against unreasonable demands and wanton disturbance, and it was a great advance on the system of the *familia rustica.* But the point which is important is that there was a certain approximation between the condition of the colonus and the slave which tended towards the fusion of both in a single class.

Besides the coloni there were on a great estate—and those of the 4th century were on a specially large scale—a number of predial slaves, who worked collectively under overseers on the part of the property which the owner himself cultivated. But it was a common practice to settle certain of the slaves (and possibly also of the freedmen) on other portions of the estate, giving them small farms on conditions similar to those to which the coloni were subject. These slaves are, in fact, described by Ulpian as *quasi coloni.* They had their own households and were hence distinguished as *casati.* In law these slaves were at first absolutely at the disposal of their masters; they had no property in the strict sense of the word, and could be sold to another proprietor and separated from their families. But the landlord's interest and the general tone of feeling alike modified practice even before the intervention of legislation; they were habitually continued in their holdings, and came to possess in fact a perpetual and hereditary enjoyment of them. By a law of Valentinian I. (377) the sale of these slaves was interdicted unless the land they occupied was at the same time sold. The legal distinction between the coloni and the slave tenants continued to exist after the invasions; but the practical difference was greatly attenuated. The colonus often occupied a servile mansus, and the slave a mansus originally appropriated to a colonus. Intermarriages of the two classes became frequent. Already at the end of the 7th century it does not appear that the distinction between them had any substantial existence.

The influence of the Northern invasions on the change from slavery to serfdom was, in all probability, of little account. The change would have taken place, though perhaps not so speedily, if they had never occurred. For the developments of the middle ages *see* SERFDOM and *VILLEINAGE.*

MODERN SLAVE TRADE

Not very long after the disappearance of serfdom in the most advanced communities comes into sight the new system of colonial slavery, which, instead of being the spontaneous outgrowth of social necessities and subserving a temporary need of human development, was politically as well as morally a monstrous aberration.

Spanish Colonies.—In 1442, when the Portuguese under Prince Henry the Navigator were exploring the Atlantic coast of Africa, one of his officers, Antam Goncalves, who had captured some Moors, was directed by the prince to carry them back to Africa. He received from the Moors in exchange for them ten blacks and a quantity of gold dust. This excited the cupidity of his fellow-countrymen; and they fitted out a large number of ships for the trade, and built several forts on the African coast. Many negroes were brought into Spain from these Portuguese settlements, and the colonial slave trade first appears in the form of the introduction into the newly discovered western world of descendants of these negroes. When Nicolas de Ovando was sent out in 1502 as governor of Haiti, whilst regulations, destined to prove illusory, were made for the protection of the natives of the island, permission was given to carry to the colony negro slaves, born in Seville and other parts of Spain, who had been instructed in the Christian faith. It appears from a letter of Ovando in 1503 that there were at that time numbers of negroes in Haiti; he requested that no more might be permitted to be brought out. In 1510 and the following years King Ferdinand ordered a number of Africans to be sent to that colony for the working of the mines.

Before this time Columbus had proposed an exchange of his Carib prisoners as slaves against live stock to be furnished to Haiti by Spanish merchants. He actually sent home, in 1494, above 500 Indian prisoners taken in wars with the caciques, who, he suggested, might be sold as slaves at Seville. But, after a royal order had been issued for their sale, Queen Isabella, interested by what she had heard of the gentle and hospitable character of the natives and of their docility, procured a letter to be written to Bishop Fonseca, the superintendent of Indian affairs, suspending the order until enquiry should be made into the causes for which they had been made prisoners, and into the lawfulness of their sale. Theologians differed on the latter question, and Isabella directed that these Indians should be sent back to their native country.

Bartolomé de las Casas, the celebrated bishop of Chiapa, accompanied Ovando to Haiti, and was a witness of the cruelties from which the Indians suffered under his administration. He came to Spain in 1517 to obtain measures in their favour, and he then made the suggestion to Charles that each Spanish resident in Haiti should have licence to import a dozen negro slaves. Las Casas, in his *Historia de las Indias* (lib. iii. cap. 101), confesses the error into which he thus fell. Other good men appear to have given similar advice about the same time, and, as has been shown, the practice was not absolutely new; indeed, the young king had in 1516, whilst still in Flanders, granted licences to his courtiers for the importation of negroes into the colonies, though Jimenes, as regent of Castile, by a decree of the same year forbade the practice. The suggestion of Las Casas was no doubt made on the ground that the negroes could, better than the Indians, bear the labour in the mines, which was rapidly exhausting the numbers of the latter. He has sometimes on this plea been exonerated from all censure; but, though entitled to honour for the zeal which he showed on behalf of the natives, he must bear the blame for his violation or neglect of moral principle. His advice was unfortunately adopted. "Charles," says Robertson, "granted a patent to one of his Flemish favourites, containing an exclusive right" of supplying 4,000 negroes annually to Haiti, Cuba, Jamaica and Porto Rico. "The favourite sold his patent to some Genoese merchants for 25,000 ducats"; these merchants obtained the slaves from the Portuguese; and thus was first systematized the slave trade between Africa and America.

England.—The first Englishman who engaged in the traffic was Sir John Hawkins (*q.v.*). The English slave traders were at first altogether occupied in supplying the Spanish settlements. Indeed, the reign of Elizabeth passed without any English colony having been permanently established in America. But in 1619 a Dutch ship from the coast of Guinea visited Jarnestown in Virginia, and sold a part of her cargo of negroes to the tobacco-planters. This was the beginning of slavery in British America; the number of negroes was afterwards continually increased—though apparently at first slowly—by importation, and the field-labour was more and more performed by servile hands, so that in 1790 the State of Virginia contained 200,000 negroes.

The African trade of England was long in the hands of exclusive companies; but by an act of the first year of William and Mary it became free and open to all subjects of the Crown. The African company, however, continued to exist, and obtained from time to time large parliamentary grants. By the Treaty of Utrecht, the asiento, or contract for supplying the Spanish colonies with 4,800 negroes annually, which had previously passed from the Dutch to the French, was transferred to Great Britain; an English company was to enjoy the monopoly for a period of 30 years from May 1, 1713. But the contract came to an end in 1739, when the complaints of the English merchants on one side and of the Spanish officials on the other rose to such a height that Philip V. declared his determination to revoke the asiento, and Sir Robert Walpole was forced by popular feeling into war with Spain. Between 1680 and 1700 about 140,000 negroes were exported by the African company, and 160,000 more by private adventurers, making a total of 300,000. Between 1700 and the end of 1786 as many as 610,000 were transported to Jamaica alone, which had been an English possession since 1655. Bryan Edwards estimated the total import into all the British colonies of America and the West Indies from 1680 to 1786 at 2,130,000, being an annual average of 20,095. The British slave trade reached its utmost extension shortly before the War of American Independence. It was then carried on principally from Liverpool, but also from London, Bristol and Lancaster: the entire number of slave ships sailing from those ports was 192 and in them space was provided for the transport of 47,146 negroes. During fhe war the number decreased, but on its termination the trade immediately revived. When Edwards wrote (1791), the number of European factories on the coasts of Africa was 40; of these 14 were English, 3 French, 15 Dutch, 4 Portuguese and 4 Danish. As correct a notion as can be obtained of the numbers annually exported from the continent about the year 1790 by traders of the several European countries engaged in the traffic is supplied by the following statement: "By the British, 38,000; by the French, 20,000; by the Dutch, 4,000; by the Danes, 2,000; by the Portuguese, 10,000; total 74,000." Thus more than half the trade was in British hands.

The hunting of human beings to make them slaves was greatly aggravated by the demand of the European colonies. The native chiefs engaged in forays, sometimes even on their own subjects, for the purpose of procuring slaves to be exchanged for Western commodities. They often set fire to a village by night and captured the inhabitants when trying to escape. Thus all that was shocking in the barbarism of Africa was multiplied and intensified by this foreign stimulation. Exclusive of the slaves who died before they sailed from Africa, 12½% were lost during their passage to the West Indies; at Jamaica 4½% died whilst in the harbours or before the sale and one-third more in the "seasoning." Thus, out of every lot of 100 shipped from Africa 17 died in about 9 weeks, and not more than 50 lived to be effective labourers in the islands. The circumstances of their subsequent life on the plantations were not favourable to the increase of their numbers. In Jamaica there were in 1690, 40,000; from that year till 1820 there were imported 800,000; yet at the latter date there were only 340,000 in the island. One cause which prevented the natural increase of population was the inequality in the numbers of the sexes; in Jamaica alone there was in 1789 an excess of 30,000 males.

Movement Against the **Slave** Trade.—When the nature of the slave trade began to be understood by the public, all that was best in England was adverse to it. Among those who denounced it—besides some whose names are now little known, but are recorded in the pages of Clarkson—were Baxter, Sir Richard Steele (in *Inkle and Yarico*), the poets Southern (in *Oroonoko),* Pope, Thomson, Shenstone, Dyer, Savage and above all Cowper *(see* his *Cizarity,* and *Task,* bk. 2), Thomas Day (author of *Sandford and Merton*), Sterne, Warburton, Hutcheson, Beattie, John Wesley, Whitfield, Adam Smith, Millar, Robertson, Dr. Johnson, Paley, Gregory, Gilbert Wakefield, Bishop Porteus, Dean Tucker. The question of the legal existence of slavery in Great Britain and Ireland was raised in consequence of an opinion given in 1729 by Yorke and Talbot, attorney-general and solicitor-general at the time, to the effect that a slave by coming into those countries from the West Indies did not become free, and might be compelled by his master to return to the plantations. Chief-justice Holt had expressed a contrary opinion; and the matter was brought to a final issue by Granville Sharp in the case of the negro Somerset. It was decided by Lord Mansfield, in the name of the whole bench, on June 22, 1772, that as soon as a slave set his foot on the soil of the British islands he became free. In 1776 it was moved in the House of Commons by David Hartley, son of the author of *Observations on Man,* that "the slave trade was contrary to the laws of God and the rights of men"; but this motion—the first which was made on the subject—failed.

The first persons in England who took united practical action against the slave trade were the Quakers, following the expression of sentiment which had emanated as early as 1671 from their founder George Fox. In 1727 they declared it to be "not a commenclable or allowed" practice; in 1761 they excluded from their society all who should be found concerned in it, and issued appeals to their members and the public against the system. In 1783 there was formed among them an association "for the relief and liberation of the negro slaves in the West Indies, and for the discouragement of the slave trade on the coast of Africa." This was the first society established in England for the purpose. The Quakers in America had taken action on the subject still earlier than those in England. The Pennsylvanian Quakers advised their members against the trade in 1696; in 1754 they issued to their brethren a strong dissuasive against encouraging it in any manner; in 1774 all persons concerned in the traffic, and in 1776 all slave holders who would not emancipate their slaves, were excluded from membership. The Quakers in the other American provinces followed the lead of their brethren in Pennsylvania. The individuals among the American Quakers who laboured most earnestly and indefatigably on behalf of the Africans were John Woolman (1720–72) and Anthony Benezet (1713–84), the latter a son of a French Huguenot driven from France by the revocation of the Edict of Nantes. The former confined his efforts chiefly to America and, indeed, to his co-religionists there; the latter sought, not without success, to found a universal propaganda in favour of abolition. A Pennsylvanian society was formed in 1774 by James Pemberton and Dr. Benjamin Rush, and in 1787 (after the war) was reconstructed on an enlarged basis under the presidency of Franklin Other similar associations were founded about the same time in different parts of the United States. The next important movement took place in England. Dr. Peckard, vice-chancellor of the University of Cambridge, who entertained strong convictions against the slave trade, proposed in 1785 as subject for a Latin prize dissertation the question, "An liceat invitos in servitutem dare." Thomas Clarkson obtained the first prize, translated his essay into English in an expanded form, and published it in 1786 with the title *Essay on the Slavery and Commerce of the Human Species.* In the process of its publication he was brought into contact with several persons already deeply interested in the question; amongst others with Granville Sharp, William Dillwyn (an American by birth, who had known Benezet), and the Rev. James Ramsay, who had lived 19 years in St. Christopher, and had published an *Essay on the Treatment and Conversion of the African Slaves in tlze British Sugar Colonies.* The distribution of Clarkson's book led to his forming connections with many persons of influence, and especially with William Wilberforce (*q.v.*). A committee was forrned on May 22, 1787, for the abolition of the slave trade, under the presidency of Granville Sharp. It is unquestionable that the principal motive power which originated and sustained their efforts was Christian principle and feeling. The most earnest and unremitting exertions were made by the persons so associated in investigating facts and collecting evidence, in forming branch committees and procuring petitions, information and support of those who pleaded the cause in parliament. To the original members were afterwards added several remarkable persons, amongst whom were Josiah Wedgwood, Bennet Langton (Dr. Johnson's friend), and, later, Zachary Macaulay, Henry Brougham and James Stephen.

In consequence of the numerous petitions presented to parliament, a committee of Privy Council was appointed by the Crown in 1788 to enquire concerning the slave trade; and Pitt moved that the House of Commons should early in the next session take the subject into consideration. Wilberforce's first motion for a committee of the whole House upon the question was made on March 19, 1789, and this committee proceeded to business on May 12 of the same year. After an admirable speech, Wilberforce laid on the table 12 resolutions which were intended as the basis of a future motion for the abolition of the trade. The discussion of these was postponed to the next session, and in 1790–91 evidence was taken upon them. At length, on April 18 of the latter year, a motion was made for the introduction of a bill to prevent the further importation of slaves into the British colonies in the West Indies. Opinion had been prejudiced by the insurrections in St. Domingo and Martinique, and in the British island of Dominica; and the motion was defeated by 163 votes against 88. Legislative sanction was, however, given to the establishment of the Sierra Leone company, for the colonization of a district on the west coast of Africa and the discouragement of the slave trade there. It was hoped at the time that that place would become the centre from which the civilization of Africa would proceed; but this expectation was not fulfilled. On April 2, 1792 Wilberforce again moved that the trade ought to be abolished; an amendment in favour of gradual abolition was carried, and it was finally resolved that the trade should cease on Jan. 1, 1796. When a similar motion was brought forward in the Lords the consideration of it was postponed to the following year, in order to give time for the examination of witnesses by a committee of the House. A bill in the Commons in the following year to abolish that part of the trade by which British merchants supplied foreign settlements with slaves was lost on the third reading; it was renewed in the Commons in 1794 and carried there, but defeated in the Lords. Then followed several years during which efforts were made by the abolitionists in parliament with little success. But in 1806, Lord Grenville and Fox having come into power, a bill was passed in both Houses to put an end to the British slave trade for foreign supply, and to forbid the importation of slaves into the colonies won by the British arms in the course of the war. On June 10 of the same year Fox brought forward a resolution "that effectual measures should be taken for the abolition of the African slave trade in such a manner and at such a period as should be deemed advisable," which was carried by a large majority. A similar resolution was successful in the House of Lords. A bill was then passed through both Houses forbidding the employment of any new vessel in the trade. Finally, in 1807, a bill was presented by Lord Grenville in the House of Lords providing for the abolition of the trade, was passed by a large majority, was then sent to the Commons (where it was moved by Lord Howick), was there amended and passed, and received the royal assent on March 25. The bill enacted that no vessel should clear out for slaves from any port within the British dominions after May 1, 1807, and that no slave should be landed in the colonies after March 1, 1808.

In 1807 the African Institution was formed, with the primary objects of keeping a vigilant watch on the slave traders and procuring, if possible, the abolition of the slave trade by the other European nations. It was also to be made an instrument for promoting the instruction of the negro races and diffusing information respecting the African continent.

The act of 1807 was habitually violated, as the traders knew that, if one voyage in three was successful, they were abundantly remunerated for their losses. This state of things. it was plain, must continue as long as the trade was only a contraband commerce, involving merely pecuniary penalties. Accordingly. in 1811. Brougham carried through parliament a bill declaring the traffic to be a felony punishable with transportation. Some years later another act was passed, making it a capital offence; but this was afterwards repealed. The law of 1811 proved effectual and brought the slave trade to an end so far as the British dominions were concerned.

French Abolition.—The abolition of the French slave trade was preceded by struggles and excesses. The western part of St. Domingo, nominally belonging to Spain, had been occupied by buccaneers, who were recognized and supported by the French Government, and had been ceded to France at the Peace of Ryswick in 1697. So vast was the annual importation of enslaved negroes into this colony before 1791 that the ratio of the blacks to the whites was as 16 to 1. In that year there were in French St. Domingo 480,000 blacks, 24,000 mulattoes and only 30,000 whites. The French law for the regulation of slavery in the plantations, known as the Code *Noir* (framed under Louis XIV. in 1685), was humane in its spirit; but we are informed that its provisions were habitually disregarded by the planters, whilst the free mulattoes laboured under serious grievances and were exposed to irritating indignities. A "Société des Amis des Noirs" was formed in Paris in 1788 for the abolition, not only of the slave trade, but of slavery itself. The president was Condorcet, and amongst the members were the duc de la Rochefoucault, the abbé Gregoire, Brissot, Clavière, Pétion and La Fayette; Mirabeau was an active sympathizer. The great motor of the parallel effort in England was the Christian spirit; in France it was the enthusiasm of humanity which was associated with the revolutionary movement. There were in 1789 a number of mulattoes in Paris, who had come from San Domingo to assert the rights of the people of colour in that colony before the national assembly. The Declaration of the Rights of Man in Aug. 1789 seemed to meet their claims, but in March 1790 the assembly, alarmed by rumours of the discontent and disaffection of the planters in San Domingo, passed a resolution that it had not been intended to comprehend the internal government of the colonies in the constitution framed for the mother country. Vincent Ogé, one of the muiatto delegates in Paris, disgusted at the overthrow of the hopes of his race, returned to San Domingo, and on landing in Oct. 1790 addressed a letter to the governor announcing his intention of taking up arms on behalf of the mulattoes if their wrongs were not redressed. He rose accordingly with a few followers, but was soon defeated and forced to take refuge in the Spanish part of the island. He afterwards surrendered, was tried and sentenced to be broken on the wheel. When the news of this reached Paris, it created a strong feeling against the planters; and on the motion of the abbé Gregoire it was resolved by the assembly on May 15, 1791 "that the people of colour resident in the French colonies, born of free parents, were entitled to, as of right, and should be allowed, the enjoyment of all the privileges of French citizens, and among others those of being eligible to seats both in the parochial and colonial assemblies." On Aug. 23 a rebellion of the negroes broke out in the northern province of San Domingo, and soon extended to the western province, where the mulattoes and blacks combined. Many enormities were committed by the insurgents, and were avenged with scarcely inferior barbarity. The French assembly, fearing the loss of the colony, repealed on Sept. 24 the decree of the preceding May. This vacillation put an end to all hope of a reconciliation of parties in the island. Civil commissioners sent out from France quarrelled with the governor and called the revolted negroes to their assistance. The white inhabitants of Cape François were massacred and the city in great part destroyed by fire. The planters now offered their allegiance to Great Britain; and an English force landed in the colony. But it was insufficient to encounter the hostility of the republican troops and the revolted negroes and mulattoes; it suffered from disease. and was obliged to evacuate the island in 1798. On the departure of the British the Government remained in the hands of Toussaint l'Ouverture (*q.v.*). Slavery had disappeared: the blacks were employed as hired servants, receiving for their remuneration the third part of the crops they raised; and the population was rapidly rising in civilization and comfort. The whole island was now French, the Spanish portion having been ceded by the Treaty of Basle. The wish of Toussaint was that San Domingo should enjoy a practical independence whilst recognizing the sovereignty and exclusive commercial rights of France. The issue of the violent and treacherous conduct of Bonaparte towards the island was that the blacks drove from their soil the forces sent to subdue them, and founded a constitution of their own, which was more than once modified. There can be no doubt that the Government of the Restoration, in seeking to obtain possession of the island, had the intention of re-establishing slavery, and even of reopening the slave trade for the purpose of recruiting the diminished population. But Bonaparte abolished that trade during the Hundred Days, though he also failed to win back the people of San Domingo, or, as it was now called by its original name, Haiti, to obedience. The Bourbons, when again restored, could not reintroduce the slave trade; the notion of conquering the island had to be given up; and its independence was formally recognized in 1825. (See HAITI.)

Progress of the Movement.—England had not been the first European Power to abolish the slave trade; that honour belongs to Denmark; a royal order was issued on May 16, 1792 that the traffic should cease in the Danish possessions from the end of 1802. The United States had in 1794 forbidden any participation by American subjects in the slave trade to foreign countries; they now prohibited the importation of slaves from Africa into their own dominions. This act was passed on March 2, 1807; it did not, however, come into force till Jan. 1, 1808. At the Congress of Vienna (Nov. 1814) the principle was acknowledged that the slave trade should be abolished as soon as possible; but the deterniination of the limit of time was reserved for separate negotiation between the Powers. It had been provided in a treaty between France and Great Britain (May 30, 1814) that no foreigner should in future introduce slaves into the French colonies, and that the trade should be absolutely interdicted to the French themselves after June 1, 1819. This postponement of abolition was dictated by the wish to introduce a fresh stock of slaves into Haiti, if that island should be recovered. Bonaparte, as we have seen, abolished the French slave trade during his brief restoration, and this abolition was confirmed at the second Peace of Paris on Nov. 20, 1815, but it was not eifectually carried out by French legislation until March 1818. In Jan. 1815 Portuguese subjects were prohibited from prosecuting the trade north of the equator, and the term after which the traffic should be everywhere unlawful was fixed to end on Jan. 21, 1823, but was afterwards extended to Feb. 1830; England paid £300,000 as a compensation to the Portuguese. A royal decree was issued on Dec. 10, 1836, forbidding the export of slaves from any Portuguese possession. But this decree was often violated It was agreed that the Spanish slave trade should come to an end in 1820, England paying to Spain an indemnification of £400,000. The Dutch trade was closed in 1814; the Swedish had been abolished in 1813. By the Peace of Ghent, Dec. 1814, the United States and England mutually bound themselves to do all in their power to extinguish the traffic It was at once prohibited in several of the South American States when they acquired independence, as in La Plata, Venezuela and Chile. In 1831 and 1833 Great Britain entered into an arrangement with France for a mutual right of search within certain seas, to which most of the other Powers acceded; and by the Ashburton Treaty (1842) with the United States provision was made for the joint maintenance of squadrons on the west coast of Africa. By all these measures the slave trade, so far as it was carried on under the flags of European nations or for the supply of their colonies, ceased to exist.

Anti-slavery Movement.—Meantime another and more radical reform had been in preparation and was already in progress, namely, the abolition of slavery itself in the foreign possessions of the several States of Europe. When the English slave trade had been closed, it was found that the evils of the traffic, as still continued by several other nations, were greatly aggravated. In consequence of the activity of the British cruisers the traders made great efforts to carry as many slaves as possible in every voyage, and practised atrocities to get rid of the slaves when capture was imminent. It was, besides, the interest of the cruisers, who shared the price of the captured slave-ship, rather to allow the slaves to be taken on board than to prevent their being shipped at all. Thrice as great a number of negroes as before, it was said, was exported from Africa, and two-thirds of these were murdered on the high seas. It was found also that the abolition of the British slave trade did not lead to an improved treatment of the negroes in the West Indies. The slaves were overworked now that fresh supplies were stopped, and their numbers rapidly decreased In 1807 there were in the West Indies 800,000; in 1830 they were reduced to 700,000. It became more and more evident that the evil could be stopped only by abolishing slavery altogether.

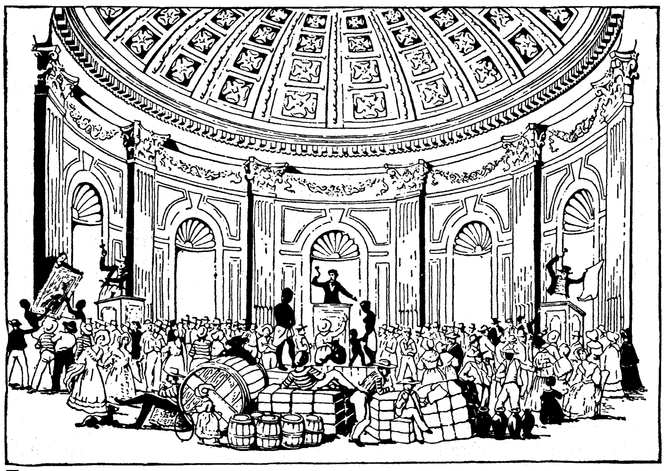
An appeal was made by Wilherforce in 1821 to Thomas Fowell Buxton to undertake the conduct of this new question in parliament. An anti-slavery society was established in 1823, the principal members of which, besides Wilberforce and Buxton, were Zachary Macaulay, Dr. Lushington and Lord Suffield. Buxton moved on May 5, 1823, that the House should take into consideration the state of slavery in the British colonies. The object he and his associates had then in view was gradual abolition by establishing something like a system of serfdom for existing slaves, and passing at the same time a measure emancipating all their children born after a certain day. Canning carried against Buxton and his friends a motion to the effect that the desired ameliorations in the condition and treatment of the slaves should be recommended by the home Government to the colonial legislatures, and enforced only in case of their resistance, direct action being taken in the single instance of Trinidad. which, being a Crown colony, had no legislature of its own. A well-conceived series of measures of reform was accordingly proposed to the colonial authorities. Thereupon a general outcry was raised by the planters at the acquiescence of the Government in the principles of the anti-slavery party. A vain attempt being made in Demerara to conceal from the knowledge of the slaves the arrival of the order in council, they became impressed with the idea that they had been set free, and accordingly refused to work. and, compulsion being resorted to, offered resistance Martial law was proclaimed; the disturbances were repressed with great severity; and the treatment of the missionary Smith, which was taken up and handled with great ability by Brougham, awakened strong feeling in England against the planters. The question, however, made little progress in parliament for some years, though Buxton, William Smith, Lushington, Brougham, Mackintosh, Butterworth and Denman, with the aid of Z. Macaulay, James Stephen, and others, continued the struggle, only suspending it during a period allowed to the local legislatures for carrying into effect the measures expected from them. In 1828 the free people of colour in the colonies were placed on a footing of legal equality with their fellow-citizens. In 1830 the public began to be aroused to a serious prosecution of the main issue. It was becoming plain that the planters would take no steps tending to the future liberation of the slaves, and the leaders of the movement determined to urge the entire abolition of slavery at the earliest practicable period. The Government continued to hesitate and to press for mitigations of the existing system. At length in 1833 the Ministry of Earl Grey took the question in hand and carried the abolition with little difficulty, the measure passing the House of Commons on Aug. 7, 1833, and receiving the royal assent on the 28th. A sum of 20 millions sterling was voted as compensation to the planters. A system of apprenticeship for seven years was established as a transitional preparation for liberty. The slaves were bound to work for their masters during this period for three-fourths of the day, and were to be liable to corporal punishment if they did not give the due amount of labour. The master was, in return, to supply them with food and clothing. All children under six years of age were to be at once free, and provision was to be made for their religious and moral instruction. Many thought the postponement of emancipation unwise. Immediate liberation was carried out in Antigua, and public tranquillity was so far from being disturbed there that the Christmas of 1833 was the first for 20 years during which martial law was not proclaimed in order to preserve the peace. Notwithstanding protracted and strenuous opposition on the part of the Government, the House of Commons passed a resolution against the continuance of the transitional system. When this was done the local legislatures saw that the slaves would no longer work for the masters; they accordingly cut off two years of the indentured apprenticeship, and gave freedom to the slaves in Aug. 1838 instead of 1840.

The example of Great Britain was gradually followed by the other European States, and some American ones had already taken action of the same kind. The immediate emancipation of the slaves in the French colonies was decreed by the Provisional Government of 1848. In 1858 it was enacted that every slave belonging to a Portuguese subject should be free in 20 years from that date, a system of tutelage being established in the meantime. This law came into operation on April 29, 1878, and the status of slavery was thenceforth illegal throughout the Portuguese possessions. The Dutch began the emancipation of their slaves in 1863. Several of the Spanish American states, on declaring their independence, had adopted measures for the discontinuance of slavery within their limits. It was abolished by a decree of the

Mexican republic on Sept. 15, 1829. The government of Buenos Aires enacted that all children born to slaves after Jan. 31, 1813, should be free; and in Colombia it was provided that those born after July 16, 1821, should be liberated on attaining their eighteenth year.

Three of the most important slave systems still remained in which no steps towards emancipation had been taken — those of the Southern United States, of Cuba and of Brazil.

Slavery in the United States. — Slavery was far from being approved in principle by the most eminent of the fathers of the American Union. Washington in his will provided for the emancipation of his own slaves; he said to Jefferson that it was "among his first wishes to see some plan adopted by which slavery in his country might be abolished by law," and again he wrote that to this subject his own suffrage should never be wanting. John Adams declared his abhorrence of the practice of slave-holding, and said that "every measure of prudence ought to be assumed for the eventual total extirpation of slavery from the United States." Franklin's opinions we have already indicated; and Madison, Hamilton and Patrick Henry all reprobated the principle of the system. Jefferson declared in regard to slavery, "I tremble for my country when I reflect that God is just" The last-named statesman, at the first Continental Congress after the evacuation by the British forces, proposed a draft ordinance (March 1, 1784) for the government of the North-west Territory, in which it was provided that "after the year 1800 there shall be neither slavery nor involuntary servitude in any of the said states, otherwise than in punishment of crime." This proviso, however, was lost; but in the ordinance of 1787 (July 13) for the government of the territory of the United States north-west of the Ohio river, which was introduced by Nathan Dane and probably drafted by Manasseh Cutler, slavery was forbidden in the territory. At the Convention of Philadelphia in 1787, where the constitution was drafted, the sentiments of the framers were against slavery; but South Carolina and Georgia insisted on its recognition as a condition of their joining the Union, and even an engagement for the mutual rendition of fugitive slaves was embodied in the Federal pact. The words "slave" and "slavery" were, however, excluded from the constitution, "because," as Madison says, "they did not choose to admit the right of property in man" in direct terms; and it was at the same time provided that Congress might interdict the foreign slave trade after the expiration of 20 years. It must not be forgotten that either before or soon after the formation of the Union the Northern States — beginning with Vermont in 1777, and ending with New Jersey in 1804 – either abolished slavery or adopted measures to effect its gradual abolition within their boundaries. But the principal operation of (at least) the latter change was simply to transfer Northern slaves to Southern markets.



THE SALE OF ESTATES. PICTURES AND SLAVES IN THE ROTUNDA, NEW ORLEANS; FROM A STEEL ENGRAVING BY J. M. STARLING EXECUTED AFTER THE PAINTING BY W. H. BROOKE

We cannot follow in detail the several steps by which the slave power for a long time persistently increased its influence in the Union. The acquisition of Louisiana in 1803, which gave a new field for the growth of the slave power, though not made in its interest, the Missouri Compromise (1820), the annexation of Texas (1845), the Fugitive Slave Law (1850), the Kansas-Nebraska bill (1854), the Dred Scott decision (1857), the attempts to acquire Cuba (especially in 1854) and to reopen the foreign slave trade (1859–60), were the principal steps — only some of them successful — in its career of aggression. They roused a determined spirit of opposition, founded on deep-seated convictions. The pioneer of the more recent abolitionist movement was Benjamin Lundy (1789–1839). He was followed by William Lloyd Garrison (1805–79), Elijah P. Lovejoy (1802–37) — a martyr, if ever there was one — Wendell Phillips, Charles Sumner, John Brown (b. 1800, hanged 1859), all of whom were in their several ways leading apostles or promoters of the cause. The best intellect of America outside the region of practical politics has been on the anti-slavery side. William E. Channing, R. W. Emerson, the poets Bryant, Longfellow, pre-eminently Whittier and Whitman, have spoken on this theme with no uncertain sound. The South, and its partisans in the North, made desperate efforts to prevent the free expression of opinion respecting the institution, and even the Christian Churches in the slave States used their influence in favour of the maintenance of slavery. But in spite of every such effort opinion steadily grew. Public sentiment in the North was deeply stirred by the *Uncle Tom's Cabin* (1852) of Mrs. Harriet Beecher Stowe, which, as Senior said, under the disguise of a novel was really a pamphlet against the Fugitive Slave Law. It gradually became apparent that the question could not be settled without an armed conflict. The election of Abraham Lincoln as president in Nov. 1860 was the signal for the rising of the South. The North at first took arms simply to maintain the Union; but the farsighted politicians from the first, and soon the whole nation, saw that the real issue was the continued existence or the total abolition of slavery. (See UNITED STATES.)

The war was practically closed by the surrender at Appomattox (April 9, 1865), but already in 1862 slavery in the territories had been abolished by Congress; on Sept. 22 of the same year Lincoln (*q.v.*) had issued the preliminary emancipation proclamation, followed on Jan. 1, 1863, by the emancipation of all slaves in the States in arms against the Union; and in Dec. 1865 a constitutional amendment was ratified abolishing and for ever prohibiting slavery throughout the United States.

Cuba. — The Spanish slave code, promulgated in 1789, is admitted on all hands to have been very humane in its character; and, in consequence of this, after Trinidad had become an English possession, the anti-slavery party resisted — and successfully — the attempt of the planters (1811) to have the Spanish law in that island replaced by the British. But notwithstanding this mildness of the code, its provisions were habitually and glaringly violated in the colonies of Spain, and in Cuba particularly the conditions of slavery were very bad. The slave population of the island was estimated in 1792 at 84,000; in 1817 at 179,000; in 1827 at 286,000; and in 1843 at 436,000. An act was passed by the Spanish legislature in 1870, providing that every slave who had then passed, or should thereafter pass, the age of 60 should be at once free, and that all yet unborn children of slaves should also be free. The latter, however, were to be maintained at the expense of the proprietors up to their eighteenth year, and during that time to be kept, as apprentices, to such work as was suitable for their age. This was known as the Moret Law, having been carried through the house of representatives by Señor Moret y Prendergast, then minister for the colonies. By the census of 1867 there was in Cuba a total population of 1,370,211 persons, of whom 764,750 were whites and 605,461 black or coloured; and of the latter number 225,938 were free and 379,523 were slaves. In 1873 the Cubans roughly estimated the population at 1,500,000 — of whom 500,000, or one-third, were slaves. In 1885, it was stated that "the institution was rapidly dying — that in a year, or at most two, slavery, even in its then mild form, would be extinct."

Brazil. — There was a convention between Great Britain and

Brazil in 1826 for the abolition of the slave trade, but it was habitually violated in spite of the English cruisers. In 1830 the traffic was declared piracy by the emperor of Brazil. England asserted by the Aberdeen Act (1845) the right of seizing suspected craft in Brazilian waters. Yet by the connivance of the local administrative authorities 54,000 Africans continued to be annually imported. In 1850 the trade is said to have been decisively put down. The planters and mine proprietors cried out against this as a national calamity. The closing of the traffic made the labour of the slaves more severe, and led to the employment on the plantations of many who before had been engaged in domestic work; but the slavery of Brazil had always been lighter than that of the United States. On Sept. 28, 1871, the Brazilian chambers decreed that slavery should be abolished throughout the empire. Though existing slaves were to remain slaves still, with the exception of those possessed by the Government, who were liberated by the act, facilities for emancipation were given; and it was provided that all children born of female slaves after the day on which the law passed should be free. They were, however, bound to serve the owners of their mothers for a term of 21 years. A clause was inserted to the effect that a certain sum should be annually set aside from fines to aid each province in emancipating slaves by purchase. Seven years before the passing of this act the emperor, whose influence had always been exerted in favour of freedom, had liberated his private slaves, and many Brazilians after 1871 followed his example. Finally, in 1888 the chambers decreed the total abolition of slavery, some 700,000 persons being accordingly freed.

Disguised Slave Trade.—In the colonies of more than one European country, after the prohibition of the slave trade, attempts were made to replace it by a system of importing labourers of the inferior races under contracts for a somewhat lengthened term; and this was in several instances found to degenerate into a sort of legalized slave traffic. About 1867 we began to hear of a system of this kind which was in operation between the South Sea islands and New Caledonia and the white settlements in Fiji. It seems to have begun in really voluntary agreements; but for these the unscrupulous greed of the traders soon substituted methods of fraud and violence. The natives were decoyed into the labour ships under false pretences. and then detained by force; or they were seized on shore or in their canoes and carried on hoard The nature of the engagements to go and work on the plantations was not fully explained to them, and they mere hired for periods exceeding the legal term. The area of this trade was ere long further extended In 1884 attention was drawn in a special degree to the Queensland traffic in Pacific Islanders by the "Hopeful" trials, and a Government commission was appointed to enquire into the methods followed by labour ships in recruiting the natives of New Guinea, the Louisiade archipelago and the D'Entrecasteaux group of islands. The result of the investigations, during which nearly 500 witnesses were examined, was the disclosure of a system which in treachery and atrocity was little inferior to the old African slave trade. These shameful deeds made the islanders regard it as a duty to avenge their wrongs on any white men they could entice upon their shores. The bishop of Melanesia, John Coleridge Patteson, fell a victim to this retaliation in the island of Nukapu on Sept. 20, 1871.

It now remains to consider the slavery of primitive origin which has existed within recent times, or continues to exist, outside of the Western world

Russian Serfdom.—In Russia, a country which had not the same historical antecedents with the Western nations, properly so called, and which is, in fact, more correctly classed as Eastern, whilst slavery had disappeared, serfdom was in force down to recent days The rural population of that country, at the earliest period accessible to our enquiries, consisted of (1) slaves, (2) free agricultural labourers and (3) peasants proper, who were small farmers or cottiers and members of a commune. The sources of slavery were there, as elsewhere, capture in war, voluntary sale by poor freemen of themselves, sale of insolvent debtors and the action of the law in certain criminal cases. In the 18th century we find the distinction between the three classes named above effaced and all of them merged in the class of serfs, who were the property either of the landed proprietors or of the State. They were not even *adscripti* glebae, though forbidden to migrate; an imperial ukase of 1721 says, "the proprietors sell their peasants and domestic servants, not even in families, but one by one, like cattle." This practice, at first tacitly sanctioned by the Government, which received dues on the sales, was at length formally recognized by several imperial ukases. Peter the Great imposed a poll-tax on all the members of the rural population, making the proprietors responsible for the tax charged on their serfs; and the "free wandering people" who were not willing to enter the army were required to settle on the land either as members of a commune or as serfs of some proprietor.

The system of serfdom attained its fullest development in the reign of Catherine II. The serfs were bought, sold and given in presents, sometimes with the land, sometimes without it, sometimes in families and sometimes individually, sale by public auction being alone forbidden, as "unbecoming in a European state." The proprietors could transport without trial their unruly serfs to Siberia or send them to the mines for life, and those who presented complaints against their masters were punished with the knout and condemned to the mines. The first symptoms of a reaction appear in the reign of Paul (1796–1801). He issued an ukase that the serfs should not be forced to work for their masters more than three days in each week. There were several feeble attempts at further reform, and even abortive projects of emancipation, from the commencement of the 19th century. But no decisive measures were taken before the accession of Alexander II. (1855). That emperor, after the Crimean War, created a secret committee composed of the great officers of State, called the chief committee for peasant affairs, to study the subject of serf-emancipation. Of this body the grand-duke Constantine was an energetic member. To accelerate the proceedings of the committee advantage was taken of the following incident. In the Lithuanian provinces the relations of the masters and serfs were regulated in the time of Nicholas by what were called inventories. The nobles, dissatisfied with these, now sought to have them revised. The Government interpreted the application as implying a wish for the abolition of serfdom, and issued a rescript authorizing the formation of committees to prepare definite proposals for a gradual emancipation. A circular was soon after sent to the governors and marshals of the nobility all over Russia proper, informing them of thisdesire of the Lithuanian nobles, and setting out the fundamental principles uhich should be observed "if the nobles of the provinces should express a similar desire." Public opinion strongly favoured the projected reform: and even the masters who were opposed to it saw that. if the operation became necessary, it would be more safely for their interests entrusted to the nobles than to the bureaucracy. Accordingly during 1858 a committee was created in nearly every province in which serfdom existed. From the schemes prepared by these committees, a general plan had to be elaborated, and the Government appointed a special imperial commission for this purpose.

The plan was formed, and, in spite of some opposition from the nobles, which was suppressed, it became law, and serfdom was abolished (Feb. 19–March 3, 1861). (See RUSSIA.) The total number of serfs belonging to proprietors at the time of the emancipation was 21,625,609, of whom 20,158,231 were peasant serfs and 1,467,378 domestic serfs. This number does not include the State serfs, who formed about one-half of the rural population. Their position had been better, as a rule, than that of the serfs on private estates; it might, indeed, R. D. M. Wallace says, be regarded as "an intermediate position between serfage and freedom." Amongst them were the serfs on the lands formerly belonging to the Church, which had been secularized and transformed into State demesnes by Catherine II. There were also serfs on the apanages affected to the use of the imperial family; these amounted to nearly three and a half millions. Thus by the law of 1861 more than 40 millions of serfs were emancipated.

(J. K. I.)

AFRICA AND THE EAST

Internal and External Slave-Trade—The conscience of the civilized world had revolted from the cruelties of the slave-depots on the West African coast and the horrors of the transit of the close-packed human cargoes across the Atlantic, but little was known of the methods by which the slaves were obtained, or of the raids and the burning of villages and the wholesale depopulation of large regions to supply the slave-markets in Mohammedan countries in the East, and the demand in Africa itself. These first became known to Europe from the descriptions of the early explorers in the middle of the 19th century—notably by Dr. Livingstone in the east, Dr. Barth in the west and Sir Samuel Baker in the north. It was estimated by Livingstone that at least ten lives were sacrificed for each slave who reached the coast, and probably 50% of those who were shipped never reached their destination. To these appalling figures must be added the numbers exported from the northern ports and those required for the internal market.

Land Routes and Internal Demand.—The principal routes from the regions south of the Sahara lay across the desert from Timbuktu, Kano and Kuka (Bornu) to Morocco and Bengasi on the Mediterranean littoral for export to Turkey, and from Tadjurah (Red Sea), Zanzibar, Kilwa and other ports on the East African coast for export to Arabia and Iran. The principal internal demand, which, unlike the Atlantic trade, included women and eunuchs for Moslem harems, was by the Mohammedan kingdoms in West and North Africa, by Morocco, Egypt and Zanzibar, and by the Christian kingdom of Abyssinia. There was also a demand by Negro kingdoms such as Uganda, Benin and Dahomey, while throughout Africa dominant tribes held their captives in war as slaves, and raided their neighbours to capture women. In these Negro kingdoms and tribes large numbers of slaves were sacrificed in pagan ceremonials, on the death of the chief or of their owners.

Abolition of Slavery.—The revelations regarding the nature of slavery which accompanied the long struggle for the abolition of the Atlantic trade conducted by Europe and America, and the practical demonstration of the futility of treaties and edicts even when backed by force to cope with smugglers (see below). had naturally given rise to a crusade against the institution of slavery itself, and for the emancipation of the slaves held by civilized nations. This was gradually achieved in varying conditions as regards compensation to onners and provision for the freed slaves. So far as Britain mas concerned total abolition in all British overseas possessions nas enacted as early as 1833. and the same result was effected more gradually in India by the abolition of the legal status of slavery in 1843. In the United States emancipation took place in 1863.

East African Slave-Trade.—The export of slaves from East Africa to Arabia. Iran and India had been a lucrative trade for centuries. In 1812 the British Government brought pressure to bear on Seyid-bin-Sultan. who had asserted his rule over Muscat in the Persian gulf and over the island of Zanzibar, which was the emporium of the trade from East Africa. It mas not however until 1822 that he agreed under the Moresby Treaty to restrict the overseas traffic within a limit which excluded Iran and India. In 1840 he transferred his capital to Zanzibar, and in 1845 he yielded to further pressure and agreed to prohibit entirely the export of slaves, from which he had derived a revenue of over £20,000 per annum.

The organized Arab bands in the interior continued to send slaves to the coast who were surreptitiously shipped in dhows under conditions even worse than the "Middle Passage" across the Atlantic had been, in spite of the patrol maintained by British war-vessels and the sultan's edicts The British Government therefore dispatched a mission under Sir Bartle Frere in 1872 to demand the complete abolition of the traffic and the closure of the slave-markets. The sultan was compelled to accept, and under the influence of Sir John Kirk did his best to enforce his decrees with the aid of a well organized force on the mainland. In 1876 on his own initiative he even concluded a treaty by which the access of slaves to the coast port was forbidden.

International Pledges.—International reprobation of the slave-trade was first expressed at the Congress of Vienna in 1815, and in 1885 the Berlin Act pledged the 13 nations of .Europe and the United States "to watch over the preservation of the native tribes . . . and to help in suppressing slavery and especially the slave-trade." Four years later (1889) when the "Partition of Africa" between the European Powers had taken definite shape, the signatories of the Berlin Act—to whom were added Iran, Zanzibar and the Congo Free State—assembled in Brussels at the instance of Queen Victoria, with the declared object of "putting an end to the crimes and devastations engendered by the traffic in African slaves, protecting effectively the aboriginal populations of Africa, and insuring for that vast continent the benefits of peace and civilization." As regards the sea-borne slave-trade reciprocal rights of search, capture and trial of vessels under 500 tons were prescribed by the "General Act" within the "Maritime Zone" (formed by the coasts of the Indian ocean from Baluchistan to Quillimane, S Lat. 18°, including the Persian gulf and the Red sea, and thence back, including Madagascar), and strict regulations were enacted as to the use of the flag of a signatory Power and the carrying of Negro passengers in native vessels.

As regards the internal traffic the Act prohibited the introduction into Africa between 20° North, and 22° South Lat. of all fire-arms and ammunition other than flint-lock guns and trade powder, except under effective guarantees It proposed the establishment of "strongly occupied stations" as refuges for the native population, of cruisers, fortified posts and expeditions for repressive action. Its framers could not foresee the astonishing rapidity with which the Powers in control, eager to substantiate their frontiers by "effective occupation," would hasten in the words of the Act "the progressive organization of the administrative, judicial, religious and military services, as the most effective means of counteracting the slave-trade."

Effect of European Control.—The internal slave-trade did not however disappear without a struggle In the eastern Sudan the suppression of the Turco-Egyptian slave-raiders by Baker and Gordon had been effaced by the sanguinary rule of the Mahdi, until conquered by Kitchener in 1898. The consolidation of French rule in the north. and the final defeat of Samory and other powerful Mohammedan potentates in the west, put an end to the organized traffic in slaves. In Nigeria the power of the Mohammedan rulers who annually employed large armies in raiding for slaves, and had depopulated great regions, was broken in 1902–03, and slave-raiding was stopped In the Congo region Tippoo Tib, Rumaliza and other notable east-coast Arabs mho were practically independent of Zanzibar were crushed by King Leopold of Belgium after a severe struggle In Nyasaland—a favourite hunting-ground of the Zanzibar slavers—a stand had been made by a Scottish trading company, and when control was assumed by Great Britain. the raids of the slavers were suppressed. The advent of Europe was probably only just in time to anticipate and prevent a Mohammedan domination in central Africa. Before the close of the first decade of the 20th century the whole of Africa except Abyssinia and Liberia had come under European control and a more or less effective administration had been established.

Abolition of Slavery.—The abolition of the Atlantic slave-trade had proved ineffective to cope with the illicit traffic until followed by the abolition of slavery itself. So also in Africa, though the conditions were not the same. In the United States and the West Indies slaves were required for work on plantations owned by white men, but in Moslem countries and in Abyssinia the institution was so intimately interwoven in the social fabric that sudden and enforced emancipation would bring ruin and misery to the slaves not less than to their owners.

Moslem and Mosaic Slavery—The Koran enjoins the good treatment of the slave, and manumission is encouraged as an act of piety. The child of a slave-concubine by her master is free-born, and the mother is usually freed also. The slave "born in the house" is generally regarded as a member of the family, and to sell such a slave. except for incorrigible misconduct, would be condemned by public opinion. The favourite slaves of a ruler often hold high office as confidential advisers, as administrators of provinces or as leaders in the army. The master is bound to care for his slave in sickness and old age, and to maintain his wife and family. Facilities are afforded for self-redemption and for ransom The so-called "praedial slaves" on the other hand would generally be members of a conquered tribe, who remained on the land which had passed into the hands of the conqueror. Their status differed entirely from that of a slave (see below). Somewhat similar conditions mere prescribed by the Mosaic code in Abyssinia, but in both cases constant raids for new slaves depopulated the adjacent tribes.

The Act of 1833 which emancipated the slaves in British colonies did not seriously affect Africa except the Cape Colony. for the newly acquired territories mere protectorates to which it did not apply. It mas possible therefore to proceed more gradually by abolishing the legal status of slavery instead of by immediate and compulsory emancipation. No court of law can then recognize any rights based on the claim of any person to property in the person of another. Every slave can assert his freedom without any ransom or formality, and an owner is liable to process of law for attempting to detain a slave against his will, or to capture a runaway. On the other hand, it is not a crime for a master to retain a slave if both desire to remain in that relationship. It is permissive as contrasted with compulsory emancipation. Local ordinances have at the same time enacted that the acquisition of new slaves and all dealings in slaves are a penal offence, and that all children born after the date of the ordinance are free-born. These methods were effective in Nigeria, and were adopted by the emperor of Abyssinia, with much success prior to the conquest of the country by Italy in 1936. (Lu.)

SLAVERY AFTER WORLD WAR I

The Convention of St. Germain-en-Laye, 1919.—At the close of World War I the Convention of St. Germain-en-Laye, 1919, was signed by the principal Allied powers in that war. It purported to have abrogated the provisions of the Berlin act of 188j and of the Brussels act, 1890, relating to slavery, as between those powers and it substituted for them a declaration that the contracting parties would "endeavour to secure the complete suppression of slavery in all its forms and of the slave-trade by land and sea." The Brussels act. 1890, is still in force as between parties to it which did not adhere to the Convention of St. Germain-en-Laye, 1919, and doubts are entertained by international lawyers of authority as to whether it was in fact abrogated even between psrties to the convention.

The Slavery Convention, 1926.—The need of a precise definition of "slavery in all its forms:" combined with the recrudescence of the slave-trade between Africa and Arabia and the conditions of servitude prevailing in Ethiopia (Abyssinia) and Liberia, prompted the League of Nations to investigate slavery. Resulting therefrom, the Slavery convention. 1926, was prepared by the League, art. I of which defined slavery as "the status or condition of a person over whom any or all the powers attaching to the right of ownership are exercised." This convention was ratified by 44 states and is still in force. The United Nations assumed the powers and functions of the League of Nations under this convention by a protocol which became effective in July 1955.

The Forced Labour Convention, 1930.—Article 5 of the Slavery convention: 1926, prohibited forms of forced labour which approximated to slavery, but the problem of forced labour was referred by the League of Nations to the International Labour office which prepared a Forced Labour convention. This draft convention was adopted in 1930 and it has been ratified by 40 states. Forced labour is defined in this convention as "work or service (other than penal labour), exacted under menace of a penalty." Any form of compulsory labour for private enterprise is prohibited and governments may exact forced labour only if the labourers are adequately paid and are employed under strict safeguards. In 1952 a Committee on Forced Labour, appointed jointly by the United Nations and the International Labour office, investigated forced labour again and as a result of its inquiries a new Forced Labour convention was prepared by the International Labour office.

The League of Nations Second Slavery Committee, 1932.—The six years following the making of the Slavery convention, 1926, were so barren of results for the suppression of slavery that in Jan. 1932 the assembly of the League of Nations decided to reconvene the Slavery commission of 1924, the recommendations of which had resulted in the preparation of the Slavery convention, 1,926. and among other things the commission was requested to advise what modifications (if any) were necessary in the existing machinery of the League for the suppression of slavery.

Its principal recommendation was that a Permanent Advisory Committee of Seven Experts on Slavery, all of different nationalities, should be established to report on the information furnished to the League by the parties to the Slavery convention, 1926.

The Permanent Advisory Committee of Seven Experts on Slavery.—This recommendation was opposed by certain powers who feared interference with their national sovereignty, but it was adopted by the League. An advisory committee of experts was set up and met annually from 1935 until 1938 inclusive. After 1938 it ceased to meet because of the outbreak of World War II. It was authorized to study the information submitted to the League by governments and to advise what action should be taken for the suppression of slavery. Its duties were strictly advisory to the council of the League. Forced labour was excluded from its functions. The report of each session was printed as a League document and copies of the documents examined by the committee were annexed to each report. The four reports deal in successive chapters with: (1) general progress in the suppression of slavery; (2) slave-raiding and the slave-trade; (3) born slaves; and (4) conditions analogous to slavery, viz., debt-bondage and pawning of persons, sham adoption of children to exploit their labour: sale of women into marriage without their consent and serfdom. In the four years that the committee functioned it did much valuable work. The work of the committee, as well as of the slavery bureau under the Brussels act, 1890, demonstrated the need for permanent machinery to supervise the application of the Slavery conventions.

The Work of the United Nations for the Suppression of Slavery.—In 1949 the assembly of the United Nations requested the Economic and Social council of the United Nations to study slavery. The council appointed an ad *hoc* committee of four experts on slavery to examine the problem and to make recommendations for the suppression of slavery. The committee recommended that the definition of slavery in the Slavery convention. 1926, was accurate and adequate and that the United Nations should assume the powers and functions of the League of Nations under the Slavery convention, 1926. This was done. It further recommended that a Supplementary Convention on Slavery should be prepared to remedy deficiencies found by experience to exist in the Slavery convention. 1926. This convention was drafted and was approved by a conference of plenipotentiaries of states held in Geneva. Switz., in Sept. 1956. The recommendation of the *ad hoc* committee on slavery that a standing committee of experts on slavery should be set up to supervise the application of the Slavery conventions did not immediately receive UN implementation.

The Existence of Slavery and Slave-Trading in Arabia.—The old form of chattel slavery involves in the Arabian peninsula a far greater number of persons than in any other part of the world. Except in the British colony of Aden, in the sultanate of Lahej in the Aden protectorate, and in Bahrein, Kuwait and Qatar on the Persian gulf the status of slavery was recognized by law throughout Arabia and there was still a slave trade from Africa into Xrabia and from other Asiatic countries into Xrabia in the late 1950s. The existence of slavery in Saudi Arabia received official confirmation from the fact that in 1936 King Ibn Saud made a decree regulating the condition of slaves and giving them the right to have their freedom under certain conditions. The same decree prohibited the importation of slaves by sea and it also authorized the minister of the interior to license slave traders. In 1953 the French ambassador in Saudi Arabia informed his government that slave traders in Saudi Arabia sent African emissaries back to Africa to recruit slaves. They went to West Africa, posed as Moslem missionaries and enticed Africans to accompany them on pilgrimages to Mecca. On arrival in Saudi Xrabia the pilgrims were arrested for landing in the country without a visa and were then handed over to slave traders who sold them into slavery. It was estimated in the late 1950s that there were between 500,000 and

700,000 slaves in Arabia.

Slavery in Ethiopia. — The existence of slavery in Ethiopia was urged against the admission of Ethiopia to the League of Nations in 1923, but the Ethiopian government gave a pledge that it would abolish slavery step by step and Ethiopia was admitted. In 1942 the legal status of slavery was abolished.

Debt-Bondage **and Serfdom.**—In countries in which the money economy is not yet firmly established'it is common for a man to pledge his services as security for a debt. The value of the services are not credited toward liquidation of the debt and the person pledged may remain enslaved for life.

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(C. W. W. G.)

SLAVONIA, historically the eastern part of Croatia, lying between the Drava, Danube and Sava rivers and including the towns of Osijek, Vukovar. Vinkovci and Slavonski Brod. In the 13th century. King Bela IV of Hungary and of Croatia detached Slavonia from Croatia and made it a separate kingdom under his crown. In 1538 the Habsburgs made it again a part of Croatia. Slavonia was made an Austrian crownland after the Hungarian rising of 1848, but was restored to Hungary on the establishment of the Austro-Hungarian dual monarchy in 1867. On Dec. 1, 1918, it became again part of Croatia. See YUGOSLAVIA: History.

SLAVONIC (SLAVIC) LANGUAGES. The Slavonic languages represent a western branch of the eastern. or satem, division of Indo-European (*q.v.*) and are very closely connected with the Baltic languages, which embrace Lithuanian, Latvian, and the now extinct Old Prussian.

Classification. — At mid-20th crntury Slavonic languages were spoken in parts of East Germany. in Poland, Czechoslovakia, Yugoslavia, Bulgaria and in most of the European part and large areas in the Asiatic part of the U.S.S R. There are 13 living Slavonic languages, classified in three groups. Russian (more specifically, Great Russian), Ukrainian (formerly called Little Russian or Ruthenian) and Byelorussian (or White Russian) comprise the East Slavonic group Polish, Slovak, Czech. and the High and Low Sorbian (also called Lusatian or Wendish) of East Germany form the Western group, while Slovene, Serbo-Croatian Macedonian, Bulgarian and Church Slavonic make up the Southern group. Church Slavonic is the liturgical language for all Orthodox and some Catholic Slavs, and its use is by no means confined to the South Slavonic area. The two Sorbian languages were guaranteed a place in schools and public life by East German laws promulgated in 1948 and 1950. The other ten are official state languages in their respective areas. Two additional languages may be noted, Polabian and Pomeranian. The former. once widely spread in the Elbe basin, became extinct in the 18th century. The latter is the conventional name for dialects once spoken along the Baltic, known from two remnants. Slovincian and Kashubian, which survived into the 20th century.

In spoken Slavonic dialects, there are scarcely any true linguistic frontiers, for transitional dialects connect all types, excepting, of course, in the area where the South Slavs are separated from the others by non-Slavonic Austrians, Hungarians and Rumanians. Almost any two intelligent Slavs can manage fairly quickly to establish elementary communication on a simple conversational level, for the languages have preserved a remarkable degree of uniformity in over-all grammatical pattern and in the vocabulary of everyday life. However. the myriad differences in the details oi phonetics, grammar, and above all of vocabulary cause misunderstandings even in the simplest of conversations, and the difficulties increase in the language of journalism, of belles-lettres, and especially in technological treatises, which tend to use newly created terminology. For a Slav to master effectively a second Slavonic language demands time and work.

History.—For at least a millennium before the 3rd century A.D. the Slavs lived to the north of the Carpathians. Scholars have not been able to reconcile archaeological and linguistic evidence to arrive at a wholly satisfactory delimitation of the area, but generally agree that its core extended from the Vistula to the Dnieper (Dnepr). Linguistic affinities indicate that the western neighbours of the Slavs were very likely first Illyrians, later perhaps Celts and then Teutons. In the southeast there was apparently contact with Iranian and various Altaic peoples. In the northeast were Finno-Ugric tribes, and in the north the Balts. In the first centuries A.D. the Slavs began to expand rapidly, first to the west and east! then southward through and around the Carpathians, appearing in the 6th century as a serious threat to the Roman Empire all along the Danube. By the 9th century they occupied Europe east of a line running roughly Kiel-Braunschweig-Magdeburg-Bamberg-Passau-Trieste, including all of the Balkan mainland except for parts of the littoral in Dalmatia and Greece. During the last millennium they have either retreated before or been absorbed by Germans in the west, Greeks and Albanians in the south, and Hungarians and Rumanians in the Danube basin. Only in the east was Slavonic expansion a continuous process, which carried the Russians to the Pacific in the 18th century.

A long period, fully three millennia, separates recorded Slavonic from any conceivable type of Indo-European from which Indic, Greek and Slavonic could all have sprung. The phonetic and morphological affinities now observable between Baltic and Slavonic demonstrate at least a long period of contiguity between Slavs and Balts, and perhaps, as some hold, an ancient Balto-Slavonic group. In any case, the Slavonic of the 9th century appears still to have been a single language. It was of course divided. like all languages, into regional dialects, but the points of divergence were relatively few in number and quite insignificant in quality.

The 8th–11th centuries brought enormous changes to the Slavs. Slavonic states arose and clashed with one another and with their non-Slavonic neighbours. Social and economic conditions were radically transformed. In language, too, change was relatively rapid; and by the 10th century the western and southern dialects had split into something like the present linguistic divisions, although in the east a greater uniformity prevailed.

No credible evidence attests to Slavonic writing before the 860s, when a mission was sent from Byzantium in answer to the request of Prince Rostislav of Moravia for teachers "in our own language." The mission was led by a brilliant scholar and diplomat, Constantine (later known as St. Cyril, d. 869), and his brother Methodius (d. 885) of Salonika, a Greek city entirely surrounded by Slavs. They created a new alphabet. the Glagolitic, and began to translate church books. Within two decades the Bible and many homiletic and liturgical texts had been translated, and some original works, including poetry, had been nritten in the new literary language. This language is called Old Church Slavonic (O Ch S.) because its local Macedono-Bulgarian origin is of less importance than its use as a literary language in the nest (Moravia, Bahemia. Pannonia), the south (Bulgaria, Macedonia), and the east (Russia) during the next two centuries. In time it was modified locally, and the Church Slavonic in use today shows clearly the hand of Russian editors.

In the West Slavonic area O.Ch S was suppressed during the 11th century, but its influence is to be seen in the vernacular literature which sprang up in Bohemia in the 13th century and flourished in the 14th–15th centuries. Czech culture was exported to Poland at this time, and the Poles quickly developed their own standard language and produced superior literature in the 16th and 17th centuries. The Slovaks, if writing Slavonic at all, used Czech until the national revival at the beginning of the 19th century. Sorbian texts began with Protestant translations in the 16th century.

In the south, Church Slavonic, in its progressively modified local forms, remained the exclusive written language for the Orthodox Serbs, Macedonians and Bulgars, and for those Croatian Catholics who clung to the Slavonic rite. It was the Renaissance which gave the impulse to vernacular literature in Croatia in the late 15th century, and the Reformation which produced the first works in Slovene in the 17th century (except for fragmentary texts from the 11th). The Serbs discarded Church Slavonic in favour of the vernacular early in the 19th century, and by 1850 a common Serbo-Croatian literary language had been elaborated. The development of modern standard Bulgarian had its roots in the 18th. but progressed little before the mid-19th century. Macedonian is the youngest Slavonic literary language, and can hardly claim to any history before 1934, nhen it was proclaimed the official language of the new Republic of Macedonia.

In the east, Church Slavonic continued in use well into the 18th century, although strongly vernacularizedmodifications were used for business documents and occasionally other writing. In Russia, the modern literary language grew out of a compromise style which utilized Church Slavonic elements to enrich the native Great Russian vernacular. The Ukrainians, on the contrary, rejected Church Slavonic in principle and based their writings chiefly on the spoken dialects. The first modern works appeared at the very end of the 18th century, but the real development of the contemporary Ukrainian literary language dates from the 1840s. The Byelorussians had used their own distinctively modified type of Church Slavonic in the 16th century, but literature in the vernacular came only three centuries later. It is difficult to speak of a Byelorussian literary language before the 20th century. Its most significant gronth came about after it achieved official status in 1918.

Alphabet.—Slavonic languages in the east and southeast are written in slightly variant forms of the so-called Cyrillic alphabet, which seems to have been devised in Bulgaria at the end of the 9th century, and nhich soon displaced Constantine's Glagolitic. In the west, Catholic Slavs use the Roman alphabet. mostly with the diacritics introduced by Jan Hus. Serbo-Croatian is written in Cyrillic by Serbs and Montenegrins, and in Roman by Croats

Vocabulary.—Much of the Slavonic lexicon is Indo-European in origin ("mother. house, be"). a significant portion may be called Balto-Slavonic ("head, hand"), and many words seem to be purely Slavonic ("human. dog"). Ancient borrowing from Iranian include important words of spiritual culture ("god, sacrifice"). and a somewhat later stratum from Germanic pertains to material culture ("coin, buy"). The vocabulary of the individual languages reflects more recent local influences, the most important being German in the west and Turkish in the Balkans. Loan-translations from Greek in the east and Latin in the west have served as patterns for creating new terminology with Slavonic elements in many languages. Inter-Slavonic borronings are manifold and often difficult to trace.

Morphology. — Common Slavonic (C.S.) retained the Indo-European case system almost intact, the only innovation being that the ablative merged with the genitive. Still discernible in late C S. was the older system of paradigms based on purely formal distinctions of stem and suffix-type: o- and jo-stems, a- and ja-stems, u-stems, i-stems, and. in restricted numbers, ū-stems and several kinds of consonant-stems. As early as O.Ch S.. however, a strong tendency prevailed to reorganize the system on the basis of gender. Thus o-, jo- and u-stems were united in a masculine-neuter paradigm which has slightly variant suffixes according to whether the stem ends in a palatal ("soft") or non-palatal ("hard") consonant, the usual feminine declension includes a- and ja-stems ("hard" and "soft"), and the i-stems are predominantly feminine. This principle of classification triumphed almost completely in the modern languages, except for Bulgarian and Macedonian, where the only remnant of declension

Phonological Divergences Between the Slavonic Languages

	candle	*border*	*day*	*sleep*	*five*	*husband*	*fort*	*ban*
C.S.	*světja	*medja	*dĭnĭ	*sŭnŭ	*pęti	*mǫži	*gordŭ	*bergŭ
O.Ch.S.	svěšta	mežda	dĭnĭ	sŭnŭ	pętĭ	mǫži	gradd	brěgŭ
Bulg.	sveštà	meždà	den	săn	pet	mǎž	grad	brjag
Mac.	svěka	měga	den	son	pet	maž	grad	breg
Ser.-Crt.	svéća / svijèća	mèđa	dân	sàn	pêt	miii	grâd	brêg / brȉjeg
Sln.	svéča	méja	dân	san	pêt	môž	grâd	brêg
Cz.	svíce	meze	den	sen	pět	muž	hrad	břeh
Slk.	svieca	medza	den	sen	pat	muž	hrad	breh
H.Sorb	swěca	mjeza	dźeń	són	pjeć	mùž	hród	brjóh
L.Sorb	swěca	mjaza	źeń	son	pěś	muž	grod	brjog
Pol.	świeca	miedza	dzień	sen	pięć	mąż	gród	brzeg
B.R.	svjačà	mjažà	dzen'	son	pjac'	muž	hbrad	bèrah
Ukr.	svičà	mežà	den'	son	p'jat'	muž	hbrod	bèreh
Russ.	svečà	mežà	den'	son	pjat'	muž	gbrod	bèreg

	plough	*wolf*	*heart*	*sister*	*brother*	*worker*	*button*
C.S.	*ōrdlo	*vĭlkŭ	*sĭrdĭce	*sestra	*brat(r)ŭ		
O.Ch.S.	ralo	vlikd	sridice	sestra	brat(r)ŭ	?	?
Bulg.	rhlo	vǎlk	sărcè	sestrb	brat	rabbtnik	kòpče
Mac.	ràlo	volk	srce	sèstra	brat	ràbotnik	dhgme
S.C.	ralo	viik	sȓce	sèstra	brat	râdnîk	dhgme
Sln.	rálo	votk	srcê	séstra	brát	dẹ́lavəc	giimb
Cz.	rádlo	vlk	srdce	sestra	brat	dělník	knoflik
Slk.	radlo	vlk	srce	sestra	brat	robotnik	gombík
H.Sorb	radto	wjelk	serce	sotra	brat	dźěłaćeŕ	bubla
	radło	wjelk	serce	sotša	brat	źěłaśaŕ	bublin
	radło	wilk	serce	siostra	brat	robotnik	guzik
	ràla	vowk	sèrca	sjastrb	brat	rabbty	ghzik
	rhlo	vovk	sèrce	sestrà	brat	robitnyk	hhdzyk
	rhlo	volk	sèrdce	sestrà	brat	rabbtij	phgovica

is in vestiges of a general objective case. The West Slavonic languages kept hard and soft variants of the masculine-neuter and the feminine a-declension, but in the Eastern and Southern groups there are only three paradigms for all but irregular nouns. The vocative disappeared completely in Russian, and is preserved only with a limited number of nouns in Slovak. Slovene, and Low Sorbian. Broadly speaking. the force of the cases is weaker in the west. while in Russian some scholars see a strengthening and extension of the case system in the relatively new forms which have specifically partitive or locative functions: over against the forms which are generally genitive or prepositional.

The C.S. verb lost the voices and moods of Indo-European, retaining special forms for two past tenses (the imperfect and aorist). the present, imperatives (derived from the old optative), and five participles, two passive and three active. The active resultative l-participle was used with auxiliaries to form a series of periphrastic perfects. Constructions with the reflexive pronoun. and to a lesser degree with passive participles, render the passive and middle voices of classical languages. The most significant innovation was the development of aspect, which remains the pivotal feature of all Slavonic verb systems. Every verb is either of perfective aspect, denoting an action viewed in its entirety, or of imperfective aspect, denoting an action not necessarily so viewed. In principle, every verbal idea is represented by a pair of verbs, one for each aspect. Most modern languages have lost aorist and imperfect, using the old perfect instead. The two are, however, completely living forms in eastern Serbocroatian. Macedonian and Bulgarian, where the perfect has come to signify a past action not witnessed by the speaker.

Phonology. — As a satem language. Slavonic has *s* and *z* for the Indo-European palatal stops $\hat{k}$ and $\hat{g}$. In a development paralleled by, but not identical with, Baltic and Iranian, Slavonic changed *s* to *x* (kh) after *i*, *u*, r, and k. As in Baltic and Germanic. o and a coincided in Slavonic. the short vowel eventually resulting in o and the long in a. With Baltic. Slavonic completely lost aspiration and maintained a sharp distinction between voiced and voiceless consonants. Specifically Slavonic features are: an insistence on the distinction between front and back vowels which led to mutual adaptations between vowels and adjacent consonants and resulted eventually in a distinction between soft and hard syllables; the change of short *i* and *u* to reduced, ultrashort vowels called jers; the gradual elimination of closed syllables by dropping final consonants or simplifying clusters, by reducing diphthongs ending in *i, u,* or nasal, and by various dialectal changes in diphthongs ending in l or *r;* the replacement of quantitative vocalic distinctions by qualitative ones. and the subsequent development of a new quantitative system with rising or falling intonation possible on short as well as long vowels.

The table gives examples of some common words to show typical phonological divergences between the Siavonic languages, while the relatively modern equivalents for "industrial worker" and "button" give a hint as to differences in roots and in word-formation. Some details are obscured by the different types of orthography current. Particularly significant for the classification of the languages are the development of *tj, dj, ě, ǫ, ę,* i and *ŭ*.

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SLAVS. The Slavs are the most numerous linguistic group in Europe. Outside Europe there are the Russians in Siberia, a mere extension of the main body, and emigrants in America.

Divisions and Distribution. — The Slavs are divided geographically and linguistically into three main groups, Eastern, North-Western and Southern.

The Russians form the Eastern group. They hold all the East European plain from the 27th meridian to the Urals, the Finnish and Tatar tribes making up but a small proportion of the population: to the east they stretch into central Siberia and thence in narrow bands along the rivers all the way to the Pacific; on the west the Ruthenians of Galicia form a wedge between the Poles and the Magyars and almost touch the 20th meridian.

The North-Western group includes the Poles, in the basin of the Vistula; the Kashubes on the coast north-west of Gdansk; the High and Low Sorbs or Wends in Lusatia, Slavs completely surrounded by Germans, the Czechs and their eastern neighbours, the Moravians, now included in Czechoslovakia. Connecting up Ruthenians, Poles and Moravians, but most closely akin to the latter, are the Slovaks (*q.v.*). The now teutonized Slavs of central Germany, once stretched as far to the north-west as Rügen and Holstein and to the south-west to the Saale. They are generally called Polabs (*q.v.*), or Slavs on the Elbe.

The Southern Slavs, Slovenes (*q.v.*), Serbo-Croats and Bulgarians are cut off from the main body by the Germans of Austria proper and the Magyars, both of whom occupy soil once Slavonic, and have absorbed much Slavonic blood, and by the Rumanians of Transylvania and the Lower Danube. These Slavs occupy the main mass of the Balkan Peninsula downwards from the Julian Alps and the line of the Muhr, Drave and Danube. North of this all three races have considerable settlements in southern Hungary. Their southern boundary is very ill-defined, various nationalities being closely intermingled. To the south-west the Slavs march with the Albanians, to the south-east with the Turks, and to the south and along the Aegean coasts they have the Greeks as neighbours.

Linguistic Divisions. — Linguistically the separation is not sharp, though it coincides with the new political frontiers. Roughly speaking, the eastern half of the peninsula is held by the Bulgarians, the western half by the Se bo-Croats. This is the most divided of the Slavonic races; its members profess three forms of religion and use three alphabets — the Serbs and Bosnians being mostly Orthodox and using the Cyrillic alphabet, but including many Muslims; the Croats being Roman Catholics, writing with Latin letters; and the Dalmatians also Roman Catholics, but using, some of them, the ancient Glagolitic script for their Slavonic liturgy. The language also falls into three dialects independent of the religions, and across these lines run the frontiers of the political divisions. In the extreme north-west, in Carniola, in the southern parts of Styria and Carinthia, and over the Italian border in the province of Gdine and the Vale of Resia live the Slovenes, much divided dialectically. Between the Slovenes and the Croats there are transition dialects, and about 1840 there was an attempt (Illyrism) to establish a common literary language. In Macedonia and along the border are special varieties of Bulgarian, some of which approach Serbian. Akin to the Macedonians were the Slavs, who once occupied the whole of Greece and left traces in the place-names, though they long ago disappeared among the older population. Akin to the Slovenes were the old inhabitants of Austria and south-west Hungary before the intrusion of the Germans and Magyars.

History. — This distribution of the Slavs can be accounted for historically. Though traditions (*e.g.,* the first Russian chronicle of Pseudo-Nestor) bring them from the basin of the Danube, most evidence goes to show that when they formed one people they were settled to the north-east of the Carpathians in the basins of the Vistula, Pripet and Upper Dněstr (Dniester). To the N. they had their nearest relatives, the ancestors of the Baltic tribes, Prussians, Lithuanians and Letts; to the E. Finns; to the S E. the Iranian population of the Steppes of Scythia (*q.v.*); to the S.W., on the other side of the Carpathians, various Thracian tribes; to the N.W. the Germans; between the Germans and Thracians they seem to have had some contact with the Celts, but at first the Illyrians, Greeks and Italians probably came between. This location, arrived at by a comparison of the fragmentary accounts of Slavonic migrations and their distribution in historic time, agrees with the place taken by the Slavonic language among the other Indo-European languages *(see* below) and by what we know of the place-names of eastern Europe, seeing that within this area the place-names seem to be exclusively Slavonic, while outside it the oldest names belong to other languages.

In spite of the vast area which the Slavs have occupied in historic times there is no reason to claim for them before the migrations a wider homeland than that above defined beyond the Carpathians; given favourable circumstances a nation multiplies so fast that a comparatively small race could cover a wide area in the course of four centuries. Therefore we need not seek for the Slavs among any of the populous nations of the ancient world. Various investigators have seen Slavs in Scythians, Sarmatians, Thracians, Illyrians, and in fact in almost all the barbarous tribes which have been mentioned in the east of Europe, but we can be sure that none of these were Slavs.

The Slavs made no considerable migration from their first home until the 1st century AD. Their first Transcarpathian seat lay remote from the knowledge of the Mediterranean peoples. Herodotus (iv. 17, 51, 105) seems to mention the Slavs under the name of Neuri, on the upper waters of the Dněstr. They are in the right place for Slavs, and their lycanthropy suggests modern Slavonic superstitions; so we may equate Neuri and Slavs, though we have no direct statement of their identity. Other classical writers down to and including Strabo tell us nothing of eastern Europe beyond the immediate neighbourhood of the Euxine.

EARLY WRITERS

Pliny (N.H. iv. 97) is the first to give the Slavs a name which can leave us in no doubt. He speaks of the Venedi (*cf.* Tacitus, *Germania,* 46, *Veneti*); Ptolemy (Geog. iii. 5. 7, 8) calls them Venedae and puts them along the Vistula and by the Venedic gulf, by which he seems to mean the Gulf of Danzig: he also speaks of the Venedic mountains to the south of the sources of the Vistula, that is, probably the northern Carpathians. The name Venedae is clearly Wend, the name that the Germans have always applied to the Slavs. Its meaning is unknown. It has been the cause of much confusion because of the Armorican Veneti, the Paphlagonian Enetae, and above all the Enetae-Venetae at the head of the Adriatic. Though nowadays we have Slovenes just north of Venice, inscriptions in the Venetian language prove that it was not Slavonic. Other names in Ptolemy which almost certainly denote Slavonic tribes are the Veltae on the Baltic, ancestors of the Wiltzi, a division of the Polabs (*q.v.*), the Sulani and the Saboci, whose name is a Slavonic translation of the Transmontani of another source.

The sudden appearance in the 6th-century writers of definite names for the Slavs and their divisions means that by then the race had made itself familiar to the Graeco-Roman world, that it had spread well beyond its original narrow limits, and had some time before come into contact with civilization. This may have been going on since the 1st century A.D., and evidence of it has been seen in the southward movement of the Costoboci irito northern Dacia (Ptolemy) and of the Carpi to the Danube (A.D. 200), but their Slavonic character is not established. A few ancient names on the Danube, notably that of the river Tsierna (*Černa*, black), have a Slavonic look, but a coincidence is quite possible. The gradual spread of the Slavs was masked by the wholesale migrations of the Goths, who for two centuries lorded it over the Slavs, at first on the Vistula and then in south Russia. We hear more of their movements because they were more immediately threatening for the Empire. In dealing with Ptolemy's location of the Goths and Slavs we must regard the former as superimposed upon the latter and occupying the same territories. This domination of the Goths was of enormous importance in the development of the Slavs. It explains the presence of a large number of Germanic loan words common to all the Slavonic languages, many of them words of cultural significance. "King, penny, house, loaf, earring" all appear in Slavonic, from the Goths, although the things must have been familiar before. On the other hand "plough" is said to be Slavonic, but that is not certain. When the Huns succeeded the Goths as masters of central Europe, they probably made the Slavs supply them with contingents. Indeed their easy victory may have been due to the dissatisfaction of the Slavs. Priscus (Miiller, F.H.G. iv. p 69, cf. Jord. *Get.* xlix. 258) in his account of Attila's camp rnrntions words which are probably Slavonic, though they have also been explained from German. After the fall of the Hunnish power the Eastern Goths and Gepidae pressed southwards and westwards to the conquest of the Empire, and the Lombards and Heruli followed in their tracks. When next we get a view of northern Germany we find it full of Slavs, *e.g.*, from Procopius (B.G. ii. 15), they held the Mark of Brandenburg by 512; a settlement effected without attracting the attention of any contemporary writer. The expansion of the Eastern Germans in the last centuries B.C. was made at the expense of the Slavs, who, while no more peaceful than the Germans, were less capable than they of combining for successful war, so that Goths and others were dwelling among them and lording it over them. The mutual competitions of the Germans drove some of these against the Empire, and when this had become weakened, so that it invited attack, some tribes and parts of tribes moved forward without any pressure from behind; this took away the strength of the German element, and the Slavs, not improbably under German organization, regained the upper hand in their own lands and even spread westwards at the expense of the German remnant.

Almost as uncertain is the exact time when the Southern Slavs began to move towards the Balkans. If already at the time of Trajan's conquests there were Slavs in Dacia, it would account for the story in Ps. Nestor that certain Volchi or Vlachi, *i.e.,* Romance speakers, had conquered the Slavs upon the Danube and driven them to the Vistula, for the place that the name of Trajan has in Slavonic tradition, and for the presence of an agricultural population, the Sarmatae Limigantes subject to the nomad Sarmatae on the Theiss. In any case, we cannot say that the Slavs occupied any large parts of the Balkan Peninsula before the beginning of the 6th century, when they appear in Byzantine history as a new terror; there seems to have been an invasion in the time of Justin, and another followed in 527 (Procopius, B.G. iii. 40 and *Hist.* Arc. 18). At the same time as the Slavs, the Huns, the Bulgars, and after 558 the Avars, were also making invasions from the same direction. The first and last disappeared like all nomads, but the Bulgars, making themselves lords of one section of the Slavs, gave it their own name. By 584 the Slavs had overrun all Greece, and were the worst western neighbours of the Eastern Empire. Hence the directions how to deal with Slavs in the Strategicurn of the emperor Maurice (c. 600) and the Tactics of Leo.

By the end of the following century they were permanently settled throughout the whole of the Balkan Peninsula. These Southern Slavs, though divided into nationalities, are closely akin to one another. There is no reason to think the Serbo-Croats an intrusive wedge, although Constantine Porphyrogenitus (*De adm.* Imp. 30–33) speaks of their coming from the north in the time of Heraclius—the middle of the 7th century. Their dialects shade into one another, and there is no trace of any influence of the Korth-Western group. Constantine was probably led astray by the occurrence of the same tribal names in different parts of the Slavonic world. Meanwhile the Southern Slavs were cut off from the rest of the race by the foundation in the 6th century of the Avar kingdom in Pannonia, and after its destruction in the 7th, by the spread of the Germans south-eastwards, and finally by the incursion of another Asiatic horde, that of the Magyars, who have maintained themselves in the midst of Slavs for a thousand years. Their conquests were made chiefly at the expense of the Slovenes and the Slovaks, and from their languages they have borrowed many words in forms which have now disappeared.

Of the history of the Eastern Slavs, who were to become the Russian people, we know little before the coming of the Swedish Rus, who gave them their name and organization; we have but the mention of Antae acting in concert with the other Slavs and the Avars in attacking the Empire on the lower Danube, and scattered accounts of Muslim travellers, which show that they had reached the Don and Volga and stretched up northward to Lake Ilmen. The more southerly tribes were tributary to the Khazars.

CULTURE AND RELIGION

The general impression is one of a people which lived in small communal groups, so impatient of authority that they scarcely combined for their own defence, and in spite of individual bravery only formidable to others when cemented together by some alien element: hence they all at one time or another fell under an alien yoke; the last survivals of Slavonic licence being the veče of Novgorod, and the Polish diet with its unpractical regard for any minority. The Slavs were acquainted with the beginnings of the domestic arts, and were probably more given to agriculture than the early Germans, though they practised it after a fashion which did not long tie them to any particular district—for all writers agree in telling of their errant nature. They were specially given to the production of honey, from which they brewed mead. They also appear to have been notable swimmers and to have been skilled in the navigation of rivers, and even to have indulged in maritime piracy on the Aegean, the Dalmatian coast and most of all the Baltic, where the island of Rügen was a menace to the Scandinavian and German sea-power. The Oriental sources also speak of some aptitude for commerce. Their talent for music and singing was already noticeable.

Of their religion it is strangely difficult to gain any real information. The word Bogŭ, "god," is reckoned a loan word from the Iranian Baga. The chief deity was the Thunderer Perún (*cf.* Lith. Perkúnas), with whom is identified Svarog, the god of heaven; other chief gods were called sons of Svarog, Dažbog the sun, Chors and Veles, the god of cattle. The place of this latter was taken by St. Blasius. A hostile deity was Stribog, god of storms. There seem to have been no priests, temples or images among the early Slavs. In Russia Vladimir set up idols and pulled them down upon his conversion to Christianity; only the Polabs had a highly developed cult with a temple and statues and a definite priesthood, perhaps in imitation of Norse or even Christian institutions. Their chief deity was called Triglav, or the three-headed; he was the same as Svętovit, apparently a sky god in whose name the monks naturally recognized Saint Vitus. The goddesses are colourless personifications, such as Vesna, spring, and Morana, the goddess of death and winter. The Slavs also believed, and many still believe, in Vily and Rusalki, nymphs of streams and woodlands; also in the Bába-Jagá, a kind of man-eating witch, and in Běsy, evil spirits, as well as in vampires and werewolves. They had a full belief in the immortality of the soul, but no very clear ideas as to its fate. It was mostly supposed to go a long journey to a paradise (raj) at the end of the world and had to be equipped for this. Also the soul of the ancestor seems to have developed into the house or hearth god (Domovój, Křet) who guarded the family. The usual survivals of pagan festivals at the solstices and equinoxes have continued under the form of church festivals.

Christianity Among the Slavs.—The means by which the various Slavonic nations were converted to Christianity has probably had more influence upon their subsequent history than racial distinctions or geographical conditions.

Wherever heathen Slavonic tribes met Christendom missionary effort naturally came into being. This was so along the Dalmatian coast, where the cities retained their Romance population and their Christian faith. From the 7th century the Croats were nominally Christian, and subject to the archbishops of Salona at Spalato and their suffragans. From the beginning of the 9th century from Merseburg, Salzburg and Passau the Gospel spread among the Slavonic tribes on the south-eastern marches of the Frankish empire, in Bohemia, Moravia, Pannonia and Carinthia. Despite the zeal of these missionaries, as Germans they belonged to a nation which was once more encroaching upon the Slavs, and as Latins (though the Great Schism had not yet taken place) they were not favourable to the use of their converts' native language. Still they were probably the first to reduce the Slavonic tongues to writing, naturally using Latin letters and lacking the skill to adapt them satisfactorily. Traces of such attempts are rare; the best are the Freisingen fragments of Old Slovene now at Munich.

In the eastern half of the Balkan Peninsula the Slavs had already begun to turn to Christianity before their conquest by the Bulgars. These latter were hostile until Boris, under the influence of his sister and of one Methodius (certainly not the famous one), adopted the new faith and put to the sword those that resisted conversion (A.D. 865). Though his Christianity came from Byzantium, Boris seems to have feared the influence of the Greek clergy and applied to the Pope for teachers, submitting to him a whole series of questions. The Pope sent clergy, but would not grant the Bulgarians as much independence as they asked, and Boris seems to have repented of his application to him. He raised the question at the Council of Constantinople (A.D. 870), which decided that Bulgaria was subject to the Eastern Church.

Cyril and Methodius.—In the same way Rostislav, prince of Greater Moravia, fearing the influence of Latin missionaries, applied to Byzantium for teachers who should preach in the vulgar tongue (A.D. 861). The emperor chose two brothers, sons of a Thessalonian citizen, Methodius and Constantine (generally known as Cyril by the name he adopted upon becoming a monk). The former was an organizer, the latter a scholar, a philosopher and a linguist. His gifts had been already exercised in a mission to the Crimea; he had brought thence the relics of S. Clement, which he finally laid in their resting-place in Rome. But the main reason for the choice was that the Thessalonians, surrounded as they were by Slavonic tribes, were well known to speak Slavonic perfectly. On their arrival in Moravia the brothers began to teach letters and the Gospel, and also to translate the necessary liturgical books and instruct the young in them. But soon (in 864) Rostislav was attacked by Louis the German and reduced to complete obedience, so that there could be no question of setting up a hierarchy in opposition to the dominant Franks, and the attempts to establish the Slavonic liturgy were strongly opposed. Hearing of the brothers' work Pope Nicholas I. sent for them to come to Rome. On their way they visited with Kocel, a Slavonic prince of Pannonia, about Lake Balaton, and he much favoured the Slavonic books. In Venice the brothers had disputes as to the use of Slavonic service-books; perhaps at this time these found their way to Croatia and Dalmatia.

On their arrival in Rome Nicholas was dead, but Adrian II. was favourable to them and their translations, and had the pupils they brought with them ordained. In Rome Constantine fell ill, took monastic vows and the name of Cyril, and died on the 14th of February 869. Methodius was consecrated archbishop of Pannonia and Moravia, about 870, but Kocel could not help him much, and the German bishops had him tried and thrown into prison; also in that very year Rostislav was dethroned by Svętopluk, who, though he threw off the Frankish yoke, was not steadfast in supporting the Slavonic liturgy. In 873 Pope John VIII. commanded the liberation of Methodius and allowed Slavonic services, and for the next few years the work of Methodius went well. In 879 he was again called to Rome, and in 880 the pope distinctly pronounced in his favour and restored him to his archbishopric, but made a German, Wiching, his suffragan. Methodius was succeeded by Wiching, who had a new pope, Stephen V. (VI.) on his side. So the Slavonic service-books and those that used them were driven out by Svętopluk and took refuge in Bulgaria, where the ground had been made ready for them. Boris, having decided to abide by the Greek Church, welcomed Clement, Gorazd and other disciples of Methodius. Clement, who was the most active in literary work, laboured in Ochrida and others in various parts of the kingdom.

In spite of the triumph of the Latino-German party, the Slavonic liturgy was not quite stamped out in the west; it seems to have survived in out-of-the-way corners of Great Moravia until that principality was destroyed by the Magyars. Also during the life of Methodius it appears to have penetrated into Bohemia, Poland and Croatia, but all these countries finally accepted the Latin Church, and so were permanently cut off from the Orthodox Serbians. Bulgarians and Russians. (X.; N. B. J.)

SLED DOG RACING: *see* Dog Sled Racing.

SLEEP is a recurring state of inactivity, decrease of consciousness and decrease in responsiveness to events in the environment. The ease with which sleep can be terminated differentiates it from coma, general anesthesia, alcoholic stupor and seasonal lethargy of certain animals (*see* Hibernation). On the other hand, there are conditions of semiawakeness ("brown study," postepileptic automatism, hypnotic trance, fugue, etc.) that are intermediate in character, possessing some features of both sleep and wakefulness. Moreover, in the routine of living there are regular diurnal gradations in the depth of slumber and the degree of alertness, which alternate with each other like the crest and trough of a 24-hour wave.

Knowledge concerning the nature of sleep has been derived from observation and experiment; from the findings gathered by these two methods, theories of sleep have been elaborated and a hygiene of sleep developed.

Observational Data.—A conspicuous characteristic of sleep, for man and nearly all animals, is the horizontal posture of repose which permits a relaxation of the body musculature. Aside from producing overt movements, muscular contractions are also used to maintain station, or posture, through tonic activity—a state of partial contraction which manifests itself in resistance to passive or externally imposed movement. In raising gently an arm of a sleeping person, little opposition is met, and when the grip on it is released, the arm drops back limply.

A rather annoying (to others) aspect of this general relaxation of sleep is that it also involves the closers of the jaw, causing the mouth to open, and then the soft palate, with its appendage (the uvula), flutters with passage of the air in and out of the lungs, producing the well-known sounds of snoring.

Muscles are supplied with two types of nerve fibres: (1) efferent, motor, centrifugally conducting fibres, which carry impulses from the nervous system, resulting in overt as well as tonic contractions; and (2) afferent, sensory, proprioceptive ("self-feeling"), centripetally conducting fibres, which furnish conscious and unconscious information concerning the state of the different parts of the body and their relation to each other. This muscle sense, literally a sixth sense, contributes greatly to the continuous stream of afferent impulses from the sense organs to the cerebral cortex (see BRAIN; NERVOUS SYSTEM).

A person shuts off the streams of visual and auditory impulses by retiring to a dark, quiet room, and decreases cutaneous impulses by lying down on a soft, smooth surface, but the proprioceptive impulses, coming as they do from the body itself, are still there, gradually decreasing only when and as the body musculature is relaxed.

Muscular relaxation and immobility, however, are not absolute. From time to time, unless mechanically restrained, the sleeper moves one part of the body or another, or turns over completely, changing his position. A person's positional repertory may be small or large, and the total amount of motility varies with the degree of fatigue, environmental temperature, amount of bed coverings, width of the bed and the quantity and composition of food and beverage taken before going to bed. As a rule, the longer the duration of sleep, the greater the frequency of movement. Occurring altogether about 20 to 40 times in the course of one night, this motility entails at least a semiawakening and a partial awareness of external relations. The sleeper does not usually recall these multiple interruptions of rest, and the total time spent in motility is small, amounting to about 30 seconds per hour, or a few minutes for a whole night's sleep. The periodic change in the position of the body is probably brought on by, and relieves, the pressure on the skin in contact with the bed surface. Alcoholic intoxication, deadening sensitivity to discomfort, leads to decreased motility during sleep, often resulting in soreness and stiffness in a muscle or even a partial paralysis from pressure exerted on a nerve for several hours.

It is possible to sleep in a semireclining position (as on a reclining chair), sitting upright (at a lecture, theatre or in an easy chair at home) or, when very tired, while standing up or riding horseback. Some animals regularly sleep in a standing position.

Of greatest interest are the changes in the activity of the nervous system during sleep. In older children and adults this manifests itself in the abolition, or at least depression, of critical reactivity to external events. In the waking state the impulses coming from the different sense organs to certain areas of the cerebral cortex are analyzed in the light of the person's previous experience, and appropriate responses (which include movement as well as refraining from overt muscular activity) are elaborated or integrated in other cortical areas. Identical afferent impulses from sense organs will not elicit the same response in different persons. This individuality of reaction is lost during sleep and is replaced by stereotyped predictable reflexes from the lower centres of the nervous system. Furthermore, compared with wakefulness, the reflex excitability of the lower centres themselves is decreased during sleep. A more powerful stimulus (change) is required to obtain a response of a certain magnitude.

During sleep the amplitude and frequency of the electrical brain waves undergo characteristic changes, and it has been possible to associate particular electroencephalogram (EEG) patterns with certain stages of sleep. Epileptic persons show typically peculiar brain waves while awake, but even more revealing are their EEG's during sleep. Furthermore, whereas an epileptic fit in the waking state is almost always ushered in by a definite EEG complex, the same complex in sleep does not lead to overt convulsions unless the sleeping epileptic is awakened at that time. This suggests that in sleep there may be a functional de-efferentation of the lower centres of the nervous system.

In contrast to the general inactivity, muscular relaxation, lack of critical reactivity, and depression of reflex excitability—all involved in the external or animalistic relations of the organism—the internal, household, visceral or vegetative functions are either unaffected or somewhat enhanced during sleep. Circulation of the blood goes on, although the heart rate is decreased and the arterial blood pressure lowered. These changes are in part related to the assumption of the horizontal position, and often occur upon simply lying down and remaining awake. In sleep there are also modifications in the rate and depth of respiration, indicative of a decreased excitability of its regulating centre, along with that of other reflex centres, in the nervous system. As a result there are certain changes in the composition of the blood, which is less thoroughly purified than in the waking state. Digestion—the movements of the different parts of the gastrointestinal tract and the secretory activity of its glands—goes on unabated. The same seems to be true of the liver and kidneys, although some decrease has been detected in the functioning of these vital organs, as well as in the metabolic rate (oxygen consumption) of the organism. There is a marked drop in body temperature, often amounting to 1° F., which is undoubtedly related to muscular relaxation and a lowering of metabolic processes. Sweating, in general, as a means of cooling off the body by evaporation, may actually be accentuated during sleep, especially in warm weather, but is diminished in skin areas of the palms of the hands and soles of the feet.

Variation in each of the above-enumerated concomitants of sleep in the course of the night has been employed as an index of its depth. Unfortunately, there is no agreement among the several depth-of-sleep curves constructed in this manner. The most commonly used method is to determine the loudness of a sound required to awaken the sleeper. The figures obtained suggest that during the night sleep gets to be very deep in the first two or three hours and then becomes progressively lighter. Similar curves could be derived from data on quiescence (the reverse of motility), the increase in the carbon dioxide of the air in the lungs and the predominance of slow (3 to 0.5 per second) "delta" brain waves. Using arterial blood pressure or body temperature as a criterion, sleep is deepest in the middle of its course. Lastly, the lowest heart rate is not reached until the sixth or seventh hour of sleep. Thus, by proper selection of an index, it can be shown that sleep is deepest in the first, second or third quarter of the night. More important, study of the figures on which the different curves are based reveals that in any one night there may be repeated fluctuations in the depth of sleep. Instead of one curve there are many, with a shallowness, to the point of awakening, occurring again and again mith increasing frequency, and the depth of sleep between decreasing in magnitude.

A concomitant of sleep, information on which is based mainly on the sleeper's ability to recall and relate his observation, is the phenomenon of dreaming. Intriguing though the dream has proved to be through the ages, beginning mith the prophetic or premonitional dreams of the ancients and progressing to the dream interpretation in modern psychoanalytic practice and research, only the pattern of the dream is of help in elucidating the nature of sleep. This pattern is indicative of a low level of cortical analysis and integration, comparable to the operation of a very young child's mind.

An objective index of dreaming is an EEG pattern, closely resembling the "alpha" rhythm which is usually associated with resting wakefulness but makes its appearance repeatedly during a night's sleep. If the sleeper is awakened during the modified alpha EEG stage of sleep, he nearly always reports dreaming, but in other EEG stages. characteristic of deeper sleep, no dreaming is recalled. The modified alpha EEG is usually accompanied by rapid, jerky eyeball movements, distinctly visible even under closed eyelids but also recordable electronically as changes in the corneoretinal potential, and often by a quickening of respiration and pulse rate. The rapid eye movements probably represent a scanning of the scene of dream action, as their direction is related to the movement of objects and persons seen in the dream. The length of the dream narrative is proportional to the lapse of time between the appearance of the modified alpha EEG and the arousing and questioning of the sleeper. Contrary to anecdotal reports, the course of time during dreaming is about the same as in real life. Sound or light stimuli too weak to awaken the sleeper, if applied while dreaming is in progress, are occasionally incorporated into the dream story. After the cessation of the objective signs of dreaming, the ability to recall details of the dream content rapidly diminishes, and in a few minutes the sleeper may forget that he dreamed at all. That explains why many persons maintain that they seldom, or never, dream. However, even the latter invariably recall dreaming if aroused while showing a modified alpha EEG sleep pattern. The objective criteria of dreaming can be used to plot the incidence and duration of dreaming episodes during a night of undisturbed sleep. There are usually five or six periods of dreaming, the first, and shortest, occurring about one hour after the onset of sleep, and the succeeding ones, corresponding to 80- to 90-minute cycles of EEG pattern variation, progressively longer. The average duration of dreaming periods is from 5 to 50 minutes, with a total of about two hours for a whole night's sleep. (See also DREAMS.)

Experimental Data.—Sleep deprivation (keeping a person awake by constant watching and prodding) has been a favourite method used in study of the sleep problem. After about 60–90 hours of enforced wakefulness (four to six times the usual span of 16–17 hours). the most prominent effect is extreme muscular weariness. The subjects of such experiments want most to be allowed to close their eyes and lie down, but it is precisely this enforced muscular activity that enables them to remain awake. Lying down means failure of the experiment. Nothing is more illustrative of the importance of proprioceptive impulses in the maintenance of wakefulness and of muscular relaxation in the precipitation of sleep. Among other features of behaviour in sleep deprivation are irritability to the point of irascibility in normally even-tempered subjects, and a mental disorganization, leading to dreaming while awake, hallucinations and automatic behaviour, occasionally bordering on temporary insanity. It is easy to understand why the third-degree method of continuous interrogation for many hours will make a person sign a "confession," even if innocent of the crime he is accused of having committed. He wants to be permitted to sleep, and he fails to realize the seriousness of his self-incrimination.

Experiments on animals include inducing lesions in, and stimulation of, different parts of the central nervous system. Dogs surgically deprived of the cerebral cortex still show alternation of sleep and wakefulness. Such decorticated animals lose the greater part of their learning ability and no longer profit from their previous experience. They would starve to death, in the presence of an abundance of food and water, unless artificially fed. They do not recognize their keeper, and their behaviour in many mays resembles that of very young puppies. Like the latter they go to sleep after they are fed, become restless only when hungry, and their sleep-wakefulness cycle loses its usual relation to night and day.

Nature performs similar experiments on human beings, in the form of anencephalous infants (born without a cerebral cortex) who often remain alive for months or even years. Unlike normal infants, who learn in a few weeks to consolidate several short naps into one long night's sleep, anencephalous ones, as long as they live, sleep at irregular intervals. Their sleep-wakefulness cycle, like that of decorticated dogs, seems to be geared largely to the satisfaction of hunger. Evidently, primitive sleep-wakefulness alternation does not require cerebral cortical activity in either animals or man.

By modern electrocoagulation procedures, it is possible to burn out discrete regions of the brain stem without removing or injuring the cerebral cortex. Extensive damage to the hypothalamus, in the region of the mammillary bodies, in cats and monkeys induces profound somnolence or frank sleep. It would appear that the waking state is maintained by impulses sent from the hypothalamus to the lower centres of the nervous system. Conversely, afferent impulses from the periphery are capable of stirring the wakefulness centre of the hypothalamus into activity. Again, nature's experimentation, in the form of one kind of sleeping sickness (see ENCEPHALITIS), seems to confirm laboratory findings. In the latter disease the cerebral cortex is undamaged, but there are extensive lesions in the brain stem in the region of the wakefulness centre. Significantly, sleeping sickness patients can at times be aroused briefly. but they are unable to maintain wakefulness. No naturally occurring destruction in the brain stem or elsewhere in the nervous system has ever produced permanent insomnia, militating against the existence of a sleep centre.

A sleep abnormality that points to the importance of afferent impulses from the sense organs in wakefulness is narcolepsy, a disease in which bouts of almost uncontrollable drowsiness may occur several times daily for years. The incidence of these attacks increases when the narcoleptic is alone and is engaged in uninteresting activity, conditions conducive to drowsiness in nearly everyone. Of added interest is that narcolepsy is usually associated with cataplexis, a sudden complete loss of muscle tonus, causing the person to sink to the ground, with consciousness usually preserved. This sudden muscular relaxation, seldom lasting more than a few minutes, is brought on by some emotional stress, particularly laughter. The causes of narcolepsy and cataplexis are unknown, but their occurrence in combination suggests that a defect in the maintenance of tonus in the skeletal musculature and failure, at times, of wakefulness may have a common cause.

Theories of Sleep.—Partial theories pertain to the mechanism of going to sleep and attempt to explain how sleep is brought about; awakening is usually ascribed to a reversal of the changes that produce sleep. General theories deal with the reason for sleep, often without attention to the mode of its onset or termination. Complete theories try to explain both the mechanisms of and reasons for the phenomenon, sometimes by proposing the same scheme for both.

Circulatory theories, of the partial kind, ascribe sleep to a shifting of the blood out of or into an important organ, usually the brain. These theories are obsolete, as the absence of such a shift of blood has been definitely established. Also discarded are the neural theories, postulating a physical break in the chains of nerve cells that serve as conducting pathways in the nervous system. Inhibitory theories implicate widespread inhibition which decreases or abolishes the activity of the cerebral cortex, but they are clearly inadequate when it is considered that decorticated animals and newborn infants (whose cerebral cortex is not yet functioning) can sleep. Deafferentation theories are based on the fact that shutting off incoming sensory impulses to the cerebral cortex is incompatible with wakefulness, but they likewise fail to explain sleep after decortication. Biological theories are general in that they consider sleep an instinct and, as such, a positive act rather than a mere cessation of wakefulness. The vagueness of these theories is at once a strength and weakness; it is impossible either to refute them or to prove their correctness. Humoral or chemical theories stem from established changes in the composition of the blood and urine, modification of metabolic processes in the tissues and a possible variation in the secretory activity of the glands of internal secretion, occurring during sleep as compared with wakefulness. Either some substance required to maintain the waking state is exhausted, and sleep serves to replenish it; or, on the contrary, some toxic substances accumulated in wakefulness are excreted or destroyed in sleep. However, alertness and efficiency of performance are not at their best at the time of getting up in the morning, nor at their worst at bedtime at night.

An evolutionary theory distinguishes between the roles of the hypothalamic centres and the more recently evolved cortical centres in the maintenance of the waking state. According to this theory. sleep as a state of inactivity requires no explanation. Wakefulness of the primitive type, seen in the newborn infant or in decorticated animals, designed to meet the minimum needs for keeping alive and for protoplasmic growth, is a subcortical, probably hypothalamic, function. The higher type of wakefulness. with its attendant alertness, critical reactivity and wider interests. as well as the adaptation of the sleep-wakefulness cycle to the 24-hour alternation of night and day, is a function of the cerebral cortex. Wakefulness maintained by the cortex depends upon its receiving impulses from both the hypothalamic centres and the sense organs, particularly the skeletal muscles.

Hygiene of Sleep.—Although no proposed theory of sleep has met with universal acceptance, enough factual information is available for a rational hygiene of sleep. Acculturation to the family and community pattern of living begins at a very early age. Even in the first few days of life the human infant sleeps more at night than in the daytime. A continuous long period of sleep at night is achieved, with some training, in two or three months. Supplementary daytime naps are reduced to two at six months (by which time a distinct diurnal body temperature curve is in evidence) and to one by the end of the first year; they are given up entirely at the age of three to six years. The belief that very young babies sleep nearly all the time—about 20 or 22 hours out of 24—has been shown to be incorrect. The average total duration of sleep of a newborn infant is only about 14–15 hours and this is reduced to 13–14 hours at the age of six months. Thereafter there is a continuous decline to 7–9 hours of sleep per 24 hours in the adult.

The nightly sleep "ration" is made up of two components: an obligatory need for sleep, which varies with the physical, mental and temperamental characteristics of the individual, and an accessory indulgence in sleep, influenced by age, sex and day-to-day fluctuating environmental factors. A person's irreducible sleep fraction is best expressed by its complement, the maximum sustainable duration of wakefulness. At one extreme of the population distribution are persons capable of remaining alert for more than 18 hours daily, at the other those who succumb to uncontrollable drowsiness in less than 14 hours. Everyone, however, tends to overindulge in sleep in the absence of stimulating events in his immediate environment, simply as an escape from boredom. Thus, in routine uninteresting existence most people sleep longer than is necessary for their well-being. By the purely empirical test of freedom from sleepiness during the customary waking hours, each person can determine his minimum sleep requirement.

Aithough sleep is in no sense a habit, the adjustment to hours of retiring and getting up, to certain types of bed and bedding and to a host of environmental conditions depends on individual experience and training. The diurnal sleep-wakefulness rhythm, it will be recalled, is cortically conditioned, and by following a regular schedule of hours for various tasks and recreation, meals and sleep, this rhythm is fortified. The reward is tuofold: (1) a more prompt occurrence of sleep at night and spontaneous awakening in the morning, and (2) greater alertness during wakefulness. espetially at customary hours of activity.

Insomnia usually involves a difficulty in falling asleep. When it is caused by pain or physical discomfort, a hypnotic drug. prescribed by a physician, may have to be resorted to. Occasionally, grief over past events or worry over possible future misfortunes produces a muscular tension that prevents the onset of sleep. Under these conditions, anything that takes a person's mind off the disturbing thoughts promotes muscular relaxation and is thus conducive to sleep. A series of routine chores. such as grooming and bathing, for an hour or two before going to bed helps induce drowsiness. Reading in bed (if the subject matter is not emotionally charged) or listening to soothing music is soporific for some persons. However, what puts one person to sleep may keep another awake.

A particular difficulty faces those who are engaged in around-the-clock operations of some industries, public utilities, transportation and communication companies, police and fire departments, hospitals and military services. These persons have to work (and therefore also sleep) at unconventional hours and are subject to many inconveniences. The common practice of rotating work shifts at frequent, often weekly, intervals all but prevents the workers from developing a suitable individual sleep-wakefulness rhythm.

The temperamental make-up of the individual also affects his ability to conform to the community pattern of living. Early to bed and early to rise is easy for the "morning" type, whose body temperature and efficiency reach their maxima around noon. A marked "evening" type dislikes getting up at the conventional hour in the morning. depends upon an artificial mode of awakening, does not reach his height of efficiency until late in the afternoon (when the work day is practically over) and hates to go to bed at night. A satisfactory adjustment can be made by nearly everyone, though not nith equal ease.

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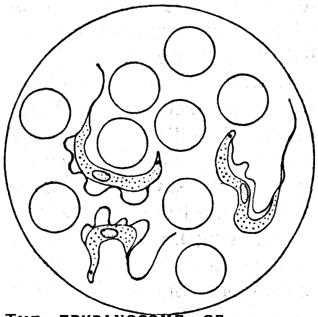
SLEEPING SICKNESS (AFRICAN TRYPANOSOMIASIS), a disease of the blood stream. lymph nodes and central nervous system, is confined to tropical Africa and has been known since the beginning of the 19th century. It is characterized by fever, inflammation of the lymph glands and, following the involvement of the brain and spinal cord, profound lethargy (hence the name "sleeping sickness"), frequently ending in death. The causative agents are *Trypanosoma gambiense,* with a distribution extending from the west coast of Africa eastward to the lakes district and southward to Angola and the southern border of the Belgian Congo, and T. *rhodesiense,* limited to the highlands of central east Africa. These trypanosomes are morphologically indistinguishable from one another and from the trypanosome of the antelope, T. *brucei,* which produces the fatal nagana disease in cattle.

Although sleeping sickness is occasionally transmitted mechanically, within two or three hours after an interrupted blood meal, by coitus or by mother's milk, an overwhelming majority of infections result from inoculation of the microorganisms by tsetse flies (primarily *Glossina palpalis* for *T. gambiense* and *G. morsitans* for *T. rhodesiense).* The fly becomes infected while feeding on the blood and tissue juices of patients and incubates the parasites; 15 or more days later it introduces the infective stage into another human being at the time of the next feeding.

The amount of experimental work which has been carried out in order that these relatively prosaic facts might be stated is very extensive and has occupied the lifetime of some of the most capable workers in tropical medicine. Thus, it was no simple task to prove that after a tsetse fly has bitten an infected human being, 12 to 15 days (*e.g.,* the incubation period within the fly) must elapse before the fly becomes infective for man. During this time the trypanosomes multiply by binary division in the mid-gut of the fly, then migrate to the salivary glands, become transformed into the infective stage and pass out of the fly's proboscis in droplets of saliva. Although experiments with human volunteers have with rare exceptions been consistently unsuccessful in attempts to infect man with T. *brucei* from wild game hosts, most workers believe that *T. rhodesiense,* and possibly *T. gambiense,* are strains of T. *brucei* that have become adapted to man. In favour of this view is the fact that strains of *T. rhodesiense* and *T. gambiense* are infective for many domestic mammals and for the wild game animals (*e.g.,* antelopes) that harbour *T. brucei.* Infection of cattle produces great economic loss and significantly reduces animal proteins available for the human population.

Pathogenesis and Symptoms.—T. *gambiense* and T. *rhodesiense* produce the same type of clinical picture during the incubation period, the septicemic and the glandular stages, but T. *rhodesiense* is much more rapid in its course and ends fatally before invasion of the central nervous system. After an incubation period in man averaging six to seven days, the trypanosomes are found in appreciable numbers in the circulating blood. Next, the lymph nodes and spleen are invaded, becoming swollen, soft and tender. The marked enlargement of these nodes in the posterior cervical triangle, known as Winterbottom's sign (after an early 19th-century traveler who noted this peculiarity), is relatively diagnostic of the disease. Irregular fever and delayed sensation to pain are also characteristic of this stage of the disease. In the Rhodesian type the toxemia becomes so profound that the victim soon succumbs; in the Gambian type the organisms proceed to invade the brain and spinal cord.


THE TRYPANOSOME OF AFRICAN SLEEPING SICKNESS

The neurological symptoms include severe headache, mental dullness and apathy. a weary shuffling gait, tremors, spastic or flaccid paralysis. chorea, profound sleepiness which develops during a meal or when the patient is standing or walking, increasing emaciation, coma and death. Occasionally there are mental disturbances which include dementia, melancholia, delusions and a syndrome mimicking central nervous system syphilis. Nevertheless, in many natives a tolerance to the infection develops. and the patient may live for many years as a carrier of the parasites.

Diagnosis is made by demonstration of the organisms in circulating blood during the septicemic stage; by their recovery from gland juice or from sternal bone marrow biopsy during the glandular stage. and from spinal fluid following invasion of the central nervous system. Prognosis is poor to grave in untreated cases of T. *gambiense* infection, and *T. rhodesiense* infection is always fatal unless treated early.

Treatment.—The earlier the disease is diagnosed and specific treatment is instituted, the greater are the chances of recovery. For the Gambian infection, a synthetic arsenical, tryparsamide, is highly effective, although it may produce acute optic neuritis, with possible loss of vision. In infections which have not reached the central nervous system stage, tryparsamide is nearly 100% curative. Older chronic cases with neurological manifestations require persistent treatment. Suramin sodium. also referred to as germanin, a nonarsenical, is also effective for the Gambian infection, as well as for the Rhodesian type during the early stage, but all treatment of T *rhodesiense* infection is useless once the fulminating toxemic stage has developed.

Prevention.—In few diseases have as heroic control measures been attempted as in African trypanosomiasis. For T. *gambiense* the following procedures have been carried out with profit: (1) isolation and proper treatment of all infected persons, including large numbers of asymptomatic chronic carriers; (2) protection of man from bites of tsetse flies by maintaining extensive clearings around villages and residence compounds; (3) prophylactic doses of suramin or of diamidine compounds once every 60 to 90 days for persons who must enter the jungle, so that they will not become infected from tsetse fly bites; and (4) occasional removal of entire native villages from endemic to free zones. Although these same measures apply in a more limited degree to Rhodesian trypanosomiasis, the need is at times suggested of exterminating wild game reservoirs of the disease near villages if man cannot otheraise be protected. Concerted campaigns were carried out to control African trypanosomiasis following the conference on sleeping sickness that met in London in 1925. In the Cameroons, by persistent tryparsamide treatment of all diagnosed cases, Gambian infection was reduced from a high percentage of extensive population groups to less than 1%, and entire tribes were saved from extincfion by this single measure. On the other hand, prophylactic chemotherapy failed in the Rhodesian endemic areas. The advent of potent insecticides. such as DDT, held promise of satisfactory destruction of the tsetse fly in areas of maximum human exposure.

For American or Brazilian trypanosomiasis (Chagas' disease), *see* TRYPANOSOMIASIS. For other "sleeping sicknesses." *see* ENCEPHALITIS. *See* also PARASITIC DISEASES and TSETSE FLY.

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SLEET, in the United States and Canada the popular name for precipitation of transparent, roundish, hard ice particles one to four millimetres in diameter, which in other countries are properly called grains of ice, ice pellets or frozen raindrops. These are often confused with graupel, small hail, soft hail (*q.v.*), granular snow and snow pellets, which resemble ice pellets somewhat in size and general appearance but are whitish, softer and less dense. Ice pellets mixed with rain and falling on surfaces having temperatures below freezing result in a pebbly surfaced crust of glaze (clear ice) forming over the surfaces.

Ice pellets are produced by raindrops formed in clouds in an upper warm-air layer becoming frozen while falling through a lower (or surface) air layer having a temperature well below freezing.

In British countries (except Canada) sleet refers to a mixture of rain and snow. (R. G. SE.)

SLEIDANUS, JOHANNES (1506–1556), German historian, the annalist of the Reformation, was born at Schleiden, near Aachen. He studied ancient languages and literatures at Liège and Cologne, and law and jurisprudence at Paris and Orléans. While among the humanists of Liège, he had adopted Protestant opinions and entering the service of Cardinal du Bellay, was employed in the futile negotiations of the French court to make an alliance with the German Protestants against the emperor Charles V. In 1542 he settled at Strasbourg. Sleidanus had been accustomed to copy all papers bearing upon the Reformation to which he had access, and Martin Bucer proposed to Philip of Hesse to appoint him historian of the Reformation, giving him a salary and access to all necessary documents. Sleidanus began his great work, finishing the first volume in 1545. In that year he went to England in a French embassy to Henry VIII. While there he collected materials for his history.

On his return he represented Strasbourg at the diets of Frankfort and Worms and went on to Marburg to explore the archives of Philip of Hesse. The War of the League of Schmalkalden interfered with this work and also prevented the payment of Sleidanus. who received a yearly pension from Edward VI. In 1551 Sleidanus represented Strasbourg at the Council of Trent, being charged to act also for the imperial cities of Esslingen, Ravensburg, Reutlingen, Biberach and Lindau.

He was afterward appointed professor of law in Strasbourg and finished his great task in 1554, though lack of money and other misfortunes compelled him to delay printing. Sleidanus died in poverty at Strasbourg in Oct. 1jj6. The book appeared in the preceding year—*Commentariorum de statu religionis et reipublicae, Carolo V. Caesare, libri XXVI;* it was translated into English by John Daws in 1560 and by G. Bohum in 1689. It was so impartial that it pleased no one, not even Melanchthon. It remains the most valuable contemporary history of the times of the Reformation and contains the largest collection of important documents.

SLEIGH (SLED or SLEDGE), a vehicle on runners instead of wheels, for traveling over snow or ice. The sleds used in bobsledding are referred to in the article BOBSLEDDING. Horse-drawn sleighs mere formerly much employed as ordinary means of conveyance in the U.S.S.R., North America and the Scandinavian countries. In the arctic regions dogs are harnessed to them. *See* TRANSPORT.

SLEMP, CAMPBELL BASCOM (1870–1943), U.S. politician, was born on Sept. 4, 1870, in Turkey Cove, Va. He graduated from the Virginia Military institute in 1891 and studied law at the University of Virginia. He became a successful businessman and made his debut in politics in 1905 when he was named chairman of the Republican state committee of Virginia and rapidly became a G O P. power in the south. In 1907 he was elected to congress to fill the unexpired house term of his father, who had died. He was re-elected eight times from 1909 to 1923.

During the 1920 presidential campaign, Slemp was leader of the Harding drive to crack the Democrats of the solid south. From 1923 to 1925 he was secretary to Pres. Calvin Coolidge, acting as the president's conciliator before congress. Slemp also helped Coolidge win the Republican nomination in 1924.

In 1928 Slemp supported Herbert Hoover. He later resigned as chairman of the party's committee in Virginia. He died on Aug. 7, 1943.

SLESSOR, SIR JOHN COTESWORTH (1897–), British air marshal, was born at Rhanikhet, India, on June 3, 1897, and educated at Haileybury college, Hertfordshire. In 1915 he was commissioned in the royal flying corps and served as a pilot in France, Egypt and the Sudan. Appointed to a permanent commission in the Royal Air Force in 1920, he served two years in India and afterward in various home appointments. In 1935–37 he commanded the wing supporting the Indian army in the Waziristan operations and for this was awarded the distinguished service order. On his return to England he served as director of the plans branch of the air ministry. In 1940, during World War II, Slessor visited the U.S. on a special mission. In 1942 he took the new and important post of assistant chief of the air staff (policy), so attending the chief Allied conierences. The following year he was appointed air officer commanding in chief, coastal command, and was able, in close co-operation with the Royal Navy and the U.S. forces, to contribute to the defeat of the German submarines in the battle of the Atlantic. In 1944 he became deputy air commander in chief of the Allied forces in the Mediterranean and a year later was made air member for personnel on the air council. In 1948 he became commandant of the Imperial Defence college before holding the highest of all posts in the R.A.F.—that of chief of the air staff. He retired in 1952. Air Marshal Slessor became well known also for books and articles on air strategy. He was created knight grand cross of the Order of the Bath in 1948. His book *The Central Blue* is largely autobiographical. (E. B. BN.)

SLEZAK, LEO (1873–1946), Czech tenor known for his performance of Wagnerian operatic roles. Born at Sumperk, Moravia, on Aug 18, 1873, he studied under Adolf Robinson and made his debut at Brno in *Lohengrin* in 1896. In 1908 he studied under Jean de Reske in Paris and in the following year established his reputation as a heroic tenor in the part of Otello in London and New York, his impersonation being helped by his imposing height, He was later esteemed for his interpretations of Wagnerian roles throughout Europe and the Cnited States. Slezak abandoned singing toward the end of his life and became known as a film comedian in Austria He died at Egern, Bavaria, on June 1, 1946.

See L. Slezak, *Song of Motley (1938).*

SLICK, SAM: *see* HALIBURTON, THOMAS CHANDLER.

SLIDELE, JOHN (1793–1871), U.S. diplomat whose seizure with James M. Mason precipitated the "Trent" case *(see* below), was born in New York city in 1793. A graduate of Columbia college in 1810, he moved to New Orleans, La., in 1819, where he practised maritime law, married into a distinguished Creole family and participated actively in politics. He sat in congress from 1843 to 1845.

In 1843 he was sent to Mexico by Pres. James K. Polk to secure territorial concessions and at the same time to avert the approaching war. Though he was not received officially by the Mexican government, he remained as an observer until the eve of war. Returning to the United States, he represented Louisiana in the senate from 1853 to 1861. He was a staunch supporter of Pres. James Buchanan and a vigorous opponent of Stephen A. Douglas.

When Louisiana seceded, Slidell cast his lot with the Confederacy. Entering the Confederate foreign service, he mas sent to France in late 1861, but on his way there he and Mason were removed by a Federal man-of-war from the British steamer "Trent" and imprisoned at Ft. Warren in Boston harbour. The British government strongly protested this action and the two men were released in Jan. 1862 at President Lincoln's insistence and over Secretary of State W. H. Seward's objections. In France. Slidell's relations with Napoleon III, though cordial, were unofficial. Thus this second mission, like that to Mexico, had little result, save that financial negotiations with the Erlangers of Paris and Frankfurt led to the Confederate cotton loan of 1863.

Following Lee's surrender at Appomattox, Slidell and his family lived in Paris until the Franco-German War, when he moved to London. Slidell died there on July 29, 1871.

See Louis Martin Sears, *John Slidell* (1925) ; Beckles Willson, *John Slidell and the Confederates in Paris (1862–65)* (1932). (L. M. S.)

SLIDE RULE, a rule consisting of graduated scales capable of relative movement. by means of which simple calculations may be carried out mechanically. In ordinary slide rules these operations include multiplication, division and extraction of square roots, as well as, in some cases, calculation of trigonometrical functions and logarithms. The slide rule has become an essential tool in the mathematics of science and engineering and is widely used in business and industry as well.

The logarithmic slide rule is a compact device for rapidly performing calculations with limited accuracy. The invention of logarithms in 1614 by John Napier of Merchiston, Scot., and the computation and publication of tables of logarithms made it possible to effect multiplication and division by the simpler operations of addition and subtraction. *(See* LOGARITHMS.) Napier's early conception of the importance of simplifying mathematical calculations resulted in his invention of logarithms. and this invention made possible the slide rule as we know it. In 1620 Edmund Gunter plotted logarithms on a two-foot straight line. With such scales, multiplication and division were performed by addition and subtraction of lengths by a pair of dividers.

William Oughtred, according to his own statement (1633), constructed and used as early as 1621 two of these Gunter's lines sliding by each other so as to do away with the need for dividers. The lines were used in both the straight and circular forms. In the former the scales were held against one another by the hands; in the latter, dividers were replaced by an "opening index"—really a pair of dividers fixed centrally on the circular scale.

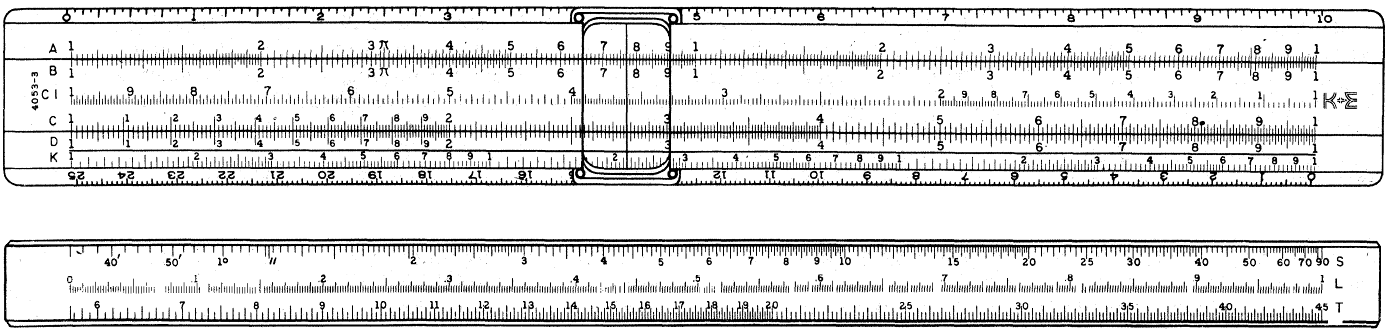

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FIG. 1.— MANNHEIM SLIDE RULE

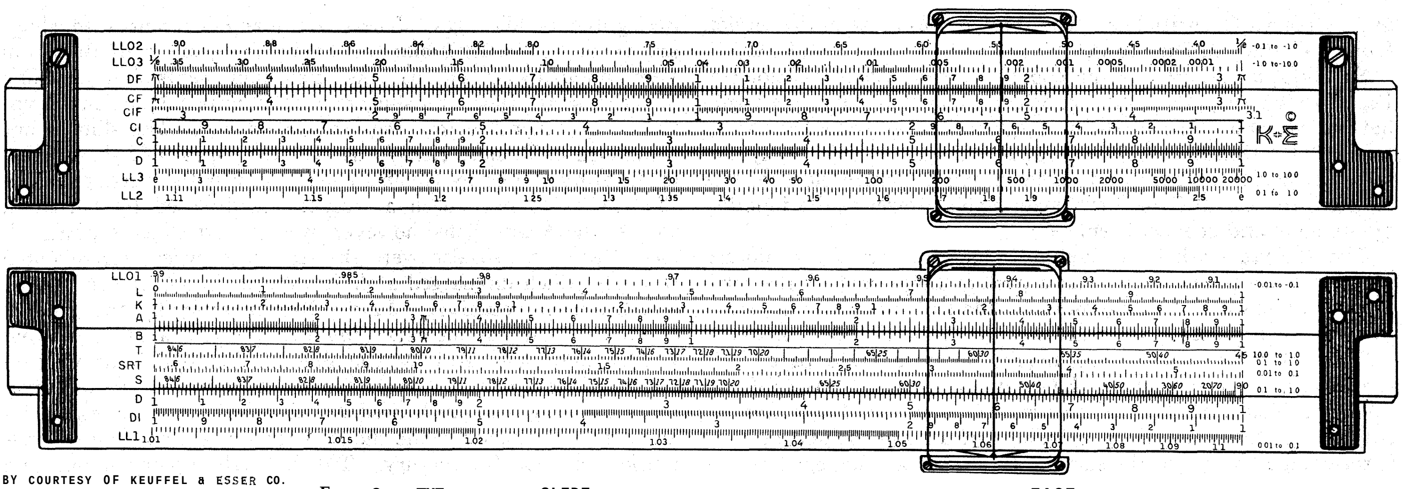

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FIG. 2. — THE LOG-LOG SLIDE RULE: TOP, FRONT FACE; BOTTOM. REVERSE FACE

Oughtred's two scales were the forerunners of the C and D scales, the basic scales on practically all slide rules from that time on.

The first known slide rule in which the slide worked between parts of a fixed stock was made by Robert Bissaker in 1654. Others were due to the enterprise of Seth Partridge (1657), Henry Coggeshall (1677) — a slide in a two-foot folding rule adapted to timber measure — and Thomas Everard (1683) for gauging purposes. The usefulness of the slide rule for rapid calculation became increasingly recognized, especially in England. during the 18th century. and the instrument was made in considerable numbers, with slight modifications.

Improvements in the direction of increased accuracy in graduation. etc , were initiated by Matthew Boulton and James Watt from about 1779 in connection with calculations in the design of steam engines at their works at Soho, Birmingham.

Amédée Mannheim. an officer of the French artillery, invented in 1859 what may be considered the first of the modern slide rules. This rule had scales on one face only and although it nas quite simple is basically of a type still made and designated by his name. The disposition of the scales in the Mannheim rule is the arrangement still adopted in the great majority of rules made in the 20th century (see fig. 1). This rule, which also brought into general use a cursor, or indicator, was much used in France, and after about 1880 was imported in large numbers into other countries. Up to this period the rule had been constructed usually of boxwood and occasionally of brass or ivory, but a great improvement was introduced in 1886 by Dennert & Pape in Germany by dividing the scales on white Celluloid, which gave a much greater distinctness in reading. This material was later almost universally adopted. and the slide rule attained a high degree of perfection.

In 1815 Peter M. Roget invented his "log-log" slide rule for performing the involution (q v.) and evolution (*q.v.*) of numbers (see fig. 2). The fixed scale, instead of being divided logarithmically, is divided into lengths which are proportional to the logarithm of the logarithm of the numbers indicated on the scale; the sliding scale is divided logarithmically.

Before 1890 slide rules were made only in England. France and Germany, but at that time an invention by William Cox led to the manufacture of rules in the United States. This invention introduced a revolutionary construction providing for scales on both front and back of the slide rule. An indicator with glass on both sides made it possible to refer to all the scales on both sides of the rule simultaneously.

Many refinements in both scale arrangements and mechanical constructions have been made since that time. The decade from 1940 to 1950 saw further developments of slide rules with scales on both faces. Most important of these improvements was the arrangement of the scales, trigonometric and log-log, so that they operate together and at the same time maintain consistent relationship to the basic C and D scales. This arrangement gave added speed and flexibility to the solving of many problems, simple and complex alike, since it produced solutions by continuous operation, without the need of intermediate readings.

See J. N. Arnold, *The Slide Rule; Principles and Applications (1954).* (A. W. K.)

SLIGO, a county of Ireland in the province of Connaught. Pop. (1956) 56.850. The area is 693.4 sq.mi. The coast line runs from Killala bay in the west to the southern side of Donegal bay, and is broken by the great triple indentation of Sligo bay. The relief is varied. Along the coast stretches a lowland area floored with Lower Carboniferous rocks which also form the foundation of much of the interior louland. The Ox mountains in the west are formed of very ancient pre-Cambrian metamorphic rocks, with intrusions of granite. They follow the Caledonian trend, striking northeastward to the hills south of Lough Gill. Along the borders of Roscommon, to the south, lies the Old Red Sandstone line of the Curlew hills.

In the east and northeast the Lower Carboniferous Limestone, sometimes capped with Millstone Grit, rises in great moorland plateaus. The west-facing escarpments of these form striking features, as in Benbulben (Ben Bulbin) (1,570 ft.). The principal streams drain through the Collooney gap to Ballysadare bay Numerous lakes occur, the largest being the lovely Lough Gill, immortalized by the poet W. B. Yeats.

The county was created by Sir Henry Sydney in 1579. At Drumcliffe (5 mi. N. of Sligo) are the only round tower remaining in the county and a Celtic cross 13 ft. in height. The principal monastic ruins are the abbey of St. Fechan at Ballysadare, with a church of the 11th or 12th century; the abbey of Sligo, and a group of buildings on the island of Inishmurray, which include a cashel, or walled enclosure. three oratories. two holy wells and also altars, pillar stones, inscribed slabs (one of which has an inscription partly in Latin) and several examples of beehive cells. This settlement is associated with Molaise, a saint of the early 6th century (not identical with the Molaise of Devenish in Loch Erne). and the remains still attract pilgrims.

The county, particularly in the low-lying areas, is well covered with boulder clay which often shows a strongly marked drumlin topography. The chief agricultural occupation is cattle raising, partly for milk but largely as dry stock. Oats and potatoes form the principal crops. Sea fishing is not now important but salmon fishing is carried on in many of the rivers. A number of scattered creameries exist and grain mills operate in Collooney and Ballysadare as well as in the port of Sligo. There, too, is a large bacon factory.

Lead was mined at Ballysadare. and the clay-ironstone from the east of the county was at one time smelted. A considerable general trade is carried on at the ports of Ballina (on the Moy) and Sligo, the county town.

The Great Southern lines from Limerick and from Dublin meet at Collooney junction which is also used by the Sligo, Leitrim and Northern Counties line. The three routes unite in the section from Collooney to Sligo town. (D G.)

SLIGO, a seaport and the county town of County Sligo. Ire. Pop. (1956) 12,947. It lies on Sligo bay and the river Garrogue between Lough Gill and the sea, 136 mi. N.W. from Dublin by road. The Dominican abbey, founded in 1252, was partly destroyed by fire in 1414 and again in 1642. Three sides of the cloisters remain, and the lofty quadrangular tower at the junction of the nave and chancel is entire.

The Roman Catholic cathedral (1869–74) serves the diocese of Elphin which includes a large part of Sligo, and of Roscommon and Galway. A castle, built by Maurice Fitzgerald in 1242, was in 1270 taken and destroyed by Goffraidh O'Domhnaill (O'Donnell); in 1310 it was rebuilt but was again partly destroyed in 1369 and 1394. Early in the reign of James I the town received a market and two annual fairs; in 1613 it was incorporated and received the privileges of a borough: and in 1621 it received a charter of the staple. In 1641 it was besieged by the parliamentary forces. but was afterward evacuated and occupied by the royalists until the termination of the war. In 1688 it declared in favour of James II, and, after being captured by the Enniskilleners, was retaken by Gen. Patrick Sarsfield, but ultimately surrendered to the earl of Granard. The borough was disfranchised in 1870.

Sligo takes rank with Galway and Limerick as one of the three principal ports of the west coast of Ireland. There is a considerable export trade in grain, flour, pork and cattle; while coals, iron, timber and provisions are imported. The harbour has commodious quays and basins. Brewing, flour milling and sawmilling are the chief industries, and there is a large butter market. Sligo is a centre of salmon and sea-fishing industries.

Three miles southwest of the town is a collection of megalithic remains. which has been taken to mark the site of the traditional battle of North Moytura. On Knocknarea (1,078 ft.). southwest of Sligo, is a cairn which tradition sets down as the burial place of Queen Mab (Meave of Connaught).

SLIM, SIR WILLIAM JOSEPH (1891–), British field marshal, best known for his work in the Burma campaign in World War II, was born in Bristol on Aug. 6, 1891, and educated at King Edward's school. Birmingham. In World War I he volunteered as a private, but within a few days he was commissioned. He saw active service in Belgium, France, Iraq and the Dardanelles. In 1920 he was granted a regular commission and transferred to the Indian army.

In 1940 Slim commanded the 10th infantry brigade of the famous 5th Indian division which landed in northeast Africa and advanced into Eritrea. He was wounded, but recovered in time to lead the 10th Indian division in Iraq and in Iran, where he decisively defeated the enemy and made the first contact with the Russian army at Teheran. For this he was awarded the Distinguished Service Order. In 1942 he commanded the 1st Burma corps and assisted in conducting an orderly retreat in Burma. Later, as commander in chief of the 14th army, he inflicted a crushing defeat on the Japanese; for, after repulsing the enemy at Imphal and Kohima and capturing Mandalay, he drove the Japanese down the Irrawaddy river to Rangoon. In 1945 he became commander in chief of Allied land forces in southeast Asia. In 1946 he was appointed commandant of the Imperial Defence college. He became chief of the imperial general staff in 1948 and was promoted to field marshal. In 1953 Slim was appointed governor general of Australia. In 1956 he published *Defeat Into Victory,* which gave a remarkable picture of the Burma campaign. (E. B. Bn.)

SLING, an implement for casting missiles. The sling was probably the earliest device by which force and range were given to the arm of a thrower of missiles. It consisted of a small strap or socket of leather or hide to which two cords were attached; the slinger held the two ends in one hand. whirled the socket and missile rapidly round his head and, loosing one cord sharply, dispatched the missile. The other type was the staff sling. in ahich the sling itself was attached to a short staff held in both hands. This was used for heavier missiles, especially in siege operations during the middle ages. There are many references to slings and to slingers in the Bible; the left-handed slingers of Benjamin were famous (Judg. xx, 16). Assyrian monuments show rhe sling of the ordinary type. and slingers were used in the ancient Egyptian army but not before the 8th century B.C. The sling is not mentioned in Homer; Herodotus (vii, 158) speaki of the slingers in the army offered by Gelon to serve against the Persians. The sling seems to have been a weapon chiefly used by barbarian troops: the Acarnanians, however, were expert slingers (Thucydides ii, 81), and so also were the Achaeans, who later invented the sling which discharged a shaft with an iron bolt head (Livy xlii. 65, from Polybius). In the Roman army by the time of the Punic wars the slingers (funditores) uere auxiliaries from Greece, Syria and Africa. The Balearic islanders, nho were in Hannibal's army, were always famous as slingers. In medieval times the sling was much used in the Frankish army, especially in defending trenches, while the staff sling was used against fortifications in the 14th century. Till the 17th century slings were used to throw grenades.

In modern times the word has taken on other meanings. It denotes a hanging loop to support a wounded arm, a chain with hooks for raising or lowering heavy goods, or a shoulder strap for carrying a rifle or carbine. A variation of the ancient sling as a hand neapon is the slingshot. a forked stick with an elastic band attached for hurling small pellets.

SLIPHER, VESTO MELVIN (1875–), U.S. astronomer whose discovery of the rotation and extraordinary space velocities of the spiral nebulae formed the first observational evidence for the expanding universe theory. He was born on a farm in Clinton county, Ind., Nov. 11, 1875, graduated from Indiana university, Bloomington, in 1901, and received his Ph.D. degree there in 1909. For about 40 years he directed the Lowell observatory at Flagstaff, Ariz., where he organized and guided the search which resulted in the discovery of the outermost planet, Pluto, predicted by Lowell.

Slipher made extensive investigations by methods of spectroscopy which resulted in the determination of the rotation periods of the planets; his discovery of molecular bands in the planetary spectrum ultimately led to the identification of their atmospheric composition. He demonstrated that many diffuse nebulae shine by the reflected light of the nearby stars. He also discovered the permanent sky and auroralike radiations of the night sky, their nocturnal intensity changes and the existence of interstellar sodium and calcium scattered throughout the depths of space. (H. L. G.)

SLIPWAY, the water-front space in a shipyard allotted to the building of a ship. It is fitted with foundations for keelblocks, shoring and inclined launching ways, and with cranes, which may be of many types, for handling materials. When a gate or side walls are provided to exclude the water from the lower or outboard end of the slipway, it is sometimes called a semisubmerged slipway. The term slipway is also used for an inclined railway extending into the water and fitted with a cradle, on wheels or rollers, on which a vessel is hauled out for cleaning, painting and repairs. Such a railway is usually called a marine railway in the United States and sometimes a patent slip in Great Britain.

A slipway should be distinguished from a slip. which is a space of water alongside a pier or wharf at which a ship may lie, as for loading or unloading.

A wet slip or wet basin in a shipyard is a berth alongside a pier, usually fitted with crane facilities, in which a vessel may lie afloat during completion after launching. (J. P. Ck.)

SLIVEN, a town of southern Bulgaria, 105 mi. E.N.E. of Philippopolis, near the southern entrance of the trans-Balkan defile known as the Iron Gate. Pop. (1956) 46,383. Sliven is the chief manufacturing centre in Bulgaria for the rough and fine homespuns known as *aba* and *skayak*, and its wine is locally celebrated. Mulberry orchards have been planted in connection with the silk industry. Sliven was frequently disputed in the middle ages between Byzantium and Bulgaria. After its capture by the Turks (1388) it was one of the privileged *voinik* towns *(see* BULGARTA) ; but these privileges were lost in the 16th century. In 1829

Sliven was occupied by the Russian army.

SLOAN, JOHN FRENCH (1871–1951), U.S. painter of the ash-can school, was born in Lock Haven, Pa., Aug. 2, 1871. He worked in a Philadelphia print shop, attending night art classes and in 1891 became a commercial artist. He moved to New York city in 1904; in 1908 he exhibited with "the Eight," a group of painters whose works were heatedly attacked by conservatives. Sloan's subjects were specially censured; he had to support himself by illustration, etching and intermittent teaching. His early painting (1900–20) is historically important — gay, caustic and warm. His liberalism was manifested in the illustrations for the socialist periodical The Masses that he executed until the U.S. entered World War I. As president of the Society of Independent Artists (1918–51) and as the author of The Gist of Art (1939), further aspects of his nonconforming spirit were indicated.

Another phase of Sloan's painting consisted of landscapes done in Massachusetts and New Mexico. From 1930 his portraits and nudes were emphasized by fine red contour lines, an innovation which was not generally accepted. A notable honour was the gold medal of the American Academy of Arts and Letters (1950). Sloan died at Hanover, N.H., on Sept. 7, 1951.

See Lloyd Goodrich, *John Sloan* (1952); Van Wyck Brooks, *John Sloan* (1954). (VL. B.)

SLOANE, SIR HANS (1660–1753), British physician. whose collection of books. manuscripts and curiosities formed the basis of the British museum. was born on April 16, 1660, at Killyleagh in County Down, Ire. He spent four years in the study of medicine in London and then traveled through France, taking his M.D. degree at the University of Orange in 1683. He returned to London with a considerable collection of plants. which were sent to John Ray and utilized by him for his History of *Plants*. Sloane was elected to the Royal society and attracted the notice of Thomas Sydenham. In 1687 he went to Jamaica as physician in the suite of the duke of Albemarle. Sloane's visit lasted only 15 months, but during that time he collected about 800 new species of plants. Of these he published an elaborate catalogue in Latin in 1606: at a later date (1707–25) he added two folio volumes. He became secretary to the Royal society in 1693 and edited the *Philosophical Transactions* for 20 years.

In 1716 Sloane was created a baronet. being the first medical practitioner to receive a hereditary title, and in 1719 he became president of the College of Physicians. In 1722 he was appointed physician general to the army, and in 1727 first physician to George II. In 1727 also he succeeded Sir Isaac Newton in the presidential chair of the Royal society. His purchase of the manor of Chelsea in 1712 has perpetuated his memory in the name of a "place," a street and a square. His great stroke as a collector was to acquire in 1701 the cabinet of William Courten, who had made collecting the business of his life. When Sloane retired from active work in 1741 his library and cabinet of curiosities had grown to be of unique value. On his death on Jan. 11. 1753. he bequeathed his collection to the nation, on condition that parliament pay to his executors £20.000. The bequest was accepted, and went to form the collection that was opened to the public as the British museum in 1759. Among Sloane's other acts of munificence was his gift to the Apothecaries' company of the botanical or physic garden, which they had rented from the Chelsea estate after 1673.

SLOCUM, HENRY WARNER (1827–1894), U.S. general, was born at Delphi, N.Y., on Sept. 24, 1827, and graduated at the U.S. Military academy, West Point, N.Y., in 1852. When the Civil War broke out he became colonel of the 27th New York volunteers and was promoted major general of volunteers (July 1862). He fought in all the Virginia campaigns from the first battle of Bull Run to Gettysburg. Transferred to the Tennessee valley, he took part in the Chattanooga and Atlanta campaigns. He resigned from the army in Sept. 1865, and was a Democratic representative in congress in 1869–73 and again in 1883–85. He died at Brooklyn on April 14, 1894.

SLOOP, a type of small sailing vessel which has one mast rigged fore and aft carrying a mainsail and a jib. Sloops may be fitted with either a gaff-topsail or a Bermuda rig consisting of a one-piece triangular mainsail. (J. B. HN.)

SLOTH, the name for a group of arboreal tropical American mammals belonging to the order Edentata (*q.v.*). Sloths are completely arboreal. living among the branches of trees, hanging beneath them, back downward and clinging with the hooklike organs to which the terminations of their limbs are reduced. When obliged to descend to the ground, which they rarely, if ever, do voluntarily, sloths (because of the unequal length of their limbs and the peculiar conformation of their feet) crawl along a level surface with considerable difficulty. Though generally slow and inactive, they can on occasions travel with considerable rapidity along the branches, availing themselves of the swaying of the boughs by the wind to cross the larger gaps. They feed on leaves and young shoots and fruits. Sloths are nocturnal, silent and solitary animals. and produce but one young at birth. They show an almost reptilian tenacity of life. Sloths fall into two subfamilies, the Choloepinae, including only the unaus (Choloepus), with two functional toes on the forefoot and three on the hind, and six or seven neck vertebrae; and the Bradypodinae, ais. comprising the genera *Bradypus* and Scaeopus, with three functional toes on each foot and nine neck vertebrae. Several other animals, *e.g.*, African potto lemurs and Asiatic lorises, are popularly called sloths.

SLOUGH, a municipal borough (from 1938) in the Eton and Slough parliamentary division of Buckinghamshire, Eng. 20 mi. W of London by road. At the beginning of the 20th century the population was 7,400; in 1961 it was 80,503 — an increase in great part caused by the transformation of a World War I mechanical depot into a trading estate. Slough is by far the biggest town in Buckinghamshire. with more than 250 industrial concerns and an area of 9 7 sq.mi.

SLOVAKIA (SLOVENSKO), a geographic region and at one time a country of central Europe bounded north by Poland, east by sub-Carpathian Ruthenia. south by Hungary and west by Austria and by Moravia. Slovakia now refers to a group of administrative regions of Czechoslovakia.

History.—Slovakia was inhabited in the first centuries of the Christian era by Illyrian, Celtic and then by Germanic tribes. The Slovaks, a people closely akin to. but distinct from, the Czechs, probably entered it (although in small numbers) from Silesia in the 6th or 7th century A.D. For a time they were subject to the Avars, but in the 9th century the area between the Morava and the central highlands formed part of the state of Great Moravia. when the population accepted the eastern form of Christianity from the brothers Cyril and Methodius (see CYRIL AND METHODIUS, SAINTS). In AD. 894 the German king Arnulf called in the Magyars to help him against Sviatopluk of Moravia. The Magyars defeated Sviatopluk and in 907 destroyed the Moravian state From the 11th century Slovakia was part of Hungary, and so remained until 1918.

The ethnic distribution, which thereafter remained practically unchanged until the most modern times. took shape early. The main ethnic frontier between Magyars and Slovaks ran along the line where the foothills merge into the plain, although there were also Magyar settlements in the larger valleys, and the landlord class and much of the urban population in the whole area was Magyar. On the other hand, as the country suffered from chronic overpopulation. a constant stream of Slovak peasants moved down into the plains. where they usually were Magyarized in two or three generations. In the east, part of the mountain population was Ruthene, and the mining areas of Spis were colonized in the 12th century with German settlers, wha founded flourishing cities. In the 1jth century Czech Hussites overran the country and for a time ruled parts of it. leaving behind them chiefly a cultural legacy. During the Reformation the German and Slovak converts adopted the Lutheran tenets, while the Magyars followed those of Calvin. The liturgical language used by the Slovak Protestants was Czech. The Counter-Reformation was, however, strongly, pressed home in Slovakia, which formed the greater part of that area of the kingdom of Hungary which was ruled de facto by the Habsburgs from 1526 to 1700.

Up to the latter date, and beyond it, the problems of the country had been exclusively social. No religious difference placed a barrier between its Catholic inhabitants. The economic interconnection between northern and central Hungary was very close.

A Slovak national renaissance began in the late 18th century. It did not affect all of the Slovaks. The peasants, who still comprised the vast majority, remained uninterested, while the small but rising middle class was divided. A group at one extreme identified the Slovaks with the Czechs as belonging equally to a Czechoslovak nation, with which they desired political unification. Others admitted kinship but not identity. Others again held the Slovaks to be a distinct nationality, to which both Czech and Hungarian nationalisms were dangerous. By this time the local Germans had largely lost their nationality, partly to the Magyars, partly to the Slovaks. The large Jewish population in the area was either unassimilated or Magyar speaking.

During the period of Austrian absolutism after 1849 northern Hungary was for several years de facto separated from the rest of the country under a regime which strongly favoured the non-Magyars. After 1867 the Hungarian government reversed this trend and pressed on Magyarization, meeting with much success, but stiffening the national feeling of the resisting minority. A Slovak National party held a few seats in the Budapest parliament.

During World War I the Czech *émigrés* in the west urged the Allies to unite the Czechs and Slovaks in an independent state. In an agreement signed at Pittsburgh, Pa., on May 30, 1918. between T. G. Masaryk and the local Slovaks. the latter agreed that the Slovaks should join the Czechs on a federal basis.

At Turciansky Svaty Martin, on Oct. 30, 1918, the Slovak national parties in Hungary voted for union with Czechoslovakia. The Paris peace conference sanctioned the union, drawing the frontiers of Slovakia so generously as to include a large Magyar minority in the south. Their release from Magyar pressure now gave the Slovaks leisure to develop irritation against the Czechs, whose regime was more centralist than they had expected.

On Oct. 6, 1938, following the Munich conference, the Slovaks proclaimed themselves autonomous within a federal Czecho-Slovak state. On Nov. 2 an arbitral award rendered by Germany and Italy restored to Hungary the southern rim of Slovakia, with most of its Magyar population. On March 18, 1939, Slovakia became a nominally independent state under German protection. It followed Germany faithfully until April 5, 1945, when it declared its return to a Czecho-Slovak state on a basis of complete equality between Czechs and Slovaks. In 1946 the 1919 Slovak-Hungarian frontier was restored (with a small extension south of Bratislava). Some of the Magyars were now expelled. Slovakia covered in 1947 an area of 18,902 sq.mi. with a population of 3,402,390; in 1956 the population was 3,816,037. The population of Bratislava, the capital. rose between 1947 and 1957 from 172.663 to 246.523.

On July 31, 1956, a new constitutional law made the Slovak national council (counterpart of the Czechoslovak national assembly) the organ of state power in Slovakia while its former legislative powers were increased. The council has the right to nominate and recall the board of commissioners (counterpart of the Czechoslovak council of ministers). The board of commissioners has full executive and administrative powers in Slovakia, with the exception of national defense, foreign affairs, foreign trade and some branches of heavy industry and of railway transport. In 1956 the industrial output of Slovakia nas 5.3 times larger than in 1937. (C. A. M.; X.)

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SLOVAK LANGUAGE. Slovak became in 1918 the official language of the eastern part of Czechoslovakia. In 1955 the estimated number of speakers of Slovak in Europe was about 3,500,000, and at the same time nearly 500,000 Slovaks in the U.S. continued to use their native tongue to some extent.

The Slovaks were under Hungarian rule from the 10th century until 1918, and for centuries there was no serious attempt to write Slovak. The flourishing Czech culture of the 14th and 15th centuries produced a written language which differed from most Slovak dialects little more than these dialects differed among themselves. By the 16th century a number of Slovak towns were keeping their records in Czech.

An attempt in the 1780s to raise the western Slovak dialects to the position of a literary language aroused little interest. In the 1840s a group led by L'udevit Štúr (1815–56) began to write in the central Slovak dialects. Štúr's language, as modified and codified by M. Hattala in 1852, rapidly gained approval and was accepted as standard.

Classification. — The contemporary literary Slovak and Czech languages differ in so many points of detail that even the shortest utterance can be identified as either Czech or Slovak. During the 1920s the official designation of both languages was Czechoslovak, but because of the striking and pervasive differences the term was abandoned. On the other hand, the over-all agreement in vocabulary, in word formation and in syntax reveal such a close relationship that the linguist is justified in speaking of a Czechoslovak subgroup of the West Slavonic languages.

The spoken Slovak dialects, as opposed to the standardized language of culture and state, fall into three major groups. The central one is the most distinctive type, and possesses certain features in common with South Slavonic. Eastern and Western Slovak are closer to each other than to the central dialects. Nowhere, however, is there a sharp linguistic frontier, for every local type of speech may be viewed as a transition dialect between the neighbours on every side. Eastern Slovak has certain affinities mith Polish (loss of long vowels, some consonantal features), but it passes into the typical Slovak of central Slovakia, which in turn is transitional to the Western Slovak dialects that shade into the Czech Moravian dialects and on to the typical Czech of Bohemia. The dialects are all mutually comprehensible, except perhaps the extreme Eastern Slovak and Bohemian Czech.

Characteristics. — Like Czech, Slovak has a system of long and short vowels and an automatic, nondistinctive stress which always falls on the first syllable of a word. The two vowel systems were doubtless almost identical in the early middle ages, but since the 14th century Czech has undergone far-reaching changes, while Slovak has been much more conservative. Slovak has retained long syllabic *l* and *r*, and a series of diphthongs (ie, *iu*, ia, *uo*). It possesses the open front vowel a (put', "five"; *mäso*, "meat"; Cz. *pět*, *maso*). In the consonantal system, Slovak did not develop the distinctive sibilant vibrant *ř* of Czech, but did retain the soft *l'* (*strieľať*, "to shoot"; Cz. *střileti*). It developed *dz* and *dž* as independent phonemes. In morphology, Slovak has suppressed certain consonantal alternations: *e.g.*, *veľký*, "big," pl. vel'ki (Cz. velci); ruka, "hand," dative ruke (Cz. ruce); *platím*, "I pay," *platený*, "paid" (Cz. *placený*). The first person singular of all verbs ends in *m*. The vocative has been lost except in a few words.

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(H. G. L.)

SLOVAKS, a Slav people mostly living in Slovakia (*q.v.*). The Slovaks seem to have occupied this territory in the 5th or 6th century A.D. and to have stretched far to the south.

SLOVENE LANGUAGE, a member of the South Slavonic group of the Slavonic languages (*q.v.*), is one of the state languages of Yugoslavia. It was spoken in 1955 by about 1,500.000 people in the northwestern corner of Yugoslavia and neighbouring areas in Austria and Italy, and by some of the 180,000 Slovenes in the U.S.

History. — The earliest record of Slovene is generally agreed to be found in the Freising manuscript, from about A.D. 1000, which contains a confessional form, a short homily and a confessional prayer. After that the Slovenes. subject to the Austrians, did not write their own language until the Reformation, when a group of Protestants, led by Primož Trubar, translated some of the Scriptures and wrote tracts. Their religious works were destroyed early in the 17th century, during the Counter-Reformation, but their grammatical and orthographical usage served as a model for the few Catholics who wrote Slovene during the next 200 years. The Enlightenment brought a new interest in Slovene. and at the end of the 18th century a Slovene translation of the Bible appeared, followed quickly by grammars (by Jernej Kopitar in 1808 and by Valentin Vodnik in 1811), dictionaries and literature of all sorts. By the middle of the 19th century a standard written language was in use.

The agreement on matters of orthography and on the words and grammatical forms suitable for literature was not accompanied by an agreement on standard pronunciation. More than a century of discussion culminated in the publication of an authoritative handbook of orthography and pronunciation in 1950. Yet great diversity of pronunciation persisted, apparently little affected by the unifying influences of the schools, radio and modern transportation.

The reason for the lack of agreement lies in the extraordinary diversity of Slovene dialects, which developed during a millennium when the Slovenes had no major administrative or economic centres: no unifying political organization and lived in scattered communities with little communication between one another. The Alpine villages in the north and west were particularly isolated, and the multiplicity of dialects is correspondingly greater there. The leading Slovene authority, Fran Ramovš, distinguished seven dialect groups, with no fewer than 46 individual dialects. While there are significant differences in consonantism, morphology and vocabulary, it is the vowels and the accent which vary most widely. Slovenes tend to pronounce the literary language with the vowels of their own local dialect when speaking formally, and in informal conversation they often add dialect grammatical forms as well.

Slovene is closely related to its eastern neighbour, the Serbo-Croatian language (*q.v.*), and the transition from eastern Slovenian dialects to the kaj Serbo-Croatian of Croatia is gradual. Practically speaking: however, the two standard languages are more remote. Slovenes have some Serbo-Croatian in school and understand it at least passively, but the average Serb or Croat, without special preparation. can read Slovene only with great difficulty and understands little or nothing of the spoken language.

Phonology. — The recommended pronunciation is a compromise between that of the Lower Carniola dialect group (*dolenjski*), which covers the largest area, and the Upper Carniola group (gorenjski), which includes the dialect of Ljubljana, the capital of Slovenia. It distinguishes seven long vowels (i, e, e, a, o, o, u) plus syllabic *r*, occurring only under stress, with either rising or falling intonation, and six short vowels (i, e, u, o, *u*, a) plus syllabic *r* which may be stressed or unstressed. If there is a long vowel in a word, it must be stressed; otherwise the stress falls on the last syllable. It is a very strong stress; unstressed vowels tend to be reduced. and some of them disappear altogether in the pronunciation of many speakers. Normal spelling, utilizing only the five letters i, e, a, o, *u*, unfortunately gives little help in pronunciation of vowels.

Slovene is characterized by the development of Common Slavonic p > o, of both *ŭ* and *ĭ* to a in long and a in short syllables, tj > *č*, dj > *j*, syllabic *l* > *ou̯* (spelled *ol*), soft *r* > *rj*, and a general tendency for long vowels to be closed! short vowels open. None of these features is unique among the Slavonic languages, but they occur together only in Slovene.

Other Features. — In grammar, Slovene has preserved the dual in nouns and verbs, and the supine is usually distinct from the infinitive. The vocative has been lost. The future for both aspects is periphrastic: *bom* (<**bǫdǫ*) + I-participle; *e.g., bom **kupil/kupoval,*** "I shall buy/be buying." The vocabulary includes many borrowings from German. while Czech and Serbo-Croatian models have been important in creating modern technical terminology.

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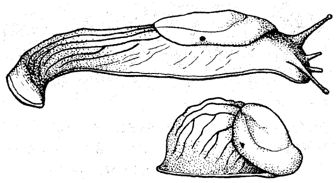
SLOVENES, a Slavonic people, most of whom live in Yugoslavia, occupying Slovenia and the adjoining sections. The boundary on the east is difficult to fix. as the linguistic transition is gradual and a certain dialect of Croatian (marked by the use of kaj = "what") may have been originally Slovene.

SLOWWORM (Blindworm) (*Anguis* fragilis), a legless lizard, which is neither slow nor blind nor a worm. The slowworm is fairly common in Great Britain and ranges across Europe to western Asia. Because of the absence of legs it is oiten mistaken ior a snake It is quite harmless. feeding on worms. slugs, etc. Its American relative, *Ophisaurus ventralis*, the so-called glass snake, has rudimentary limbs. These, with a few other genera, comprise the family Anguidae.

SLUG, any snail with the shell reduced to an internal plate, a series of granules or completely absent. Generally the term reiers to a land mollusk, but members of the marine order Nudibranchia are called sea slugs.

Ranging in size from $\frac{1}{4}$ in. to more than 6 in.. slugs are restricted to very moist habitats. All are usually active only at night or on overcast days. Eggs are buried in the soil. and the animals live one to four years. All species are both male and female. some with one, others with two genital pores. Most slugs have the respiratory and excretory ducts combined into a single external opening. Usually slugs are mottled nith brown, gray. green or buff, but some species have brilliant markings of orange. red, purple or yellow.



COMMON SLUG (ABOVE) IN CRAWLING POSITION, (BELOW) INACTIVE

The approximately 300 species of land slugs are not closely related, since loss of an external shell happened several times during snail evolution. The common slugs (families Arionidae, Limacidae and Phiiomycidae) of temperate-zone fields, forests, gardens and greenhouses. feed on fungi, decaying plants and occasionally the leaves of living plants. Often a nuisance in gardens and greenhouses. they can be controlled by spreading ashes or a bait composed of bran and metaldehyde (30 to 1). The tropics have a few European species introduced by man and the very primitive plant-eating Veronicellidae. Other vegetarian slugs include the relict Athoracophoridae of Melanesia, Australia and New Zealand and the intertidal pulmonates of the family Oncidiidae. Slugs which feed on other snails or earthworms include the European Testacellidae, South African Aperidae and Malayan-Indonesian Rathouisiidae.

The sea slugs (nudibranchs) live in shallow reef waters. sand flats or rocky pools where they browse on minute algae. Delicately coloured and oiten translucent. they are among the most beautiful sea creatures. Retiring in habit, they are seldom seen by seaside visitors. (G. A. S.)

SLUM: see Housing.

SLUMP: see Trade Cycle.

SLUTER, CLAUS (c. 1350–1406). the greatest sculptor of his time, was probably born at Haarlem in Holland. He entered the Brussels stonemasons' guild about 1380. and in 1385 was employed in the workshop of Jean de Marville. chief sculptor to Philip the Bold, duke of Burgundy. On Marville's death in 1389, Sluter succeeded to his posirion and to two major works then in progress, the portal of the ducal chapel at the Chartreuse de Champmol, Dijon (q v.), and the duke's tomb. which was to be installed in the same building. In 1392 he visited Paris, and in 1393 Mehun-sur-Yèvre, where he inspected the works executed ior the duke of Berry by André Beauneveu. In 1395 the duke of Burgundy commissioned a monumental Crucifixion group to crown a nell (the *Puits* de *Moise* or "Well of Moses") in the cloister of the Chartreuse. On Sluter's death. the direction of the workshop passed to his nephew and pupil, Claus de Werve.

The three works mentioned above still exist, albeit in damaged condition. The tomb (Dijon museum) has suffered severely and the effigy of the duke is a 19th-century replacement. The substructure, an open arcaded gallery along which passes a numerous procession of diminutive mourners, is an ingenious and original conception which is probably due to Marville. Two of these mourners were in existence in 1404 and others may have been completed by Sluter before his death; the best of them, despite their small scale, exhibit a masterly breadth and realism. The tomb was not finished, however, until 1410 and many of the figures were doubtless made under Werve's direction.

GIRAUDON
DETAIL OF AN ANGEL FROM THE "WELL OF MOSES" BY CLAUS SLUTER. IN THE DIJON MUSEUM, FRANCE

The life-size statues of the Chartreuse portal (complete by 1397) comprise the Virgin and Child (sometimes attributed to Marville) on the central pillar of the doorway and, on either side, figures of the duke and duchess (the latter finished by 1393) protected respectively by St. John the Baptist and St. Catherine (both finished by 1391). The imposing physical presence and intense psychological interaction of these figures seem almost to annihilate their architectural frame. The celestial personages hover in a swirl of near-baroque drapery; the ducal pair are living portraiture, reverend and grave. The Calvary group has been reduced to a battered torso of Christ and a base surrounded by six life-size prophets (executed 1400–05), which rank among the greatest masterpieces of European sculpture. Transcendental beings swathed in endless convolutions of Gothic drapery, they are at the same time living persons whose presence asserts itself like a physical shock. The sculptor's chisel, minutely exploring the wrinkles of ancient flesh, has drawn a map of the soul unparalleled in art, except in the late portraits of Rembrandt.

Sluter's work represents the culmination of a tradition—that of the France-Flemish realist sculpture whose older masters were Jean Pepin of Huy and Jean de Liège—but his genius was intensely personal. Both the painting and sculpture of northern Europe would have worn a different aspect in the 15th century, but for the prophets of the *Puits de Moise.*

See Henri David, *Claus Sluter* (1951). (D. Kg.)

SLUYS (Slois), **BATTLE OF,** fought on June 24, 1340, one of the two sea fights in which Edward III of England commanded in person, the other being Espagnols sur Mer (*q.v.*). The place of the encounter was in front of the town of Sluys (Sluis; Fr. Écluse) on the inlet between West Flanders and Zeeland. In the mid-14th century this was an open roadstead capable of holding large fleets. It was later silted up by the Eede. A French fleet, which the king, in a letter to his son Edward the Black Prince, put at 190 sail, had been collected in preparation for an invasion of England. It was commanded by Hue Quiéret, admiral for the king of France, and Nicholas Béhuchet, who had been one of the king's treasurers and was probably a lawyer. Part of the fleet consisted of Genoese galleys, which served as mercenaries under Barbavera.

Although English historians speak of Edward's fleet as inferior in number to the French, it is certain that he sailed from Orwell on June 22 with 200 sail, and that he was joined on the coast of Flanders by his admiral for the North sea, Sir Robert Morley, with 50 others. Some of these vessels were no doubt mere transports, for the king brought with him the household of his queen, Philippa of Hainault, who was then at Bruges. Edward anchored at Blankenberghe on the afternoon of the 23rd and sent three squires to reconnoitre the French position. The Genoese Barbavera advised his colleagues to go to sea, but Béhuchet, who as constable exercised the general command, refused to leave the anchorage. He probably wished to occupy it in order to bar the king's road to Bruges. The disposition of the French was made in accordance with the usual medieval tactics of a fleet fighting on the defensive. Quiéret and Béhuchet formed their force into three or four lines, with the ships tied to one another, and with a few of the largest stationed in front as outposts.

Edward entered the roadstead on the morning of the 24th, and after maneuvering to place his ships to windward and bring the sun behind him, attacked. The battle was a succession of hand-to-hand conflicts to board or to repel boarders. Edward makes no mention of any actual help given him by his Flemish allies, though he says they were willing, but the French say that they joined after dark. They also assert that the king was wounded by Béhuchet, but this is not certain. There is only legendary testimony for a personal encounter between him and the French commander, though it would not be improbable.

The battle ended with the almost total destruction of the French. Quiéret was slain. Béhuchet is said to have been hanged by Edward's orders. Barbavera escaped to sea with his squadron on the morning of the 25th, carrying off two English prizes. After the battle Edward remained at anchor several days, and it is probable that his fleet had suffered heavily. (D. H.)

SMALL ARMS, MILITARY. In military language, the term small arms includes a great variety of weapons designed to be carried on the person and held in the hands when used, or fired from light supports as in airplanes and tanks. Small arms are light, portable weapons distinguished from heavy artillery-type weapons that must be fired from mobile carriages or fixed mounts, but not all of them are small. During the first half of the 20th century the U.S. army fixed the dividing line between small arms and artillery at calibre .60, but this line is no longer universally observed because of the development of portable rocket launchers and recoilless rifles. Small arms are often placed in three broad categories: handguns (pistols and revolvers), shoulder weapons (muskets, rifles, carbines and others) and edged weapons (swords, daggers, pikes, lances, bayonets, etc.). After the invention of machine guns late in the 19th century, these weapons were assigned to the small-arms category although they were far heavier than rifles and normally had to be fired from a bipod, tripod or other support. A narrow interpretation of the term has been adopted for this discussion because there is a separate article on Machine Gun, another on Pistol and Revolver and still others on edged weapons (*see* Bayonet; Dagger; Dirk; Lance; and Sword). This article deals primarily with shoulder firearms, chiefly muskets and rifles. It treats the subject in broad historical terms to show the development of the basic principles of these weapons and their ammunition from their first appearance in the 14th century to the present day. The following outline indicates the main topics covered:

I. Historical Development to 1900
- A. Early History
  1. Hand Cannon
  2. Matchlock
  3. Wheel Lock
  4. Flint Arms
  5. Standardization of Arms
  6. Percussion System
- B. Development of Rifling
  1. American Rifle
  2. Ammunition for Rifles
- C. Breechloaders and Repeaters
  1. Lorenzoni System
  2. Ferguson Rifle
  3. Hall Rifle
  4. Dreyse Rifle
  5. Sharps Rifle
  6. Other Types
  7. Pistols and Revolvers
  8. Later Development of Repeaters
- D. Ammunition
  1. Gunpowder
  2. Cartridges

II. 20th-Century Small Arms
- A. Repeating Rifles
  - 1. Bolt Action
  - 2. U.S. and British Rifles
- B. Semiautomatic Rifles and Carbines
  - 1. Garand Rifle
  - 2. Johnson Rifle
  - 3. German and Soviet Rifles
  - 4. Carbines
- C. Rifle Developments Aiter World War II
  - 1. NATO Cartridge
  - 2. FN Rifle
  - 3. M14 and M15 Rifles
  - 4. Soviet Rifles
- D. Automatic Rifles
- E. Submachine Guns (Machine Carbines)
- F. Antitank Weapons
- G. Recoilless Rifles
- H. Ammunition Developments
  - 1. Bullets
  - 2. Chargers and Clips
  - 3. Types of Cartridges
  - 4. Types of Ammunition

I. HISTORICAL DEVELOPMENT TO 1900

A. Early History

1. Hand Cannon.— The first portable military firearms probably developed in the second quarter of the 14th century. The eariiest written records date from the 1360s, but it would seem that they refer to a weapon already in use. Variously called hand bombards, hand culverins. *gonnes*, *Handbüchsen* (handguns) or, in modern parlance. hand cannon, these primitive small arms usually consisted of a tube 8–12 in. long, closed at the breech end. with a touchhole bored through the top about two inches from the breech. Usually they were made of brass or bronze, but there are a few references to iron barrels.

To protect the shooter's hand from the heat of the discharge, and also to provide a lever for controlling the recoil, these barrels were attached to a straight wooden haft from five to eight or more feet in length, There were several means of attachment. Sometimes the tube was simply lashed to the haft with iron bands; sometimes it was set into the haft as well as being lashed by the bands: sometimes a socket was fastened to the breech end into which the haft could be inserted; and sometimes the breech was extended in a spike or tang which could be driven into the haft. All these variations are encountered in specimens made before 1400.

A German manuscript of about 1390 survives to indicate some of the details of loading and firing. The barrel was filled three-fifths full of powder well rammed down. Then a wooden sabot or wad was added, and finally the ball. The charge was ignited by inserting a red-hot wire through the touchhole in the top of the barrel or by using a glowing coal held in tongs. An improvement that was probably in use by 1400 was the use of a "match," a length of loose hemp rope soaked in a solution of saltpetre or spirits of wine so that it would burn slowly and steadily, much in the manner of the modern punk used to light firecrackers.

There were several methods of handling these guns, depending somewhat on their size. Small ones could be managed by one man, who clamped the haft between his left arm and his body and supported the piece just behind the breech with his left hand while he applied the wire or match with his right hand. In other instances the butt was rested on the ground and the fore end supported by a forked rest; the shooter had only to steady the weapon while he applied the fire. Still other guns needed the services of two men to hold and shoot them.

As time passed. iinprovements came rapidly. The touchhole was moved from the top of the barrel to the side, where it was better protected from the weather. A pan to hold a small amount of powder was affixed outside the touchhole to provide for surer ignition; the pan was soon fitted with a movable cover. The barrel was lengthened. The haft was shortened and broadened so that it could be held against the shoulder, and gradually a curve was introduced so that the recoil was directed upward instead of directly back against the user. The curved stock is thought to have developed first in France just before 1500.

Some years earlier, certainly before 1425, a most significant advance occurred with the addition of a pivoted S-shaped bar of metal with a pair of jaws on the top end for holding the match. Now all that the soldier needed to do was to raise the lower end of the lever. or serpentine. and the lighted end of the match would be automatically depressed and brought into contact with the powder in the pan. Only the pressure of a finger was necessary. One hand could be used for supporting the gun while the other controlled the serpentine. The shooter could look where he was aiming rather than fix his attention on the pan to make sure he touched the coal to it.

2. Matchlock.— The final major advance in the development of small arms fired by a lighted match came about 1450 with the development of the matchlock. This improvement consisted of adding a trigger and connecting the serpentine lo it by a simple link arrangement so that it acted against a spring. Pressure on the trigger depressed the serpentine and fired the gun. When the trigger was released the spring raised the serpentine and held it away from the pan. All working parts were now placed inside the lock plate and protected. It was at last a true lock. Further developments consisted only in lightening and improving the design of the weapon for easier handling and in replacing the early lever trigger with one that acted against a sear much in the manner of modern firearms. This last advance took place shortly before 1600.

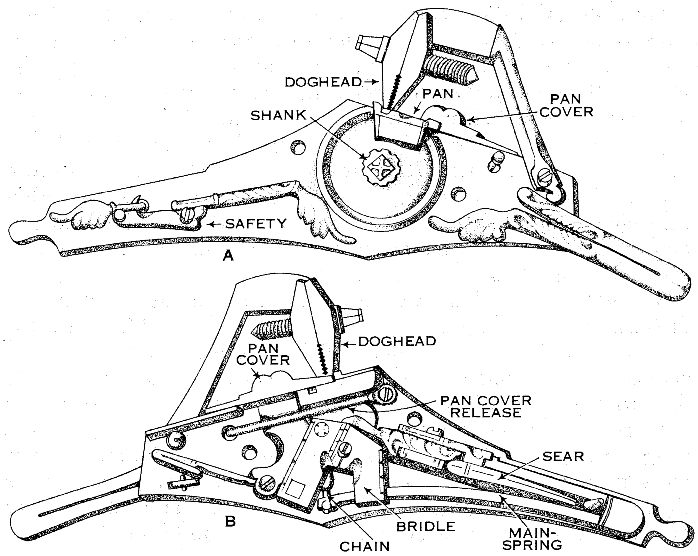
Many names were applied to these early matchlocks, including arquebus (*q.v.*), *Hak-büchse,* hacyuebut, hagbutt, hachbuss and other similar terms, as well as caliver and musket (*q.v.*). Because of the similarity of the terms and the indefinite and careless way in which they were used by contemporaries, much has been written in an attempt to obtain accurate definitions. Actually, they seem to have meant different things in difierent countries and in difierent periods. This is particularly true of the word arquebus and its cognates. Some authors applied it indiscriminately to any firearm. Other and more careful writers used it to designate a gun that was lighter than a musket and could be fired without a rest, thus making it for a short period synonymous with caliver. Still later, at the beginning of the 17th century, it was used to designate a wheel lock (see below) as opposed to a matchlock.

The term musket has always referred to a heavy military firearm. It is generally believed that the term was first used by the Spanish (ntosquete) to denote a military firearm developed shortly before 1.550 and introduced into the Spanish service by Fernando Álvarez de Toledo, duque de Alba. These first muskets weighed about 20 lb. and had a bore of 8 or 10 gauge. (In this sense, gauge indicated the number of spherical lead balls of the same diameter as the bore that were required to reach a weight of one pound.) As years passed, the size was reduced until by the middle of the 17th century the standard English musket weighed about 16 lb. and fired a 12-gauge ball from a 10-gauge bore.

Although the matchlock was a tremendous improvement over the primitive hand cannon. it still had many very serious drawbacks. It was slow and clumsy to use. The lighted match was a decided liability! It was a constant hazard in the presence of powder, and could not be used in the wind or rain; its glow and smell prevented its use in an ambush; it could not be lighted and used at a moment's notice but had to be kept burning whenever it seemed there was even a remote possibility of action.

Despite these many disadvantages, the matchlock remained the principal military firearm of Europe for many years after better and more efficient arms were developed. It was not completely supplanted in many armies on the continent until about 1700, although in America the change had taken place as much as 75 years earlier.

3. Wheel Lock.—Chronologically. the first of the improved ignition systems that eventually supplanted the matchlock was the wheel lock. Possibly invented by Johann Kiefuss of Nürnberg, Ger., about 1515, this lock worked on the same principle as the modern cigarette lighter: the spark was produced by holding a piece of iron pyrite against a revolving rough-edged wheel. The mechanism devised to produce this action was considerably



FROM H. L PETERSON. "ARMS AND ARMOR IN COLONIAL AMERICA"; REPRODUCED BY PERMISSION OF THE STACKPOLE COMPANY, HARRISBURG, PENNSYLVANIA

FIG. 1.— GERMAN WHEEL LOCK MECHANISM (C. 1565), PHANTOM VIEW: (A) RIGHT SIDE. (B) LEFT SIDE

more complex than the matchlock, yet it was sturdy and not likely to get out of order easily. The power for revolving the wheel was supplied by a heavy V-shaped mainspring. This spring was attached to the spindle of the wheel by a short chain of two or three links. When the wheel was wound by hooking a key or spanner over the outside shank of the wheel, this chain was wrapped around the spindle. and the mainspring mas compressed and locked in position by a laterally acting sear that engaged a hole in the inner surface of the wheel.

The flashpan of a wheel lock was attached to the lock plate just as it was in the later matchlock.. It differed from the pan of a matchlock in that it was pierced in the bottom to allow a portion of the wheel to intrude; and instead of a pivoted cover it possessed a sliding cover that was connected with the internal lock mechanism. The pyrite was held in the doghead, a miniature vise mounted on an arm that pivoted just in front of the pan. A spring fastened on the outside of the lock plate just below the arm of the doghead acted upon the arm in such a way that when the head was placed against the pan cover in firing position a constant downward pressure was maintained.

The loading and firing of a wheel lock was a comparatively simple and sure process. First, the wheel was wound. Then the charge was placed in the barrel in the normal manner. Next. the pan was filled with priming powder. the cover was slid shut and the doghead pushed down against it. The trigger was then pulled. The pressure on the trigger released the sear from its lodging in the hole in the wheel. The wheel thus freed began to turn, and as it did so a cam attached to it struck against a bar connected to the pan cover and automatically opened the pan. The doghead with its piece of pyrite. which had been held against the pan cover by its spring. was thus forced against the part of the revolving wheel that intruded through the slot in the pan. .\strong series of sparks was produced, and the priming powder ignited.

The wheel lock was a tremendous improvement over the matchlock. The lighted match was no longer needed. The weapon could be carried ready to fire at a moment's notice. It could be fired with one hand, thus making the pistol practical; and it could be fired from horseback. As cavalry could now be armed with firearms, radical changes in tactics resulted, especially in Germany and northern Europe.

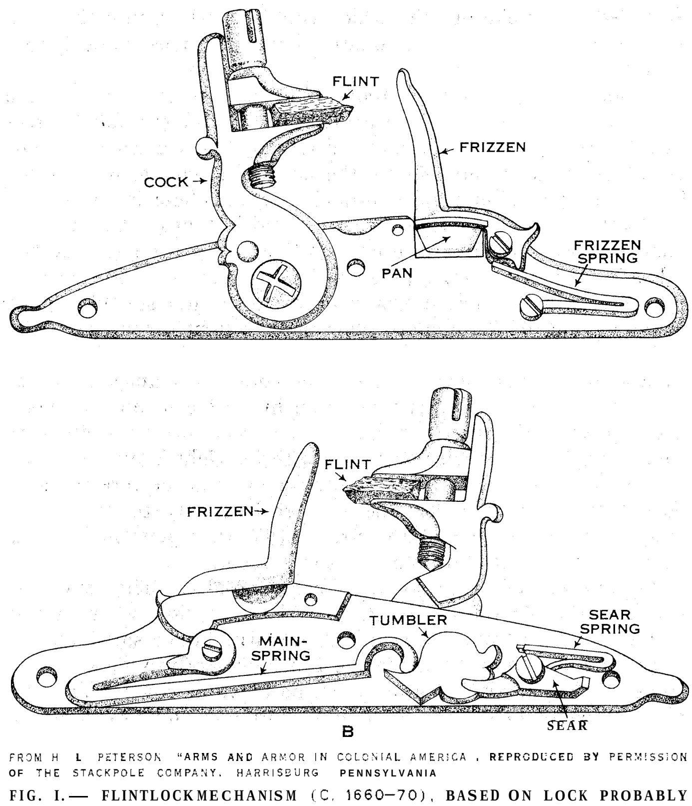
But the wheel lock was an expensive weapon; it never succeeded in supplanting the matchlock as the standard European military firearm. In America it was widely used because conditions there demanded a faster and more reliable gun than Europeans found necessary. In Europe generally it remained the weapon of horsemen and special troops.

4. Flint Arms.—The ignition system that finally supplanted the matchlock was a simple mechanism that produced its spark by striking flint against steel in a procedure similar to that for lighting household fires. In firearms the flint was held in a vise on one end of an arm, known as the cock. The other end of the arm was pivoted on the lock plate so that the flint-bearing end could be swung in an arc in the direction of the steel. The steel, which was also called the battery (now sometimes called the frizzen), was mounted on another pivoted arm and placed in a position opposing the cock. The flashpan was placed directly below the battery. When the trigger was pulled, the cock, impelled by a strong spring, moved forward in a short arc. The flint, held in the jaws of the cock, struck the steel a glancing blow producing a shower of sparks that dropped into the priming powder in the pan. If all went well, the flash of the priming powder penetrated to the powder in the bore and fired the weapon. But sometimes this failed to happen and there was only a "flash in the pan."

Modern students recognize at least six distinct types of flintlocks: the snaphance, English lock, dog lock, Scandinavian snap lock. miquelet lock and the "true" flintlock. These terms denote both different evolutionary stages in the development of the flintlock and regional variations. The first of these forms to appear was the snaphance, believed to have been developed in Scandinavia and the Low Countries about the middle of the 16th century. It was characterized by a separate battery and pan cover. Its name was derived from the Dutch words describing the action of the cock, snaphaan, or "snapping cock." This term was also adopted by English writers and used by them for over 150 years to indicate any form of firearm with a snapping cock, thus causing much confusion among arms historians in later years.

The miquelet lock developed almost as early as the snaphance, but it was confined to southern Europe. principally Spain and Italy. An exceptionally strong and simple lock, it remained virtually unchanged from the time of its invention until the opening years of the 19th century. Its main characteristics were an external mainspring and a battery and pan cover made in one piece.

The Scandinavian snap lock was also a product of the 16th century. It. too, had an external mainspring, and sometimes the battery and pan cover were combined as in the miquelet. There were, in fact, many points of similarity between the Scandinavian



FROM H L PETERSON "ARMS AND ARMOR IN COLONIAL AMERICA , REPRODUCED BY PERMISSION OF THE STACKPOLE COMPANY. HARRISBURG PENNSYLVANIA

FIG. I.— FLINTLOCKMECHANISM (C. 1660–70), BASED ON LOCK PROBABLY OF DUTCH ORIGIN: PHANTOM VIEW: (A) RIGHT SIDE. (B) LEFT SIDE and southern European types, unusual for such widely separated areas. The principal differences were in the shapes of the parts and in minor mechanical details.

The English lock and dog lock were variations of the Dutch snaphance in which the battery and pan cover were made in one piece. The internal mechanism was the same as that of the snaphance. There was no half-cock or safety position. and thus on the dog lock a dog catch mas pivoted on the outside of the lock to engage the tail of the cock and provide such a safety position. Both these forms were in concurrent use in England from the first quarter of the 17th century until about 1650. when the French flintlock began to supersede them. The dog catch, however, persisted on many guns until after 1700, though it no longer served a necessary function.

The true flintlock mas invented in France probably by Marin Le Bourgeoys about 1610–15. It combined features of both the snaphance and the miquelet and produced a simple, safe and reliable weapon. The battery and pan cover were combined in one piece so that the striking of the flint on the steel automatically opened the pan, and the internal mechanism was altered so that there was a haif-cock or safety position. From France this new lock quickly spread throughout most of western Europe, although it never succeeded in displacing the miquelet or, to a lesser degree, the Scandinavian locks. It soon became the standard system for all the better guns and after 1700 for almost all guns.

The chief advantages of the flintlock over the wheel lock lay in its simplicity and cheapness of construction and in the fact that the user no longer had to carry a separate spanner or wrench to operate it. Special troops were armed with the flintlock in Europe by 1650, and after 1700 it had completely replaced the matchlock as a military weapon. In America the change was somewhat more rapid; every colony had banned the matchlock by 1677.

5. Standardization **of** Arms.—The beginning of the 18th century also brought the standardization of military small arms. Some attempts at standardization had been made earlier, it is true. but real success was not achieved until well into the first quarter of the century. By that time royal manufactories and systems of inspection had been set up in several countries and official models adopted. Muskets were the first arms to be standardized in most countries. Pistols and carbines or musketoons followed.

The average musket of the period was a flintlock smoothbore weighing about 12 lb. Calibres ranged from .69 in France and Spain to .75 in England and even slightly larger in some of the German states. With such a musket a well-trained recruit was expected to be able to load and fire in 15 seconds.

These muskets mere not noted for accuracy. The best that could be expected was to hit the figure of a man at 80 to 100 yd. The military men of the period were more interested in rapidity of fire than in accuracy; they operated on the principle of laying donn fields of fire much in the manner of modern machine gunners. Carbines and musketoons were shorter and lighter versions of the musket and were carried by cavalry, artillery and other special troops. Pistols were still shorter arms, also smoothbore. with calibres almost as large and even less accurate. Most cavalrymen scorned them and looked on the sword as their only true and effective weapon. (See also PISTOL AND REVOLVER.)

6. Percussion System.—A Scottish clergyman, Alexander John Forsyth, revolutionized all firearms theory with the invention of a percussion compound that would explode when struck a sharp blow. Working at his manse. Forsyth made his first percussion lock in 1805 and patented it in 1807 after some months of experimenting at the Tower of London. His compound was basically potassium chlorate. When placed in a tube communicating with the bore of a gun and struck by the hammer it produced a flash strong enough to ignite the charge. Separate priming powder and free sparks were no longer necessary. Forsyth thus laid the basis for later self-contained metallic cartridges and for contact fuses in shells and opened a whole new field of possibilities.

The next task was to perfect methods of utilizing this new material efficiently. Pellets and tubes filled with the compound were tried in the so-called pill and tube locks. Then came the percussion cap claimed by several as an invention. Joshua Shaw, an Anglo-American living in Philadelphia, developed the device in the United States but was refused a patent because he was not a U.S. citizen at the time. The first caps, shaped somewhat like the top hat of the period, were made first of iron (1514). then of pewter (1815) and finally (1816) of copper. The bottom of the cavity contained a minute amount of the percussion mixture covered by a disk of tin foil; the whole mas sealed and made waterproof by a drop of shellac. In operation, this cap was placed over a tube, knoan variously as a cone or nipple, that projected from the barrel. The hammer, acting exactly in the manner of the cock on flint arms, struck the cap a sharp blow and produced a flash that was directed by the tube into the bore where it set off the propellent charge.

Despite the obvious advantages of the percussion system, a number of years passed before it was adopted as standard for military small arms. Military men could appreciate the fact that percussion guns were simpler to make, were surer to go off, and were not affectedby wind or even light rain. They saw, too, that it was no longer necessary to carry extra flints and to chip and adjust them as they wore down. Nevertheless. they were concerned about the supply of percussion caps, the methods of carrying them and the delicate process of applying them to the gun. Thus it was not until 1842 that either the United States or Great Britain began the manufacture of standard military muskets of the percussion type, though the United States had adopted the system for special weapons as early as 1833 and Great Britain in 1836.

B. Development of Rifling

Rifling, or the cutting of spiral grooves in the barrel of a firearm to impart a spin to the projectile and thus improve its accuracy. was invented between 1450 and 1500. Some authorities claim the invention for Leipzig. Ger., in 1498, while others assert that the honour belongs to Vienna. Be that as it may, a specimen exists bearing the arms of the emperor Maximilian I which can be dated definitely between 1493 and 1508. The grooves in many of these very early rifles were straight instead of spiral, and some students maintain that the purpose of the grooves was to receive the fouling from the gunpowder and not to impart stability to the projectile. Fowder fouling was a serious problem, especially with the earliest types of black powder, and such grooves would collect the powder somewhat so that more shots could be fired between cleanings. At the same time, however, it should be noted that the theory of stabilizing a projectile by causing it to revolve on its axis was well understood at that period and was utilized on crossbow bolts and some arrows. This. plus the fact that many of the early grooves are spiral, would seem to indicate that perhaps both purposes were intended.

If a ball were to take the spin imparted by the rifling. it had to fit the bore tightly. This meant that the ball had to be forced down the bore with repeated blows of the ramrod, or it had to be wrapped in a greased patch of cloth or leather that would ease its passage while still permitting a tight enough fit for it to take the rifling. Both methods were used from an early date, and descriptions of them can be found in manuals of the late 16th and early 17th centuries.

Rifling a gun barrel was a comparatively expensive process, and there were other drawbacks about these guns that prevented their rapid adoption as military neapons. The tight fit required of the ball made loading a slow process, even when the greased patch was used. This was a distinct handicap from the military standpoint. Ramrods mere apt to break because of the need to exert considerable pressure on the ball. and a gun without its ramrod was worthless in battle. The thicker barrels of the rifles tended to make them muzzle-heavy; they nere even harder to balance with a bayonet. Use of the early plug bayonet that fitted into the bore was, of course, out of the question with rifles. Finally, it took more skill to use a rifle to best advantage. a decided drawback in the eyes of the men who had to drill raw recruits and levies.

Despite these handicaps, some rifles saw military service at an early date. Christian IV of Denmark is said to have been the first to arm troops with this weapon early in the 17th century; soon thereafter the French royal horse guard could boast that they were armed with eight rifled carbines per troop. By the middle of the 18th century the use of the rifle as a military arm had spread widely on the continent, and most Scandinavian and Germanic countries had organized special troops provided with rifles. The Swedish model of 1761 mas even equipped with a bayonet.

Great Britain lagged far behind the other nations of Europe in the adoption of rifles for military service. Some of the continental troops employed by the British in the various European wars of the 18th century had had rifles, it is true. but it remained for the American rifle, encountered by British troops during the French and Indian War and the American Revolution, to wield the deciding influence in introducing the weapon to the regular British service. Copies of the American rifles were made in small quantities and issued to special troops; the Highlanders serving in America had them at least as early as 1760, and thereafter the practice spread. The breech-loading Ferguson rifle, described below, was tried briefly in 1776–77 and again late in the century, followed by the famous Baker rifles for the first official rifle brigade in 1800. .Interestingly, these Baker rifles followed German patterns more closely than they did American and were equipped with bayonets.

1. American Rifle.—The American rifles that so influenced the British had been developed by German and Swiss immigrants on the eastern seaboard, especially in Pennsylvania. For this reason they are frequently called Pennsylvania rifles and sometimes Kentucky rifles because of their popularity with the settlers of the territory that later became the states of Kentucky and Tennessee. The earliest of the rifles made by these immigrants in the 18th century were indistinguishable from the short, large-calibre rifles of their homelands. As the years passed, however, the colonists lengthened the barrels, decreased the size of the bore and added a brass patch box to hold the greased pieces of cloth with which they wrapped their bullets. In so doing, they achieved a distinctly American gun. Stocked in handsomely grained curly maple, it reached its fullest development between 1770 and 1810.

The American rifle was a supremely accurate weapon. In the hands of practised marksmen it could find its mark at unheard-of distances, striking a target at 300 yd., almost three times the effective range of the musket. For this reason it was an exceptionally valuable weapon for special troops such as light infantry and snipers who were supported by regular infantry with muskets. But because the rifle took considerable time to load and had no bayonet it could not replace the musket as the regular infantry arm. The tactics of the day called for rapidity rather than accuracy in laying down a field of fire before the enemy closed in with the bayonet and decided the issue in hand-to-hand fighting. This point has been overlooked frequently in the past by popular writers who were not trained soldiers and did not understand the tactical situation. A whole body of literature has developed criticizing the military authorities for not recognizing the superiority of the rifle and adopting it immediately as the standard infantry arm. George Washington, Anthony Wayne, Peter Muhlenberg, Daniel Morgan and other American generals, some of them trained riflemen themselves, recognized fully the values of the rifle but realized also that it needed improvement before it could replace the musket.

2. Ammunition for Rifles.—Attempts to make improvements in rifles occupied the time of leading gun designers throughout the western world for half a century following the American Revolution. The principal problem was to increase the speed of loading. Two notable attempts nere made with the round balls that had always been standard for rifles. In Great Britain, the Brunswick rifle was designed to fire a ball with a raised band around its equator to fit the gun's two-groove rifling. The British government adopted the Brunswick rifle in 1836, but it fouled badly and was often called by its contemporaries the worst military rifle in Europe. In France Henri Gustave Delvigne designed a rifle barrel with a narrow chamber at the breech just large enough to contain the powder charge. When the ball was dropped loosely down the barrel so that it rested against the opening of this chamber. several sharp blows with the iron ramrod would expand its diameter and make it fit the bore tightly. This distortion of the ball affected its accuracy, however, and the loading process, though more rapid than that with the patched ball, was still slower than the loading of a musket.

The answer lay not in the round ball but in the elongated projectile. As early as 1823 a Captain Norton of the British 34th regiment found the right approach in a bullet with a base hollowed in such a manner that the gases produced by the explosion of the charge would expand it and cause it to press tightly against the sides of the bore. In 1836 the British gun designer William Greener developed an elongated projectile with a conical plug fitted into the base cavity. On firing. the plug was driven far enough forward into this cavity to expand the walls of the missile into the rifle grooves. Both these bullets were tested by the British government and rejected.

In France, Delvigne, who had given up his experiments on round balls and switched to cylindroconoidal projectiles, teamed up with Colonel Thouvenin of the French artillery to produce a new system, usually known today as the Thouvenin system or the *carabine à tige*. In this rifle a stout pin or *tige* just long enough to pass through the powder charge mas fixed to the centre of the breech plug When the cylindroconoidal projectile was dropped down the barrel, its base struck against this pin, which acted as an anvil for flattening the bullet under blows from the ramrod. Since the ramrod had a shaped cavity in its tip, the bullet retained its form and its accuracy. The pin had a tendency to bend after repeated use, honever, and fouling presented a particularly difficult problem. The hammered bullet did not provide the answer.

It was another Frenchman who finally produced the solution. In 1849 Capt. Claude Étienne Mini6 perfected the projectile that made his name a household word throughout the world. In developing his bullet, Minié followed the pattern set by Norton and Greener—a cylindroconoidal slug with a hollow cavity in the base. At first Minié inserted in this cavity an iron cup that was driven forward by the force of the explosion to expand the base of the bullet until it fitted the bore tightly. Later cups of other materials were tried. and finally it was discovered that if the cavity itself were properly designed, no cup of any kind was necessary.

Here at last was the device that made the rifle a practical military weapon for all branches of the service. The Mini6 ball, as it came to be called, could be dropped down the barrel and rammed home as easily as a musket ball. The rifle could thus be fired as rapidly as the musket. As the rifle had the advantage of greater accuracy, only a few years passed before the smoothbore disappeared from the military scene. Rifled arms of the Mini6 system were adopted as standard by Great Britain in 1851 and by the United States in 1855.

In addition to the main course of rifle projectile evolution, there were also one or two side developments using specially shaped projectiles and bores that achieved some success. These mere the oval-bored and hexagonal-bored rifles. In these systems, instead of the usual grooves, the whole bore twisted to impart the proper spin to the bullet. Among these types, the oval bore has the longer history. Of the many guns that attempted to utilize it, one of the best known was the Greene bolt-action rifle used occasionally during the American Civil War. The hexagonal bore and projectile are associated primarily with the English gun designer Sir Joseph Whitworth, who produced both cannon and small arms utilizing this system. His guns were supremely accurate, and many saw service in the American Civil War in the hands of Confederate troops.

C. Breechloaders and Repeaters

Attempts to produce breech-loading and repeating firearms date back almost to the first appearance of small arms. Breech-loading cannon, in fact, predate the first handguns. Multishot firearms were known at least as early as the first part of the 16th century. Most of the primitive breechloaders used separate chambers that were wedged or screwed into place A few used metal tubes surprisingly similar to modern metallic cartridges All suffered from an excessive leakage of gas and flame and from the fact that fouling soon made them difficult or impossible to use. Xlultishot arms most often employed multiple barrels and locks. revolving cylinders or a Roman candle effect in nhich the priming charge set off the foremost explosive charge in a series of charges loaded one on top of the other in the barrel and a powder train carried the flame onward, setting off one shot after another until the barrel was empty.

1. Lorenzoni System.—During the first half of the 17th century an especially good breech-loading and repeating flintlock firearm was developed, possibly by the Florentine gunrnaker Michele Lorenzoni, and its use soon spread throughout Europe and, by the early 18th century. to America. In Europe the mechanism is known today as the *système Lorenzoni;* in the United States it is called the Cookson type, since the first such gun described in an American publication bore the name of the British gunsmith John Cookson. In this firearm, the balls and ponder were placed in separate tubular magazines in the stock. A single backward-and-forward motion of a lever on the reverse side of the gun caused a special revolving breechblock to select a ball and a charge of powder from their respective magazines. place them in their proper position in the barrel, prime the flashpan and set the gun at half cock.

Some guns based on this system were designed to fire five, six or seven shots. It was an excellent and efficient system, but its construction required the skill of a master gunsmith. It also suffered from the hazard of the possible ignition of the whole powder magazine if the breech were not closed properly at the time of discharge. Despite these dranbacks, guns of this type were still being manufactured as late as 1800.

2. Ferguson Rifle.—Among the breechloaders, the 18th century witnessed the development of several systems nhich, as far as is knonn, were the first such arms used by soldiers. France tried one in 1723. and Austria armed its dragoons and light cavalry with them in 1770. Both experiments were of brief duration. In England an excellent breech-loading rifle was developed slowly during the first half of the century, reaching its peak in time for the American Revolution. The man uho brought this rifle to its fullest development was Patrick Ferguson of the British army, and 100 or 200 men under his command were armed with this rifle for a short time during the American Revolution.

The Ferguson system was simple and efficient. A plug operating on a screw passed vertically through the breech of the barrel. The lower end of this plug was attached to the trigger guard. which acted as a handle. One revolution of the trigger guard in a clockwise direction lowered the plug until its top was flush nith the bottom of the chamber in the breech. The plug being thus depressed left a hole in the top of the barrel nhich communicated directly uith the bore. In order to load the gun rhe barrel was pointed slightly downward, the trigger guard revolved and the plug accordingly depressed. A ball was dropped into the hole in the top of the barrel whence it rolled forward until stopped by the lands of the rifling at the end of the chamber. The ball was followed by a charge of ponder, measured simply by filling the cavity of the chamber behind the ball. The trigger guard was then revolved in a counterclockwise direction, closing the opening in the top of the barrel and forcing out any excess powder that might have been poured in The pan nas then primed separately, and the piece was ready for firing. The Ferguson rifle was probably the finest military firearm used during the American Revolution. It could be fired six times in a minute It was accurate and was equipped with a bayonet. Nevertheless, it did not meet with official favour, and its active career was brief.

3. Hall Rifle.—It remained for the United States in 1817 to adopt the first breech-loading rifle as a standard military arm that saw long service. This was the Hall rifle, a flintlock weapon invented by John H. Hall of Yarmouth, Me., in 1811. In Hall's system a pivoted breechblock containing the lock mechanism and the chamber could be tipped up, loaded and then closed and locked in position by a spring catch. Since the junction of the chamber and the barrel mas a simple butt joint, there was considerable gas leakage. Nevertheless. the Hall system. in both flint and percussion. was used for rifles and carbines for almost 25 years, the last-known carbine contract being awarded in 1850. The Hall rifle also enjoyed the distinction of being the first military firearm made in America with completely interchangeable parts.

4. Dreyse Rifle.—In Europe the breechloader was also making its appearance on the military scene. Johann Nikolaus von Dreyse invented his famous needle gun in 1829, and it was adopted by the Prussian army in 1848. Dreyse's gun used a long. sharp firing pin to pierce the charge of propelling powder and strike the fulminate primer located in the base of the bullet. This needlelike firing pin gave the gun its name and also proved to be the arm's major weakness. for it tended to break or warp during heavy use. Dreyse's breech-closing mechanism included the bolt action; it was the first appearance of that very important device and was probably Dreyse's greatest contribution to firearms design. Despite the weakness of the firing pin, the needle gun remained standard in Prussia until it was replaced by the Mauser in 1871. In France, Antoine Alphonse Chassepot developed a rifle similar to Dreyse's but with a shorter pin and an improved cartridge. Elseahere, Norway adopted a breechloader with a tip-up breech designed by F. W. Scheel in 1842, and in other countries experimentation continued.

5. Sharps Rifle.—In the United States. Christian Sharps of Philadelphia. who had worked under Hall making the latter's breech-loading flintlock rifles. invented the first really satisfactory breech-loading system in 1848 In Sharps's guns the breechblock was raised and lowered in a vertical mortise by the action of a lever that usually served also as a trigger guard. When the breechblock was lowered, the chamber was exposed and a paper or linen cartridge could be inserted. As the breechblock was raised it sheared off the rear of the cartridge, exposing the powder to sparks from the priming pellet, nhich was not contained in the cartridge but was fed automatically over the nipple by the action of the hammer. The Sharps action was very strong and tight. It allowed no gas leakage, and it would not bend or crack, even with excessively large charges. The basic Sharps principle, in fact. is still in use today on some heavy arms and small cannon in which strength is needed.

6. Other Types.—During the 1850s and 1860s a large number of breech-loading arms were developed in the United States, and most of them saw service in the Civil War. It was only the war, in fact, that permitted most of them to get into production, since they were not good enough to have survived in a civilian market. In 1863 the United States government decided to look toward the adoption of a breechloader for its principal infantry and cavalry arms. In 1866 it began the conversion of muzzle-loaders then in use. and in 1873 the first new breechloaders firing .45–70 (calibre .45 with 50 gr. of ponder) metallic cartridges were manufactured. On these rifles and carbines, the top of the breech tipped up in a trap-door action alloning the insertion of the cartridge. The new metallic cartridge eliminated all norries about gas leakage. and the action mas strong. The 45–70 Springfield remained the principal U.S. military rifle until it was replaced by the Krag-Jorgensen in 1892.

Meanwhile experimentation with repeating weapons had not ceased with the *système Lorenzoni* discussed above The United States tried the Roman-candle principle briefly during the Revolution and again during the War of 1812. Sliding locks that could fire superimposed loads one after another also were tried. The British experimented with multibarreled carbines, and there were other attempts to obtain greater firepower.

7. Pistols and Revolvers.—The pistol makers were the first to achieve real success. first with the revolving barrels of the pepperbox and then with the revolving cylinders of the Colt revolver. The pepperbox pistols consisted of a series of barrels grouped around a central axis; they could be fired one after another by a single hammer. The system had developed slowly over a century and a half, reaching its height during the 1830s and 1840s. By this time, all were percussion arms and all were muzzle-loading. On some the barrels revolved automatically; on others it was necessary to turn them by hand. Normally these pistols had from 3 to 6 barrels. but occasionally there were more—8, 10, 12 or even 18. When first developed, they were the fastest-firing guns of their time.

Like the pepperbox, the revolver also developed slowly over a period of centuries. It was made a really practical arm by Samuel Colt in 1830 when as a boy of 16 he whittled out a model of a pistol in which the cocking of the hammer automatically revolved the cylinder. Colt's revolvers were all percussion until after the close of the American Civil War. Each chamber in the cylinder was loaded separately with a combustible cartridge, and the individual nipple for each chamber was capped by hand. The Colt revolver was an excellent weapon and one of America's greatest contributions to small-arms technology. As such it was soon copied by a host of other designers, in both the Cnited States and Europe, n-ho sought in various ways to avoid the patents that Colt held in the United States. Great Britain and France and that protected his system until they expired in 1856. By that time the revolver was firmly established. (See also PISTOL AND REVOLVER.j

8. Later Development of Repeaters.— Further advances in the field of repeating arms waited upon developments in ammunition. The evolution of the cartridge is discussed below, but its tie-in with the invention of practical repeating arms is particularly important here. through the work of two U.S. gunsmiths, Horace Smith and Daniel B. Wesson. These two young artisans became friends in 1852 and together developed a new repeating pistol and rifle using a new cartridge. The repeating mechanism was an improvement on one devised some time before by Walter Hunt and Lewis Jennings. As strengthened and simplified by Smith and Wesson, it formed the basis for the Volcanic pistols and rifles of 1855 and, later. with further improvements by B. Tyler Henry. for the famous Henry and Winchester rifles.

Before the Henry rifle reached its full development, it acquired a serious competitor in the form of the Spencer rifle and carbine. Christopher M. Spencer patented his gun March 6, 1860. It was an excellent firearm with a tubular magazine for seven metallic cartridges in the butt. It was sturdy. did not get out of order easily and was a great favourite with troops durir: . the Civil War, when more than 100.000 Spencer arms saw active service. After the war the Spencer company was purchased by Winchester, and manufacture of Spencer arms was discontinued.

During the second half of the 19th century almost all nations experimented with various repeating rifles and carbines. By 1900 almost all had adopted one form or another as their principal small arm. The Norwegians and Danes adopted the Krag-Jorgensen. as did the United States. after much experimentation with other systems, in 1892. The British adopted first the Lee-Metford in 1888, followed by the Lee-Enfield in 1895. The Germans chose the Mauser, and so on throughout Europe. All were bolt-action rifles with magazines for five or six shots. A few nations preferred the Winchester system, however, either manufacturing their own variations or buying arms directly from Winchester. Only the most backward clung to the old single-shot guns.

D. AMMUNITION

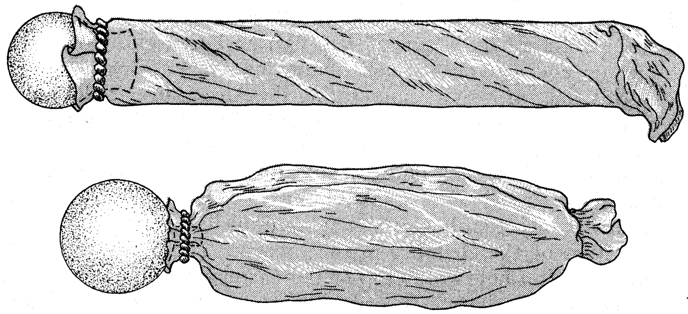
Many of the steps in the evolution of firearms design have been directly related to corresponding improvements in the types of ammunition available. It is impossible to understand one without the other.

1. Gunpowder.— First, there mere improvements in gunpowder (q v.) itself. From the time of its discovery in Europe. sometime in the 13th century, until the appearance of smokeless ponder late in the 19th century, all gunpowder was composed of three essential ingredients— saltpetre. charcoal and sulfur The earliest method of making ponder was to grind these three ingredients and mix them together. This resulted in a black substance of about the texture and consistency of fine coal dust. This form of powder was known as meal or serpentine powder. It was explosive, but it had many distinct disadvantages. It was first of all unstable. It was also hygroscopic. and when stored in a damp place it formed lumps that would burn slowly but would not explode. If the powder were rammed into the barrel with too great pressure it would form a lump and lose much, if not all, of its explosive force. Even when the complete charge remained in its mealy form, not all of it burned, and a gummy residue quickly fouled the gun barrel.

There were other disadvantages that related primarily to shipping and storing serpentine powder. Because of the dusty nature of its contents, a quantity of highly explosive dust was given off every time a container of the powder was shifted or jarred, which created a distinct safety hazard. Also, since the mixture of the three ingredients was purely a mechanical alignment, there was a tendency for these materials to settle out according to their specific densities if the powder were allowed to stand undisturbed for any period of time. Consequently. the periodic inverting of powder kegs was an important part of the routine of every well-run magazine.

Despite these obvious drawbacks, serpentine powder continued in use as the main propelling charge in firearms until about the middle of the 16th century, when "corned" powder began to supersede it. Corned or granulated powder was made by moistening the mixture and squeezing the resultant mass through sieves under considerable pressure. Corned powder overcame most of the disadvantages of the serpentine powder, and, in addition, it burned much more rapidly and thus added considerable force to the explosion. For these reasons, corned powder quickly supplanted the earlier variety as the main propellant for firearms. Serpentine powder, however, remained as the principal material for priming for at least another century.

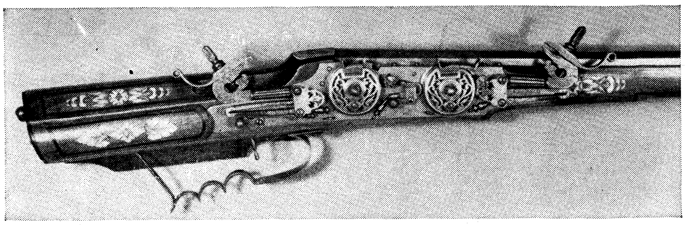
At first, gunpowder was carried in flasks or horns. During the first half of the 16th century a device known as the bandolier appeared and became popular in many parts of Europe and in America. It consisted of a number of cylindrical containers, each holding enough powder for one charge, suspended from a belt that could be worn over the shoulder. Usually there was also a little flask for priming powder, and a bag for the bullets, which were carried separately.



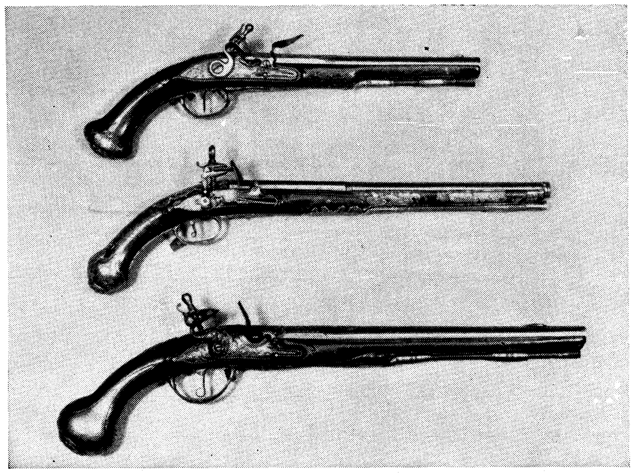
FROM H L PETERSON. ARMS AND ARMOR IN COLONIAL AMERICA"; REPRODUCED BY PERMISSION OF THE STACKPOLE COMPANY, HARRISBURG, PENNSYLVANIA

FIG. 3.— EARLY TYPES OF POWDER AND BALL AMMUNITION: (A) LATE 16TH-CENTURY PAPER CARTRIDGE WITH BALL ATTACHED BY FLANGE: (B) 17TH-CENTURY PAPER CARTRIDGE WITH BALL ATTACHED BY SPRUE

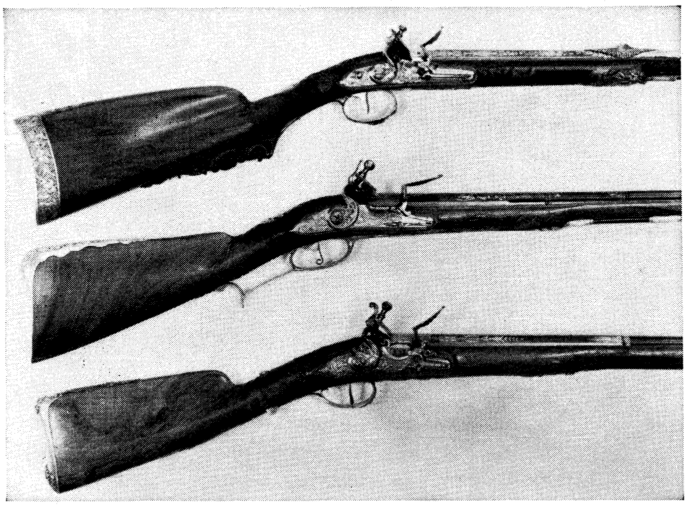
2. Cartridges.— None of these methods was entirely satisfactory There was still the need for greater speed and safety. The answer lay in the individual cartridge. The first cartridges appeared in the second half of the 16th century. At first they mere simply charges of ponder wrapped in paper. The ball was still loaded separately. Before 1600, however, several methods had been devised for attaching the ball, and during the next century these were refined until by 1700 the ball was wrapped inside the paper with the powder in one self-contained unit. These paper cartridges were in nidespread use in America by 1650. and they were adopted as standard by most European armies during the opening years of the 18th century. They remained standard as long as muzzle-loading arms were used. To use one of these



South German double wheel-lock arquebus; about 1600

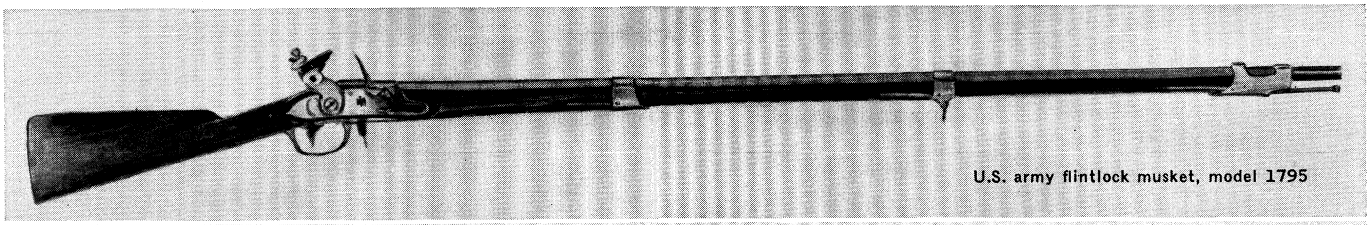


18th-century pistols: top, Swedish holster pistol; centre, Italian miquelet-lock belt pistol, dated 1756; bottom, German holster pistol



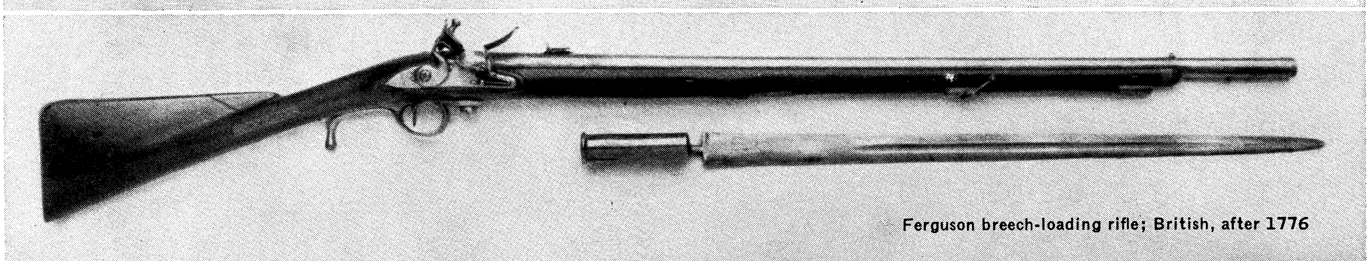
European flintlocks, 18th and 19th centuries: top, French, c. 1805, by Boutet et Fils; centre, German, c. 1750; bottom, Italian blunderbuss, c. 1800

Colt model 1860 U.S. army revolver, muzzle-loading and cap-fired. Considered the most important revolver of the Civil War

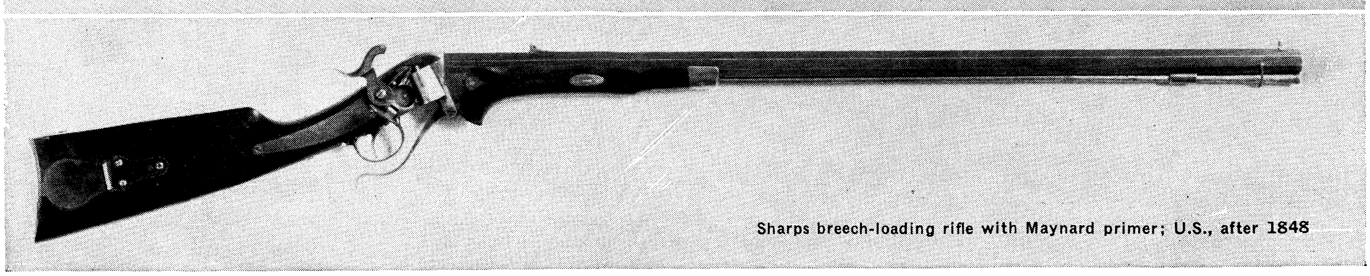


U.S. army flintlock musket, model 1795

Kentucky rifle, 1810–15



Ferguson breech-loading rifle; British, after 1776

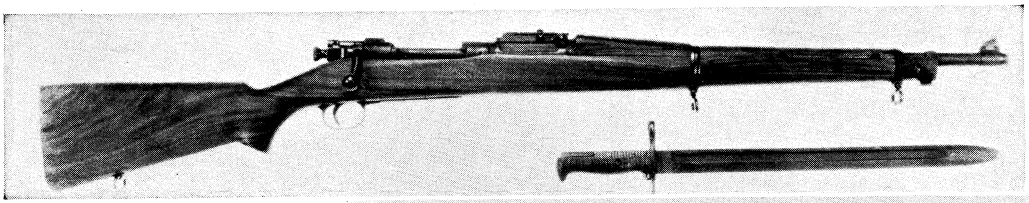


Sharps breech-loading rifle with Maynard primer; U.S., after 1848

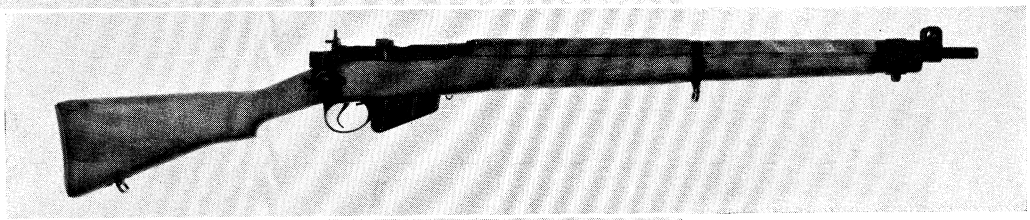
EUROPEAN AND U.S. SMALL ARMS, 17TH TO 19TH CENTURIES

BY COURTESY OF (SECOND ROW LEFT) WALLACE COLLECTION, LONDON, (SECOND ROW RIGHT, FOURTH, FIFTH AND SIXTH ROWS) SMITHSONIAN INSTITUTION, (THIRD ROW) U.S. ARMY; PHOTOGRAPHS, (TOP LEFT, TOP RIGHT) AUTHENTICATED NEWS

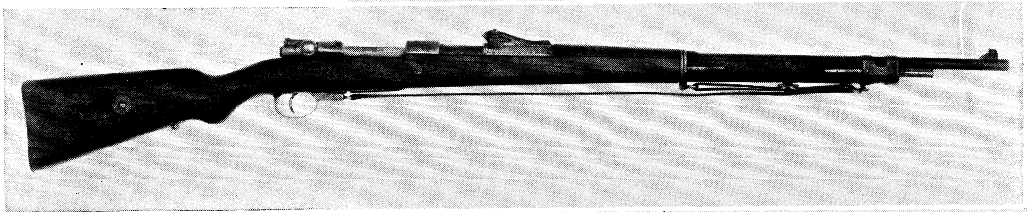
SMALL ARMS, MILITARY



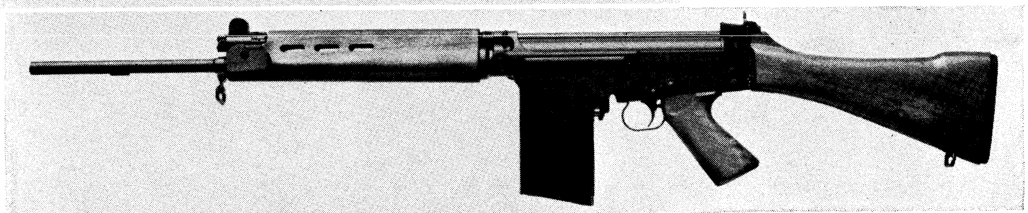
Left: U.S. Springfield calibre-.30 rifie, model M1903; with bayonet



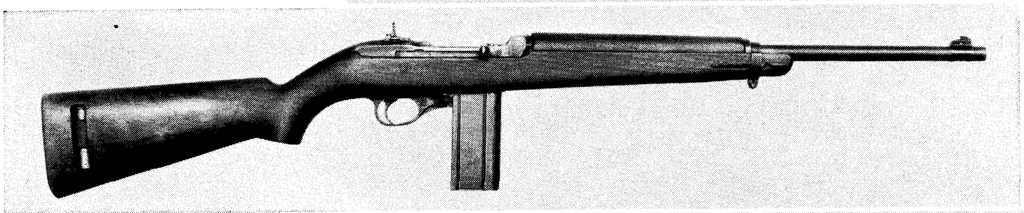
Right: British Lee-Enfield (S.M.L.-E.) calibre-.303 ritle; model No. 1 Mark VI, 1929–30



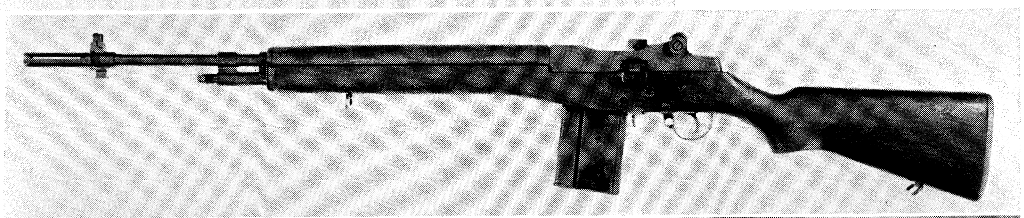
Left: German Mauser rifle, 7.9-mm., model ***Gewehr*** 98



Right: Belgian FN light automatic rifle, 7.62-mm.



Left: U.S. Winchester calibre-.30 carbine, model M1



Right: **U.S. M14 7.62-mm. rifle; standard rifle of the U.S. army**

U.S. infantry small arms of World War II. Back row, left to right: Browning automatic rifle M1918A2, submachine gun M3A1, carbine M2, rifle M1. Front row, heavy machine gun M1917A1, light machine gun M1919A4, light machine gun M1919A6

U.S. 3.5-in. rocket launcher, the bazooka

MODERN SMALL ARMS

BY COURTESY OF (TOP, FIFTH ROW, SIXTH ROW, BOTTOM LEFT, BOTTOM RIGHT) U S ARMY, (SECOND ROW, THIRD ROW) OLIN MATHIESON CHEMICAL CORPORATION, WINCHESTER-WESTERN DIVISION, (FOURTH ROW) FABRIQUE NATIONALE D'ARMES DE GUERRE cartridges, the soldier simply bit off the end of the paper tube, poured a little powder into the pan (if the gun was a flintlock), dumped the rest down the barrel and then rammed the ball and the paper down on top.

The early breech-loading and multishot weapons brought forth a great variety of cartridges. Some were wrapped or covered with paper, some with linen, animal tissue, collodion. metal, rubber and even other materials. All, however, lacked an internal primer that would supply the spark to ignite the charge.

In 1846 a Paris gunsmith named B. Houiller patented two cartridges that represented the first completely self-contained metallic-cased ammunition for small arms. One, known today as the pin-fire cartridge, held a small percussion cap mounted sideways in its base with a pin poised above it and protruding through the case itself. A blow from the hammer drove the pin into the cap, exploding it and setting off the charge. The other was the first of the rim-fire cartridges with a compound of fulminate of mercury in a cavity that encircled the rim of the cartridge base. A blow from a sharp-nosed hammer set this cartridge off in the same manner as the percussion cap that utilized the same explosive compound. In these first rim-fire cartridges the fulminate of mercury also supplied the propelling force. and, as a consequence. the charges were weak In 1856 Smith and Wesson produced a rim-fire cartridge with a suitable charge of black powder as well as the detonating compound, and thus developed a truly useful cartridge.

The rim-fire cartridge gained widespread acceptance for every sort of firearm, but it had certain defects which still had to be overcome. It was difficult to spread the detonating compound evenly all around the rim cavity, and if the rim cavity was not filled all the way around there was a chance that the hammer would strike a blank space and produce a misfire. Also it was difficult to produce a brass case strong enough to withstand the pressures developed by the heavy charges in large-calibre guns and still weak enough in the rim to indent easily under the blow of the hammer.

The final answer to these problems was found in the centre-fire cartridge that was developed at about the same time as the rim-fire. Many men in England, France and the United States contributed to its evolution. In 1852 Charles Lancaster of Great Britain invented a cartridge with an internal perforated disk forming a small cavity at the base. This cavity was filled with fulminate and exploded nhen a blow from the hammer crushed the compound between the base of the case and the inner disk. This system was improved by A. M. Pottet of France in 1857 with a design that allowed a percussion cap to be inserted in a domed cavity in the base. Colonel Boxer of the British Royal laboratory improved Pottet's design in 1867 and produced the basic form of one of the tno standard types of centre-fire cartridges that are the universal standard — the type in which the anvil or inner surface against which the priming compound is crushed is made separately from the cartridge case. The other standard type was developed by Col. (later Gen.) Hiram Berdan of the United States in 1866. In it the anvil nas formed as an integral part of the case. After 1867 there were minor improvements in design and manufacturing techniques, and smokeless nitrocellulose ponder replaced black powder as the propelling charge. but there were no basic changes in these two systems.

BIBLIOGRAPHY.—As the literature dealing with firearms is huge, readers with special interests would do well to consult Ray Riling, *Guns and Shooting: a Selected Chronological Bibliography* (1951), which lists almost 3,000 titles. Some of the most generally useiul books are the following: Josef Alm, *Eldhandvapen* (1933); Torsten Lenk, *Flintlåset* (1939); J. N. George, *English Pistols atzd Revolvers* (1938) and *English Guns and Rifles* (1947); James E. Hicks, *Notes on French Ordnance, 1717 to 1936* (1938); J. Margerand, *Armement et équipement de l'infanterie française* (1945); W. Keith Neal, *Spanish Guns and Pistols* (1955); Harold L. Peterson, *Arms and Armor in Colonial America, 1526–1783* (1956); John G. W. Dillin, *The Kentucky Rifle* (1924 and subsequent editions); Ned H. Roberts, *The Muzzle-Loading Cap Lock Rifle, 3rd* ed. (1948); Arcadi Gluckman, *Cnited States Martial Pistols atzd Revolvers* (1939) and *United States Muskets, Rifles and Carbines* (1948); Berkeley R. Lewis, *Small Arms and Ammunition in the United States Service* (1936); William A. Albaugh and E. N. Simmons, *Confederate Arms* (1957); James E. Serven, *Colt Firearms, 1836–1954* (1954); Alden Hatch, *Rentington Arms in American History* (1956); Lewis Winant, *Pepperbox Firearnzs* (1952), *Firearms Curiosa* (1955), *Early Percussion Firearnzs* (1959); Charles E. Chapel, *The Gun Collector's Handbook of Values* (constantly being revised); and Herschel Logan, *Cartridges* (1948). (HD. L. P.)

II. 20th-CENTURY SMALL ARMS

By the year 1900. foot soldiers in the armies of all leading military powers had at their disposal a nide variety of high-powered repeating rifles, lightweight carbines, semiautomatic pistols and revolvers and fully automatic machine guns. All these weapons fired ammunition that was far superior to that in use a generation earlier. much of it being filled with the propellant known as smokeless powder. Lead bullets covered with a thin jacket of cupronickel or other metal could be fired with great accuracy and lethal effect at man-size targets more than 500 yd. distant; extreme ranges ran up to 3.000 yd. and more. Military small arms had not only become lighter, more dependable, more accurate and longer ranging than those of earlier years. but they had become faster firing. Rates of small-arms fire rose tremendously in the period 1890–1910 as magazine-fed repeating rifles and automatic machine guns became standard military weapons.

These developments in small arms changed the whole face of war during the first two decades of the 20th century. They helped bring to an end the long reign of the cavalry arm. They turned frontal attacks by infantry on \veil-defended positions into mass slaughter. The new small arms, along with improved artillery, forced armies to build elaborate fortifications or seek safety in underground trenches. For a time they so strengthened the defense that no army could hope to take the offensive against a determined enemy and gain more than a few miles without suffering heavy casualties. The ne weapons led to a long period of tactical stalemate on the western front during World War I, a condition that stimulated development of a new weapon, the armoured tank. that was destined to play a major role in World War II. (See TANK; TRENCH WARFARE.)

During the period after 1880 ingenious inventors brought forth such a great variety of small arms that a mere listing of them all, with but brief description of each, would fill a large book. As machine guns, pistols and revolvers are treated in separate articles, they are mentioned here only incidentally; this article is focused mainly on rifles, carbines and submachine guns, but does not attempt to describe or name all the countless varieties that have seen military service. It is limited to a discussion of broad trends of development. with specific mention of some of the most notable types. As the development of ammunition for small arms has been so closely related to development of the weapons themselves, some discussion of small-arms ammunition has been included.

A. REPEATING RIFLES

Among the many different types and models of military rifles that appeared during the 1890s and early 1900s, certain common characteristics stand out. They all weighed between 8 and 10 lb., had barrels ranging from 24 to 30 in. in length. and were between 43 and 52 in in over-all length. The new rifles were shorter and lighter than their predecessors of the mid-19th century, and they fired ammunition of about calibre .30 (7.62 mm.) rather than the heavier bullets of earlier years. They were magazine-fed and were usually loaded by five-round clips or chargers. They were designed to be rugged enough to withstand hard usage and to keep firing even under the worst weather conditions, though further improvements along these lines were constantly being sought.

The military rifle most widely used and copied during the first quarter of the 20th century was the German Mauser. It had first appeared in Germany in the 1880s and over the years had been adopted by a score of countries other than Germany. No other military rifle ever enjoyed such wide use. A bolt-action piece loaded with a five-shot charger, the Mauser was produced in many models, including both a standard rifle (*Gewehr*) and a shorter carbine (*Karabiner*). Improved models of 1898 served as the basic weapons of the German infantry throughout World Wars I and II.

1. Bolt Action. — The term bolt action calls for some explana-

tion because it is fundamental to an understanding of all modern rifles. The bolt or breech mechanism of a rifle operates on the same principle as the sliding bolt used to lock a door, though it is far more complicated and its manufacture calls for much more precise workmanship. The typical rifle bolt is a steel cylinder containing a firing pin; it slides back and forth in the frame or receiver. The bolt has a solid head and, like the door lock, is fitted with a projecting handle with a round knob at the end. One or more lugs near the front or rear of the bolt fit into slots in the receiver and hold the bolt firmly in place against the base of the cartridge in the chamber when the weapon is to be fired. When the trigger is pressed, a long slender firing pin within the bolt is pushed forward by a spring to strike the primer cap in the base of the cartridge. After firing, the shooter grasps the round knob, raises it slightly to turn the bolt and disengage the lugs, and then slides the bolt back to extract the fired case. Forward movement of the bolt strips a fresh cartridge from the magazine and forces it into the chamber; a downward pull on the knob locks the bolt in place. Straight-pull rifles such as the Austrian Mannlicher and Canadian Ross require no turning to permit the bolt to slide back.

2. U.S. and British Rifles.—In 1892 the U.S. army adopted the Norwegian Krag-Jorgensen rifle in preference to the Mauser and many other weapons tested. Produced as both a rifle and a carbine, it underwent several modifications during its short period of service. In 1903 it was replaced by the Springfield rifle, a modified copy of the Mauser manufactured at the U.S. army's Springfield (Mass.) armoury and at Rock Island (Ill.) arsenal. An excellent rifle, the Springfield served as the basic infantry weapon of the U.S. army for the next 35 years and helped win for the U.S. soldier a world-wide reputation for rifle marksmanship. As late as World War II, modified Springfields with telescopic sights continued to serve as sniper rifles. The 1903 Springfield was a calibre-.30 weapon with a 24-in. barrel, about 6 in. shorter than the Krag-Jörgensen. For this reason, no carbine type of Springfield was considered necessary for mounted troops.

In the British army, too, during the South African War; there was a demand for a shorter rifle with a magazine feed that could serve for both infantry and cavalry, thus eliminating the carbine. A committee was appointed in 1900 to study the matter, and in Dec. 1902 a new rifle described as the "short, magazine, Lee-Enfield, Mark I" (S.M.L.E.) was adopted. It replaced the Lee-Metford (1888) and the long Lee-Enfield (1895). Its over-all length of 44½ in. was approximately 5 in. shorter than the "long rifle." The S.M.L.E. combined the bolt action developed by an American, James P. Lee, with the Enfield type of rifling. It fired rimmed calibre-,303 ammunition, and its bolt locked on the rear as did that of the Krag-Jorgensen. An improved model known as Mark III was adopted in 1907, followed by Mark 111* in 1918, a model with no cutoff (a device to permit reloading with single cartridges) and no long-range sights. The S.M.L.E. was fed from a ten-shot box magazine loaded by five-shot clips or single rounds. Though not quite so accurate as the Mauser or Springfield at long range, the S.M.L.E. held twice the number of cartridges and was faster firing.

At the outbreak of World War I in 1914 the British army was about to adopt a new Enfield rifle chambered for calibre-.276 rimless ammunition. But, in the face of war, the British government abandoned its plans for mass production of a new rifle and new type of ammunition. Instead, the ,276 rifle was modified to fire the standard calibre-.303 rim-type cartridges, and orders for its production were placed with factories in the United States. Production was slow, and by 1917, when the United States entered the war, British need for these rifles had declined while the U.S. forces a-ere desperately short of Springfields. To meet this emergency the British rifles in production were converted to fire U.S. calibre-.30 ammunition and were standardized as the M1917, or American Enfield. Over 2,000,000 of these rifles were produced during the war at three U.S. plants. The Enfield thus became, in terms of quantity production, the leading U.S. rifle of World War I. The rifling of the Enfield, unlike that of most rifles of its era, consisted of five grooves with a left-hand twist.

Other notable military rifle types of the early 20th century were the Austrian Mannlicher, Russian Mosin-Nagant, Japanese Arisaka. French Lebel and Canadian Ross. As noted above, the Ross and the Mannlicher were of the straight-pull type. They sufferedfrom frequent jamming in mud or sand, and the Ross was dropped during World War I because of frequent maliunctioning.

B. Semiautomatic Rifles and Carbines

All the rifles described above were repeaters, not automatics or semiautomatics. They fired one shot each time the trigger was pulled (or squeezed. to use the preferred military term). but after each shot the user had to pull back the bolt by hand to eject the spent case and then slide it forward to bring another cartridge into the chamber. By 1900, and even much earlier, firearms designers had begun to think seriously of developing semiautomatic or seli-loading rifles that would automatically bring a fresh cartridge into firing position after each shot, using the force of recoil or gas pressure for the purpose. France and Germany experimented with semiautomatics on a small scale during World War I. France issuing a few of the St. Étienne model and Germany some Mondragons designed by a Mexican officer of that name. But neither type functioned well in combat. The United States was the first nation to achieve real success in this field.

1. Garand Rifle.—After a generation of experiment and test (mostly with calibre-,276 rifles during the 1920s) the U.S. army in Jan. 1936 adopted a calibre-.30 semiautomatic rifle developed by John C. Garand. a civilian engineer at the Springfield armoury. Replacing the 1903 Springfield, the Garand rifle, or M1 as it was officially designated, became the basic weapon of the U.S. infantry in World War II and the Korean war. It was a calibre-.30 gas-operated weapon fed by an eight-round clip and weighing about 94 Ib. Its 24-in barrel was rifled with four grooves.

As the gas-operating mechanism of the M1 differed from the manually operated bolt described above, it merits brief explanation at this point. A small hole or gas port on the underside of the barrel near the muzzle permitted part of the propellent gases to escape into a small cylinder holding a piston that was connected to the bolt. As the gas pressure forced back the piston and the bolt, the empty cartridge case was ejected and the hammer was cocked. A spring then forced the bolt forward. As it moved forward the bolt stripped the top cartridge from the magazine and seated it in the chamber ready to fire. Gas pressure thus performed automatically the reloading task formerly done by hand. For this reason, weapons of this type are often called self-loading or autoloading.

With the Garand rifle the U.S. army adopted a new cartridge of the same dimensions as its predecessor but with a lighter bullet —152 gr. as compared with 172 gr. Some critics considered this a backward step but military authorities defended it on two main counts: first. the lighter bullet caused less recoil and thus helped the training of recruits in marksmanship; second. the extreme range of the heavier bullet—over 3,000 yd.—was of little military value and proved dangerous in target practice on 1,000-yd. ranges. Rifles were seldom used in combat beyond about 600 yd.

2. Johnson Rifle.—Soon after the Garand rifle was adopted in 1936, and while Springfield armoury was tooling up for its manufacture, a serious competitor appeared on the scene and precipitated a major rifle controversy in the United States. This was the semiautomatic rifle designed as a private venture by Melvin M. Johnson. It had a 22-in, barrel, weighed about 9½ lb., operated on the short-recoil principle rather than the gas system of the Garand and was fed with a ten-shot rotary magazine. Largely because of defects that appeared in the first production models of the Garand, there arose a demand that the Johnson be adopted in its stead. But, after much public discussion and extensive tests in 1939–40, the U.S. army decided to retain the Garand after improving its gas take-off. The Johnson rifle meanwhile was adopted by the Netherlands Indies forces and saw some service with U.S. marine corps units in World War II.

3. German and Soviet Rifles.—The German and Soviet armies also employed semiautomatic rifles to some extent in World War II, but their performance fell short of expectations. The German semiautomatics that saw most service were the models *Gewehr* 41, 41-W and 41-M. *Gewehr* 43 and *Karabiner* 43. All were gas-operated and fired 7.92 mm. cartridges. The 41 and 41-W did not have a gas port in the barrel but employed a cone attached to the muzzle to trap some of the expanding gas. As early as 1936 the Soviet army adopted the 7.62-mm. Simonov gas-operated rifle, which was capable of both semiautomatic and fully automatic fire. Its gas port and piston were on top of the barrel, thus resembling the German *Gewehr* 43. Another Soviet gas-operated semiautoinatic rifle, the 7.62-mm. Tokarev, appeared in 1938 and 1910 models. But throughout World War II most German and Soviet troops carried manually operated repeating rifles or carbines.

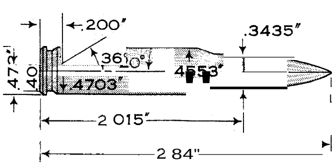
Principal Dimensions and Weighfs of Representative Military Rifles

Country	Rifle	Calibre	Approximate weight (pounds)	Length over-all (inches)	Type
Switzerland	Schmidt-Rubin (1889)	7.5 mm.	9.8	51.5	straight-pull repeater
U.S.	Krag-Jörgensen (1892)	.30 in.	9.2	49	turning-bolt repeater
Austria	Mannlicher (1895)	8 mm.	8.4	50	straight-pull repeater
Germany	Mauser 1898)	7.92 mm.	9	49.4	turning-bolt repeater
Russia	Mosin-Nagant (*c*. 1900)	7.62 mm.	9	51.8	turning-bolt repeater
U.S.	Springfield (1903)	.30 in.	8.7	43.2	turning-bolt repeater
Japan	Arisaka (1905)	6.5 mm.	9	51	turning-bolt repeater
Great Britain	S.M.L.E. Mark III (1907; originally adopted 1902)	.303 in.	8.7	44.5	turning-bolt repeater
France	Lebel (1907; originally adopted 1886)	8 mm.	9.2	51.5	turning-bolt repeater
U.S.	Enfield (1917)	.30 in.	9.2	46.3	turning-bolt repeater
U.S.	Garand M1 (1936)	.30 in.	9.6	43.6	gas-operated semiautomatic
Japan	Model 99 (1939)	7.7 mm.	7.7	45	turning-bolt repeater
U.S.S.R.	Tokarev (1938–40)	7.62 mm.	8.8	47.8	gas-operated semiautomatic
Germany	*Gewehr* 41-W (1941)	7.92 mm.	10.8	45	gas-operated semiautomatic
U.S.	Carbine M1 (1941)	.30 in.	5.5	35.6	gas-operated semiautomatic
Germany	*Gewehr* 43 (1943)	7.92 mm.	9	43	gas-operated semiautomatic
Great Britain (also Canada, Australia and Belgium)	Fabrique Nationale (FN), light-barrel version (1954)	7.62 mm.	8.7	44.4	gas-operated semiautomatic and automatic
U.S	M14, light barrel (1957)	7 62 mm	8 7	44 1	gas-operated semiautomatic and automatic
US.	M15, heavy barrel (1957)	7.62 mm	137	45.5	gas operated semiautomatic and automatic

4. Carbines. — Early in World War II the U.S. army again adopted a carbine. This time the carbine did not serve as a cavalry weapon, as had carbines of the 19th century, but as a defensive weapon for service troops and operators of crew-served weapons whose positions might be overrun in mobile warfare. For such troops the pistol had too short a range and too little accuracy, while the standard rifle was unnecessarily heavy and ponerful. A gas-operated weapon developed by the Winchester Repeating Arms company, the U S. carbine M1 was similar in design to the Garand rifle but was 8 in. shorter. It weighed only about $5\frac{1}{2}$ lb and fired a different type of ammunition from a 15-round magazine. The M2 carbine that appeared late in the nar had a selector snitch that gave the user a choice of fully automatic or semiautomatic fire; it was fed from a 30-round magazine. Some airborne troops carried a carbine (M1A1) with a folding skeleton metal stock.

The British army also employed light rifles or carbines for certain types of troops in World War II. Rifle No. 4. Mark I* weighed only $6\frac{3}{4}$ lb. and was sometimes described as a carbine. Rifle No. 5, Mark I* was a British carbine especially designed for jungle fighting.

Most rifles and some carbines were equipped with detachable bayonets or bayonet knives for hand-to-hand combat, though bayonet fighting was not common in World War II or the Korean war and many observers considered the bayonet obsolete. Another attachment, the grenade launcher, enabled troops armed with rifles and carbines to hurl antitank and antipersonnel grenades for short distances. (*See* BAYONET; GRENADES.)



FROM J S HATCHER HATCHER S NOTEBOOK REPRODUCED BY PERMISSION OF THE STACK POLE COMPANY HARRISBURG, PA

FIG. 4 —7.62-MM. NATO CARTRIDGE

C. RIFLE DEVELOPMENTS AFTER WORLD WAR II

At the end of World War II small arms were overshadowed by the atomic bomb and long-range guided missiles, but they were by no means forgotten. All leading military powers sought to improve their small arms in the light of World War II experience. The main objectives were to make rifles lighter and faster firing. The United States and Great Britain, joined in 1949 by other members of the North Atlantic Treaty organization (NATO), made determined efforts to improve their military rifles and also to standardize their equipment, particularly ammunition. Agreement in this field was not reached overnight. The Korean war (1950–53) was fought in the main with small arms and ammunition of the World War II type.

1. NATO Cartridge. — Acceptance of a common small-arms cartridge came first, though not without some difficulty. The British government proposed that a rifle cartridge of calibre .280 (7 mm.) with lead-core bullet be adopted. The U S. government favoured a more powerful cartridge of calibre 30 with steel core. After extensive tests the U S. cartridge, known as T65 during its development at Frankford arsenal, gained NATO acceptance in Dec. 1953. Formal action to standardize the new ammunition for all NATO countries came in 1954. In line nith the policy of using the metric system, the new round was officially designated Cartridge, NATO, Calibre 7 62-mm. Its length. 2 84 in., nas $\frac{1}{2}$ in. shorter than the existing U S. M2 cartridge, and its weight was about 10% less. The saving in length and weight resulted from the use of improved propellants, such as ball powder, that required less space The 165-gr bullet of the new cartridge was capable of inflicting a fatal wound on personnel protected by standard steel helmets and body armour at a distance of approximately 1.000 yd. It was standardized for both rifles and machine guns. Many older weapons nere converted to take the new round.

2. FN Rifle. — The British government meanwhile brought forth a rifle, designated EM2, of unusual design and appearance, with pistol grip placed ahead of the magazine. It had a straight stock, weighed about eight pounds and nas chambered to fire the .280 cartridge. The Belgian firm Fabrique Nationale d'Armes de Guerre entered the competition with another rifle, popularly known as the FN and officially designated the T48 in U S tests. It also was designed to fire the .280 cartridge. The ordnance department of the U S. army carried on extensive development and test work at Springfield armoury nith designs based generally on modifications of the Garand rifle to provide both automatic and semiautomatic fire. After field tests and prolonged discussion, reaching up to the level of the British prime minister and U.S. president in 1952, the British government in 1954 adopted the FN rifle, which meanwhile had been altered to fire the 7.62-mm. cartridge and been designed in light barrel and heavy barrel models. Belgium, Canada and Australia also adopted the FN rifle in 1954.

The FN was a gas-operated weapon with selector switch for either semiautomatic or fully automatic fire. It weighed about $8\frac{3}{4}$ lb., had a 20-round magazine and extended to 44.4 in over-all length. including flash suppressor. In appearance the FN was markedly different from weapons of the Garand type, for it had a separate pistol grip behind the trigger guard and a carrying handle that could be swung up above the barrel. Because its butt could be swung downward on a hinge, thus permitting access to the receiver mechanism the FN mas easy to field strip and clean.

3. M14 and **M15** Rifles. — In 1957 the U S army announced that it had adopted a new semiautomatic rifle designated the M14, known during its test period as the T44. A gas-operated weapon, the M14 was similar in design to the Garand, or M1, which it was eventually to replace. Its weight was 8.7 lb., approximately 1 lb. less than the Garand. Like the Garand, it was developed at Springfield armoury. It fired the standard 7.62-mm. NATO cartridge. had a magazine capacity of 20 rounds and could be fitted with a selector switch to permit semiautomatic or fully automatic fire. A notable feature of both the U.S. rifle and the FN was a slotted flash suppressor at the muzzle. The new U.S. rifle, like the FN, was manufactured also in a heavy-barrel version (M15) that weighed approximately 13¾ lb. and was better adapted for fully automatic fire. This heavy-barrel version mas equipped with a bipod support for the muzzle.

Combined with the M60 ground machine gun, the new rifle formed a complete family of small arms for the U.S. army, all firing the same ammunition. The M14 rifle was designed to replace the Garand rifle. the carbine and the M3 submachine gun, except as the latter mas used on vehicles. The heavy-barrel M15 was to replace the Browning automatic rifle (BAR) as the automatic weapon of the infantry squad. The 23-lb. air-cooled light machine gun was to replace three existing models of calibre-.30 ground machine guns. The new rifle and machine gun would thus reduce the number of weapons in the U.S. army's small-arms system from seven to three, greatly simplifying logistical support and shortening the time needed for troop training.

4. Soviet Rifles.—The Soviet Union also adopted a new family of infantry weapons during the 1950s, including a rifle, submachine gun (see below) and light machine gun. All fired a standard short 7.62-mm. cartridge. The Soviet rifle, described as a semiautomatic carbine, was a gas-operated weapon with ten-round magazine and a permanently attached folding bayonet. It weighed about 8½ lb. and had a stock made of laminated wood. The Soviet light machine gun was designed to provide fully automatic fire for the rifle squad. It weighed about 14½ lb. and was fed by a drum-type magazine.

D. Automatic Rifles

Automatic rifles, sometimes classed as light machine guns, represent attempts to combine the burst fire of the machine gun with the mobile flexibility of the rifle. Their combat employment reached its peak in World War II, though several models saw service in World War I. The typical automatic rifle was a shoulder-fired weapon weighing between 20 and 30 lb. and equipped with a bipod to support the muzzle when firing from a prone position. One of the earliest weapons of this type was the 28-lb. gun developed by the U.S. army officer Isaac N. Lewis. The British army adopted the Lewis gun as a platoon weapon just before the outbreak of World War I, and it proved to be a major factor in British infantry firepower during 1914–18. It was later adopted by the U.S. navy but not by the U.S. army.

The most famous U.S. army weapon of this type, the calibre-.30 Browning automatic rifle (BAR), appeared too late to see service in World War I, but it served well for the next 40 years as the basic automatic weapon of the rifle squad. It was a shoulder-fired, gas-operated rifle weighing about 20 lb. complete with bipod support. A comparable British weapon that saw extensive service in World War II was the 22–26-1b. Bren machine gun, a weapon that by U.S. standards would be classed as an automatic rifle. The Bren took its name from Brno, Czech., where it was originally manufactured, and Enfield, Eng., where it was further developed. It was basically a calibre-.303 weapon but was produced also in 7.92-mm. size. A selector switch permitted either semiautomatic or fully automatic fire.

The German army used the MG34, developed secretly in 1934 in violation of the Versailles treaty, and the MG42, which had the extremely high cyclic rate of 1,500 shots per minute. For paratroops the Germans in 1944 adopted a special gas-operated 7.92-mm. rifle named *Fallschirmjägergewehr* 42 (FG42). It had a selector switch that permitted either semiautomatic or fully automatic fire. With sling, bayonet and bipod it weighed about 10½ lb. A 13-lb. light machine gun developed in 1940–41 by Melvin M. Johnson saw some service with U.S troops, the Dutch and other Allied nations in World War II.

E. Submachine Guns (Machine Carbines)

Since their introduction by the Germans and Italians in World War I, these weapons have been known variously as machine carbines in Britain, machine pistols in Germany and submachine guns in the United States. They are small, light weapons standing between the pistol and the rifle. They are far simpler in design than machine guns but they offer rapid-firing action. either semiautomatic or fully automatic. In spite of their limited range and poor accuracy they have proved to be useful for paratroops, commandos, tank crews and others who require a light gun able to deliver a high volume of fire at close quarters. Submachine guns normally fire pistol-type ammunition—calibre .45 in the United States and 9 mm. in western Europe—at rates ranging from 450 to 900 rounds per minute. Nearly all submachine guns have short barrels and heavy bolts and operate on the plain blowback principle. (See Machine Gun.)

Among the earliest weapons of this type to see military service were the Bergmann Muskete, the Villar-Perosa gun and the Beretta machine carbine. In the United States the most famous submachine gun was that patented in 1920 by a retired army officer, John T. Thompson. Popularly known as the Tommy gun, it gained notoriety as the weapon of U.S. gangsters during the prohibition era. The U.S. army adopted it in 1928, and the British army also used it. The Thompson submachine gun weighed about ten pounds and fired calibre-.45 ammunition from a circular drum holding 50 rounds or a box magazine holding 20 rounds.

During World War II and the Korean war, all major armies employed submachine guns in considerable numbers. They all developed weapons of simple design intended for cheap mass production and weighing between seven and ten pounds. Best known among them were the British Sten, Australian Austen and Owen, Finnish Suomi and German Schmeisser (MP38 and MP40). The latter, with folding stock, weighed about nine pounds, fired 9-mm. ammunition and was carried by paratroops and motorcycle units of the German army in its 1940 blitzkrieg. Later types firing 7.92-mm. ammunition were known as MP43, MP44 and *Sturmgewehr* 44. Following the German example, the U.S. army first simplified the Thompson gun and then turned in 1942 to a new all-metal submachine gun weighing about nine pounds and firing calibre-.45 pistol ammunition from a vertical magazine under the bolt. Officially designated the M3, it soon took the nickname "grease gun" because of its resemblance to the tool used to grease automobiles. The Soviet army also replaced its 1940 model (calibre 7.62 mm.) early in the war to speed production. First came the M41 PPSh, fed by a 71-round drum, and then the PPS-43 with folding metal stock and curved 35-round box magazine. The M41 gun was extensively used by the North Koreans during the Korean war. A new calibre-7.62 mm. Soviet submachine gun appeared in the 1950s. It weighed about 9½ lb. and was fed by a 30-round curved magazine. It was produced in two models, one with a conventional wooden stock and the other with a folding metal stock.

F. Antitank Weapons

To meet the need for a powerful infantry weapon to attack armoured vehicles, the British army adopted the Boys antitank rifle. It mas much like an ordinary bolt-action magazine rifle but fired a heavy, calibre-.55 armour-piercing bullet at high velocity. A little over five feet in length, the rifle weighed 36 lb. and could penetrate 24-mm. armour at 100 yd.

The most revolutionary light antitank weapon that appeared in World War II was the shoulder-fired U.S rocket launcher familiarly known as the bazooka. It was one of the simplest weapons employed during the war, and one of the most effective. The bazooka was an outgrowth of efforts to fire a powerful antitank grenade from a rifle and thus give the infantryman a means of defense against tanks. As the open-end rocket launcher had no recoil. it could fire a heavier round than could a conventional rifle. The bazooka gained its remarkable armour-piercing capability from the use of ammunition designed on, the shaped-charge principle. Its chief limitations were its short range, lack of accuracy and backblast. Though its bore diameter of 2.36 in. far exceeded the normal upper limit of calibre .60, the bazooka was usually classed as a small arm, or, more properly, an infantry weapon. The same was true of the 3.5-in. bazooka that saw service in the Korean war (see BAZOOKA).

G. Recoilless Rifles

Another new type of infantry weapon, the recoilless rifle. made its appearance in combat toward the end of World War II and saw much service in the Korean war. It had some of the characteristics of an artillery piece but, because of its light weight, was often classed as a small arm. Ordnance designers had long dreamed of creating a powerful meapon that would have no recoil and would therefore need no heavy recoil-absorbing mechanism. The dream was realized by designing a gun that permitted some of the propellent gases to escape through exhaust ports in the breech, thus giving the weapon a forward thrust equal to the normal recoil. The 57-mm. recoilless rifle developed for the US. army weighed less than 50 lb. and could be fired by one man from the shoulder (though not in the usual rifle firing position) or from a bipod or tripod mount. A larger 75-mm. recoilless rifle also saw some service with the U.S. army in World War II; after the war, 105-mm. and 106-mm. models nere developed to be mounted on a jeep or fired from a ground support. In 1559 the US. army announced a new 90-mm. recoilless rifle said to be capable of knocking out the heaviest tanks. It was a 35-lb., four-foot-long meapon that fired a shaped-charge projectile to an effective range of 500 yd.

Recoilless weapons are characterized by their simplicity, lightness and vented breechblocks. They fire high-explosive and antitank ammunition of unique design. Their cartridge cases are perforated to permit a portion of the propellent gases to escape to the rear; their shells are pre-engraved (*i.e.,* with rotating bands notched to fit the rifling). Recoilless rifles have lower muzzle velocity and much shorter range than do guns or howitzers of the same calibre. One of the greatest drawbacks to their tactical use is the rearward blast that betrays their location and makes them unsuitable for use in confined spaces.

H. Ammunition Developments

Remarkable progress was made in the improvement of small-arms ammunition during the period 1880–1910 with still further development during the next half century. Smokeless ponder, improved brass cartridge cases, better bullet design jacketed bullets, and clips and chargers for loading magazines—these were among the most noteworthy developments of the pre-World War I era The earlier shift from bullets of spherical to cylindro-conoidal shape had stimulated a trend toward smallbore rifles. since an elongated bullet had less diameter than did a spherical bullet of the same weight.

1. Bullets.—After P. M. E. Vieille's discovery of so-called smokeless poader in the 1830s. this propellant came into general use, ending the long reign of black powder. It gave off less smoke than black powder but mas not completely smokeless. The high muzzle velocities (over 2,000 ft. per second) attained nith smokeless powder were too much for conventional soft lead bullets to withstand. Bullets tore loose from the rifling, failed to spin properly and emerged from the muzzle unbalanced and hopelessly inaccurate. The answer to this problem lay in the jacketed or metal-patched bullet—a lead core covered nith a thin shell of steel or cupronickel. Credit for making great improvements during the 1880s in the work of earlier pioneers in this field is usually given to Eduard Rubin, a Swiss army officer. For a time the French army adopted a different solution, using a solid bronze bullet in its 8-mm. round for the Lebel rifle. but virtually all other nations adopted jacketed bullets, or compound bullets as they were sometimes called.

Soon after the turn of the century another change in bullet design occurred when the pointed bullet, known as the spitzer type, gradually supplanted the round-nosed bullet that had been standard in all armies for many years. Another apparently trivial but actually important development came in the early 1900s nith the discovery that further streamlining of bullets, accomplished by giving them a slight taper or boat tail at the base, increased their range. An early example of this type appeared in World War I, the French 8-mm. boat-tailed round known as *Balle* D. Some nations followed the French example. but others kept flat-based bullets in service for many years. Meanwhile the substitution of gilding metal (copper and zinc) and allied compounds for steel and cupronickel in bullet jackets was found to lessen bore erosion and metal fouling Later, during World War II. when copper was scarce, the United States turned to the use of steel jackets coated nith a thin deposit of copper or gilding metal.

Most early 20th-century rifle cartridges produced chamber pressures betneen 35.000 and 50 000 Ib. per square inch and muzzle velocities betneen 2 000 and 2.800 ft. per second. They fired bullets that were a little more than one inch long and weighed between 135 and 244 gr. Their powder charges normally ranged between 30 and 50 gr. Cartridges varied in calibre from 6 mm. (.236 in.) in the U S. navy's Lee rifle to 8 mm. (.315 in.) in the French Lebel, and in over-all length from about 2.50 in. to 3.35 in. Fired from a firm support at a target 200 yd. distant, the best ammunition nould group ten shots within a circle about five inches in diameter. Using U.S. Springfield?, expert riflemen could consistently hit a 20-in bull's-eye at 600 yd.

2. Chargers **and** Clips.—The introduction of magazine rifles in all armies put an end to the older method of feeding from a tube in the butt or under the barrel, and the use of chargers or clips for loading became standard practice. These terms are often used loosely and interchangeably, but. for the sake of historical accuracy, a distinction is best observed. A clip was originally a light metal openwork box in which a small number of cartridges, usually between five and ten. were placed, one on top of the other, against a spring at the bottom. They all faced the same way and their bullet ends were exposed. The entire clip filled with cartridges was slipped into the magazine, the so-called *en* bloc system of loading. It remained there until all its cartridges were fired, then dropped out at the bottom or, on some models, popped out at the top. In contrast. a charger was merely a flat strip of metal nith its edges curled slightly to hook over the rims or extractor grooves of a row of cartridges, usually five. To load a rifle, the bolt was drawn back, the charger holding a row of cartridges was slipped into position above the receiver, and the cartridges were pushed down into the magazine against a spring-supported follower. The empty charger was then discarded. The Garand rifle was loaded with a double-row, eight-round clip; the Springfield and other Mauser-type rifles were loaded from five-round chargers.

3. Types of Cartridges— Three types of central-fire cartridges —rimmed, semirimmed and rimless—deserve some explanation. The first was the type developed on the pattern of the earlier rimfire case but operated on a differentprinciple. It was a central-fire case and its rim mas a flange at the base that could be gripped by the extractor hook to remove the spent case from the chamber after firing. The rimless type had no protruding flange but had instead an annular groove just forward of the base into which the extractor could fit; the groove thus served the same purpose as the rim. The semirimmed case was essentially rimless. but its base section had a somewhat greater diameter than the main body of the case, thus giving it some of the characteristics of both the rimmed and rimless types. The widely used Mauser family of rifles fired rimless cartridges, as did the U.S. Springfield. British, French and Russian rifles fired rimmed ammunition.

Another feature of most modern cartridge cases is their bottleneck shape. As bullets of smaller calibre came into use at the end of the 19th century, ordnance designers had to narrow the mouths of cartridge cases and fit the bullets into them like corks in bottles. Retaining the standard size for the main body of the cartridge case provided room for a large powder charge nithout resorting to use of a much longer and narrow case. Most 20th-century military rifle cases assumed the bottleneck shape, but that for the U.S. carbine did not, nor did ammunition for pistols and submachine guns.

Three years after adoption of the Springfield rifle the U.S. army standardized the calibre-.30 M1906 cartridge, familiarly known as the .30-'06. It had a rimless case and fired a 150-gr. flat-based bullet. After World War I this cartridge was replaced by a more powerful type, with a 172-gr. boat-tailed bullet, known as M1. It had an extreme range of 3.500 yd.. or nearly two miles. Its lead core was hardened with antimony and its jacket was of gilding metal rather than cupronickel. As noted above, the M1 cartridge was supplanted by a lighter (152-gr.) flat-based round, known as M2, in the late 1930s when the Garand semiautomatic rifle came into use. It remained the basic rifle round of the U.S. army until the 1950s when its replacement by the 7.62-mm. NATO cartridge began (*see* above).

During the second quarter of the 20th century another major advance in small-arms ammunition came with the introduction of noncorrosive primers. In the early 1920s manufacturers of sporting ammunition had brought forth cartridges containing no potassium chlorate, a substance that left a moisture-attracting residue in the bore and caused rusting if the weapon were not cleaned promptly after firing. U.S. military authorities were reluctant to accept new primer compositions without exhaustive testing, particularly in view of their problems with defective primers during World War I. The first large-scale production of noncorrosive military primers in the United States came during World War II when commercial firms manufacturing carbine ammunition employed their own primers with good success. Germany made extensive use of noncorrosive primers during World War II for 9-mm. and 7.92-mm. ammunition. In 1949 the U.S. army standardized a noncorrosive styphnate mixture for small-arms primers.

4. **Types** of Ammunition.— The most noteworthy trend in small-arms ammunition development in the 1910–60 period was the appearance of many different types of ammunition to serve special purposes. The impetus for this development came largely from the employment of machine guns for aircraft and antiaircraft fire. In addition to the familiar type known as ball ammunition there were added others known as armour-piercing. incendiary, tracer, armour-piercing-incendiary and special types for launching rifle grenades. Whatever the type. the term cartridge was used to designate the complete round, including cartridge case, propellant, primer and bullet.

Ball ammunition is most closely akin to the lead spheres of an earlier age and is chiefly an antipersonnel round. Its core is of lead alloy or common steel. Despite its name, the bullet fired by a round of ball rifle ammunition is not actually ball-shaped; it more nearly resembles a short cigar, with the front end pointed (but not sharply pointed) and the other end flat or slightly tapered. The bullet of the calibre-.45 ball cartridge for pistols, revolvers and submachine guns is more nearly ball-shaped, with rounded nose and flat base.

Armour-piercing (AP) cartridges assumed great importance during and after World War I as a means of attacking tanks, planes and other armoured vehicles. In the U.S. army there was a strong tendency during and after World War II to use AP ammunition for all purposes and do away with ball ammunition. The bullets of AP cartridges normally consist of a hardened steel core, gilding metal jacket and a small amount of lead to fill the space between the point of the core and the point of the jacket.

Tracer cartridges contain a chemical agent that emits light or smoke to enable the shooter to see where his shots are going. Such ammunition proved to be of special value in adjusting the aim of machine guns in aerial combat and, to a lesser extent, in setting fire to gasoline tanks of enemy planes.

Incendiary cartridges contain a chemical agent that ignites upon striking the target. They are highly effective against aircraft with light armour protection carrying heavy loads of fuel.

Grenade cartridges are designed to propel grenades (*q.v.*) from rifles and, in some cases, from carbines. They have no bullet but contain a powder charge that propels the grenade from a launcher fitted to the muzzle.

Efforts to improve rifle ammunition during the decades following World War I were directed toward reducing barrel erosion, eliminating muzzle flash and attaining improved ballistic performance. One of the most notable developments was a propellant known as ball powder that was widely used in British ammunition and in U.S. carbine ammunition during the 1940s and in many other types in later years. Brass remained the preferred metal for cartridge cases in spite of extensive experiments with steel, aluminum and plastics. Brass was strong, nonrusting and could easily be worked into the desired shape; it was also sufficiently elastic to expand slightly under the pressure of firing and then to contract for easy extraction.

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SMALLEY, GEORGE WASHBURN (1833–1916), U.S. journalist and war correspondent, was born at Franklin, Mass., on June 2, 1833. He was educated at Yale university. where he received a master of arts degree in 1853. and Harvard lam school. After practising law in Boston, he served as a correspondent for the *New York Tribune* from Nov. 1861 to Oct. 1862 in the Shenandoah Valley campaigns of the American Civil War and with the army of the Potomac. He is credited with assisting the Union forces by carrying orders in the field at the battle of Antietam (Sept, 17, 1862). Two days later his account of the battle appeared in the *New York Tribune;* it was the first newspaper story on Antietam and a notable achievement for the time.

In 1866 Smalley went to Europe to report the Seven Weeks' War between Prussia and Austria. He thereafter organized a *Tribune* European bureau in London and was head of European correspondence for the paper until 1895. During the period he won wide acclaim for his dispatches on the Franco-German War.

In 1895 Smalley returned to the United States, where for ten years he was U.S. correspondent for the *Times* (London). He later settled in London, and died on April 4, 1916. Smalley had married in Dec. 1862 the adopted daughter of the U.S. reformer Wendell Phillips, with whom Smalley was associated in Boston before he became a *Tribune* correspondent.

Smalley's books, largely collections of his letters to the *Tribune,* include *A Review of Mr. Bright's Speeches* (1868); *London Letters,* 2 vol. (1891); *Studies of Men* (1895); and *Anglo-American Memories* (first series, 1911; second series, 1912). He also wrote *The Life of Sir Sydney H. Waterlow, Bart.* (1909).

SMALL HOLDINGS. The term small holdings covers several categories of relatively small farm tracts. Throughout the world, the essential characteristics of small holdings include recognized rights to operate the land, a high ratio of labour to land with the labour furnished mainly by the operator and his family, and relatively low levels of farm production and income. In most parts of the world, the labour is mainly by hand with the assistance of one or two horses, oxen or cows and simple tools.

This article outlines the characteristics and traces the history of small holdings after the breakdown of feudalism and indicates their prevalence in the second half of the 20th century. Separate sections deal with farm ownership in the United States and discuss some of the economic aspects of small holdings. For additional information on the trend to larger holdings in the United States *see* FARM MANAGEMENT: *Production Resources. See* also AGRICULTURE; FARM TENANCY; LAND REFORMS; LAND TENURE: ECONOMIC AND AGRARIAN ASPECTS.

Included in the commonly accepted meaning are the subsistence tracts of the peasant farmer and garden tracts and part-time farms as well as small family farms. The mechanized family farm, of substantial size in commercial agricultural areas, usually is excluded. Certainly excluded are the plantation, the estate, the collective farm and the factory-in-the-field farm. Many ranches, even if family operated, would not commonly be thought of as small holdings, for the size is an important, though not by any means the only, determinant. The United Kingdom Small Holdings act of 1892 and the Small Holdings and Allotment act of 1926 provided examples of legal applications of the term. In other countries somewhat the same results were accomplished by legislation not so exactly named.

The bulk of the world's population lives on farms and perhaps three-fourths of the world's farmers live on small holdings. The farm population constitutes about 1,500,000,000 people or about 60% of the estimated total world population. Small holdings are most prevalent in Asia and other underdeveloped parts of the world, but are also numerous in other countries. Population pressure on the land is sufficient in much of the world to reduce the average size of farms well within the small-holding limits. In most countries small holdings also are used by labourers and other part-time farmers for housing, subsistence and incidental agricultural production.

History of **the** Small Holding.—In Denmark, England and other countries of western Europe. governmental interest in small holdings was aroused by the breakdown of feudalism. The object of governmental programs was to provide holdings for labourers and tenants who were being dispossessed. As early as 1682, 20 years before serfdom was abolished, it was decreed in Denmark that no farms that were large enough to support a family should be combined with other farms. This was an anticonsolidation rule aimed at landlords who had discovered that the prevailing three-field system was not very efficient and might be profitably replaced by improved rotation methods. thereby consolidating some of the peasant-cultivated land. But that would have meant less taxes and fewer soldiers for the crown—hence the rule that meant in practice that no tenant could be dispossessed. In the same country, as early as 1781–82, many of the agricultural labourers were by law given ownership of four to six acres of land to keep the individual available to work the lord's land. Comprehensive legislation after 1899 furthered the establishment of small holdings averaging five to seven acres, the government lending the prospective holder nine-tenths of the purchase price of land and buildings.

Later emphasis was on having a farm large enough to keep the farmer fully employed and provide a living for the family; hence 12½ ac. of land were set as a minimum goal for all farms. Still later government measures were directed at obtaining land for small holdings or to add to small holdings, as equitably as possible, from entailed estates and from the higher valued, more extensive holdings.

In England small independent holdings existed under the feudal system, their numbers being greater in some manors than in others. For centuries, through the modification and disappearance of the feudal system, the number of small holdings or family farms increased until they became the predominant form of land occupancy. This trend continued up to the last great enclosure movement beginning in the latter part of the 18th century.

The enclosure movement contributed greatly to a reduction in the number of small holdings and to an increase in the number of farm labourers.

The success of large numbers of small holdings was dependent on the common for pasture. When the common was enclosed an allotment was made to the commoner in proportion to his interest. These allotments were of little value to many small holders, however, because they were often far from the allottee's cottage and because he was obliged to fence them. Consequently many small holders sold their land to larger landowners and became labourers.

With the reaction to the materialism of the Industrial Revolution, the social and economic consequences of the decline of small holdings aroused the attention of the English government. The weight of arguments for small holdings resulted in reform legislation beginning with the Allotments acts of 1887 and 1890. The Small Holdings act of 1892 authorized county councils to create small holdings on a self-supporting basis where a need was proved to exist. Small holdings were legally defined in the Small Holdings act of 1892 as holdings of less than 50 ac. in extent or under £50 in annual rental value. In 1926 the limit of annual rental value was raised to £100. If an applicant could not purchase land he could obtain a holding on lease. The results of the act of 1892 were negligible largely because it was only permissive, and it was amended by the Small Holdings act of 1908, a much more comprehensive enactment, particularly in introducing the principle of central initiative and authority. This act instructed county councils to provide small holdings in response to the demand. In case the council failed to carry out its obligations the ministry of agriculture was given power to develop a plan. If a loss was actually incurred the ministry was authorized to bear one-half the loss.

Operations under the act of 1908 mere suspended during World War I. Legislation following World War I had the main objective of providing small holdings under particularly favourable terms for ex-servicemen.

The Small Holdings and Allotments act, 1926, renewed the powers of county councils to provide small holdings. In the event that holdings could not be provided without loss, the ministry of agriculture would contribute 75% of the estimated annual loss. Under this series of enactments a total of 28,700 small holdings were established from 467,000 ac. of land. Only a small part of this land was held by councils on lease.

In 1947 small-holding policy was made the subject of part iv of the 1947 Agricultural act. The objective emphasized in this act was the use of small holdings as a step in the agricultural "ladder" for farm families with little capital. Permitted sizes of holdings were increased to 75 ac. or £150 rental value. In 1958 a Small Farmers scheme was introduced providing grants to eligible small farmers for the purpose of carrying out approved plans for improving the farm business.

During the early 1900s small-holdings programs were established in many other countries, including Germany, Rumania, Hungary and parts of Russia immediately following the Revolution. The collectivization of agriculture greatly reduced numbers of small holdings in many Communist countries. However, in 1954 Yugoslavia instituted a policy permitting decollectivization of agriculture. Beginning about 1930, attention in France, Switzerland, Germany and other countries was focused on the consolidation of fragmented holdings and enlargement of excessively small holdings. After World War II land reforms favourable to small holdings were undertaken in Japan, Italy, Egypt, Mexico and other countries.

Prevalence of Small Holdings.—In England and Wales in the 1950s, 22% of the holdings of over 1 ac. were from 1 to 5 ac., 24% were from 5 to 20 ac. and only 36% of the holdings were of 50 ac. or more. The number of units under 50 ac. provides a rough measure of the importance of small holdings in Great Britain. They vary considerably in size, in returns and in types of products grown. Many of the holdings under five acres are cottage gardens or allotments. Some occupy small acreages with specialization in intensive enterprises such as growing vegetables or producing eggs. Others are larger and more diversified. Probably most of the holdings from 20 to 50 ac. are commercial units producing mainly for sale. In Ireland, long after the period commonly considered as the reform period, very small holdings continued to increase both in number and in per cent of total, though average size remained fairly constant. Three-fourths of the holdings in Ireland are under 50 ac. In Germany and other countries of western Europe considerable permanent hired labour is used on farms of 20 ha. (hectare = 2.47 ac.) and over.

Data from selected countries show that the size distribution of holdings is highly variable from country to country, but small holdings greatly predominate. Moreover, allotments made as a part of land reform, as in Italy, are small—only one to five hectares per holder. The numbers of holdings reporting less than one hectare vary widely, largely because of the varying farm definitions used in various countries.

In eastern Europe small units were prevalent prior to collectivization. In Bulgaria in 1934 only 1% of the holdings were larger than 49 ac. Less than 3% of those of Yugoslavia in 1931 were more than 49 ac. Even in Hungary, with its large pre-World War II estates, 70% of all holdings in 193j were in tracts of 7 ac. or less. It may be significant that in some of these countries members of the new state co-operative farms were permitted to retain small plots—of 0.5 to 1.2 ac. in Bulgaria and Rumania, up to 2.j ac. in Yugoslavia and about 2 ac. in Hungary.

In Egypt, where 95% of those who own land have j ac. or less, expropriated land was to be distributed in units varying in size, according to quality, from a minimum of 2 feddans to a maximum of j feddans (about 2 to 5 ac.). In Iran units of 14.5 to 21 ac. each were distributed. In Iraq settlement after 1946 appeared to recognize that tracts could be too small; the Dujail project involved allocation of $62\frac{1}{2}$ ac. per family from a tract of 75,000 ac. of newly irrigated, formerly desert land.

In the orient, holdings are extremely small and tend toward further reduction under the pressure of population. More than 90% of Japanese farmers work less than 2.0 ha. After World War II Japan instituted a comprehensive system of land reform. Under these laws strict upper limits were set on farm size. Numbers of small farms increased substantially but net productivity of labour apparently rose with increased savings and capital formulation. Very small farms are also characteristic of India and China. More than half the farms in India are under 2.0 ha. In the late 1950s considerable emphasis was placed on the formation of co-operative and collective farms in China.

In Africa small native holdings greatly predominate even in areas such as Nigeria, producing export crops of cocoa and peanuts for the world market. Ninety per cent of the non-European farms in Southern Rhodesia also are in holdings of under 14 ac. Cultivation in these countries is by plow or hand hoe.

There is appreciable variation in the size of holdings in Central and South America. Chile, with 2.5 ac. of cropland per capita, has about 20 cultivated acres per person engaged in agriculture. On the other hand, in Guatemala more than one-fifth of all agricultural holdings are leas than 0.7 ha. and more than 75% are less than 3.5 ha. Over half of the holdings in Puerto Rico are under 3.5 ha. in size. Even in Uruguay, which is still accepting settlers, 42% of the holdings are less than 20 ha. in size.

United States.—In the United States, even during the period of abundant land, relatively small holdings were generally favoured. In 1820 the minimum unit of sale of government land was lowered to 80 ac. Limitation of acreage of public land that could be acquired by one individual was early recognized. The Pre-emption act of 1841, as amended, provided that a settler could legally enter upon public land and establish a claim for not more than 160 ac.; he could not make more than one such entry, and such a claim could not be made by anyone owning as much as 320 ac. The Homestead act of 1862, under which something like 285,000,000 ac. were patented, provided that a qualified individual might acquire title to land, not to exceed 160 ac., by five years of residence thereon with improvements, or by six months of residence plus payment of $1.25 per acre.

*U.S. Farms by Categories, 1929–54**
(in 000)

Class of farm	value of sales (1954 prices)	1929	1939	1949	1954
Part-time and residential.	Cnder $2,500		1,181	1,670	1,507
Small-scale	Under $2,500				1,174
Medium and large . .	2 0 0 and over				2,101
All farms	—	6,203	5,950	5,382	4,782

*Excludes farms listed in 1940 and 1930 censuses that could not meet minimum criteria used in censuses of 1950 and 1954 Adapted from J. V. McElveen, "Family Farms in a Changing Economy," A.I.B. 171, U.S. Dept. of Agriculture (March 1957).

In 1954 the United States census of agriculture classified 4,782,000 holdings as farms. A postenumerative survey indicated that about 419,000 additional places that would have qualified mere missed by census enumerators; most of the latter were small holdings. About 35% of the 4,782,000 farms enumerated operated less than 50 ac., and more than 50% were under 100 ac.

Because of the wide variation in productivity, acreage is not a very satisfactory measure of size of farms in the United States. In terms of value of products for sale, farms in the United States can be separated into three major groups, two with value of sales under $2,500 and one with value of sales $2,500 and over. (See table.) Medium to large farms accounted for about 44% of the farms in the United States in 1954. Their numbers increased with the growing commercialization of agriculture. Most of them are mechanized family farms (see also FARM MANAGEMENT). Less than 2% of the farms in the United States would be classified as large-scale units primarily dependent on hired labour. Nearly one-third of the farms are part-time and residential units, most of them classed as small holdings, with farm production for sale of less than $2,500. Over four-fifths of these had sales of less than $1,200 in 1954. Nearly one-fourth of the farms in the United States can be classified as small-scale units primarily dependent on farming for a living. While the number of small-scale farms was decreasing, they remained a substantial segment of U.S. agriculture, characterized by low levels of mechanization, relatively small acreages and underemployment of operator and family labour. A substantial number of the operators were 55 years of age or over.

Beginning in the 1930s the problem of the small farmer was approached in a modest way by the Farmers Home administration of the U.S. department of agriculture with a program of supervised credit and individual guidance for the development and enlargement of land resources and working capital. In 1955 a rural development program was initiated by the U.S. department of agriculture in several counties in areas where farm incomes were low. Approximately 100 counties came to participate in this program.

Some Economic Aspects of Small Holdings.—Developments in machinery. equipment and modem aids and techniques focused attention on the fragmentation of holdings in some areas and on the uneconomic sizes of fields and lack of the opportunity to make efficient use of modern agricultural machinery.

This situation suggested consolidation of small and scattered holdings and the injection of capital to mechanize the consolidated units to give at least part of the reorganized population more income per hour worked and turn part of the population to other work. The difficulty of attaining efficient production with a small land unit (except for a few types of intensive specialization) led to attempts to overturn the small-holding pattern in some countries.

Another aspect of the problem is what is called the underemployment of farm labour. It has been argued that many small holders value leisure and the satisfactions of self-employment more highly than the advantages they might gain from fuller or more productive employment. Furthermore, a high percentage of families on small holdings have some off-the-farm employment. In these cases the small tract can serve to provide a form of security plus some food and space for family living. But for many families more productive use of labour involves farm enlargement, occupational adjustments and the development of nearby non-farm industries.

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SMALL ISLES, a parish of islands of the Inner Hebrides, Inverness-shire, Scot. Pop. (1951) 215. It consists of the islands of Canna, Sanday, Rum, Eigg and Muck, lying in the order named, like a crescent with a trend from northwest to southeast, Canna being the most northerly and Muck the most southerly. They are separated from Skye by Cuillin sound and from the mainland by the Sound of Ardnamurchan. The surface is moorland, pasture and mountain (exceeding 2,500 ft. on Rum). The islands are rich in seafowl and Rum contains red deer and wildcats. The fisheries include cod, ling and herring. Steamers call at Eigg, Rum and Canna.

Antiquarian remains at Canna include a weather-worn sculptured stone cross and the ruins of a chapel of St. Columba. On the northeast coast of Eigg is a cave with a narrow mouth, opening into a hollow a j5 ft. long. In it Macleod of Skye, toward the end of the 16th century ordered 200 Macdonalds to be suffocated: their bones were found long afterward.

SMALLPOX or **VARIOLA** is an acute infectious disease characterized by fever and, beginning about two days later, an eruption which after passing through the stages of papule, vesicle and pustule, dries up, leaving more or less distinct scars.

The characteristic eruption may be so profuse as to be confluent, especially on the face, or so scanty that the lesions are missed altogether. The lesions are commonly more deeply seated in the skin than are the lesions of chicken pox (varicella) and the scars are therefore more permanent than those of chicken pox, but mild forms of smallpox may also have comparatively superficial pocks, with correspondingly less tendency toward pustulation and less scarring.

These modifications, both toward fewer lesions and toward their being more superficial, may occur either naturally or as the result of a vaccination not recent enough to give complete protection. Nearly complete vaccinal protection commonly gives few lesions, but even if the vaccination has been a score or more years before, smaller and more superficial lesions are the rule where an unvaccinated person would have a severe attack. Such superficial lesions are also characteristic of the naturally occurring mild strains of the disease, called "variola minor." or in some countries '(alastrim" or "amaas." Even with strains of full severity. called "variola major." there may be much variation as regards severity from individual to individual among the unprotected.

Besides the characteristic focal eruptions (papule to vesicle to pustule to scab to scar) there may sometimes be seen a toxic eruption during the initial fever. These toxic rashes may be diffuse blushes on trunk or limbs somewhat suggestive of scarlet fever or measles; they may on the other hand be deeper red, with small haemorrhages like flea bites or larger blotches in the skin. They are unusual enough to be of not much importance except for the fact that the deeper red eruptions have often disguised the diagnosis so that smallpox is not thought of until the contagion has spread over a hospital or farther. Cases with such a haemorrhagic eruption are likely to be the most severe, even fatal before the characteristic focal eruption appears, and can carry an intense contagion.

Diagnosis. — Prompt diagnosis is of the highest importance in combating smallpox. one of the world's most dreaded plagues. Though general vaccination helps, there is no community anywhere so efficiently vaccinated as to prevent smallpox from getting a temporary toe hold on occasion. The mechanical refrigerator was largely responsible for the scarcity of the disease in the United States: vaccine is kept very cold constantly so that a screen of recently and successfully vaccinated individuals can be thrown promptly around any cases which might occur. Better refrigeration, quicker transportation, safer and more regularly potent vaccine and more enlightened sanitary practices also caused marked reductions elsewhere in the world. Smallpox rates and infant mortality rates are two of the best indexes of living standards. The scarcity of the disease, however, brought about a considerable dulling of a former accustomed keenness in diagnosis.

The course of a typical case is the surest criterion for diagnosis: fever beginning 7–21 days after effective exposure to a preceding case. then papules (pimples) appearing after 1–5 days of fever and becoming vesicles (blisters) in 1–4 days, pustules in another 1–4 days and crusting over (scabbing) in 2–6 days. The scabs fall off in 10–40 days after the beginning of the eruption, leaving pink scars which become white after months or years. Unfortunately this is too slow a method for efficient diagnosis. Complete isolation of the patient. search for persons who may have been in contact with him and vaccination of those who might be exposed should be begun nithin hours, not days. after the first trace of a case. For this reason the distribution of the eruption, which can be used at any stage after it appears, is the best guide.

The eruption of smallpox, nhether scanty or profuse, has more lesions on the parts of the body exposed to irritation than elsewhere, more on the face than on the abdomen dnd chest, more on the forearms and wrists than on the upper arms, more on the arms than on the trunk. more on back of the arms and hands than on the front. more on the shoulders than across the loins, more on the chest than on the abdomen, more on the limbs than on the trunk and more on the back than on 'the abdomen. Protected places such as the depression of the eyelid or back of the ear (unless irritated by wearing glasses) are relatively spared.

Cause. — The cause of smallpox is a virus whose particles can be visualized by the electron microscope and can pass through a filter which holds back most bacteria but are larger than the particles of such a virus as that which causes poliomyelitis. Elementary particles are also visible, after staining, in an oil-immersion microscope.

This virus can be cultivated in a developing chicken embryo in a fertilized egg, as well as on some other living animal tissues with a higher percentage of failures. Cultural, microscopic and serological identification of the virus may be a help in diagnosis but somewhat slow for effective handling of a case.

Method of Spread. — Each case of smallpox arises from contact, direct or indirect, with a preceding case of the disease. There are no natural animal carriers or natural propagation of the virus outside the human body, and the virus ordinarily does not live very long outside the body nor is it ordinarily carried more than a few feet through the air. Nevertheless all articles which may have been contaminated from a smallpox patient should be thoroughly disinfected by heat before they come in contact with unprotected persons. Smallpox is one of the few diseases in which terminal disinfection (as by formaldehyde) of living quarters is specified after removal or death of the patient. The virus may be carried passively by a third person, himself immune, from a sick person or from a corpse. The disease is presumably contracted by inhalation of particles bearing the virus, therefore thorough masking as well as the wearing of gowns should be carried out for necessary contact with the sick; isolation must be much more rigid than with the other contagious diseases.

Although smallpox is counted among the most contagious of diseases, its failure to spread to nonimmunes in spite of ample opportunity is no adequate evidence against diagnosis of the disease. Repeatedly persons with full-blown smallpox of virulent strains, which are usually more contagious than the milder strains, have come into contact with many nonimmunes without thus spreading the disease.

It can be similarly seen that failure to take the disease after exposure is no proof that one's vaccinal immunity is perfect. Though ordinarily once in five or ten years is often enough to be vaccinated, for medical and nursing personnel subject to exposure at any time. or for those living in contact with native families of a smallpox-infested region, vaccination with fully potent vaccine every one or two years should be the rule. There is always the chance that the tube of vaccine used was not of full potency, unless preceding immunity had decreased enough to permit a reaction approaching that of a first vaccination. This points to the wisdom of not counting on vaccination scars or statements of the patient's having been vaccinated to dismiss the possibility of smallpox in diagnosis.

History and Prevalence. — The Persian physician Rhazes about A.D. 900 wrote the first known account separating smallpox from measles, although Eusebius mentioned a Syrian epidemic in A.D. 302 and the term "variola" was used by Bishop Marius of the disease in France and Italy in 570. About 1200, Gilbert of England first referred to smallpox as a contagious disease but even this was continually contradicted — even by Thomas Sydenham (1675) who described the disease better than anyone before him.

Smallpox was pandemic in Europe in 1614, epidemic in England during 1666–75, and there mere scattered outbreaks in New England all through the 17th century. On account of their habits during sickness. the American Indians were severely stricken, and students have asssigned smallpox as one of the chief reasons for the conquest of the land by the white men. Of course there were many mistakes in diagnosis, and smallpox was confused with the great pox (syphilis). William Heberden in 1767 first clearly distinguished chicken pox from smallpox, but even in the 19th century the great skin physician. Ferdinand von Hebra of Vienna. Aus., denied the difference. It nould be difficult to assign to any one man credit for showing that variola virus can, by repeated transfer to the skin of animals, be attenuated and become vaccinia virus (cowpox); the cumulative evidence is convincing. One corollary to this is the danger of making vaccine virus too penetrating if the harvesting from the calf's skin is too deep or perhaps if the various layers of the chicken embryo are used as a source.

After the turn of the 20th century the predominance in some localities of very mild types gave rise to the thought that the mild type was a disease different from smallpox, but tests for immunity indicated that these are merely different forms of the same disease, each form generally breeding true to its type.

Statistics as to prevalence of smallpox must be accepted with some caution. Confusion with severe chicken pox and vice versa is easy. and reporting and diagnosis are likely to be imperfect in the very regions where vaccination is imperfect; in some places in the United States mild forms seem to have slumbered unrecognized for months or years. Eastern Asia has been a breeding ground for outbreaks of the severe form of the disease in Europe and the United States, although some outbreaks have arisen from travellers from Mexico.

Mild smallpox has been well established in the central and western United States but the reduction was so phenomenal that the elimination of the disease in the U.S., as far as indigenous cases are concerned, became a distinct possibility. Rapid air travel however, brought a need for fresh vaccination of all international travellers.

In 1921 there were 89,357 cases and 481 deaths from smallpox reported in the Cnited States; in 1924, 45,25j cases and 814 deaths; in 1939, 9.877 cases and 41 deaths; in 1945, 346 cases and 12 deaths; in 1950 only 42 cases. In 1949 there were reported in French West Africa 1.889 cases and 181 deaths; in the Belgian Congo 2,261 cases and 9 deaths; in Egypt 3 cases and 1 death (11,194 cases and 1,016 deaths in 1944); in Nigeria 14,790 cases and 2,224 deaths; in the Union of South Africa 1.461 cases and 115 deaths; in Argentina 500 cases and 3 deaths; in Brazil 598 cases and 6 deaths; in Canada. Australia and New Zealand none; in Mexico 1,030 cases and 293 deaths; in Peru 5,907 cases; in Burma 3.456 cases and 1,051 deaths; in China 237 cases and 80 deaths (reported. but 20,562 cases and 2,593 deaths reported in 1946, 20 574 cases in South Korea in 1946); in Formosa 188 cases and 20 deaths (5,250 and 1,718 in 1947); in India 74.178 cases and 17,740 deaths (304.062 cases and 216,538 deaths in 1944); in Indonesia 13 442 cases and 1,913 deaths; in Indochina 2,570 cases and 932 deaths; in Iraq 702 cases and 102 deaths; in Japan 124 cases and 13 deaths; in Pakistan 4.806 cases and 1,471 deaths; in Turkey 73 cases and 14 deaths. Two cases each were reported from France and Italy (2.831 in Italy in 1945), 11 from Portugal and 17 from England and Wales.

Treatment. — At mid-century, no specific treatment was yet known for the disease. Secondary infection during the pustular stage may be diminished by the sulfonamides or antibiotics which thus may make the disease milder. Prevention is by means of isolation and vaccination. Of all widely prevalent diseases, this is the most completely preventable by public health measures.

BIBLIOGRAPHY. — The literature on smallpox is enormous. In sorting and evaluating it, statistical soundness is not so important as thorough, accurate observation, which is rare. For this reason, some of the older literature, when opportunities for observation were more frequent, is more valuable than some having the advantage of more modern methods. The 295-page article on "Variola" by H. Immermann of Basle, Switz., in *Nothnagel's Specielle Pathologic und Therapie*, vol. 4, no. 4 (Vienna, 1896) gives the older views well. Diagnosis was put on the firmest basis so far achieved by the publication of *The Diagnosis oj Smallpox by T. F.* Ricketts and J. B. Byles (London, 1908): Ricketts, as medical superintendent of the London Smallpox Hospital and Ambulance Service in the epidemics of 1893 and 1902, had probably the richest experience in smallpox which had fallen to the lot of one man. *Blattern und Schutzpockenimpfung* by the Reich Board of Health (Berlin, 1925) gives the German point of view; *Epidemiology of Smallpox,* De Lamar Lecture, by J. P. Leake (1929), a U.S. view; and "Smallpox." by C. O. Stallybrass, *Public Health,* 60:77-79 (Jan. 1947), a British view. *Questions and Answers on Smallpox and Vaccination by J.* P. Leake was first printed in the Public *Health Reports* of the U.S. Public Health Service (Jan. 28, 1927): the last revision was that of 1946 issued as reprint no. 1137 from the Government Printing Office, Washington, D.C. Current data on the prevalence of smallpox are found in the monthly *Epidemiological and Vital Statistics Reports* of the World Health Organization, Geneva, Switz. (J. P. L.)

SMALRIDGE, GEORGE (1663–1719), English bishop, son of Thomas Smalridge, was born at Lichfield where he received his early education. After attending Westminster school, he entered Christ Church, Oxford, in 1682.

His political opinions were largely modelled on those of his friend Francis Atterbury, with whom he was associated at Oxford and elsewhere.

After being a tutor at Christ Church, he was minister of two chapels in London, and for six or seven years he acted as deputy for William Jane, the regius professor of divinity at Oxford; his Jacobite opinions, however. prevented him from securing this position when, upon Jane's death, it fell vacant in 1707. In 1711 he mas made dean of Carlisle and canon of Christ Church, and in 1713 he succeeded Atterbury as bishop of Bristol, but retained his deanery.

In 171j Smalridge, along with his friend Atterbury, refused to sign the declaration against the pretender, James Edward, defending his action in his *Reasons For Not Signing the Declaration.* His political principles had. apparently. undergone no decisive change since 1701 when he had announced in a sermon that "whosoever did not abhor the execution of Charles I mas so ill a man that no good man could converse with him."

In other ways also he showed animus against the house of Hanover. but his only punishment was his removal from the post of lord almoner to the king.

The bishop was esteemed by Jonathan Swift, Sir Richard Steele, William Whiston and other famous men of his day, while Samuel Johnson declared his sermons to be of the highest class.

Smalridge died on Sept. 27, 1719, and was buried in Christ Church cathedral. In 1726 his widow Mary collected and published his *Sixty Sermons, Preached on Several Occasions, Published From the Originals;* other editions appeared in 1827, 1832, 1853 and 1862. Selections from correspondence between Smalridge and Arthur Charlett, Walter Gough and several other figures of that time may be found in Nichol's *Literary Illustrations.* In Christ Church hall, Oxford, there was placed a portrait of Smalridge, painted by Sir Godfrey Kneller. Smalridge left two daughters and one son, Philip, who, like his father, was educated at Westminster and then at Christ Church.

SMALTITE, a mineral with the general composition cobalt nickel arsenide, $(Co,Ni)As_3$. In smaltite, cobalt exceeds nickel; while in chloanthite, nickel predominates. Both smaltite and chloanthite are deficient in arsenic, with the actual composition about $(Co,Ni)As_{2-2.5}$. Crystals are usually zoned. with the outer portion richer in arsenic. Considerable iron may be present.

Cubic and octahedral crystals are rare; smaltite is usually found as compact or granular masses. The colour is tin white to silver gray with a bright metallic lustre. The hardness is j.j to 6 and the specific gravity 6.5. It occurs with other cobalt and nickel minerals, associated with ores of silver and copper at Cobalt, Ont. (L. S. RL.)

SMART, CHRISTOPHER (1722–1771), English poet, mas born at Shipbourne, Kent, on April 11, 1722. His father was steward for the Kentish estates of William, Viscount Vane, younger son of Lord Barnard of Raby castle, Durham. Christopher Smart went to school at Maidstone and at the Durham grammar school of Durham. He spent part of his vacations at Raby castle, and his gifts as a poet gained him the patronage of the Vane family. Henrietta, duchess of Cleveland, allowed him a pension of £40 which was paid until her death in 1742. At Cambridge. where he was entered at Pembroke college in 1739, he spent much of his time in taverns and got badly into debt, but in spite of his irregularities he became fellow of his college, praelector in philosophy and keeper of the common chest in 1745. In Nov. 1747 he was compelled to remain in his rooms for fear of creditors. About 1752 he left Cambridge for London, though he kept his name on the college books. He wrote in London under the pseudonyms of "Mary Midnight" rind "Pentweazle."

Smart had a hand in many journalistic undertakings, and he completed a prose translation of Horace. Some criticisms made by "Sir" John Hill on his *Poems on Several Occasions* (1752) provoked his satire of the *Hilliad* (1753), noteworthy as providing the model for the *Rolliad.*

In 1751 Smart had shown symptoms of mental aberration. which developed into religious mania. and between 1; j6 and 1758 he was in an asylum. where he was visited by Samuel Johnson. who thought him sane. The poem written by him in the asylum. "A Song to David." is his only famous work, and has been compared by some critics to the work of Blake. After his release Smart produced other religious poems, but none of them shows the same inspiration. For some time before his death. which took place on May 21, 1771, he lived in the rules of King's Bench. and was supported by small subscriptions raised by Burney and other friends.

From the *Poems of the Late Christopher Smart* (1791) "A Song to David" (pr. 1763) was excluded. It was reprinted in 1819, and in an abridged form is included in T. H. Ward's *English Poets,* vol. iii; it was reprinted in 1895, and in 1901 with an introduction by R. A. Streatfeild.

SMART, SIR GEORGE THOMAS (1776–1867), English musician. was born in London. his father being a music seller. He was a choirboy at the Chapel Royal, and became violinist. organist, teacher of singing and conductor. From 1811 onward Sir George Smart was one of the chief musical leaders and organizers in England. conducting at the Philharmonic. Covent Garden. the provincial festivals. etc.. and in 1838 he was appointed composer to the Chapel Royal. He mas a master of the Handelian traditions. was personally acquainted with Beethoven and a close friend of Carl Maria von Weber. who died in his house. Much of his church music is still heard in the churches. He died in London on Feb. 23. 1867.

SMART, JOHN (*c.* 1742–1811), one of the foremost English miniature painters. the place and exact date of whose birth are not known. In his youth he won a series of prizes from the Society of Arts. He exhibited with the Society of Artists from 1762 and became president of that body in 1778. Smart spent ten successful years in India from 178j till 1795, becoming miniature painter to the nawab of Arcot. After his return to England he exhibited fairly regularly with the Royal Academy. Smart's first wife left him for William Pars. the water-colour painter, and he married once, and possibly twice. again. He died in London on Nay 1. 1811.

In an age prolific in miniature painters of the front rank. Smart's achievement is regarded as highly as that of his rival and contemporary. Richard Cosway. He employed entirely different methods. His brushwork was meticulous and his finish highly wrought; he used body colour to render the rich costume of the late 18th century. Though not acute analyses of character, his miniatures have great finesse and charm. Throughout his life Smart made a practice of dating as well as signing his works; on those he painted in India he added the letter I to his signature J. S.

See B. S. Long. *British Miniaturists* (1929); A. Jaffé, *The Art Quarterly,* vol. xvii, pp. 242–254 (1954). (G. Rs.)

SMEATON, JOHN (1724–1792), English civil engineer, builder of Eddystone lighthouse and founder of the civil engineering profession in Britain, was born at Austhorpe, Yorkshire. on June 8, 1724. He learned mathematical instrument making in London and, through contributing scientific papers to the Royal society, was elected a fellow in 1753. A tour of the Low Countries during 1755, studying canals. harbours and mills, was the turning point in his career. In 1756–59 he built the third lighthouse on Eddystone reef. opposite Plymouth, with dovetailed blocks of portland stone, and this established his reputation. In 1882 the upper portion was re-erected on Plymouth Hoe as a memorial. He also constructed the Forth and Clyde canal, built arched bridges at Perth, Banff and Coldstream, and completed the harbour at Ramsgate.

In 1754 Smeaton introduced cast-iron shafts and gearing into wind- and water mills, and received the Royal society's Copley medal for *An Experimental Enquiry Concerning the Natural Powers of Water and Wind to Turn Mills* (1759). He constructed a boring mill at Carron ironworks and, due to his improved designs, the Newcomen engine achieved its maximum performance. He designed large atmospheric pumping engines for Long Benton colliery, Northumberland, Chacewater mine. Cornwall, and Kronstadt docks, Russia. Smeaton was an original member of the Society of Engineers, founded in 1771, and in 1791 wrote his *Narrative of the Building . . . of the Eddystone Lighthouse.* He died at Austhorpe on Oct. 28, 1792, and was buried in Whitkirk parish church.

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SMEDEREVO (Ger. SEMENDRIA), an important commercial town, and capital of the Podunavski district of Serbia, Yugos. Pop (1953) 18.328. It is a walled town on the Danube. There is a good quay. and grapes, white wine. oils, livestock, pigs and cereals are exported. The only manufacture is that of railway trucks.

Smederevo is believed to stand on the site of the Roman settlement *Mons aureus,* and there is a tradition that its famous vineyards were planted by the Roman emperor Probus (A.D 276–282). In the 15th century when the Serbian prince George Brankovich became lord of Tokay in Hungary, he planted vines from Smederevo on his estates there, and from these came the famous white wine of Tokay. Close to the river is a medieval castle, with 19 square toners, built by George Brankovich in 1430, with a large cross built in, in red bricks. Under the surface of the walls are representations of three heads showing only the eyes, nose and mouth, and probably connected with the sacrificial practice of entombing individuals during the building. Smederevo was the capital of Serbia from 1430, when Belgrade was captured by the Turks, to 1459. Kara George, the leader of the first Serbo-Turkish rising, was murdered there in 1817, and the town was bombarded in World War I. It was occupied by German troops in World War II.

SMELL AND TASTE. Food flavour is man's commonest and most familiar smell and taste experience. Flavour, commonly misnamed "taste," is a composite of pressure, touch, temperature. common chemical sensitivity and smell, as well as taste. Sight and sound also contribute to the perception that delights the gourmet's senses. The smell component in flavour can be demonstrated by pinching shut the nostrils and trying to distinguish foods by taste alone: a slice of raw potato becomes indistinguishable from an apple; cinnamon yields only mild sweetness (a true taste) in addition to texture. Perfumes, on the other hand, excite primarily the sense of smell, although some may have slight taste or tactual components.

It is not possible to predict with certainty the sensation that an entirely new synthetic chemical will arouse until it has been tasted or smelled. The exact chemistry of odour and taste is still unknown in spite of the many empirical relations between chemical constitution and odour or taste that have been uncovered.

The common chemical sense, often classed with taste and smell as the "chemical senses," depends upon undifferentiated free nerve endings in the moist mucous membranes of the mouth, upper respiratory passages or other orifices of the body. Typical of the common chemical sense is the mild pain of pepper or other irritant spices, whereas taste is characterized by sensation qualities of salty, sour, bitter or sweet, and odour by foul, fruity, burnt, fragrant, etc. The common chemical sense, taste and smell form a hierarchy, respectively, from the simple to the more complex in structure, from the least to the most sensitive and from the least to the most differentiated in quality of sensation. In lower forms, especially water-inhabiting organisms, the distinctiveness of the three senses may not always be obvious because irritant, odour and taste stimuli are all transported in the fluid medium; on land, odours or irritating vapours are largely air-borne, whereas taste stimuli are in solution and stimulate by direct contact between solution and taste bud. In fishes the presence of distinct olfactory pits or of taste buds on barbels and other portions of the external body surface aid in identifying the senses.

No special account of the common chemical sensitivity will be given here. Taste and smell, having a relatively simpler morphology than vision or hearing, are often classified as lower senses Furthermore, the chemical senses have particular significance for the behaviour of lower organisms in the selection and acceptance of foods, the avoidance of noxious agents and the detection and attraction of sexual mates. Civilized man, more dependent upon his higher senses, finds in his lower senses the flavour and spice of life.

SENSE OF TASTE

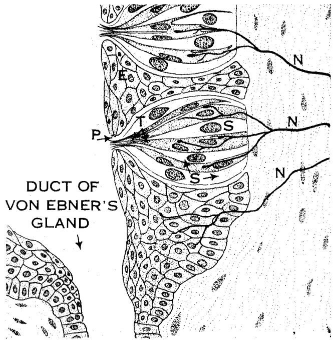


FIG. 1.— SCHEMATIC MICROSCOPIC SECTION OF TASTE BUDS OF CIRCUMVALLATE PAPILLA

(P) Gustatory pore with protruding filaments; (T) taste cells; (S) sustentacular cells; (N) nerve fibres; (E) stratified epithelium

The sense organs of taste are the taste buds, goblet-shaped clusters of cells that open by a small pore to the mouth cavity. The buds contain two types of cell, the thicker supporting cells and the more slender gustatory cells with a fine terminal hair projecting into the taste pore (fig. 1). In man and other mammals, taste buds are located primarily in the fungiform, foliate and circumvallate papillae of the tongue (*q.v.*) or in adjacent structures of the throat. Sensory nerve fibres entering the taste buds entuine about and make contact with one or more taste cells. When the nerves to the tongue are cut. these fibres and the whole taste bud degenerate. When the nerve fibres regenerate, the taste buds are reconstituted from the surrounding cells of the epithelium.

In invertebrates, the clearest distinction between taste and smell can be made in insects, although there is ample evidence that worms. gastropods and other forms reject bitter substances but accept sugars added to the substrate upon which they are feeding. In insects, contact chemoreceptors are located on certain hairs of the legs and mouth parts. Localized stimulation of these hairs by small droplets of sugar solution produce a definite proboscis extension. This response may be inhibited by adding salt to the sugar solution. In flies, the labellar hairs contain three nerve fibres, only two of which appear to extend to the chemoreceptive tip region. It is possible to record electrical discharges in these nerve fibres folloning chemical stimulation. Similar receptors may be found occasionally on the proboscis or antennae, but the latter are more commonly major olfactory organs.

Innervation. — There is no single sensory nerve for taste in vertebrates In man. the anterior tno-thirds of the tongue is supplied by the lingual nerve. the back of the tongue by the glossopharyngeal nerve and the throat and larynx by certain branches of the vagus nerve, all of which subserve touch, temperature and pain sensitivity to the tongue as well as taste. The taste fibres of the anterior tongue branch from the lingual nerve to form a slender nerve, the chorda tympani, which traverses the eardrum en route to the brain stem. When the chorda tympani is cut or damaged. as in the removal of the eardrum. taste buds disappear and taste sensitivity is lost on the anterior two-thirds of the tongue on the same side. The taste fibres from all the sensory nerves from the mouth run together in the tractus solitarius and its associated nucleus of the medulla oblongata. At this and all levels of the brain. taste fibres seem to be closely associated with touch and temperature sensory neurons for the tongue. From the medulla the fibres ascend by a pathway, not entirely delineated. to a small cluster of cells in the medial part of the sensory nucleus of the thalamus. From here fibres proceed to the anterior cerebral cortex where the taste fibres, still in close association with those for touch and temperature, project to the sensory receiving area for the mouth. No one part of the cerebrum appears to be exclusively devoted to taste.

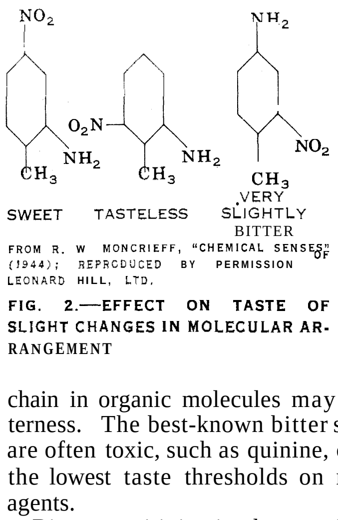
There is no simple relation between chemical composition and taste quality except in the case of acids. The taste qualities of inorganic salts are complex, only sodium chloride yielding the purely saline taste. Sweet and bitter tastes occur in many different chemical classes.

The tongue surface is not entirely sensitive. The middle surface is insensitive to taste, but salt sensitivity occurs around all edges, sweet sensitivity primarily at the tip, sour at the sides and bitter at the back. For many years it was believed that there were only four basic types of taste receptors, one each for salt, sour, bitter and sweet. Electrophysiological recording of sensory impulses in the taste nerves shows that this simple schema does not hold, at least in animal preparations. Individual nerve fibres from the tongue possess mixed sensitivity, in many cases responding to more than one of the basic taste stimuli. as acid plus salt, acid plus salt plus sugar. etc. Records from the individual taste cells show the same multiple sensitivity. The taste buds, therefore, appear to possess different clusters or patterns of sensit'vity. In some species, certain taste receptors may be activate by water but inhibited by sodium chloride. Thus, the taste impulse pattern to the brain may be increased or decreased by taste stimulation. The perception of taste depends upon the interpretation of such impulse patterns by the brain.

Sour. — The hydrogen ions of acids are largely responsible for the sour taste, and sourness increases with increase in hydrogen ion concentration. but this factor alone does not determine sourness. Weak organic acids such as the acetic acid of vinegar are more sour than would be predicted from hydrogen ion concentration alone.

Salt. — Although the salty taste is often associated with soluble salts, most chemical salts, except sodium chloride, have complex tastes such as bitter-salt, sour-salt, etc. Salts of low molecular weight are predominantly salty while those of higher molecular weight are bitter. The salts of heavy metals such as mercury have a metallic taste, although some of the salts of lead (especially lead acetate) and beryllium are sweet. Both the anion and cation contribute to taste quality and to stimulating efficiency. In man the following series for degree of saltiness, in decreasing order, is known: ammonium, potassium, calcium, sodium, lithium, magnesium salts. The seriation varies with species.

Sweet. — Except in the case of certain inorganic salts of lead or beryllium, the sweet taste is associated largely with organic compounds such as the alcohols, glycols, sugars and sugar derivatives. The complex relation between chemical structure and sweet taste is not readily explained by present-day systemizations. This is particularly apparent for synthetic sweeteners such as saccharin and Dulcin. Sensitivity for these synthetic substances is especially remarkable; at threshold saccharin is 700 times more dilute than cane sugar. Furthermore, the spatial arrangement of atoms in the taste molecule is strikingly important, so that slight changes in arrangement within a sweet molecule mill make it tasteless (fig. 2).



FROM R. W MONCRIEFF, "CHEMICAL SENSES" (1944); REPRODUCED BY PERMISSION OF LEONARD HILL, LTD.

FIG. 2.—EFFECT ON TASTE OF SLIGHT CHANGES IN MOLECULAR ARRANGEMENT

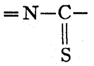
Bitter. — Bitter, like sweet, is elicited by many chemical classes and is often found in association with sweet and other taste qualities. An increase in molecular weight of inorganic salts or an increase in length of the carbon chain in organic molecules may be associated with increased bitterness. The best-known bitter substances are the alkaloids, which are often toxic, such as quinine, caffeine! strychnine: etc. Some of the lowest taste thresholds on record are found in this class of agents.

Bitter sensitivity is characterized by the unique defect known as taste blindness, an inability to detect such chemicals as PTC (phenyl thio carbamide) or the other substances with the chemical grouping

$$=N-\underset{\underset{S}{\|}}{C}-$$

in the molecule. Taste blindness appears to be genetically determined, a Mendelian recessive character such that about one-third of Caucasians cannot taste PTC, but this proportion varies in the different races of man. Evidence for taste blindness has been observed only in primates, human and subhuman, and not in lower forms.

The gene responsible for the defect apparently appeared at a relatively late stage of evolution. Taste blindness for



is not correlated with insensitivity to other bitter stimuli. There exists no definitive explanation for this defect.

Factors Affecting Taste Sensitivity. — It has long been known that fluids of extreme temperature, especially extreme cold, may cause temporary taste insensitivity. The optimum range for taste in general appears to be around or slightly below body temperature. The effect of temperature is often difficult to assess because the temperature of both the taste solution in the mouth and the mouth itself change. In more exact studies the tongue and mouth are first adapted to the temperature of the taste solution. In this case, sugar sensitivity increases with temperature rise, salt and quinine sensitivity decrease and acid sensitivity is relatively unchanged. It is quite clear that sense of taste does not behave like a chemical system with a simple temperature coefficient; otheraise all taste sensitivity should improve at the higher temperatures. Taste adaptation (*i.e.,* partial or complete disappearance of taste) may occur if a solution is held in the mouth for a period of time. In some cases, cross adaptation will occur; that is, adaptation by acid may adapt the sour taste for all other acids. Adaptation also may be followed by contrast; *e.g.,* distilled water tastes sweet following exposure to weak acid. Taste masking by mixtures of other tastes is well known from everyday experience. The bitterness of tea and coffee or the sourness of lemonade are masked or suppressed by sugar or saccharin.

The difference threshold or percentage increase in taste stimulus required for a just noticeable difference in intensity is approximately one-fifth, or a 20% increase in concentration. At very weak intensities, however, sensitivity is poorer, so that as much as a 100% increase in concentration may be required for a detectable difference.

Food Choice. — The sense of taste is intimately concerned with eating or the rejection of noxious agents. One of the earliest reflex responses of the infant, that of sucking, can be controlled by taste stimuli. Sweet solutions are sucked more readily than is plain water; bitter, salty or sour stimuli will stop the sucking reflex. Palatability and acceptability of food are due in good measure to taste. In children and lower organisms many food preferences or rejections appear to be directly related to taste. In the case of invertebrates, the very specific feeding reaction, proboscis extension, is so automatic a response that it is widely used as an index of taste stimulation. If a fly is fixed to a stylus by wax it can be held relatively immobile so that different parts of the mouth, legs and body may be stimulated by a drop of solution. Sugar solution will cause proboscis extension when applied to the legs or mouth parts. A fly that has been starved will show a positive response to a weak sugar solution that ordinarily would not affect a satiated one. Addition of salt or acid to the solution inhibits this response.

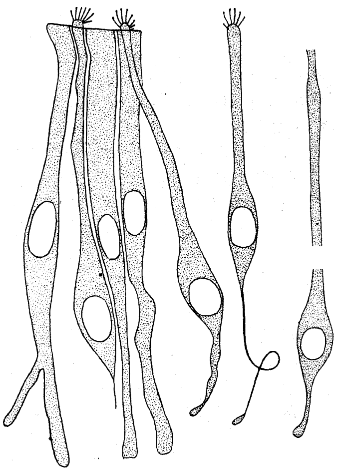
In lower mammals such as the rat, dramatic examples of beneficial self-selection behaviour can be cited. The laboratory rat, when given a free choice of pure carbohydrates, proteins, vitamins and minerals in separate containers, will show a consistent pattern of choice that may be modified by certain physiological stresses and strains. A rat rendered salt-deficient by removal of the adrenal glands, for example, will increase its intake of sodium chloride sufficiently to maintain health and growth; normally, adrenalectomy is fatal in the absence of salt-replacement therapy. Case histories of similar effects have been reported in human beings, one dramatic case being that of a child with adrenal pathology who kept himself alive by satisfying an intense salt craving. In adult man such responses may be less automatic. Adult eating habits are very much influenced by past experience and may even run counter to those most necessary to physiological well-being. Food habits and food fads, cultural conditioning, social usage and other complex psychological factors play a significant role in eating behaviour.

Toxic substances are often rejected by taste alone because of their bitterness, but not all toxic agents have a taste. The rat poison alpha-naphthyl thiourea (ANTU) was developed from a relatively insoluble and therefore tasteless form of highly toxic chemical; the soluble forms had all been rejected by the animal, but not the insoluble ANTU.

Unfortunately, not all toxic agents have the bitter taste. Lead salts are toxic but sweet. Lead acetate, sometimes called sugar of lead, was once used as a sweetening agent with disastrous results before its true action was appreciated. Other synthetic sweeteners or palatable taste stimuli may have toxic effects, so that taste alone is not a sure guide to safety.

SENSE OF SMELL

In mammals the olfactory receptors are located in the upper part of the nasal cavity. (See also OLFACTORY SYSTEM) In man, the yellow pigmented olfactory membrane measures about 2.5 sq.cm. in each nasal cavity. The olfactory sense organ is a long thin cell ending in several delicate hairs that project into and through the mucus covering the nasal epithelium (fig. 3). Electron microscope photographs show from 6 to 12 olfactory hairs per cell. The central end narrows to a fine nerve fibre which, in company with many other such fibres, enters the olfactory bulb of the brain through a fine channel in the bony roof of the nasal cavity. The olfactory area of the rabbit contains about 100,000,000 receptor cells, uhich, with their olfactory hairs, provide a total surface area equal to that of the total skin surface of the young rabbit.



FROM G H PARKER, "SMELL, TASTE AND ALLIED SENSES REPRODUCED BY PERMISSION OF J B. LIPPINCOTT CO

FIG. 3 — SEPARATED SECTION OF OLFACTORY MUCOSA SHOWING SENSE CELLS WITH OLFACTORY HAIRS AND SUPPORTING CELLS

Nerve endings of the trigeminal nerve fibres subserving common chemical sensitivity are widely distributed throughout the nasal cavity and olfactory region. Relatively mild odorants such as orange oil as well as the more obvious irritants such as ammonia stimulate such free nerve endings as well as the olfactory endings.

Odorous molecules may be carried to the olfactory region by slight eddy currents during quiet respiration, but vigorous sniffing produces a surge into the olfactory region. Odour sensitivity therefore may be impaired by blocking the nasal passages mechanically, as when membranes are congested by infection.

It is generally agreed that in insects the antennae are the principal olfactory sites, but such other appendages as the maxillary and labial palpi of the head may also bear olfactory endings (fig. 4). The olfactory sensilla of the honeybee appear to be the pore plates (fig. 5), but in some beetles, housefly larvae and *Drosophila* the sensilla are peglike hair derivatives. The cuticle of such pegs is less than one micron in thickness and the majority are innervated by a group of bipolar sensory cells. The stimulus, therefore, is separated from the neural elements by a nonliving cuticle with no detectable mucous or other secretion. This observation is often cited as evidence that odour molecules stimulate sense cells directly without prior solution in a liquid covering. Other authorities believe that in vertebrates olfactory stimulation occurs only after the odour molecule is dissolved in the mucus covering the olfactory epithelium. In spite of the obvious biological gap between man and the invertebrates, a number of studies seem to show that odour sensitivity of man and insect are very similar. Evidence from insect studies might be directly applicable to man.

In vertebrates the olfactory nerve fibres enter the olfactory bulb to end in a series of intricate basket-like terminations or clusters called glomeruli. Each glomerulus receives impulses from about 26,000 receptors and sends them on through 24 mitral cells and 68 tufted cells, showing a high degree of neural convergence. Most mitral-cell axons pass into the lateral olfactory tract en route to the higher olfactory centres at the base of the brain. Most tufted cells cross over to the olfactory bulb of the opposite side. Electrical activity in the primary olfactory nerves, the olfactory bulb, lateral olfactory tracts and pyriform lobe of the brain have been recorded following odour stimulation. It is known that when the olfactory bulb itself is removed by surgery, the ability to discriminate odours is lost, but the details of the higher neural centres for olfaction are still unclear.

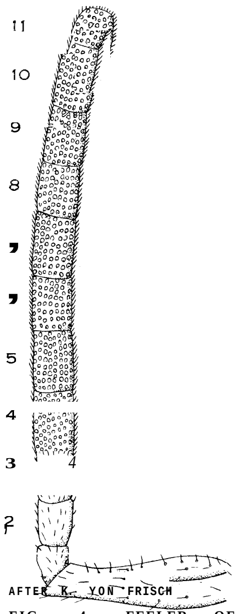


FIG. 4.— FEELER OF WORKER BEE: JOINTS 4 THROUGH 11 BEAR OLFACTORY ORGANS

Olfactory Qualities. — The vocabulary of odour is rich with words attempting to describe the great variety of olfactory qualities. Most odour names. however, are object names, and most attempts at classification of odour are largely psychological. One of the best known is that of H. Henning, who tested over 400 different scents on human observers. On the basis of the apparent similarities of perceived odour quality or confusions in naming, he concluded that there were six main odour qualities: fruity, flowery, resinous, spicy, foul and burnt. Their interrelations could be systematized by a diagram, the smell prism (fig. 6), which schematized only sensation qualities, not odorants or even the basic odour receptors.

Studies utilizing electrophysiological methods have been very revealing of the sensory mechanism underlying the different odour qualities. Electrical activity in the olfactory bulb can be detected readily by fine insulated wire electrodes inserted into the bulb itself. Two forms of activity have been observed: (1) a wave-like response that may be recorded from the surface of the bulb and (2) impulse activity that reflects discharges in the mitral cells following stimulation. Those portions of the bulb toward the anterior or oral region in the rabbit were found to be more sensitive to water-soluble substances, whereas the more posterior or aboral parts of the olfactory bulb were more sensitive to fat-soluble substances. In addition, when very fine electrodes mere used so that one unit could be identified, different mitral cells were found to be sensitive to different groups of chemicals. However, evidence for the existence of only a few primary receptors did not emerge from such studies; a variety of different combinations of sensitivity were found. Recordings from the primary receptor nerve fibres similarly reveal different patterns of sensitivity. Electrical recording of this type also shows that olfactory sensitivity can be enhanced by discharges in the sympathetic nerves to the nasal mucosa instigated by a painful stimulus or a pinch on the foot of the experimental animal. This appears to be a reflex to improve the detection of dangerous odours in the natural environment.

Odorous Substances. — To be odorous, a substance must be slightly volatile so that the molecules can be given off and carried into the nostrils by air currents. Fat and water solubility have also been thought to be necessary, and chemicals that possess both water and fat solubility are often strong odorants: but manv water- and fat-soluble substances are inodorous. The unique chemical or physical property that causes odour remains to be defined.

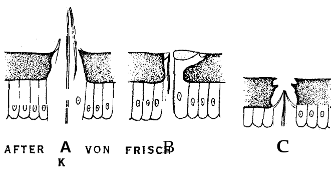
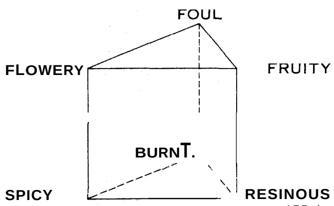


FIG. 5.—CROSS SECTION OF OLFACTORY ORGANS ON FEELERS OF INSECTS (A) OLFACTORY PEG. (B) PORE PLATE. (C) PIT PEG

Of the elements, only seven are odorous: fluorine, chlorine, bromine, iodine, oxygen as ozone, phosphorus and arsenic. Most odorous substances are organic compounds in which both the arrangement and structure of the molecule as well as the presence of particular chemical groups within the molecule influence odour. Stereoisomers (*i.e.*, different arrangements of the same molecular components) may have different odours. On the other hand, a series of benzene derivatives all have a similar odour. It is of historic interest that the first natural compounds with the benzenoid structure were found in association with pleasant-smelling substances such as oil of wintergreen or oil of anise and so were labeled aromatic to distinguish them from fatty substances.

The natural scent of flowers and roots depends upon the presence of minute quantities of highly odorous essential oils. Although the major odour constituents can be identified by chemical analysis, naturally occurring essences are so complex that their odours can be duplicated only by including small amounts of the natural product in the synthetic formulation.

Odour Sensitivity. — In spite of the relative inaccessibility of the olfactory end organs, odour stimuli can be detected at extremely low concentrations. Olfaction is said to be 10,000 times more sensitive than taste. A threshold value for such a well-known odorant as ethyl mercaptan has been cited in the range of 4×10^{-8} mg. per litre of air. A just noticeable difference in odour intensity may be apparent by a 20% increase in odorant strength, but at low concentrations as much as 100% increase in concentration may be required. Temperature influences the strength of an odour by affecting the volatility and hence the emission of odorous particles from the source Humidity also affects odour for the same reasons. Following a spoor or odour trail is easier during high humidity since evaporation and dissipation of the odour are retarded. In perfumes, fixatives having the prime function of retarding evaporation are used to fix the more volatile constituents of the blend. The temporary anosmia, or absence of sense of smell, following nasal infection may be complete or partial; in the latter case only the odours of certain substances are affected. Paranosmia, or change in perceived odour quality, also may occur in some instances. Changes in sensitivity are said to occur during the menstrual cycle, particularly with certain odorants related to steroids and sex hormones. Olfactory acuity also is said to become more acute during hunger.

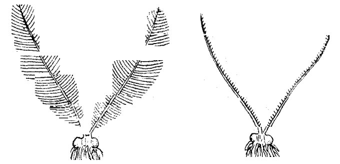


AFTER H. HENNING, S. S. STEVENS (ED), "HANDBOOK OF EXPERIMENTAL PSYCHOLOGY" (1951), REPRODUCED BY PERMISSION OF JOHN WILEY & SONS. INC.

FIG. 6 — SMELL PRISM (SEE TEXT)

Adaptation to odours is a striking olfactory phenomenon. The stench of the slaughterhouse or chemical laboratory ceases to be a nuisance after a few minutes have passed. Adaptation measured by the threshold rise is greater with stronger odours. Cross adaptation between different odours may take place; thus eucalyptole may be difficult to detect after adaptation by camphor but will be little affected by benzaldehyde. Adaptation long was regarded as the result of changes in the receptor, but later experiments with the electrophysiological method showed that the peripheral receptor does not seem to adapt. Rhythmic discharges continue in the olfactory bulb locg after the experimenter fails to detect the odour that is stimulating the experimental animal. Hence. it appears that olfactory adaptation may be Iocated partially in the brain, as well as in the sense organ.

Odour Blending and Flavour. — The ancient art of perfumery and the modern science of odour control attest to the realities of odour mixing and blending. When two different odours are presented at the same time they both may be readily identifiable. The more they resemble each other, the greater will be the tendency to blend, yet the trained chemist usually is able to discriminate the component notes of a successfully blended perfume. When the intensity of one odour is substantially greater than that of a second, masking often occurs. Chemical neutralization is the commonest basis for odour control. Nonchemical, purely physiological or psychological neutralization, although reported by some workers, has not been generally accepted. Odour blending and compounding is in good measure largely the art of the perfumer and is not a science.



(A) AFTER SPIEGEL (B) AFTER MARCUS

FIG 7—OLFACTORY ORGANS OF CRUSTACEA. FIRST ANTENNA OF (LEFT) CRANGON (MALE), (RIGHT) UROLYCHUS NITIDUS (FEMALE)

The distinctive and unique flavours of food are due largely to the sense of smell. Flavour is the composite of many senses, but the aroma of roast beef and the delicate bouquet of wine are largely olfactory in origin. Flavour technology assumes an ever-increasing place in the food industry; it has become common practice to make use of flavour panels of four to eight members concerned with the detection of fine differences between a standard and a modified or experimental product. Such a panel may be asked to give a description or rating of the flavour components present or to give an over-all rating of flavour quality. With careful training and controlled psychophysical methods with adequate statistical control, such panels are found to yield highly reliable results. Their ability to detect differences is often more delicate than that achieved by physical or chemical methods. Though the exact physical basis for a particular flavour quality may be unknown, the human nose and palate can note its presence.

Such analytical panels are to be distinguished from large consumer panels used in surveys of flavour preferences or likes and dislikes. In these the emphasis is on acceptability, often a hedonic or emotional reaction to the product. Such reactions are more unstable and may vary among individuals because of idiosyncrasy or differences in experience. The strong cheese odour so palatable to the gourmet produces only revulsion in the uninitiated.

Effects on **Behaviour.**—Control of behaviour by olfactory stimuli is striking and obvious in lower animals. Recognition of friend or foe by social insects may depend upon olfactory cues: certain ants attack their own kind furiously if deprived of the sense of smell by amputation of their antennae; bees entering a strange hive are put to death because the scent of a foreign hive clings to them. In addition, bees possess a scent organ on the end of the abdomen by which they can mark by scent a newly discovered food source to guide foraging workers in the final stages of their search. The very existence of natural scents in flowers attests to the evolutionary importance of odour; insects attracted by odour to the nectar of flowers are the agents of pollination.

The effect of odours on sexual behaviour of invertebrates is legendary; a female moth was observed to attract more than 100 males during relatively brief observation periods of $6\frac{1}{2}$ hours. The remarkable difference in antennal development between the male and the female moth is shown in fig. 7. Mammals in the wild state appear to utilize their odour glands for sexual attraction. Even the domesticated laboratory rat will show a preference for the arm of a maze containing the odour of an oestrous female over one that contains the odour of a dioestrous female. That some rudiments of these effects may be found in man seems likely. The most sexually provocative perfumes have a high proportion of musk or musklike "odour notes." Genuine musk, of course, is derived from the sexual glands of the musk deer; chemically it is related to certain of the sex hormones, and the fact that odour sensitivity varies with the menstrual or ovarian cycle has been mentioned. Further study of the nature and extent of these effects in man is needed to place on a scientific basis what may be known in the folklore. The behaviour of civilized man, molded and shaped by custom and culture though it is, has many of its roots in his basic sensual appetites. *See* also SENSATION; PSYCHOPHYSICAL METHODS.

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SMELLIE, WILLIAM (1697–1763), "the master of British midwifery," was born at Lanark in 1697. In 1739 he went to London. where in 1741 he began to teach midwifery by lecture-demonstrations for midwives and medical students. One reason for his success was that he attended poor women free of charge on condition that his students were allowed to watch. He thus broke the female monopoly in midwifery, and medical men (men midwives) began to be called in to attend childbirth.

Smellie invented (simultaneously with A. Levret of Paris) the "long" obstetric forceps, but his immortal contribution was his discovery and lucid description of "the mechanism of labour" (*i.e.*, the way in which the child's head adapts itself to the changes in shape and dimensions of the bony pelvic canal during birth). He retired to Lanark and died there on March 5, 1763.

Smellie's teaching was embodied in his *Treatise on the Theory and Practice of Midwifery*, 3 vol. (1752–64), and *A Set of Anatomical Tables* (1754).

BIBLIOGRAPHY.—Smellie's *Treatise*, ed. with a memoir by A. H. McClintock, New Sydenham Society, 3 vol (1876–78); J. Glaister, *Dr. William Smellie and His Contemporaries* (1894); R. W. Johnstone, *William Smellie. the Master of British Midwifery* (1952). (R. W. Jo.)

SMELT, in general, small, delicate fishes of the family Osmeridae, particularly certain species of *Osmerus*. The smelts, slender. silvery fishes, are closely related to the salmons and trouts; like the trouts, they have two dorsal fins, of which the second is small, fleshy and lacking rays; the ventral fins are attached below the first dorsal fins. They are chiefly cold-water fishes confined to the northern hemisphere. The American smelt (*Osmerus mordax)* ranges along the shores from Virginia to eastern Labrador and has become naturally landlocked in many lakes and ponds of the northeastern U.S. and Canada. They were introduced in 1912 into Crystal lake, Mich., from where they spread throughout the Great Lakes, becoming an important commercial species. Whether smelt are marine or landlocked, they come in to shore in late winter and spring and run for short distances upstream to spawn. The small, sticky eggs cluster and adhere to any object which they touch; they hatch in 8 to 30 days. The American smelt may grow to be 14 to 15 in. long, but most adults are usually smaller. The European smelt (*O. eperlanus*), ranging from Scandinavia to the English channel, is similar in appearance and habits to the American form.

Several closely related species occur in the north Pacific region. These include the rainbow herring (*Osmerus dentex*), the surf smelt (*Hypomesus pretiosus),* the Kodiak smelt (*Thaleichthys albatrossis)* and the eulachon or candlefish *(Thaleichthys pacificus*). A number of unrelated small fishes somewhat resembling osmerids externally are also called smelt in various parts of the world.

In the United States commercial fishermen take almost 11,000,000 lb. of smelts annually, and amateurs take an unknown but large additional quantity. More than 70% of the total is from the Great Lakes, a large part of the remainder from the Pacific coast, and about 1% from New England. *See* also Index references under "Smelt" in the Index volume. (L A. WD.)

SMELTING: *see* METALLURGY.

SMERDIS, the younger son of Cyrus the Great, who, according to the historian Ctesias, was appointed governor of the eastern provinces by his father on his deathbed. Before Smerdis' elder brother Cambyses set out to conquer Egypt, he secretly caused his brother to be murdered, being afraid that Smerdis might attempt a rebellion during his absence. His death was not known to the people, and so in the spring of 522 a usurper pretended to be Smerdis and proclaimed himself king on a mountain near the Persian town Pishiyauvada. Because of the despotic rule of Cambyses and his long absence in Egypt, "the whole people, Persians, Medes and all the other nations," acknowledged the usurper, especially as he granted a remission of taxes for three years. Cambyses began to march against him, but seeing that his cause was hopeless, killed himself (but *see* further CAMBYSES). The real name of the usurper was, as Darius tells us, Gaumata, a Magian priest from Media; this name has been preserved by Justin i. 9 (from Charon of Lampsacus?), but given to his brother (called by Herodotus

Patizeithes), who is said to have been the real promoter of the intrigue; the true name of the usurper is here given as Oropastes; by Ctesias as Sphendadates.

The history of the false Smerdis is narrated by Herodotus and Ctesias according to official traditions; Cambyses before his death confessed to the murder of his brother, and in public explained the whole fraud. But, as Darius said, nobody had the courage to oppose the new king, who ruled for seven months over the whole empire. Contracts dating from his reign have been found in Babylonia.

He transferred the seat of government to Media; and there in a castle in the district of Nisaya he was surprised and killed by Darius.

In the next year, another pseudo-Smerdis, named Vahyazdata, rose against Darius in eastern Persia and met with great success. But he was finally defeated, taken prisoner and executed.

See DARIUS (I) and PERSIA: History. (ED. M.)

SMET, PIERRE JEAN DE (1801–1873), Belgian Jesuit, known throughout the western United States as the Indians' truest friend, was born at Termonde, Belg., in 1801. He sailed to the United States in 1821 to enter the Society of Jesus, and was ordained priesr in 1827 at St. Louis university in Missouri, his headquarters for life. During 40 years he crossed the Atlantic 19 times, visiting European cities and courts to beg funds, equipment and recruits for the university and Indian missions. He founded his first mission in Iowa (1838). In negotiating peace between the Sioux and Potawatomi his unusual power over Indians was revealed. For 30 years, having their complete confidence, he mas welcomed among all tribes. He helped pacify the Plains Indians in 1841; in 1863, when he went alone to avert a Sioux attack; and in 1868, when he induced Sitting Bull to negotiate. He arranged peace in the Pacific northwest in 1851 and, as United States commissioner with Gen. William S. Harney, again in 1858. Ever outspoken for Indian rights and against punitive expeditions, De Smet won ready consent to establish Christian missions and send teachers. Between sea voyages and western travels totaling 180,000 mi., he published three books in four languages. His vigorous and winning personality made friends of statesmen, pioneers, traders and soldiers. He died in St. Louis, May 23, 1873.

See Hiram Martin Chittenden and Alfred Talbot Richardson, *Life, Letters, and Travels of Father Pierre-Jean De Smet, S.J.*, 4 vol. (1905). (J. V. J.)

SMETANA, BEDRICK (FREDERICK) (1824–1884), Czech composer, was born at Litomysl, southeast Bohemia, on March 2, 1824. He showed musical talent at an early age, appearing in public as a pianist when only six years old. At the Gymnasium of Prague, where he went to school in 1839, he neglected his studies for music to such an extent that his father removed him to a similar establishment at Plzen where he could be under the eye of a relative. There he met Katharina Kollar, a young pianist who was to become his wife ten years later. Overcoming parental opposition, Smetana went to Prague in 1844 to study composition under Josef Proksch, barely managing to live on the pittance allowed him by his father. He secured a post as music master to the family of Count Leopold Thun in his second year at Prague and eventually, with the generous help of Liszt, he started a private music school. Political troubles made life in German-dominated Prague difficult and, like many other Czechs Smetana sought greater opportunities abroad, becoming in 1856 director of music at Goteborg, Swed. During his five years' stay there he composed three symphonic poems — Richard *III, Wallenstein's* Camp and Hakon Jarl — in which the influence of Liszt is very apparent. His wife found the northern climate trying and died on her way home in 1859. His second wife, whom he married a year later, grew so homesick in Goteborg that Smetana resigned his post in 1861. He was also influenced in this decision by the better prospects opening up in his country for the development of a national art, a task to which he was to devote the rest of his life.

While waiting for the production (1866) of his first patriotic opera *Branibori* v Cechach (*The Brandenburgers in Bohemia*), Smetana composed the only opera in this form that was to prove a world-wide success — Prodana Nevesta (The Bartered Bride). His next two operas, Dalibor and *Libuse,* both serious works based on legends, disappointed the public who wanted another Bartered Bride, and brought from the critics renewed charges of Wagnerism. In World War II *Libuse,* long accepted as a masterpiece, became a symbol of Czech defiance of the German occupation.

Early in 1874 symptoms of total deafness began seriously to threaten Smetana and complete deafness came suddenly in October of that year. He nevertheless managed to compose the great series of six tone poems known as Ma *Vlast* (*My* Country), two delightful light operas, Hubicka (The Kiss) and *Tajemstvi* (The Secret), and the E-minor string quartet, Z *meho zivota* (*From* My Life) in which he wryly alludes to the tragedy of his deafness. A few more works came from his pen, but in 1884 his mind began to give way. He was unable to attend the celebrations at Prague in honour of his 60th birthday and died in a mental hospital on May 12 of that year. His tomb, in the famous cemetery on the Vysehrad, became a place of pilgrimage to the Czechs. Smetana, as a great patriotic figure and as a composer, is much more highly regarded in Czechoslovakia than Dvorak. Paul Stefan writes of him as "the hero of Czech music, not only its great founder, but its guardian spirit and its great architect." (AC. R.)

SMETHWICK, a municipal, county and parliamentary borough, Staffordshire, Eng., adjoining Birmingham 33 mi. N.W. Pop. (1951) 76,407. Area 3.9 sq.mi. The borough was incorporated in 1899, became a county borough in 1907 and a parliamentary borough in 1918. It returns one member. It was mentioned in Domesday Book as "Smedewich." The historic inventions of Matthew Boulton, James Watt and William Murdock (*qq.v.*) had their origin in the Soho foundry at Handsworth which was partly removed to Smethmick in 1848. The town has since become renowned for its glass works, the manufacture of lighthouse apparatus, iron and steel, rolling stock, industrial furnaces, weighing machines, aluminum castings, cycles, nuts, bolts, screws and metal windows.

SMETONA, ANTANAS (1874–1944), Lithuanian statesman and journalist, was born on Aug. 10, 1874, in the Ukmerge district, Lithuania, and made his law studies at St. Petersburg graduating in 1902. Smetona edited the first Lithuanian daily, Vilniaus *Zinios* ("Wilno news"), and the democratic party organ, *Lietuvos* Ukininkas. In 1905 he was elected a member of the presidium of the Vilnius (Wilno) diet, which proclaimed Lithuanian autonomy. On the convocation of the tautos taryba ("national council,") during the German military occupation of the country, he was unanimously elected its president, and from 1919–20 served as first president of the newly proclaimed independent state of Lithuania. In 1921 Smetona served as chairman of the Lithuanian delegation at Riga during the negotiations on the settlement of the Latvian-Lithuanian boundary dispute. Early in 1923, when the insurrection broke out in the Memel territory against the German directorate, Smetona was requested by the Lithuanian government to compose the trouble in co-operation with the Allied representatives. In the same year he became lecturer on philosophy in the newly established university. After the military *coup d'état* at Kaunas (Nov. 16–17, 1926), Smetona was elected (Dec. 17) president of the republic. He was re-elected in 1932 and in 1938, but in 1940, when Lithuania became a part of the Soviet Union, Smetona fled. arriving in the United States in March 1941. He died in a fire at Cleveland, O., Jan. 9, 1944.

SMIBERT (SMYBERT), **JOHN** (1688–1751), British-American portrait painter, one of the first well-trained artists to work in the American colonies, was born in Edinburgh, March 24, 1688, and apprenticed to a house painter. He went to London about 1709 to study art and worked there, except for a three-year visit to Italy, until 1728. In that year he accompanied George Berkeley (*q.v.*) to Rhode Island as prospective professor of fine arts in the college which Berkeley hoped to establish in Bermuda. When this project failed, he went in 1730 to Boston, Mass., where he married and spent the rest of his life. He painted many prominent Bostonians, but had to supplement his income by keeping a shop, where he sold art supplies and prints. His collection of copies from the "old masters" was unique in colonial America and influenced the development of several later artists, notably Copiey and Allston. In 1742 he drew the plans for Faneuil hall, Boston. He died in Boston, April 2, 1751. His best-known work is "Bishop Berkeley, Family and Friends" (1729, Yale university), which contains a self-portrait of the artist. Many of his single portraits are exhibited in American museums and historical societies.

(D. H. W.)

SMILES, SAMUEL (1812–1904), Scottish author, was born at Haddington, Scot.. on Dec. 23, 1812. He was the eldest of 11 children left, on their father's death, to be supported by their mother on slender means. To her spirit and example must be attributed some of the enthusiasm for self-reliance and self-education, that was later embodied in Smiles's writings and led to their popularity and influence. He qualified in medicine at Edinburgh, but early abandoned his medical practice for journalism.

From 1838 until 1844 he edited the weekly *Leeds Times;* 1845 until 1854 he was secretary of the Leeds and Thirsk railway, and from 1854 until 1866 of the South Eastern railway. At Leeds he came in contact with George Stephenson, whose *Life* by him, published in 1857, passed through five editions in its first year and was the precursor of a long series of biographies of leaders in the world of industry. In 1859 had appeared his most successful book, *Self-Help.*

The book's success suggested others of similar purpose, *Character* (1871), *Thrift* (1875), *Duty* (1880).

Smiles died in Kensington on April 16, 1904.

SMILLIE, the name of a family of U.S. painters, engravers and etchers.

JAMES SMILLIE (1807–1885), engraver, was born in Edinburgh, Scot., on Nov. 23, 1807, and emigrated to New York in 1829. He was a landscape line engraver of some distinction, the best known of his numerous works being a series of large plates after Thomas Cole's "The Voyage of Life." After 1861 he devoted his time to the engraving of bank notes. He died on Dec. 4, 1885.

JAMES DAVID SMILLIE (1833–1909), his eldest son, an engraver, etcher and painter, was born on Jan. 16, 1833, in New York city. He studied with his father and at the National Academy of Design. His work includes engraved steel vignettes for bank notes and some illustrations, notably F. O. C. Darley's pictures for Dickens' and Cooper's novels. He was elected an associate of the National academy in 1865—the year after he first began painting—and an academician in 1876, and was a founder (1866) of the American Water Color society and of the New York Etching club. Smillie's most significant works are his etchings, dry points and aquatints, which show complete technical mastery. He died on Sept. 14, 1909.

GEORGE HENRY SMILLIE (1840–1921), younger son of James Smillie, was a landscape painter. Like his brother, he first studied with his father; later he was a pupil of James MacDougal Hart. He, too, was a member of the National Academy of Design and of the American Water Color society. Smillie's best-known work probably is the "Lake in the Woods," first shown at the National academy in 1872. He died Nov. 10, 1921.

SMITH, ADAM (1723–1790), Scottish political economist and philosopher, whose book *The Wealth of Nations* exerted the greatest influence on subsequent economic and political theory and practice, was the son of the comptroller of the customs at Kirkcaldy. Fife, Scot. The exact date of his birth is unknown, but he was baptized at Kirkcaldy on June 5, 1723, his father having died some six months previously. In 1737 he proceeded to Glasgow university, studying moral philosophy under "the never-to-be-forgotten" Francis Hutcheson (as Smith called him). In 1740 he entered Balliol college, Oxford, but as William Robert Scott has said, "the Oxford of his time gave little if any help towards what was to be his lifework," and he relinquished his exhibition in 1746. In 1748 he began delivering public lectures in Edinburgh under the patronage of Lord Kames. Some of these dealt with rhetoric and belles-lettres, but later he took up the subject of "the progress of opulence," and it was then, in his middle or late 20s, that he first expounded the economic philosophy of "the obvious and simple system of natural liberty" which he was later to proclaim to the world in his *Inquiry into the Nature and Causes of the Wealth of Nations.* About 1750 he met David Hume, who became one of the closest of his many friends.

In 1751 Smith was appointed professor of logic at Glasgow university, transferring in 1752 to the chair of moral philosophy. His lectures covered the field of ethics, rhetoric, jurisprudence and political economy. or "police and revenue." In 1759 he published his *Theory of Moral Sentiments,* embodying some of his Glasgow lectures. This work, which established Smith's reputation in his own day, is concerned with the explanation of moral approval and disapproval. His capacity for fluent, persuasive, if rather rhetorical argument is much in evidence. He bases his explanation, not as the third Lord Shaftesbury and Hutcheson had done, on a special "moral sense," nor, like Hume, to any decisive extent on utility. but on sympathy. There has been considerable controversy as to how far there is contradiction or contrast between Smith's emphasis in the *Moral Sentiments* on sympathy as a fundamental human motive, and, on the other hand, the key role of self-interest in *The Wealth of Nations.* In the former he seems to put more emphasis on the general harmony of human motives and activities under a beneficent Providence, while in the latter, in spite of the general theme of "the invisible hand" promoting the harmony of interests, Smith finds many more occasions for pointing out cases of conflict and of the narrow selfishness of human motives.

Smith now began to give more attention to jurisprudence and political economy in his lectures and less to his theories of morals. An impression can be obtained as to the development of his ideas on political economy from the notes of his lectures taken down by a student in about 1763 which were later edited by E. Cannan (*Lectures on Justice, Police, Revenue and Arms,* 1896), and from what Scott, its discoverer and publisher, describes as "An Early Draft of Part of *The Wealth of Nations,*" which he dates about 1763.

At the end of 1763 Smith obtained a lucrative post as tutor to the young duke of Buccleuch and resigned his professorship. From 1764–66 he traveled with his pupil, mostly in France, where he came to know such intellectual leaders as Turgot, D'Alembert, André Morellet, Helvétius and, in particular, François Quesnay, the head of the Physiocratic school (*q.v.*) whose work he much respected. On returning home to Kirkcaldy he devoted much of the next ten years to his magnum opus, which appeared in 1776. In 1778 he was appointed to a comfortable post as commissioner of customs in Scotland and went to live with his mother in Edinburgh. He died there on July 17, 1790, after a painful illness. He had apparently devoted a considerable part of his income to numerous secret acts of charity.

Shortly before his death Smith had nearly all his manuscripts destroyed. In his last years he seems to have been planning two major treatises, one on the theory and history of law and one on the sciences and arts. The posthumously published *Essays on Philosoplzical Subjects* (1795) probably contain parts of what would have been the latter treatise.

The Wealth of Nations — It is on *The Wealth of Nations* that Smith's renown securely rests. This work, in the first place, with those of Sir William Petty, Richard Cantillon, Quesnay and Turgot, did most to create the subject of political economy and develop it into an autonomous systematic discipline; and secondly, in the western world, it is the most influential book on the subject ever published. In the plan of Smith's lifework, however, it seems that *The Wealth of Nations* had represented only one section of a comprehensive system of moral or social philosophy, in which he had intended to survey and explain the progress of society in all its aspects.

Controversial views have been expressed as to the extent of Smith's originality in *The Wealth of Nations.* However. it seems justifiable to regard him neither as the original and almost unique creator or founder of political economy, nor, on the other hand, as a completely unoriginal systematizer, deeply indebted in particular to Turgot and Quesnay. A survey of the influences on, or ingredients of. Smith's work would almost amount to a history of the economic thought of the century or more before his time. In his general philosophical approach Smith continued the tradition of the "natural law" school of Hugo Grotius and Samuel von

Pufendorf, and in the broad layout of his ideas started from his Glasgow predecessors Gershom Carmichael and, above all, Francis Hutcheson. Hume must have helped in strengthening and developing his liberal ideas, and Montesquieu his historical approach. His English predecessors, Petty, John Locke, Bernard Mandeville, Joseph Harris and Sir James Steuart, must also have been of some help.

The Wealth of Nations is a work of much wider sweep than its 19th-century successors, much wider even than *The Principles of Political Economy* by John Stuart Mill. Above all, it is marvelously rich in learning about earlier periods as well as acute in its observation of the contemporary scene. It is also a great work of political philosophy, most eloquently and persuasively delivered. As regards the economic analysis and theorizing, this provides a fairly loose and slender thread, not usually at all rigorously worked out and occurring mostly in the first two books. Nevertheless, *The Wealth of Nations,* rambling and prolix though it often is. did systematize its subject, with enormous gains to its public influence. Its five books are surveyed below:

Book I: The Division of Labour, Value and Distribution.— "The annual labour of every nation is the fund which originally supplies it with all the necessaries and conveniences of life" is Smith's opening sentence, and it enunciates, with its primary emphasis on the "real" productivity of labour, one of the leading themes of the work. Increasing the productivity of labour requires, above all, its specialization or "division," on which Smith places extreme emphasis as the key to economic progress. The division of labour is limited by the extent of the market, but, as exchanges multiply and ramify, money as a medium of exchange is required, and there arise the problems of the values and prices of goods and services. In these opening five chapters Smith pursues a now well-worn sequence of ideas, than which there is no more lucid or logical way of leading into the central problems of economics or social economy.

Smith begins his treatment of value with the distinction between value in exchange and value in use, or "utility," and drives this distinction so far as to proclaim that value in use is not necessary even for "the greatest value in exchange." After setting out, without keeping clearly separate, the concepts of the labour commanded by a good, the toil and trouble of commanding a good, and the labour contained in it, and having laid down labour as a measure or standard of value, he settles for an explanation of "natural" prices in terms of cost of production, made up of wages, profit and rent. Smith's distinction between "natural" and "market" prices established a pattern of analysis followed out by the main 19th-century theories of value and price. Natural price is the "long-run" competitive equilibrium price determined by cost of production, while market price is the "short-run" price, determined by supply and demand. Natural price consists of wages, rent and profits at their "natural" levels. As regards wages, these will tend in a stationary economy to a subsistence level, though they will remain above subsistence in a progressive economy. Smith emphasizes the stronger bargaining position of combinations of employers as against the workers, and also suggests the idea behind the later "wages fund" doctrine that wages are an advance by the employer to maintain the worker while his product is ripening. He distinguishes profit as a separate income by marking it off from wages of "inspection and direction," and he notes the element of compensation for risk. He argues that through increasing competition the rate of profit will tend to fall as an economy progresses toward the stationary state. On rent Smith's position is rather ambiguous, and his chapter on the subject includes a vast digression on variations in the value of silver. His explanation mentions the element of monopoly, as well as the productivity of land, and he argues that rent enters into price "in a different way from wages and profit," since "high or low wages and profit are the causes of high or low price; high or low rent is the effect of it"— thus anticipating David Ricardo's theory. Book I ends with an analysis of the effects of economic progress on wages, profits and rents—the incomes, that is, of the "three great, original and constituent orders of every civilized society, from whose revenue that of every other order is ultimately derived." Smith's analysis provided the pattern for subsequent important attempts on this subject, though the precise logic of his model is not entirely clear.

Book 11: Capital, Saving and Investment.—The title of the second book is "Of the Nature. Accumulation, and Employment of Stock," the term "stock" including consumers' capital, as well as producers' capital, which latter is capital in Smith's sense. He classifies capital into fixed and circulating, each with four sub-branches. He includes money as a part of the circulating capital of society, but not explicitly the means of subsistence advanced to productive labourers. In a long chapter on money, "the great wheel of circulation, the great instrument of commerce," he explains the saving to the economy which arises from the development of banking and paper money in place of the precious metals.

Smith comes next to his definitions of "productive" and "unproductive" labour, in which he is attempting to adapt the peculiar definition of the Physiocrats according to which only agricultural labour was "productive." Smith's distinction seems little more helpful for modern analysis, since he defines services—though not retailing—as unproductive, "how honourable, how useful, or how necessary soever" they may be. There follows Smith's theory of saving and investment, or that saving *is* investment. This lays unqualified emphasis on the universal and inevitable beneficence of "parsimony," or private voluntary saving, as "the immediate cause of the increase of capital," since, for any income-receiver, "that portion which he annually saves, as, for the sake of the profit, it is immediately employed as a capital, is consumed in the same manner" as what he spends on his consumption. Hence "every frugal man is a public benefactor," since, apparently, for every individual decision to save there is a corresponding decision to invest.

Joseph Schumpeter has pointed out the immense influence over the next century and a half of this analysis. It is very similar to that of Turgot's published ten years previously in his *Réflexions,* though Smith elaborates its implications, especially for policy, much more emphatically. The Turgot-Smith theory swept away the rudimentary analysis of effective demand of their predecessors as well as Quesnay's reservations regarding the inevitable beneficence of saving.

Smith's analysis of saving and investment, implying the utilization of all income for consumption or investment spending, formed the basis for important parts of his attack (notably in the first chapter of book iv) on what, following Physiocratic usage, he called "the mercantile system," for its preoccupation with monetary policies and "the popular notion that wealth consists in money." There Smith argues that "it is not for its own sake that men demand money" which "can serve no other purpose besides purchasing goods." Complaints of a general scarcity of money are wrongheaded, for "though a particular merchant, with abundance of goods in his warehouse, may sometimes be ruined by not being able to sell them in time, a nation or country is not liable to the same accident . . . It might, indeed, suffer some loss and inconveniency, and be forced upon some of those expedients which are necessary for supplying the place of money. The annual produce of its land and labour would be the same or very nearly the same."

Smith's theory of saving and investment is also an essential part of his general campaign for reliance on the invisible hand of the individualist profit motive as against state action. For, as he argues when discussing tariffs, "no regulation of commerce can increase the quantity of industry in any society beyond what its capital can maintain. It can only direct a part of it into a direction which it might not have gone." The same system of ideas pervades, also, his final chapter of book iv, "Of Public Debts," with its underlying assumption that all government expenditure is "unproductive." However, perhaps in contrast with his extremely emphatic and influential analysis of saving and investment, Smith favoured a legal maximum rate of interest rather than complete freedom. Nevertheless, what John Maynard Keynes was to call "the classical system of ideas" first emerged fully developed in *The Wealth of Nations.* The "law of markets" of Mill and Jean Baptiste Say, and what came to be known in Great Britain in the 1920s and 1930s as "the Treasury view," that government expenditure could do little or nothing to raise the level of employment, are traceable, above all, to Adam Smith.

Book *III:* "Of the *Different* Progress of *Opulence* in Different Nations."—This is probably the oldest part of the work, deriving from Smith's Edinburgh lectures. It forms an interlude on the course of economic development as it proceeds by the exchange of goods and services between town and country or manufacturing and agriculture, and it is illustrated by a selective survey of European economic history. Smith argues for a "natural course of things," according to which "the capital of every growing society is. first, directed to agriculture, then to manufacture, and lastly to foreign commerce." Any other order is "unnatural and retrograde." Indeed, it is in agriculture that the investment of a given capital is most advantageous to society. Over much of Europe. though fortunately not to the same extent in Britain, pernicious legislation with regard to land tenure and primogeniture. and internal obstructions and export prohibitions on the corn trade, have distorted the natural order and prevented the invisible hand from harmonizing the private and social gains from investment.

Book *IV:* "Of Systems of Political Economy". —This is devoted to Smith's attack on "the mercantile system" in the framework of a general review of commercial policies. It concludes with a critical but friendly chapter on "the agricultural system" of the Physiocrats. Smith's most definitely identifiable target was the existing mass of restrictive regulations and monopolistic institutions, practices and privileges, in fact, all those "systems either of preference or of restraint" which "being thus completely taken away, the obvious and simple system of natural liberty establishes itself of its own accord." He has already argued for free choice of occupations by the removal of apprenticeship restrictions and settlement laws, and for free trade in land by the abolition of primogeniture and entails. In book iv he calls, of course, for internal free trade, which he recognizes as a vital factor in the economic progress of Britain as contrasted with France. Most important are his weighty and detailed case for freedom in international trade and his attacks on duties, bounties and the monopolistic privileges of the chartered companies. However, he makes certain concessions regarding restrictions in special circumstances on the export of corn, a moderate export tax on wool and moderate import duties on manufactures where these might yield "a considerable advantage" to a country's own industries, though he will give no protection to infant industries as such. Smith argues for gradualness or "a good deal of reserve and circumspection" in the removal of restrictions, where considerable unemployment might be caused, and says that to expect that complete free trade should ever be established in Great Britain is Utopian.

It is in book iv that Smith introduces several of his most famous passages advocating the free play of self-interest: "As every individual, therefore, endeavours as much as he can both to employ his capital in the support of domestic industry, and so to direct that industry that its produce may be of the greatest value; every individual necessarily labours to render the annual revenue of the society as great as he can. 'He generally, indeed, neither intends to promote the public interest, nor knows how much he is promoting it. By preferring the support of domestic to that of foreign industry, he intends only his own security; and by directing that industry in such a manner as its produce may be of the greatest value, he intends only his own gain, and he is in this. as in many other cases, led by an invisible hand to promote an end which was no part of his intention. Nor is it always the worse for the society that it was no part of it. By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it."

In his very striking chapter "Of Colonies" Smith campaigns against all nationalistic and monopolistic restrictions on colonial trade, claiming that these benefit only a small minority and not the broad masses of the nation. Because of the burden of defense "under the present system of management, therefore, Great Britain derives nothing but loss from the dominion which she assumes over her colonies." After a searching discussion of political relationships he suggests the vision of a free-trade association of politically independent partners, in which the mother country and its colonies would become "faithful, affectionate, and generous allies."

Book V: *"Of* the Revenue of the Sovereign or *Commonwealth."* —This deals with the expenditure (or functions) of the state and with taxation and public debts. Smith confines the role of the state to three heads: (1) defense (which in a famous aside approving the Navigation acts he had declared to be "much more important than . . . opulence"); (2) justice and civil government, particularly "the defence of the rich against the poor"; and (3) that of "erecting and maintaining those public institutions and those public works, which, though they may be in the highest degree advantageous to a great society, are, however, of such a nature, that the profit could never repay the expense to any individual or small number of individuals." This third heading could, of course, be a most capacious one. Smith specifically mentions the provision of roads, bridges, canals. harbours and, to some extent, education as duties of the state. He discusses further possibilities such as banks, his main criterion being that any state enterprise should pay its way. He emphasizes that what the state may beneficially take on is relative to the efficiency and standards of the government of the day, and he expresses a low view of the capacities of the contemporary British government; however, he has an equally unfavourable opinion of the efficiency of most joint stock companies. Previously he had enunciated as a principle (which might legitimatize an almost indefinite extension of governmental intervention) that "those exertions of the natural liberty of a few individuals which might endanger the security of the whole society, are, and ought to be, restrained by the lams of all governments." As regards taxation. Smith favours proportionality, along with certainty, convenience and economy, though later he claims that "it is not very unreasonable that the rich should contribute to the public expense, not only in proportion to their revenue. but something more than in that proportion."

Though Smith's main treatment of the functions of government comes in book v, various suggestions for beneficent state action are scattered throughout *The Wealth* of Nations. As J. Viner has pointed out. Smith never collected his full program together and, indeed, probably omitted to mention some kinds of state activity which he would heartily have favoured, such as some sort of provision for the destitute or unemployed. So state action emerges as an exception, which is to be assumed guilty until proved innocent or beneficent. while private initiative is to be assumed beneficent until proved guilty. Taken together, his considerable exceptions might build up into a very large role for the state, though, unlike his predecessors and his successors since Keynes, he held rigidly that the state neither could nor should seek to control the aggregate level of activity and employment. Indeed it mas the sweep and force of Smith's advocacy of the simple system of natural liberty which gave The Wealth *of Nations* its revolutionary influence and which constituted its great message for succeeding generations: "All systems either of preference or of restraint, therefore. being thus completely taken away, the obvious and simple system of natural liberty establishes itself of its own accord. Every man, as long as he does not violate the laws of justice. is left perfectly free to pursue his omn interest his own way, and to bring both his industry and capital into competition with those of any other man, or order of men. The sovereign is completely discharged from a duty, in the attempting to perform which he must always be exposed to innumerable delusions, and for the proper performance of which no human nisdom or knowledge could ever be sufficient; the duty of superintending the industry of private people, and of directing it towards the employments most suitable to the interest of the society." At the same time The *Wealth* of Nations provided a first great survey of economic life in all its interdependence, and a framework for the development of political economy as a separate discipline.

For a modern edition of *The Wealth* of *Nations* see that of E. Cannan, 2 vol., 6th ed. (1950). See also *The* Theory *of* Moral Sentiments, 6th ed. (1790) ; and Essays *on* Philosophical *Subjects,* new ed. (1872).

See also Index references under "Smith, Adam" in vol. 24.

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Smith, etc. (1811); J. Rae, *Life of Adam Smith* (1895); *W*. R. Scott, *Adam Smith as Student and Professor* (1937). For commentaries on Smith's political economy *see* the prefaces to J. R. McCulloch's. J. E. T. Rogers', J. S. Nicholson's and E. Cannan's editions of *The Wealth of Nations* (1853, 1869, 1901 and 1950); *Adanz Smith 1776–1926*, including notabiy an essay by J. Viner, "Adam Smith and Laissez-faire" (1928); J. A. Schumpeter, *History of Economic Analysis*, pp. 181–194 (1954). For Smith's moral philosophy *see* Sir Leslie Stephen, *History of English Thought in the 18th Century*, vol. ii, pp. 70–77 (1876); W. R. Sorley, *History of English Philosophy*, new ed., pp. 156–194 (1937). (T. W. H.)

SMITH, ALFRED EMANUEL (1873–1944), U.S. politician and governor of New York state, was born in New York city on Dec. 30, 1873, in the Old Fourth ward under the Brooklyn bridge, of poor but respectable parents. Upon the death of his father, who had been a rather unsuccessful truckman, in 1886, Smith's education at St. James's parochial school, near his home, was interrupted. Forced to help support his mother and sister, the boy held a variety of jobs and finally became a checker at the Fulton fish market, where he remained for seven years. Even as a small boy Smith had given indications of talent in elocution and amateur dramatics, and, despite long hours at work, he continued his interest in theatricals and at one time considered a stage career.

Smith's political career began in 1895 when the Tammany district leader made him an investigator in the office of the city commissioner of jurors, with a salary of $800 a year. In the autumn of 1903 he was elected to the New York state assembly on the Democratic ticket. He went to Albany, N.Y., with little formal education but with an alert mind and an intimate knowledge of the city district he represented. He served continuously from 1904 to 1915. By 1913 he had become speaker of the assembly, an office second only to that of governor in power. During his first ten years in the legislature Smith gave small indication of the political independence he was to show later as governor. Industrious and intelligent, he was nevertheless a routine politician who obeyed the orders of Charles F. Murphy, the Tammany Hall "boss." After 1911, however, his viewpoint was broadened through his appointment to a commission which investigated factory conditions. In 1915 he was sent as a delegate to the constitutional convention held at Albany to revise the state's fundamental law.

Tammany Hall rewarded Smith in 1915 by making him sheriff of New York county. In 1917 he was elected president of the board of aldermen of Greater New York. The following year he resigned to run for governor against Charles S. Whitman. Although it was generally believed that he did not have a chance, he won by the narrow margin of 14,000 votes. He served four terms as governor, the first man in the history of the state to have this honour.

"Al" Smith, as he was affectionately known, showed extraordinary ability as a vote-getter. In 1920, when he ran against Nathan L. Miller, he was defeated in the Republican presidential landslide, but polled 1.000.000 more votes in his state than did the Democratic presidential nominee. He then became head of the United States Trucking corporation, but in 1922 was drafted to run for governor again. This time he defeated Miller, seeking re-election, 1,397,633 to 1,011,725—at that time the largest majority ever given a gubernatorial candidate in New York. In 1924 he defeated Theodore Roosevelt, Jr., and in 1926 defeated Ogden L. Mills. As governor, Smith fought for adequate housing, improved factory laws, proper care of the insane, child welfare and state parks. He effected a reorganization of the state government on a consolidated, businesslike basis. He repeatedly demonstrated his gubernatorial leadership by forcing Republican legislatures to accept his recommendations.

Smith was the first Roman Catholic to receive serious consideration as a presidential candidate in the United States. His religion, combined with his long record as an opponent of prohibition, resulted in a prolonged deadlock at the Democratic national convention of 1924. His nomination was opposed by the Protestant "dry" faction led by William G. McAdoo. On the 103rd ballot a compromise candidate, John W. Davis, was nominated.

In 1928, Smith was the leading candidate for the Democratic presidential nomination. At the Houston (Tex.) convention of the party on June 28 he was again placed in nomination by Franklin D. Roosevelt. The first ballot gave him the necessary two-thirds vote of the delegates, and Sen. Joseph T. Robinson was later nominated for vice-president. Though the western and southern Democratic delegates managed to bury the hatchet at the convention they could not persuade the voters to do so in the election. The opposition to Smith in the rural districts of closely contested states in the west and south contributed to his defeat in the election.

Smith carried on an aggressive campaign, making several extended speaking tours into the south and west. Hailed by Roosevelt as the "happy warrior," he was a picturesque figure who made his brown derby, cigar and colourful speech his trademarks and "The Sidewalks of New York" his theme song. But when the electoral votes were counted it was found that he had lost to Herbert Hoover, 444 to 87. Smith lost his own state as well as five southern states that had not gone Republican since the reconstruction era. The popular vote was much closer, 21,391,000 to 15,016.000. Smith polled the largest popular vote ever given to a Democrat up to that time.

The remaining years of Smith's life were embittered by the financial difficulties of the Empire State building, of which he became president, and by a bitter conflict with Franklin D. Roosevelt. Smith lost contact with his old following and supported the Republican presidential candidates in 1936 and 1940. He died on Oct. 4, 1944.

See Oscar Handlin, *Al Smith and His America* (1958); and Alfred E. Smith, Up *to Now* (1929); Henry F. Pringle, *Aljred E. Smith, a Critical Study* (1927). (H. F. PR.; OS. HA.)

SMITH, CHARLOTTE (1749–1806), English novelist and poet, once famous for her sonnets and her romances, was born in London, May 4, 1749, the daughter of Nicholas Turner, a man of property. Her husband, Benjamin Smith, whom she married in 1765, was imprisoned for debt from Dec. 1783 to July 1784 and then fled to France to avoid creditors. There his wife joined him until, by her efforts, he could return to England (1785). Two years later she left him and turned to writing to support her children (she had 12, of whom 6 survived her). She had already published *Elegiac Sonnets* (1784) but, although these were well received, her free translations of *Manon Lescaut* (1785) and part of *Les Causes Célèbres (The Romance of Real Life*, 1786) promised higher financial reward for novels: hence *Emmeline, or the Orphan of the Castle* (1788), *Ethelinde, or the Recluse of the Lake* (1789), which Fanney Burney enjoyed, etc. *Desmond* (1792), based on the innocent love of a man for a married woman, was accused of immorality, and its political ideas, inspired by the French Revolution also caused some talk. Mrs. Smith began *The Old Manor House* (1793), generally considered her best novel, when, with Cowper and Romney, she was the guest of William Hayley (*q.v.*); she read a chapter to the company each evening. Scott praised "her invention. . . . her knowledge of the human bosom, her power of natural description, her wit and her satire"; but in spite of her Cowperlike attitude to nature and her radical ideas her novels, with their rather stilted dialogue and occasional Gothic effects, belong essentially to the large derivative group of 18th-century women novelists.

Toward the end of her life she turned to palatably instructive books for children, the best being *Conversations Introducing Poetry* (1804). She died at Tilford, near Farnham, Surrey, on Oct. 28, 1806.

See F. M. A. Hilbish, *Charlotte Smith* (1941).

SMITH, EDMUND KIRBY (1824–1893), Confederate general in the American Civil War, the son of Col. Joseph Lee Smith (1776–1846), an American lawyer and soldier, who served in the War of 1812, was born at St. Augustine (Fla.), on May 16, 1824. He graduated at West Point in 1845, being assigned to the infantry. In the Mexican War he was breveted first lieutenant, and captain for gallantry. He was assistant professor of mathematics at West Point from 1849 to 1852 and was later engaged in Indian warfare on the Texas frontier. In 1861 he attained the rank of major.

When Florida seceded he resigned his army commission and entered the Confederate service as a lieutenant-colonel. He was made a brigadier general on June 17, 1861, and was wounded at the battle of Bull Run (*q.v.*). In command of the Confederate forces in the Cumherland gap region, he took part in Gen. Bragg's invasion of Kentucky (1862), and inflicted upon the .Federal forces a severe defeat at Richmond (Ky.), on Aug. 30. From Feb. 1863 to the fall of the Confederacy he was in command of the trans-Mississippi department, and was successful in making this section of the Confederacy self-supporting. He instituted a regular system of blockade-running, and met and defeated the Red river expedition under Gen. N. P. Banks in 1864.

Kirby Smith and his troops surrendered in May 1865, being the last armed forces of the Confederate states to do so. After the war, he was president of the Atlantic and Pacific Telegraph company, president of the Western Military academy, chancellor of the University of Nashville, and from 1875 to his death professor of mathematics at the University of the South, Sewanee (Tenn.).

Smith died at Sewanee on March 28. 1893.

SMITH, GEORGE (1 840-1876), English Assyriologist was born on March 26,1840, at Chelsea, London. Through the interest of Sir Henry Rawlinson, Smith, who was a bank-note engraver by trade, was appointed assistant in the Assyriology department of the British Museum, and the earliest of his successes was the discovery of two inscriptions, one fixing the date of the total eclipse of the sun in the month Sivan in May 763 B.C., and the other the date of an invasion of Babylonia by the Elamites in 2280 B.C. In 1872 Smith achieved world-wide fame by his translation of the Chaldaean account of the Deluge. In the following January the *Daily Telegraph* arranged with Smith that he should go to Nineveh and carry out excavations with a view to finding the missing fragments of the Deluge story. This journey resulted in the discovery of the missing tablets, and of fragments which recorded the succession and duration of the Babylonian dynasties. In 1874 Smith again left England for Nineveh, this time at the expense of the Museum, and continued his excavations at Kouyunjik. In March 1876 the trustees of the British Museum despatched Smith once more to excavate the rest of Assur-banipal's library. He died at Aleppo Aug. 19, 1876.

SMITH, SIR GEORGE ADAM (I 856-1942), Scottish divine, mas born in Calcutta on Oct. 19, 1856, uhere his father, George Smith, C.I.E., was then principal of the Doveton college. He was educated at Edinburgh in the Royal high school, the university and New college. After studying at Tiibingen and Leipzig and travelling in Egypt and Syria, he entered the ministry of the Free Church of Scotland and was appointed professor of Old Testament subjects in the Free Church college at Glasgow, 1892. He was principal and vice-chancellor of Aberdeen university from 1909 to 1935 and moderator of the general assembly of the United Free Church of Scotland, 1916–17. He was knighted in 1916. In 1933 he was appointed chaplain to the king in Scotland He died March 3, 1942.

Among his works are *The Book of Isaiah* (2 vols. 1888–90); The *Book of the Twelve Prophets* (2 vols., 1896–97); *Historical Geography of the Holy Land* (1894); *Life of Henry Drummond* (1898); *Modern Criticism and the Preaching of the O. T.* (3rd Edn., 1902); *Jerusalem* (2 vols., 1908); *The Early Poetry of Israel* (1912); *Atlas of the His?. Geog. of the Holy Land* (1915); *Jeremiah* (1923).

SMITH, GERRIT (1797–1874), American reformer and philanthropist, was born in Utica (N.Y.), on March 6, 1797. About 1828 he became an active worker in the cause of temperance, and in his home village, Peterboro, he built one of the first temperance hotels in the country. He became an abolitionist in 1835, after seeing an anti-slavery meeting at Utica broken up by a mob. In 1840 he took a leading part in the organization of the Liberty Party, and in 1848 and 1852 he was nominated for the Presidency by the remnant of this organization that had not been absorbed by the Free Soil Party. An "Industrial Congress" at Philadelphia also nominated him for the Presidency in 1848, and the "Land Reformers" in 1856. In 1840 and in 1858 he was a candidate for the governorship of New York on an anti-slavery platform. In 1853 he was elected to the U.S. House of Representatives as an independent. At the end of the first session he resigned his seat. After becoming an opponent of land monopoly, he gave numerous farms of 50 ac. each to indigent families, and also attempted to colonize tracts in northern New York with free negroes; but this experiment was a failure. Peterboro became a station on the "underground railroad"; and after 1850 Smith furnished money for the legal expenses of persons charged with infractions of the fugitive slave law. With John Brown, to whom he gave a farm in Essex county (N.Y.), he became very intimate, and from time to time supplied him with funds, though it seems without knowing that any of the money would be employed in an attempt to incite a slave insurrection. Under the excitement following the raid on Harper's Ferry, he became temporarily insane, and for several weeks was confined in an asylum in Utica. He favoured a vigorous prosecution of the Civil War, but at its close advocated a mild policy toward the late Confederate States, declaring that part of the guilt of slavery lay upon the North. He even became one of the securities for Jefferson Davis, thereby incurring the resentment of Northern Radical leaders. He died on Dec. 28, 1874, while on a visit to relatives in New York city.

See O. B. Frothingham, *Gerrit Smith: a Biography (1879).*

SMITH, GOLDWIN (1823–1910), British historian and publicist, was born at Reading on Aug. 13,1823. He was educated at Eton and Magdalen college, Oxford, and became a fellow of University college. He was assistant secretary to the royal commission on the subject of university reform in 1850, and secretary to the commissioner appointed by the act of 1854. In 1868, when the question of reform at Oxford was again growing acute, he published a brilliant pamphlet, entitled *The Reorganization of the University of Oxford.* His aspiration that colonists and Americans should be attracted to Oxford has been realized by Mr. Rhodes's will. His principal historical writings—*The United Kingdom: a Political History* (1899), and *The United States: an Outline of Political History* (1893)—make no claim to original research, but are remarkable examples of terse and brilliant narrative.

The outbreak of the American Civil War proved a turning-point in his life. He warmly championed the cause of the North, and his pamphlets, especially one entitled *Does the Bible sanction American Slavery?* (1863), played a prominent part in converting English opinion. Visiting America on a lecture tour in 1864, he received an enthusiastic welcome, and was entertained at a public banquet in New York. In 1868 he threw up his career in England and settled in the United States, where he held the professorship of English and Constitutional History at Cornell University till 1871. In that year he removed to Toronto, where he edited the *Canadian Monthly*, and subsequently founded the *Week* and the *Bystander*.

He did not, however, cease to take an active interest in English politics. He stated that "if he ever had a political leader, his leader was John Bright, not Mr. Gladstone." Speaking in 1886, he referred to his "standing by the side of John Bright against the dismemberment of the great Anglo-Saxon community of the West, as I now stand against the dismemberment of the great Anglo-Saxon community of the East." These words form the key to his views of the future of the British Empire. He always maintained that Canada, separated by great barriers, running north and south, into four zones, each having unimpeded communication with the adjoining portions of the United States, was destined by its natural configuration to enter into a commercial union with them, which would result in her breaking away from the British empire, and in the union of the Anglo-Saxons of the American continent into one great nation. These views are most fully stated in his *Canada and the Canadian Question* (1891).

Goldwin Smith died at his residence, The Grange, Toronto, on June 7, 1910.

See Arnold Haultain, *Goldwin Smith, his Life and Opinions* (1913), which includes Smith's journal during his first visit to America in 1864.

SMITH, SIR HENRY GEORGE WAKELYN, BART. (1787–1860), British general, son of John Smith, surgeon, of Whittlesey, Cambridgeshire, was born at that place on June 28, 1787. Harry Smith (as he consistently preferred to be called throughout his life) was educated privately and entered the army in 1805. His first active service was in South America in 1806, and he subsequently served through the Peninsular War from the concentration at Salamanca in Nov. 1808 to the battle of Toulouse on April 10, 1814. He married in 1812 a young Spanish girl, Juana Maria de Los Dolores de Leon, who remained with him throughout the rest of the war, accompanying the baggage train, sleeping in the open on the field of battle, riding freely among the troops, and sharing all the privations of campaigning. "Juanita" was idolized by the soldiers. At the close of the war Harry Smith volunteered for service in the United States. where he was present at the battle of Bladensburg (Xug. 24, 1814), and witnessed the burning of the capitol at Washington, which, as he said, "horrified us. coming fresh from the duke's humane warfare in the south of France." Returning to Europe he was brigade major at Waterloo; and in 1828 was ordered to the Cape of Good Hope. where he commanded a division in the Kaffir War of 1834–36. In 1835 he accomplished the feat of riding from Capetown to Grahamstown, a distance of 600 mi., in less than six days; and was appointed governor of the new province of Queen Adelaide, where he gained unbounded influence over the native tribes. But though supported by Sir Benjamin D'Urban, the high commissioner, the ministry in London reversed his policy and—to quote Smith's own words—"directed the province of Queen Adelaide to be restored to barbarism." Smith himself was removed from his command, his departure being deplored alike by the Kaffirs and the Dutch: and numbers of the latter, largely in consequence of this policy of Lord Glenelg, began the migration to the interior known as "the great trek."

Harry Smith was now appointed deputy adjutant general of the forces in India, where he took part in the Gwalior campaign of 1843 (for which he received a K.C.B.) and the Sikh War of 1845–46. He was in command of a division under Sir Hugh Gough at the battles of Moodkee and Ferozeshah. where he conspicuously distinguished himself, but was insufficiently supported by the commander-in chief. After the second of these actions Smith was appointed to an independent command, and on Jan. 28, 1846, he infiicted a crushing defeat on the Sikhs at Aliwal on the Sutlej. At Sobraon on Feb. 10 he again commanded a division under Gough. For the great victory of Aliwal he was awarded the thanks of parliament. and was created a baronet. In 1847 he returned to South Africa as governor of Cape Colony and high commissioner, to grapple with the difficulties he had foreseen 11 years before *(see* CAPE OF GOOD HOPE: *History)*. He took command of an expedition to deal with the disaffected Boers in the Orange River Sovereignty, and fought the action of Boomplaats on Aug. 29, 1848. In Dec. 1850 war broke out with the Kaffirs; Smith was insufficiently supplied with troops from England; and Lord Grey recalled him in 1852 before the Kaffirs had been completely subdued. He protested strongly against the abandonment of the Orange River Sovereignty to the Boers, which was carried out two years after his departure, and he actively furthered the granting of responsible government to Cape Colony. His Spanish wife was his constant companion in his second as in his earlier sojourn in South Africa, where her memory is recalled by the town of Ladysmith in Natal, as is that of her husband by Harrismith in the Orange Free State; while Aliwal North, founded in 1849 and named after his great Indian victory, further commemorates Smith. On his return to England he held a military appointment for some years, and died in London on Oct. 12, 1860. Juana, Lady Smith, survived till 1872.

SMITH, HENRY JOHN STEPHEN (1826–1883), British mathematician who specialized in the theory of numbers, was born in Dublin, Ire., on Nov. 2, 1826. When he was two years old his father died and his mother left Ireland for England. After being privately educated he entered Rugby in 1841 and Ealliol college, Oxford, in 1844. He was elected a fellow of Balliol in 1850 and Savilian professor of geometry in 1861. He was elected a fellow of the Royal society in 1861, served on various royal commissions and from 1877 was chairman of the managing body of the meteorological office. He died at Oxford on Feb. 9. 1883.

Smith published a few papers on geometry and then began a study of the existing work on the theory of numbers. The results of his researches are contained in his *Report on the Theory of Numbers*, which appeared in the British association volumes from 1859 to 1865. His further original researches on the subject were communicated to the Royal society in two memoirs. "Systems of Linear Indeterminate Equations and Congruences" and the "Orders and Genera of Ternary Quadratic Forms" *(Phil. Trans.*, 1861 and 1867). After 1864 he devoted himself chiefly to elliptic functions. His *Collected Papers*, prefaced by several biographical notices. were edited by J. W. L. Glaisher (1894). (O. OE.)

SMITH, HOLLAND McTYEIRE (1882–), U.S. marine corps officer who in World War II exemplified the fighting tradition established by men like Philip Sheridan and "Stonewall" Jackson, was born April 20, 1882. in Seale, Ala.. and graduated from Alabama Polytechnic institute, at Auburn, in 1901, receiving a law degree from the University of Alabama. Tuscaloosa. two years later. He practised law for one year and then entered the marine corps. During World War I Smith saw combat service in France, 1917–18. He specialized in amphibious warfare and trained marines and soldiers for the amphibious forces in World War II. Later he commanded the 5th amphibious corps, with the rank of lieutenant general, in successful operations in the Gilbert and Marshall Islands, on Saipan, Guam and Tinian and at Iwo Jima. His initials "H. M." and his insistence on thoroughness in training brought him the nickname "Howlin' Mad." Smith was retired for age May 15, 1946. and promoted to general. His autobiography, *Coral and Brass*, was published in 1949. (J. B. HN.)

SMITH, JAMES (1775–1839) and **HORACE** (1779–1849), authors of the *Kejected Addresses*, sons of a London solicitor, were born, the former on Feb. 10, 177j. and the latter on Dec. 31, 1779, both in London. In 1812 the managers of the Drury Lane theatre offered a prize of £50 for an address to be recited at the reopening of the rebuilt theatre in October. The brothers Smith had the idea of making the most pnpular poets of the time figure as competitors and issuing a volume of unsuccessful addresses in parody of their various styles. They divided the task between them. James took Wordsworth, Southey, Coleridge and Crabbe, while Moore, Scott and Bowles were assigned to Horace. Both had a hand in Byron. Seven editions were called for within three months. *Rejected Addresses* is a classic in the literature of parody. The only other undertaking of the two brothers was *Horace in London* (1813). James Smith made another hit in writing *Country Cousins, A Trip to Paris, A Trip to America* and other lively skits for Charles Mathews who said he was "the only man who can write clever nonsense." James was reputed one of the best of talkers in an age when the art was studied. and it was remarked that he held his own without falling into the great error of wits—sarcasm. But in his old age the irreverent *Fraser's* put him in its gallery of living portraits as a gouty and elderly but painstaking joker. He died in London on Dec. 24. 1839.

After making a fortune as a stockbroker, Horace Smith wrote about a score of historical novels—*Brambletye House* (1826), *Tor Hill* (1826), *Reuben Apsley* (1827). *Zillah* (1828), *The New Forest* (1829), *Walter Colyton* (1830), etc. But he was more of an essayist than a storyteller. Three volumes of *Gaieties and Gravities*, published by him in 1826, contain many witty essays both in prose and in verse. but the only single piece that has taken a permanent place is the "Address to the Mummy in Belzoni's Exhibition." Shelley said of Horace: "Is it not odd that the only truly generous person I ever knew who had money enough to he generous with should be a stockbroker? He writes poetry and pastoral dramas and yet knows how to make money. and does make it, and is still generous." Horace Smith died at Tunbridge Wells on July 12. 1849.

SMITH, JEREMIAH, JUNIOR (1870–1935), American lawyer and economist. was born at Dover. N.H., on Jan. 14, 1870. He graduated at Harvard university in 1892 and the Harvard law school in 1895. In 1895 he became secretary to Justice Gray of the C.S. supreme court. but in 1896 started the practice of law in Boston. He was a captain in the quartermaster corps, A.E.F.. in France in 1918. At the conclusion of hostilities he was appointed counsel to the treasury department in Europe and was associated in that capacity with the U.S. peace commission, acting also as an adviser in financial matters. After the signature of the Treaty of Versailles he resumed practice in Boston. During 1924–26 he was commissioner general of the League of Nations in Hungary, being successful in stabilizing the currency and placing Hungarian finance on a sound basis. On the completion of his work, July, 1926, he returned to practice in Boston. He generously refused to accept any remuneration except his expenses; and the sum of approximately $60,000 thus saved was designated by the Government as a scholarship fund for sending Hungarian students to the United States.

SMITH, JOHN (1579–1631), the best known of the early settlers of Virginia, was born of excellent parentage at Willoughby, in Lincolnshire. England. He attended school but was an unwilling scholar, the call of the sea making itself heard in his consciousness. Hence when about 16 years of age he started on his adventures. These he pursued on land and sea, with a short interruption, for ten years, and to his lot fell a great number of unusual experiences and hairbreadth escapes.

It is unfortunate that our main source of information in reference to this period of Smith's life is the testimony of Smith himself, but where it has been possible to check his narrative it has been found substantially correct. Hence, argue his friends, why not accept his credibility as a whole? It is a notable fact that probably the closest student of Smith's works, Edward Arber, who in 1884 edited John Smith's works for the *English Scholar's Library,* gives his adherence unreservedly to this credibility. Professor Arber's hope, however, to establish Smith's reputation beyond dispute was vain, for very shortly after the appearance of Arber's edition hfr. Alexander Brown brought out his two books, *The First Republic in America* and *The Genesis of the United States*, in both of which Smith is heavily attacked. His animus against Smith arose from the fact that an exaltation of Smith appeared to him to carry with it a belittling of those engaged with Smith in the effort to establish a settlement at Jamestown, an effort engaged in by many leading Englishmen of the time, and of such importance as to merit disassociation from it of the idea that its success was at any time dependent on any one man.

When Smith finally returned to England in 1605, he was only twenty-six years of age, but his varied experiences had matured him early, and he had graduated from the ranks of the mere fighter and entered those of the pioneer and the colonizer. He threw himself with energy into colonization schemes. He embarked heart and soul in the London Company enterprise—first in securing the charter and then in securing colonists. Not only did he go himself, but he spent his money in getting others to go. It is a great compliment to Smith that the Council of the company in London chose him to be a member of the Council in Virginia. His selection shows that, though young, he was already a man of mark.

The colonists set out from England Dec. 19, 1606, and did not reach Virginia till April 26, 1607 When the box containing the names of the members of the Council was opened, and it was found to contain Smith's, he was not permitted to take his seat, being under arrest on a charge of conspiracy on the trip over. Later, however. he was cleared, and his principal accuser fined £200. He was admitted a member of the Council June 26, 1607.

The actual landing of the colonists at Jamestown was made on May 14, and on May 22 Captain Newport with a party including Captain Smith made explorations up the James River, reaching the site of Richmond at the falls. Beyond this he desired to march inland but mas dissuaded by the Indian chief whose town was at the falls. Reaching Jamestown on the return on May 27, the party found that the Indians had the day before made an attack on the English when they were busy planting their corn, unsuspicious and unprepared. It was by means of the guns of the three ships lying close inshore that the enemy was forced to retire. In this fight was disclosed at least one of the advantages of Jamestown as the place of settlement, whatever points there may have been in its disfavour. The channel of the river there runs very close to the shore. Moreover, Jamestown Island was at that time a peninsula with a narrow, easily defensible neck, which was later, when Smith became president, protected by a block house.

On June 21 Captain Newport sailed away to England leaving 105 people at Jamestown with provisions for thirteen or fourteen weeks, under the command of the Council, with Edward Maria Wingfield as president, elected by the Council itself. Now a serious defect of organization soon become apparent. It was the Council that had the authority, not the president, who, however, presided at the deliberations of that body and had an additional vote in case of a tie This form of government was absolutely bad. Too much time was taken up in wrangling in the Council, too much feeling was engendered between individual councillors. The situation—scanty provisions and sickness within the stockade among inexperienced and largely unsuitable colonists and, without, lurking and hostile savages—called for concentration and not dispersion of power. The strong hand was needed.

It fell to Smith's lot to trade with the Indians for provisions that were to keep the settlers alive till the return of Captain Newport. These difficult and dangerous trading expeditions he conducted with success. He always returned to Jamestown safe and with good supplies. Others, all too frequently, when these duties later devolved on them. either returned not at all or with empty baskets Smith, no doubt, used all means in these expeditions—professions of friendship, cajolery, force, fraud, as well as fair trading. Several of these expeditions he made up the Chickahominy. On Dec. 10 he started out to discover the source of the Chickahominy, for it was thought that probably this source was in a ridge whose westerly flowing streams might have their outlet in the South Sea It was on this trip that he was captured by the Indians and the best-known incident of his life occurred, namely, his rescue by Pocahontas, who when, according to the orders of Powhatan, her father, the great chief of a confederacy of Indians, he was led forth to execution in retaliation for the killing by him of an Indian in the fight in which he was captured. threw herself upon him and by her entreaties prevailed with her father to spare his hfe. This was the act of a kindhearted, simple little Indian maiden of twelve or thirteen years of age who had been entertained by Smith with stories and sights of marvels in the time he had been at her father's residence before the execution had been decided on. He was then adopted as a member of the tribe. Later he was permitted to return to Jamestown. He faced another danger, however, when he returned. His enemy Gabriel Archer, who had in his absence been made a member of the Council, promptly charged him under the Levitical law with the death of his companions. On this absurd charge he was actually tried and sentenced to be hanged. But the hanging was averted by the arrival of Captain Newport from England. When Newport with his "First Supply" arrived on the 9th of Jan. 1608, only 38 of the colonists remained of the original 105. When Newport again left the colony on April 10, he took with him Captains Wingfield and Archer. On April 20 arrived the "Phoenix," Captain Francis Nelson, the consort of Newport's ship of the "First Supply." Newport's ship and Nelson's ship had brought 120 colonists.

In the early summer of 1608 Smith set out on his famous exploration of the Chesapeake Bay and its tributaries. He explored both sides of the bay far up to its head and went up the Potomac River as far as the site of the present city of Washington and up the Rappahannock as far as the site of Fredericksburg. At one time he uas so violently hurt by a stingray that he found it necessary to return to Jamestown to be treated by a surgeon. On this trip—or two trips—the party travelled three thousand miles in an open boat and met many adventures. One hardly knows which more to admire, the determined endurance of Smith and his men or the careful collection of data which went later into a narrative of the expedition and into a truly remarkable map

When Smith returned from Stingray Point to get his surgeon, he found the colonists clamouring that Ratcliffe should be deposed from the presidency and Smith put in his place. This was accordingly done by the Council, but Smith asked his friend Scrivener to act for a time, and he resumed his explorations He remained in Jamestown only from the 21st to the 24th of July. He returned from the second voyage on Sept. 7, 1608. and three days later assumed the duties of president. His activities were incessant. In October came Captain Newport with the "Second Supply" consisting of seventy colonists. The population of Jamestown now numbered about 200, of whom, owing to improved conduct of affairs, no more than six or seven succumbed to disease before the arrival of the "Third Supply" the following year.

Newport's instructions from the Council in London, impatient for quick returns on the company's investment, were to find gold, discover the passage to the South Sea, search for Raleigh's missing colonists, crown Powhatan (in order to gain his favour), and to employ certain Poles and Dutchmen in making pitch, tar, glass, and soap-ashes. Smith was opposed to these objects, with a varying degree of intensity, as diverting energy which should be expended in making the colony self-supporting, first and foremost in the matter of the food supply. As for Powhatan, he knew that his favour and support were important, that trade with the Indians for supplies was essential, but he was opposed to the use of any great amount of flattery. It was only another case, however, in which a distant and imperfectly informed higher authority had to be obeyed by the able administrator on the spot. Hence Smith bent his energies toward carrying out the instructions. But when Newport returned to England, Smith sent, with his celebrated map already referred to, a letter to the Council setting forth plainly his views as to these instructions and as to all questions affecting the good of the colony. His letter is most important, stressing the necessity of sending over competent toilers to make the colony self-supporting.

During the winter Smith found it necessary to make several expeditions among the Indians to obtain corn to stave off famine and was always successful, though it was sometimes necessary for him to force the Indians to trade. He had many narrow escapes from disaster. His courage, his resourcefulness, and his knowledge of Indian character, however, brought him through. After his return from the last expedition, with what seemed to be enough corn to last for a long time, he compelled the lazy among the colonists to do their share of work, and many necessary things were done in Jamestown and the vicinity. Forty acres of corn were planted. Now the rats at Jamestown, however, ate up large quantities of the precious corn, and Smith experimented by sending parties oil to live on oysters and fish, and even billeted some among the friendly Indians in the neighbourhood of Jamestown. Despite ever>-thing untoward that had happened and the shortage of food, Smith could feel in the spring and summer of 1609 that a solid foundation was being laid for the future wellbeing of the colony. His authority was now supreme because all the other members of the Council had died or returned to England.

On July 10, 1609, there arrived a ship under Captain Samuel Argall, to fish for sturgeon and to trade, and Captain Smith found it advisable to commandeer the provisions brought out, with the understanding, of course, that they would be paid for by the company. The ship brought out letters much less welcome to Smith than the supplies. In them he was much criticized for what the Council was pleased to think his harsh treatment of the Indian; and for failure to send back to England more valuable cargoes. Smith bridled at the injustice. His letter to the Council sent by Newport the preceding November had had little effect. News was also brought that the London Company had obtained a new charter, providing for a reorganization of the plan of government of the colony. There was to be a governor-general, who was, or whose deputy was, to be in real control. Lord De la Warr was to be this governor; nine supply ships were coming over. Smith understood, of course, that this change in the government was wise, but he did not relish being set aside, and he honestly thought that he with his experience, especially with his knowledge of the Indians, was the best man that could be found for the position. And almost certainly he was correct, though it may be argued that Smith had by his overhearing and impatient manner with his equals—though not with his inferiors—in station made so many enemies among influential members of the company and colony that the time had come for a new man to be put in control, who would be sure, however, to profit by the experience of his predecessor.

Lord De la Warr did not at first intend to come to Virginia himself till much later but to remain in England and there give attention to its affairs. He was to be represented in Virginia by Sir Thomas Gates, lieutenant-governor. The "Sea Venture," carrying Sir Thomas Gates, lieutenant-governor, Sir George Somers, admiral, Sir Thomas Dale, high marshal, and Captain Christopher Newport, vice-admiral, was wrecked on one of the Bermuda Islands, and the arrival in Virginia of these high officials was much delayed. This vessel also carried instructions. The other ships were dispersed and much distressed by the same storm that wrecked the "Sea Venture," but four of them sailed up the James on August 11 and others came in later, all in a very dilapidated condition. These ships brought Ratcliffe, Martin and Archer, former members of the Council in Virginia. When these demanded that Smith give up his office, he refused, since neither the new governor nor the lieutenant-governor was at hand, nor had he been officially informed of the changes made. He chose, however, to recognize Martin as a member of the Council, though maintaining that the other two were not now legally members, and a few days before his year's term as president was to expire on Sept. 10, he named Martin as his successor, who immediately, however, resigned in favour of Smith. Smith now sent Martin to make a settlement among the Nansemond Indians and he himself went to inspect a settlement he had previously sent Captain West to make at the falls of the James. He found affairs going badly. When he was returning to Jamestown, he was dangerously burned by an explosion of gunpowder and his return to England was necessitated. With him went charges drawn up by his enemies in Virginia, which, however, were not pressed. But Smith was never employed again by the London Company. He had made too many enemies.

When he left, the harvest was newly gathered and the colony was otherwise in a sufficiently stable condition to ensure its steady growth if only a competent administrator had been in charge. We cannot, however, go further into the history of the colony except to say that things at once went to pieces. The winter of 1609–10 is known as the "starving time." The colony was only saved from extinction by the arrival in the spring of Sir Thomas Gates and a little later of Lord De la Warr.

Though Captain Smith saw no more service with the Virginia Company of London, he, when he recovered his health, carried on his work in the interests of colonization and in the establishment of fisheries. With two ships he made a fishing and exploring voyage in 1614, and, as he had done in the case of the Chesapeake Bay country, mdde a surprisingly accurate map of the New England coast from the Penobscot to Cape Cod. He called the country "New England" and he assigned the name "Plymouth" to the mainland opposite Cape Cod.

Smith gained the favour of Sir Ferdinando Gorges, one of the principal members of the Virginia Company of Bristol. Under his patronage he made in 1615 two attempts to reach New England for purposes of settlement, the first of which failed on account of stress of weather, and the next attempt was frustrated by his being captured by pirates. In 1617 he made another unsuccessful attempt. He had been given by the Virginia Company of Bristol the vain title of admiral of New England. In 1618 he endeavoured without success to enlist the support of Lord Bacon for his colonization plans. In 1619 he offered to pilot the Pilgrim Fathers to North Virginia, that is, New England, but the offer was not accepted. After this he was mainly engaged in producing pamphlets, books, and maps, the design of which was to excite an interest in the colonization of America and now especially that part of it he had named New England. He died in June, 1631. He was buried in St. Sepulchre's Church, London.

Smith's principal writings, the titles being given in modern spelling and abbreviated form and in the order of their publication, are as follows: *A True Relation* (1608); *A Map of Virginia* (1612); *A Description of New England* (1616); *New England's Trials* (1620); *The General History of Virginia, New England, and the Summer Isles* (1624); *An Accidence for All Young Seamen* (1626); the same work recast and enlarged and given the title

A Sea Grammar (1627); *The True Travels* (1630); *Advertisements for the Unexperienced Planters* (1631).

The best edition of Smith's works is that edited by Edward Arber, and published in Birmingham. Eng., in 1884. In this are also printed most of the pamphlets of his contemporaries, including those unfriendly to Smith. A later biography is by E. K. Chatterton. This was published in 1927 as one of the *Golden Hind Series*, which contains the biographies of the great Elizabethan seamen and explorers who gave lustre to that age. This book contains a full bibliography of Smith's own writings, and a very extensive list of the writings in reference to him. An engraving was made of Captain John Smith from life by Simon van der Pass, which has been reproduced many times. There is in the Virginia state library a portrait of an Englishman dressed in Turkish costume, which experts pronounce an original portrait of Captain Smith. (H. R. McI.)

SMITH, JOHN RAPHAEL (1752–1812), English painter and mezzotint engraver, a master particularly of the latter art, was the son of Thomas Smith, called Smith of Derby, a landscape painter. Some of the younger Smith's reproductions of Reynolds' works rank among the masterpieces of the art of mezzotint, the prints being delicate, excellent in drawing and finely expressive of colour. Smith also had an extensive connection as a print dealer and publisher, and his small full-lengths in crayons and his portraits support his claim to be a successful draftsman and painter. He died at Doncaster, Yorkshire, on March 2, 1812.

SMITH, JOSEPH (1790–1877), U.S. naval officer whose outstanding service during the Civil War as chief of the bureau of navy yards and docks, in the navy department, won the praise of Secretary Welles and President Lincoln. He was born in Hanover, Mass., March 30. 1790, and became a midshipman in 1809. He received a silver medal from congress for gallantry in the battle of Lake Champlain. After commanding the ship of the line "Ohio!" he was commodore of the Mediterranean squadron. 1843–45. Smith became chief of the bureau of navy yards and docks in 1846, serving until 1869. He was made a rear admiral on the retired list when that rank was established in 1862. He died in Washington, D.C., Jan. 17, 1877. His son, JOSEPH BRYANT SMITH. was killed while in command of the U.S.S. "Congress" during her battle with the "Merrimac" on March 8, 1862. (J. B. HN.)

SMITH, JOSEPH (1805–1844), U.S. founder of the Mormon religion, was born at Sharon, Vt., Dec. 23, 1805, the third son of Joseph and Lucy Mack Smirh. His early career is shrouded in controversy. Neighbours in Palmyra, N.Y., described him as a romancer and diviner who dug for buried treasure, and their stories can be largely verified by court records, early newspaper accounts and the autobiography of his mother. In his own history, written after 1838, Smith described himself as an unschooled, pious boy who had a vision of God and Jesus Christ at the age of 14. At 17, he said, an angel directed him to buried golden plates containing a history of the American Indians, which described them as descendants of Hebrens who had centuries earlier sailed to America by way of the Pacific. This *Book of Mormon* he translated from "reformed Egyptian" with the aid of magic stones he called the Urim and Thummim.

By most objective scholars the book is regarded as a potpourri of local Indian origin legends, fragments of autobiography, and the current religious and political controversies, particularly Anti-masonry, all transformed with remarkable ingenuity into a religious saga of quasi-biblical authority. After its publication in 1830, Smith offered it as scientific evidence of his divine calling, and claimed that his new church, organized April 6, 1830, was a restoration of the ancient, primitive Christian religion

Converts in ever-increasing numbers followed Smith from New York to Ohio, then to Missouri and on to Illinois, despite great suffering. The young prophet governed his people with the help of revelations, which dealt with such divergent matters as the anthropomorphic nature of God, the communistic United Order and the size, location and financing of a hotel. He taught that the heavens are peopled with many gods, and that every man can aspire in time to be a god himself.

Joseph Smith was a man of commanding presence, athletic grace and prodigious personal charm. A genius at improvisation, he managed to combine Jewish and Christian mysticism with the goal of perpetual prosperity, and to establish the tradition of Mormonism as a complete "way of life." Although his revelation on polygamy was not made public (by Brigham Young) until 1852, four years after Smith's death, and though it is not supported by the *Book of Mormon,* there is evidence that he may have married as many as 50 wives. He publicly acknowledged only his first, Emma Hale Smith, who bore him nine children.

When a handful of dissenting Mormons attacked him in their newspaper, Smith had their press destroyed. For this he was imprisoned, with his brother Hyrum. On June 27, 1844, an anti-Mormon mob stormed the jail at Carthage, Ill., and shot both men. The church split into pieces, but the majority followed Brigham Young (*q.v.*), a sagacious administrator and colonizer, who led the Mormon exodus to Great Salt lake. A smaller group, led by the eldest of Smith's four surviving sons, who denied that their father had practised polygamy, settled in Independence, Mo. (*See* also LATTER-DAY SAINTS, CHURCH OF JESUS CHKIST OF.)

Joseph Smith's writings include, in addition to *The Book of Mormon* (1830), *A Book of Commandments for the Government of the Church of Christ* (1833); *Doctrine and Covenants of the Church of The Latter Day Saints* (1835).

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SMITH, SIR KEITH MACPHERSON (1890–) and **SIR ROSS MACPHERSON** (1892–1922), brothers, Australian pioneer aviators, were born at Adelaide, S. Austr., on Dec. 20, 1890. and Dec. 4. 1892, respectively. They were both educated at Queen's school, Adelaide, and at Warriston school, Moffat. Scotland. During World M'ar I, Keith served in the Royal Flying Corps and Royal Air Force as a pilot, 1917–19, while Ross served with the Australian Light Horse in Gallipoli and Sinai. In 1916 he learned to fly in Egypt and spent the last two years of the war in the Australian flying corps in Palestine. He made the first flight from Cairo to Calcutta in 1918. In Nov.–Dec. 1919, Ross as first and Keith as second pilot, in a Vickers Vimy twin-engined biplane with Rolls Royce 375 h.p. engines, accompanied by Sgts. J. M. Bennett and W. H. Shiers as mechanics, made the first flight from England to Australia, landing at Darwin, Northern territory, on Dec 10, 1919. For this flight the brothers received knighthoods and the prize of £10,000. Three years later they began preparations for a pioneer round-the-world flight in a Vickers pusher-amphibian aircraft, but Ross was killed, together with Bennett, while testing the aircraft at Brooklands, Eng., on April 13, 1922. Keith went into business in Sydney, Austr. (D. CR.)

SMITH, ROBERT (1757–1842), U.S. statesman, was U.S. secretary of the navy, 1802–09, under Jefferson; also secretary of state, 1809–11, under Madison. In the last mentioned post he entered into an agreement with David M. Erskine, the British minister at Washington, D.C., which was promptly repudiated by George Canning, the British foreign secretary; and, when Canning sent the insolent Francis James Jackson to take Erskine's place at Washington, it became necessary for Secretary Smith to break off all relations with the British minister.

Smith was much maligned by his enemies, the chief of whom was Albert Gallatin, uho had been kept out of the office of secretary of state; and the reputation of Smith has subsequently suffered at the hands of historians. But a later writer pointed out that as a member of the Maryland legislature, and as secretary of the navy under Jefferson, Smith appeared eminently successful; and this writer has also shown that his work as secretary of state was of a high order, that Gallatin's charges against him (the mishandling of government funds) broke down completely. and that Gallatin, by threatening to resign as secretary of the treasury, prompted Madison to call for the resignation of Smith.

After his retirement Smith reviewed his career as secretary of state in an *Address to the People of the United States* (June 1811).

Thereafter he served in various positions in Maryland, and died on Nov. 26. 1842. the last survivor of the electoral college of 1789, which elected George Washington first president of the United States.

See Charles C. Tansill, "Robert Smith, Secretary of State," in Samuel Flagg Bemis (ed.), *The American Secretaries of State and Their Diplomacy*, iii, 151–200 (1927).

SMITH, SEBA (MAJOR JACK DOWNING) (1792–1868), U.S. editor and humorist, creator of Major Jack Downing, a rustic Yankee whose horse sense and wise saws as the purported counselor and friend of Andrew Jackson brought laughs that swept the country, mas born in Buckfield. Me., on Sept. 14. 1792. A graduate of Bowdoin college. Brunswick, Me.. Smith in 1829 founded the *Portland Courier,* where the Major's fictional letters first appeared in Jan. 1830, continuing later in the *National Intelligencer* until July 1853. Major Jack was a common man magnified as oracle; yet there was irony in his role of threadbare office seeker exposing follies in a mobocracy. As adviser to President Jackson, Jack was in the heyday of his popularity; this led to shameless counterfeiting of Smith's invention and to his collection of the letters in book form. the last volume being published in 1859 under the title of *My Thirty Years Out of the Senate*. In the Downing letters Smith is intent on the portrayal of New England character, an aim more completely carried out in his *Way Down East* (1854). Smith's title to distinction comes from his hitting upon something new in humour that has become a part of American tradition. Practically forgotten himself. he numbers among his followers in satire James Russell Lowell's Hosea Biglow, Artemus Ward and Will Rogers.

Smith died July 28, 1868. in Patchogue, N.Y.

See Mary A. Wyman, *Two American Pioneers, Seha Smith and Elizabeth Oakes Smith* (1927); Constance Rourke, *American Humor* (1931). (M. A. WN.)

SMITH, SYDNEY (1771–1845), English writer and Anglican priest, son of Robert Smith, was born at Woodford, Essex. on June 3, 1771, the son of a wealthy and eccentric landowner. Sydney was the second of a family of four brothers and one sister, all remarkable for their talents. While two of the brothers, Robert Percy. known as "Bobus," afterward advocate general of Bengal, and Cecil. were sent to Eton. Sydney was sent with the youngest to Winchester, where he rose to be captain of the school. In 1789 he had become a scholar of New college. Oxford; he received a fellowship after two years' residence, took his degree in 1792 and proceeded M.A. in 1796. He was ordained priest at Oxford in 1796. and became a curate in the small village of Nether Avon, near Xmesbury. in the midst of Salisbury plain. The squire of the parish, Michael Hicks-Beach, engaged him after a time as tutor to his eldest son. It was arranged that they should proceed to the University of Weimar, but before they reached their destination Germany was disturbed by war and "in stress of politics," said Smith, "we put into Edinburgh." This was in 1798. While his pupil attended lectures, Smith was not idle. He studied moral philosophy under Dugald Stewart, and devoted much time to medicine and chemistry. He also preached in the Episcopal chapel, where his practical brilliant discourses attracted many hearers.

In 1800 he published his first book. *Six Sermons, Preached in Charlotte Street Chapel, Edinburgh,* and in the same year married, against the wishes of her friends, Catharine Amelia Pybus. They settled at no. 46 George street. Edinburgh. Toward the end of his five-year residence in Edinburgh, in Jeffrey's flat in Buccleuch place, Sydney Smith proposed the setting up of a review as an organ for young malcontents. "I was appointed editor." he says in the preface to the collection of his contributions. "and remained long enough in Edinburgh to edit the first number" (Oct. 1802) of the *Edinburgh Review*. He continued to write for the *Review* for the next quarter of a century, and his brilliant articles were a main element in its success.

Life in London.—He left Edinburgh for good in 1803, when the education of his pupils was completed, and settled in London, where he was morning preacher at Berkeley chapel. Mayfair, and "alternate evening preacher" at the Foundling hospital. He lectured on moral philosophy at the Royal institution for three seasons, from 1804 to 1806, when the London world crowded to Albemarle street to hear him. With the brilliant reputation that Sydney Smith had acquired in the course of a few seasons in London, he would probably have obtained some good preferment had he been on the powerful side in politics. Sydney Smith's elder brother "Bobus" had married Caroline Vernon, aunt of the 3rd Lord Holland. and he was always a welcome visitor at Holland house. His Whig friends came into office for a short time in 1806, and presented him with the living of Foston-le-Clay in Yorkshire. He shrank from this banishment for a time, and discharged his parish duties through a curate; but Spencer Perceval's Residence act was passed in 1808, and after trying in vain to negotiate an exchange, he moved his household to Yorkshire in 1809.

"Peter Plymley."—The ministry of "all the talents" was driven out of office in 1807 in favour of a "no popery" party, and in that year appeared the first installment of Sydney Smith's most famous production, *Peter Plymley's Letters,* on the subject of Catholic emancipation, ridiculing the opposition of the country clergy. Its full title was A *Letter on the Subject of the Catholics to My Brother Abraham Who Lives in the Country, by Peter Plymley*. Nine other letters followed before the end of 1808, when they appeared in collected form. Rumours of Peter Plymley's identity got abroad. Lord Holland wrote to him expressing his own opinion and Grenville's, that there had been nothing like it since the days of Swift (*Memoir,* i, 151). He also pointed out that Swift had lost a bishopric for his wittiest performance. Smith won the hearts of his Yorkshire parishioners as quickly as he had conquered a wider world. There had been no resident clergyman in his parish for 150 years; he had a farm of 300 ac. to keep in order; a rectory had to be built. All these things were attended to besides his contributions to the *Edinburgh Review*. He continued to serve the cause of toleration by ardent speeches in favour of Catholic emancipation. "I defy Dr. Duigenan[1]," he pleaded, addressing a meeting of clergy in 1823, "in the full vigour of his incapacity, in the strongest access of that Protestant epilepsy with which he was so often convulsed, to have added a single security to the security of that oath." At this time appeared one of his most vigorous and effective polemics, *A Letter to the Electors Upon the Catholic Question* (1826).

Later Years.—After 20 years' service in Yorkshire, he obtained preferment at last from a Tory minister, Lord Lyndhurst. who presented him with a prebend in Bristol cathedral in 1828, and two livings in the neighbourhood. From this time he discontinued writing for the *Edinburgh Review* on the ground that it was more becoming in a dignitary of the church to put his name to what he wrote. It was expected that when the Whigs came into power Sydney Smith would be made a bishop. But though he was not without warm friends at headquarters, the opposition was too strong for them. One of the first things that Lord Grey said on entering Downing street was, "Now I shall be able to do something for Sydney Smith"; but he was not able to do more than appoint him in 1831 to a residentiary canonry at St. Paul's in exchange for the prebendal stall he held at Bristol. He was as eager a champion of parliamentary reform as he had been of Catholic emancipation, and one of his best fighting speeches was delivered at Taunton in Oct. 1831 when he made his well-known comparison of the house of lords, who had just thrown out the Reform bill, with Mrs. Partington of Sidmouth, setting out with mop and pattens to stem the Atlantic in a storm.

On the death of his brother Courtenay he inherited £50,000, which put him out of the reach of poverty. He died at his house in Green street, London, on Feb. 22, 1845, and was buried at Kensal Green.

Sydney Smith's other publications include: *Sermons,* 2 vol. (1809); *The Ballot* (1839); *Works,* 3 vol. (1839), including the *Peter Plymley* and the *Singleton Letters* and many articles from the *Edznburgh Review;* A *Fragment on the Irish Roman Catholic Church* (1845); *Sermons at St. Paul's* ... (1846); and some other pamphlets and sermons. Lady Holland said (*Memoir,* i. 190) that her father left an unpublished manuscript. compiled from docu-

[1]Patrick Duigenan, M.P. for the city of Armagh, a Protestant agitator.

mentary evidence, to exhibit the history of English misrule in Ireland, but had hesitated to publish it. This mas suppressed by his widow in deference to the opinion of Lord Macaulay.

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SMITH, THEOBALD (1859–1934), U.S. pathologist, a pioneer in the comparative etiology and immunology of infectious and parasitic diseases, was born in Albany, N.Y., July 31, 1859. He earned baccalaureate and medical degrees at Cornell university, Ithaca, N.Y. (1881), and Albany Medical college (1883). From 1884 to 1895 Smith was director of the pathological laboratory of the bureau of animal industry in Washington, D.C., where he was also professor of bacteriology at Columbian university (later George Washington university). He served also as director of the pathological laboratory of the Massachusetts state board of health (1895–1915); as professor of comparative pathology at Harvard university (1896–1915); and as director of the department of animal pathology of the Rockefeller Institute for Medical Research (1915–29). Some of his most valuable research included the role of ticks in transmitting Texas or southern cattle fever (1888); his differentiation of bovine from human tubercle bacilli (1898), which was of value to Robert Koch in his later work; and the demonstration that killed cultures of bacteria may produce immunity. He died on Dec. 10, 1934.

See Hans Zinsser, "Biographical Memoir of T. Smith," *Biographical Memoirs of National Academy of Science* (1937–38), with bibliography. (W. F. N.)

SMITH, WALTER BEDELL (1895–1961), U.S. army officer and diplomat, was born in Indianapolis, Ind., Oct. 5, 1895. He began his military career as an enlisted man in the Indiana national guard, 1910–15, and in 1917 mas commissioned second lieutenant of infantry in the U.S. army. In Feb. 1942. during World War II, Smith was appointed secretary of the joint chiefs of staff and U.S. secretary of the combined chiefs of staff, with the rank of brigadier general. The following September he became chief of staff, European theatre of operations, and chief of staff to Gen. Dwight D. Eisenhower, serving in those posts until Eisenhower's departure from Europe after the war. Smith negotiated and accepted for the Allies the surrender of Italy in 1943 and that of Germany in 1945.

On his return to the United States in 1945 Smith became chief of the operations and planning division of the mar department general staff. Shortly thereafter he was appointed U.S. ambassador to the Soviet Union, holding the post from 1946 to 1949. Later he commanded the U.S. 1st army, 1949–50, mas director of the Central Intelligence agency, 1950–53 (having been promoted full general in 1951), and on Jan. 31, 1953, retired from active military service to become undersecretary of state. In Oct. 1954 he resigned from government service and entered private business. He died in Washington, D.C.. on Aug. 9, 1961. General Smith was the author of *My Three Years in Moscow* (1950) and *Eisenhower's Six Great Decisions* (1956). (F. C. PE.)

SMITH, WILLIAM (1769–1839), English geologist, called the father of English geology and known as "Strata Smith," was born at Churchill in Oxfordshire on March 23, 1769. At 18 he became assistant to a surveyor, Edward Webb, of Stow-on-the-Wold, and traversed the Oolitic lands of Oxfordshire and Gloucestershire, the Lias clays and red marls of Warwickshire and other districts, studying their varieties of strata and soils. In 1791 his observations at Stowey and High Littleton in Somersetshire first impressed him with the regularity of the strata. In 1793 he executed the surveys and levelings for the line of the Somerset coal canal, in the course of which he confirmed his supposition, that the strata above the coal were not horizontal. but inclined in one direction —to the east—so as to terminate successively at the surface.

On being appointed engineer to the canal in 1794 he made a tour with regard to inland navigation. He carefully examined the geological structure of England, and corroborated his generalization of a settled order of succession in the strata. In 1794 he coloured his first geological map—that of the vicinity of Bath—showing the ranges of the different strata across England.

In 1799 Smith dictated his first table of British Strata, (presented to the Geological society of London in 1831). It was headed *Order of the Strata, and Their Imbedded Organic Remains, in the Neighbourhood of Bath; Examined and Proved Prior to 1799.* In 1813 Joseph Townsend published, with acknowledgment, much information on the English strata communicated by William Smith, in a work entitled *The Character of Moses Established for Veracity as an Historian, Recording Events From the Creation to the Deluge*. Meanwhile Smith was completing and arranging the data for his large *Geological Map of England and Wales, With Part of Scotland* (15 sheets, 1815). The map—of great significance in the development of modern geology—was reduced to smaller form in 1819; and from this date to 1822, 21 separate county geological maps and several sheets of sections were published in successive years, constituting a *Geological Atlas of England and Wales.*

Smith's collection of fossils was purchased in 1816–18 by the British museum. In 1817 a portion of the descriptive catalogue, *Stratigraphical System of Organized Fossils,* was published. In 1816 he had commenced the publication of *Strata Identified* by *Organized Fossils,* with figures printed on paper to correspond in some degree with the natural hue of the strata. In this work (of which only four parts were published, 1816–19) is exemplified the principle he established of the identification of strata by their included organic remains, which changed the whole conception of paleontology. In 1831 the Geological society of London conferred on Smith the first Wollaston medal; and from the government he received a life pension of £100 per annum. The last years of his life were spent at Hackness (of which he made a good geological map), near Scarborough; and in the latter town. He died at Northampton on Aug. 28, 1839.

Smith's *Memoirs,* edited by his nephew, John Phillips, appeared in 1844.

See C. L. and M. A. Fenton, *Giants of Geology,* rev. ed., pp. 70–83 (1952).

SMITH, WILLIAM FARRAR (1824–1903), U.S. general, was born at St. Albans, Vt.. on Feb. 17, 1824, and graduated from West Point in 1845, being assigned to the engineer branch of the army. In Aug. 1861 he became brigadier general of volunteers, and in July 1862 he received promotion to the rank of major general, U.S. Volunteers. Smith led with conspicuous valour at Antietam and later was placed at the head of the 6th corps of the army of the Potomac, which he led at the disastrous battle of Fredericksburg (*q.v.*). The recriminations which followed led to a general order in which Smith and several other senior officers of the army were dismissed and suspended by Gen. Burnside. As a brigadier general Smith commanded troops in Pennsylvania during the critical days of the Gettysburg campaign. Later, in 1863, as chief engineer of the army of the Cumberland, he conducted the engineer operations which reopened the "cracker-line" from Chattanooga (*q.v.*) to the base of supplies. For the Virginian campaign of 1864 Smith was specially assigned by Grant to command the 18th corps, army of the James, and he took part in the battle of Cold Harbor and the first operations against Petersburg, after which, while absent on leave, he was suddenly deprived of his command by Grant. He resigned from the Volunteers in 1865 and from the U.S. army in 1867. After 1881 he was engaged in civil engineering work.

Smith died at Philadelphia on Feb. 28, 1903.

SMITH, WILLIAM HENRY (1825–1891), English man of business and statesman, was born in London on June 24, 1825. His father was the founder of the distributing firm of W. H. Smith & Son, in the Strand, and at an early age he became a partner and devoted himself to the business. In 1865 he contested Westminster in the Conservative interest against John Stuart Mill. He failed, but he won the seat in 1868. He was secretary to the treasury (1874), first lord of the admiralty (1877) secretary for war (1885), chief secretary for Ireland (1885), secretary for war (1886), and in the end of that year first lord of the treasury and leader of the House of Commons. He was no orator, and made no pretence to genius, but his success in these high offices was complete, and was due to the universal respect which was gained by his patience, good temper, zeal for the public service, and thorough kindness of heart. He died at Walmer Castle (which he occupied as Warden of the Cinque Ports) on Oct. 6, 1891. In recognition of his services a peerage in her own right was conferred on his widow, with the title of Viscountess Hambleden.

SMITH, WILLIAM ROBERTSON (1846–1894), Scottish philologist, physicist, archaeologist, Biblical critic, and editor, from 1881, of the 9th edition of this *Encyclopædia,* was born on Nov. 8, 1846, at Keig in Aberdeenshire, where his father was Free Church minister. He was educated at home and at Aberdeen University, where he won, among other honours, the Ferguson mathematical scholarship. In 1866 he entered the Free Church college at Edinburgh as a student of theology. During two summer sessions he studied philosophy and theology at Bonn and Göttingen. From 1868 to 1870 he acted as assistant to the professor of natural philosophy in Edinburgh University. During this period he produced much original work in the experimental and mathematical treatment of electricity. In 1870 he was appointed and ordained to the office of professor of Oriental languages and Old Testament exegesis at the Free Church college, Aberdeen. He was the pupil and personal friend of many leaders of the higher criticism in Germany, and from the first he advocated views which, though now widely accepted, were then regarded with apprehension. The articles on Biblical subjects which he contributed to the 9th edition of the *Encyclopædia Britannica* distressed and alarmed the authorities of the Free Church. In 1876 a committee of the General Assembly of that Church reported on them so adversely that Smith demanded a formal trial, in the course of which he defended himself with consummate ability and eloquence. The indictment dropped, but a vote of want of confidence was passed, and in 1881 Smith was removed from his chair. At the end of the trial he was probably the most popular man in Scotland. Marks of sympathy were showered on him from all sides.

In 1875 he was appointed one of the Old Testament revisers; in 1880–1882 he delivered by invitation, to very large audiences in Edinburgh and Glasgow, two courses of lectures on the criticism of the Old Testament, which he afterwards published *(The Old Testament in the Jewish Church,* first edition 1881, second edition 1892, and *The Prophets of Israel,* 1882, which also passed through two editions); and soon after his dismissal from his chair he joined Professor Baynes in the editorship of the *Encyclopedia Britannica,* and after Professor Baynes's death remained in supreme editorial control till the work was completed. His versatility, firmness combined with tact, width of view, and painstaking struggle for accuracy were largely responsible for the maintenance of its high standard. But he did not let his other duties interfere with his Semitic studies. He visited Arabia, Egypt, Syria, Palestine, Tunis and southern Spain, and had an intimate knowledge of, and personal acquaintance with, not only the literature, but the life of the East. His early friendship with J. F. McLennan, that most original student of primitive marriage, had a great influence on Smith's studies, and his attention was always strongly attracted to the comparative study of primitive customs and their meaning. His chief contributions to this branch of learning were a section of the article "Sacrifice" in the 9th edition of the *Encyclopædia Britannica,* his *Kinship and Marriage in Early Arabia* (Cambridge, 1885), and his *Lectures on the Religion of the Semites* (1st ed. 1889, 2nd ed. 1894). His originality and grasp of mind enabled him to seize the essential among masses of details, and he had in a marked degree the power of carrying a subject farther than his predecessors.

In 1883 Robertson Smith was appointed Lord Almoner's Professor of Arabic at Cambridge, which henceforth became his home. He occupied rooms in Trinity college till 1885, when he was elected to a professorial fellowship at Christ's college. In 1886 he became university librarian, and in 1889 Adams professor of Arabic. In 1888–1891 he delivered, as Burnett lecturer, three courses of lectures at Aberdeen on the primitive religion of the Semites. Early in 1890 grave symptoms of constitutional disease manifested themselves, and the last years of his life were full of suffering, which he bore with the utmost courage and patience. He never ceased to work, and when near his end was actively engaged in planning the *Encyclopaedia Biblica,* which he had hoped to edit. He died at Cambridge on March 31, 1894, and was buried at Keig. Small and slight in person and never robust in health, Robertson Smith was yet a man of ceaseless and fiery energy; of an intellect extraordinarily alert and quick, and as sagacious in practical matters as it was keen and piercing in speculation; of an erudition astonishing both in its range and in its readiness; of a temper susceptible of the highest enthusiasm for worthy ends, and able to inspire others with its own ardour; endowed with the warmest affections, and with the kindest and most generous disposition, but impatient of stupidity and ready to blaze out at whatever savoured of wrong and injustice. The sweetness and purity of his nature combined with his brilliant conversational powers to render him the most delightful of friends.

See the *Life* by J. S. Black and G. W. Chrystal (1912); *see* also James Bryce, *Studies in Contemporary Biography* (1903).

SMITH, SIR WILLIAM SIDNEY (1764–1840), English admiral, was born at Westminster on July 21, 1764, and entered the navy. In Jan. 1780 he was appointed lieutenant of the "Alcide" (74) after serving at Cape St. Vincent under Rodney; and in May 1782 was made commander of the "Fury" sloop, and promoted captain. He was knighted for his services (1790–92) in advising the king of Sweden during the war with Russia. In 1793 he assisted Lord Hood in the attempt to burn the enemy's ships at Toulon. In 1796 he was captured while hunting French privateers in the Channel, and imprisoned in Paris, whence he made his escape in 1798. In 1799 he left Constantinople, where he was plenipotentiary jointly with his brother, and hastened to the relief of St. Jean d'Acre, compelling Napoleon to raise the siege in May. For this exploit he received an annuity of £1,000. Smith co-operated with Abercromby in Egypt, and was wounded at Aboukir. Promoted rear-admiral of the blue in 1805, he was sent in 1806 to Sicily and Naples, and relieved Gaeta and captured Capri. Proceeding to Malta in 1807, he destroyed the Turkish fleet off Abydos, and in the following November blockaded the Tagus and assisted the Portuguese royal family to embark for Rio de Janeiro. Recalled from Rio de Janeiro, where he had been sent as commander-in-chief (1808), owing to his quarrel with the British minister, he was made a vice-admiral of the blue (1810) and in 1812 was sent to the Mediterranean, as second in command under Sir Edward Pellew. Made K.C.B. in 1815, and admiral in 1821, he died on May 26, 1840, at Paris. His self-assertion brought him into conflict with many of his contemporaries, including Nelson and Sir John Moore, but he was a daring and ingenious officer.

See Barrow, *Life of Admiral Sir W. S. Smith* (2 vols., 1848).

SMITH, WINCHELL (1871–1933), U.S. playwright, directed and wrote, usually with others, a number of popular successes. Born in Hartford, Conn., on April 5, 1871, he attended school there. He was an actor in New York city from 1892 and in 1904 began to produce, with Arnold Daly, plays by George Bernard Shaw. In 1906 he dramatized, with Byron Ongley, Barr McCutcheon's *Brewster's Millions,* the story of a man who had to spend $1,000,000 within a year. Smith's legendary actor "George Spelvin" (a second name given to a member of the cast who played two parts) first "appeared" in that play. His comedy *Lightnin'* (1918), written with Frank Bacon who starred in it, ran for 1,291 performances, a new record.

Smith's other plays included *The Fortune Hunter* (1909), in which John Barrymore appeared, and *The Only Son.*

He died on June 10, 1933.

SMITH COLLEGE, an institution for the higher education of women at Northampton, Mass. It was founded under the will of Sophia Smith (1796–1870) of Hatfield, who chose the neighbouring town of Northampton as the site of the college and selected the first trustees. The college was chartered in 1871 and opened in 1875. It became the largest independent college for women in the United States.

The equipment of the college consists of a campus of more than 200 ac., including about 30 ac. for athletics, dormitory units, the Neilson library, the Hillyer and Tryon Art galleries, Sage hall for music, the Lyman plant houses and a botanic garden, a swimming pool, an infirmary, a students' building containing a theatre, a student centre, an auditorium seating more than 2,000, gymnasiums and boat houses.

All students enter by the examinations of the college entrance examination board. The undergraduate courses, which are chiefly elective, lead to the degree of bachelor of arts. About 20% of the students in the junior and senior (third- and fourth-year) classes follow honours programs which allow a maximum amount of flexibility and give opportunities for individual work. Graduate courses lead to master's degrees in arts, education, physical education and, more rarely, to the degree of doctor of philosophy.

The Smith college school for social work, which established an eight weeks' summer session and programs of supervision in field work in various cities in winter, trains psychiatric social workers and prepares students for the degree of master of social science. Scholarships and fellowships are offered annually. From 1925 the college sent groups of students abroad, each under the direction of a member of the faculty, for study in the junior year, groups of Smith college juniors being established in Paris, Fr., Geneva, Switz., Florence, It., and Madrid, Sp. The college also made an exchange arrangement with the University of Toronto and sent students to the Wayne university junior-year in Munich. The department of education conducts a nursery school and a day school.

The college publishes the Smith College Studies in history, classics, modern languages and social work.

The college is governed by a board of 15 trustees, 4 of whom are nominated by the alumnae and serve for eight years, the others, with the exception of the president, serving for ten years and retiring in rotation. (W. A. N.; B. F. W.)

SMITH-DORRIEN, SIR HORACE LOCKWOOD (1858–1930), British general, was born on May 26, 1858. He joined the army in 1876, took part in the Zulu War and in the Egyptian campaign of 1882 and, attached to the Egyptian army, served at Suakim in 1884 and on the Nile in 1885–86. He took part in the Tirah campaign of 1897–98, in the final advance to Khartum in 1885 and later in South Africa. After being adjutant-general in India, he held the Aldershot command until 1912, when he was transferred to the Southern command.

On the death of Sir James Grierson in Aug. 1914, Sir H. Smith-Dorrien was appointed commander of the II. Army Corps. His troops received the brunt of the enemy's onset at Mons, and, although his action in giving battle at Le Cateau was criticized, it was subsequently recognized that it saved the British army from disaster. Afterward he commanded his corps at the battle of the Marne, on the Aisne, and during the severe fighting in Flanders in October and November. On the splitting-up of the expeditionary forces into two armies he was appointed to the command of the 2nd. Difficulties with the commander in chief led, in April 1915, to his return to England where he was placed in charge of one of the home defense armies. In the following November he was chosen to take charge of the operations against German East Africa, but he fell ill on the voyage out, and had to return home. From 1918–23 he was governor and commander in chief of Gibraltar. After his retirement in 1923 he published (1925) Memories of 48 Years' Service. He died Aug. 12, 1930.

SMITHSON, HENRIETTA CONSTANCE (1800–1854), Irish actress, the daughter of a theatrical manager, made her first stage appearance in 1815 at the Crow Street theatre, Dublin, as Albina Mandeville in Reynolds' Will. Three years later she appeared at Drury Lane, London, as Letitia Hardy. She had no particular success in England; but in Paris, in 1828 and 1832, where she first went with Macready, she aroused immense enthusiasm as Desdemnna, Virginia, Juliet and Jane Shore. She died on March 3, 1854.

SMITHSON, JAMES (1765–1829), English scientist and founder of the Smithsonian institution at Washington, D.C., was the natural son of Hugh Smithson Percy, first duke of Northumberland of the third creation. The duke's family name was Smithson. James Smithson's mother, Elizabeth Keate Macie, was a gentlewoman of large fortune, who had been twice married before James Smithson was born. She was a lineal descendant of King Henry VII. Most of Smithson's large fortune came from his mother's family but some also came from his father's relatives. He was educated at Pembroke college, Oxford, and is said to have been the best chemist and mineralogist of his year. He later became well known for his important work in these fields. The carbonate of zinc is named smithsonite (*q.v.*) in his honour. At the age of 22 he was admitted into membership in the Royal society on the recommendation of the great physicist Henry Cavendish, among others. He had a great regard for original research and publication. He wrote: "Every man is a valuable member of society who by his observations, researches, and experiments procures knowledge for men."

Smithson never married. Much of his life was spent on the continent, where he was well acquainted with the scientific leaders of the period. He died in Genoa, Italy, on June 27, 1829. The founding of the Smithsonian institution in Washington, D.C., was the result of a provision of Smithson's will. During his life Smithson never visited America, but in 1904 his remains were brought to the U.S. and are now interred in the original building of his institution in Washington. See also SMITHSONIAN INSTITUTION.

(L. CAR.)

SMITHSONIAN INSTITUTION, an institution of learning in Washington, D.C., founded by the bequest of an English scientist, James Smithson (*q.v.*). His estate was left to a nephew, Henry James Hungerford, with the stipulation that, should Hungerford die without issue, or should his issue die intestate or under 21, the whole estate should go "to the United States of America, to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men." Hungerford died without issue in 1835. There was much opposition in the U.S. to the acceptance of Smithson's bequest, especially by John C. Calhoun and others, who held that congress had no power under the constitution to accept such a gift, but it was accepted, largely through the efforts of John Quincy Adams.

Establishment. — In Sept. 1838 £104.960 in gold sovereigns was delivered from the clipper "Mediator" to the Philadelphia mint, where it was recoined into U.S. money to the amount of $508,318.46. In 1867, after the death of Hungerford's mother, a residuary legacy of $26,210 was received and the fund then amounted to $650,000. By savings of interest and by other gifts the fund was increased.

After 10 years of debate congress in 1846 accepted the trust and created by enactment an "establishment" called the Smithsonian institution, consisting of the president of the United States, the vice-president. the chief justice and the members of the president's cabinet. The institution has a secretary who is its executive officer. Smithson's money, a great fortune in that day, was lent to the U.S. treasury, the government agreeing to pay perpetually 6% interest upon it. The act of congress that created the institution provided that it should be governed by a board of regents composed of the vice-president and chief justice, three members of the senate, three members of the house of representatives and six private citizens. The act also provided for a library and for a museum to contain "objects of art and of foreign and curious research, and objects of natural history, etc.," belonging to the United States. The museum was later designated the United States National museum but remains under the direction of the Smithsonian institution.

The regents met for the first time on Sept. 7, 1816, and in the autumn of the same year they elected as secretary Joseph Henry (*q.v.*), then a professor at Princeton university, known for his experiments on the electromagnet and other subjects relating to electricity. Under his guidance the institution took shape. Henry seized the unique opportunity offered by the opening up of the great western areas of the United States to make collections of vegetation and wildlife and to study the Indian tribes. A principal feature of his administration was the establishment of international exchanges of scientific literature.

The diffusion of knowledge was promoted by publishing a series of periodical reports on the progress of different branches of knowledge, occasional separate treatises on subjects of general interest and monographs on special subjects investigated by experts. The Smithsonian was probably the first establishment in the United States to have a staff of full-time research scientists in a broad series of fields. In 1846 a plan was presented for the unification and systematization of weather observation under the institution. In Dec. 1847 an appropriation was made by the board for such meteorological research; in 1849 telegraphic transmission of meteorological intelligence collected by the institution mas begun; weather maps were successfully made in 1856. In 1870 the meteorological work of the institution was incorporated with the U.S. army signal corps. Still later the U.S. weather bureau was established by act of congress. After 1854 Henry's annual reports contained a general appendix with reports of lectures, such as were held under the auspices of the institution until 1865, summaries of correspondence, special papers, etc.

National Museum. — Spencer F. Baird (*q.v.*), Henry's successor, incorporated in the general appendix annual reports on the progress of the sciences. He also perfected Henry's system of international exchanges under which the institution, through agents in the principal cities of the world, exchanges its own publications, those of other departments of the U.S. government and those of learned societies for foreign publications. Baird had been at the head of the US. National museum, a branch of the institution, before he became secretary of the institution, and the museum particularly was developed during his administration. It was built up around the collections of the U.S. patent office, which were turned over to it in 1858, and those of the National institute, transferred to the Smithsonian in 1861 when the institute was dissolved. A part of the collection (including Smithson's collection) was destroyed by fire in 1865. The museum gained much valuable archaeological and ethnological material from the exploring parties sent out under John Wesley Powell (*q.v.*). It obtained excellent ichthyological specimens through Baird's position as U.S. fish commissioner, and acquired general collections from the Centennial exhibition of 1576. Its great collection of plants is known as the National herbarium. The museum had a phenomenal growth. In 1960 it occupied parts of three Smithsonian buildings and its catalogued objects totaled more than 54,000,000, distributed among its eight departments (anthropology, botany, geology zoology, science and technology, arts and manufactures, civil history and armed forces history).

The Bureau of American Ethnology was established as a branch of the institution in 1879, when the various organizations doing survey work in the west united as the U.S. geological survey, and anthropological and ethnological research was transferred to the Smithsonian institution. The bureau carried on studies of the American Indians and published monographs and reports of its researches. The river basin surveys became an active program of the bureau in 1945 when a unit was organized to salvage and preserve archaeological materials in the path of national flood-control, irrigation, hydroelectric and navigation projects.

Astrophysical Observatory. — In 1887 Samuel P. Langley (*q.v.*) was appointed as assistant secretary of the institution, and succeeded as secretary upon Baird's death in the same year. In 1890 Langley established the Smithsonian Astrophysical observatory to carry on research on the physical aspects of the heavenly bodies, particularly the sun. Its early research concerned especially the measurement of the intensity and characteristics of the infrared solar rays. Langley developed the bolometer, an instrument capable of recording one-millionth of a degree of temperature. After 1900 the research concentrated on measuring the quantity and quality of the sun's radiation as it is found in free space at the earth's mean diameter. Field stations for solar observation mere operated at several points in Africa, South America and the United States. In 1955 the observatory moved its scientific headquarters to Cambridge, Mass. Its activities encompassed the study of meteorites and the optical tracking of artificial earth satellites.

National Zoological Park. — By acts of congress of March 2, 1889, and April 30, 1890. the National Zoological park mas established under the institution. In a wooded area of 175 ac. in the valley of Rock creek in Washington, D.C.. the institution installed a small collection of animals that later grew to be one of the foremost collections of its kind in the United States.

Art Collections. — Upon her death in 1903, Mrs. Harriet Lane Johnston left her art collection to a national gallery of art, when such a gallery should be established. In 1906 the supreme court of the District of Columbia decreed that the art collection of the Smithsonian institution was a national gallery, and turned the bequeathed collection over to it. It was later renamed the National Collection of Fine Arts. Housed in the Smithsonian's natural history building. the gallery attracted gifts of great interest and value, including the Ralph Cross Johnson collection of old masters the William T. Evans collection of paintings of American artists and the John Gellatly collection of paintings, glass, jewels and antiques. The gallery also directs a Smithsonian traveling exhibition service.

In 1907 Charles Doolittle Walcott (*q.v.*), eminent geologist and paleontologist, was elected secretary. During his administration of almost exactly 20 years the outstanding event for the Smithsonian was the receipt of the gift by Charles L. Freer of Detroit, Mich., of the Freer Gallery of Art, together with a large testamentary endowment. The Freer gift comprised more than 9.000 pieces, including works of American artists, especially James McNeill Whistler, Dwight W. Tryon, Abbott H. Thayer and T. W. Dewing, and of Japanese and Chinese masters, including precious screens ceramics and bronzes.

A major event of the 1930s was the establishment of the National Gallery of Art, the gift of Andrew W. Mellon (*q.v.*) to the American people, as a bureau of the Smithsonian.

Further Developments. — In 1928 Charles Greeley Abbot, astrophysicist and assistant secretary of the Smithsonian from 1918. was elected secretary. He continued the researches begun by Langley on the variation of the sun's radiation, improving instruments and methods and establishing three solar observatories in aidely separated regions of the earth.

Abbot was succeeded in 1945 by Alexander Wetmore, eminent ornithologist, whose administration was marked by the addition of two bureaus to the Smithsonian organization, both in 1946—the National Air museum, created by congress to collect, preserve and display aeronautical equipment of historical interest and significance; and the Canal Zone Biological area, a 3,000-ac. jungle-covered reserve on Barro Colorado Island, C.Z., where a wide variety of biological studies are conducted.

Leonard Carmichael, psychologist. became secretary in 1953. Under his leadership two Smithsonian programs mere notably advanced—an extensive project of renovating and modernizing museum exhibits; and a long-term program to provide new buildings for the growing institution. The total number of visitors to the Smithsonian, including all its buildings, exceeds 12,000,000 each year.

The Smithsonian park occupies an area in Washington, D.C., equivalent to about 12 city blocks. The oldest building. that of the institution proper. was erected in 1847–55. It is of Seneca brownstone in a mingled Gothic and Romanesque style, designed by James Renmick (*q.v.*), and is located in the southwestern part of the grounds. Southeast of it is the arts and industries building, erected in 1881; on the north side of the park is the natural history building (1911). Southwest of the original Smithsonian building is the Freer Gallery of Art (1921). The monumental National Gallery of Art building (1941) faces on the Mall and Constitution avenue, between Fourth and Seventh streets, N.W. In 1959 construction of a new building for a museum of history and technology was begun directly west of the natural history building. On the grounds is a bronze statue of Joseph Henry by W. W. Story.

Publications. — The institution conducts an extensive publication program and has issued and distributed throughout the morld about 10,000 scientific books and monographs. in the following series: Annual *Reports* (1846 *et seq.)*, in which the *Reports* of the

National museum were included until 1884, after which the museum *Reports* appeared as separate volumes; *Smithsonian Contributions to Knowledge* (1848–1916); *Smithsonian Miscellaneous Collections* (1862 *et seq.*); *Proceedings of the United States National Museum* (1878 *et seq.*); *Bulletins of the United States National Museum* (1875 *et seq.*), containing larger monographs than those printed in the *Proceedings,* and including *Contributions From the United States National Herbarium* (1890); *Annual Reports of the Bureau of American Ethnology* (1880 *et seq.*); *Bulletins of the Bureau of American Ethnology* (1886 *et seq.*); *Annals of the Astrophysical Observatory* (1900 *et seq.*); *Smithsonian Contributions to Astrophysics* (1956 *et seq.*); *Catalogues of the National Collection of Fine Arts* (1922 *et seq.*); *Oriental Studies of the Freer Gallery of Art* (1933 *et seq.*); *Freer Gallery of Art Occasional Papers* (1951 *et seq.*); and *Ars Orientalis* (1954 *et seq.*), sponsored jointly by the Smithsonian institution and the University of Michigan.

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(C. G. A.; L. CAR.)

SMITHSONITE, a mineral consisting of zinc carbonate, an ore of zinc which was formerly, until sphalerite (*q.v.*) began to be used in the 1880s, the principle source of all zinc produced (*see* also ZINC). In England smithsonite is known as calamine (*q.v.*). The formula of smithsonite is $ZnCO_3$. It crystallizes in the hexagonal system and is a member of the calcite group. Crystals are rare; it occurs usually in crusts or botryoidal masses. A porous variety is called dry-bone ore. The hardness is 4 to 4.5, and the specific gravity is 4.43 for the pure material, but varies with isomorphous replacement of the zinc by iron, manganese, calcium and magnesium. The colour of the pure mineral is white, but it is more often brownish and sometimes green or blue; a bright yellow variety containing some cadmium sulfide has been found in Arkansas and is known as "turkey-fat" ore. It is a secondary mineral, formed by the action of ground water containing carbon dioxide on primary zinc minerals. It is frequently associated with hemimorphite, sphalerite and galena.

Smithsonite occurs in Silesia and the Rhineland (Germany); Sardinia (Italy); Laurium, Greece (a translucent blue-green variety); Santander, Spain; Missouri, New Mexico, Utah, Colorado, Montana and other localities in the United States; and in Algeria, Tunisia, Northern Rhodesia and Tsumeb, South-West Africa. The mineral was named after James Smithson, the founder of the Smithsonian institution. (L. S. RL.)

SMOG: *see* SMOKE AND SMOKE PREVENTION; FOG; DUST.

SMOHALLA (SHMOQULA; *i.e.,* "preacher"), a religious prophet of the North American Indians and founder of the sect called Dreamers, was born in the Columbia river valley about 1820 and became chief of the Wanapum tribe in Washington state. On one occasion after a tribal fray he was left for dead, but recovered and journeyed through California, Mexico, Arizona and Nevada back to his home on the upper Columbia, where he announced that he had been in the spirit world and had returned with a new revelation. This consisted in a return to primitive Indian customs, and a ritual combining genuine Indian features with what he remembered of Roman Catholic ceremonies. Smohalla had frequent trances and his influence extended over most of the tribes of eastern Washington and Oregon and western Idaho. The sect gave much trouble from 1870 to 1885 by refusing to come under reservation restrictions. A church was established at Priest Rapids on the upper Columbia, and one at Union Gap on the Yakima reservation. Smohalla died about 1908 but his religion continued to be influential.

See J. Mooney, "The Ghost-Dance Religion," in *14th Annual Report,* Bureau of Ethnology (1896).

SMOKE: IN WARFARE. While smoke has been one of the symbols and signs of warfare from earliest times, it was usually fire—rather than its by-product, smoke—that was dreaded by ancient armies in the field. Among primitive warriors, the American Indians had learned to employ smoke as an adjunct to military activity. They developed a visual signaling system of ascending smoke puffs that could be seen and interpreted by friendly tribesmen at considerable distances. Up until World War I, however, the use of smoke for tactical purposes was confined to special situations and was produced by improvised methods. It was during World War I that smoke and other chemical munitions had their inception on a standardized basis on the battlefields of Belgium and France. Later the employment of smoke munitions in warfare became recognized doctrine in all armies. In military operations smoke is used to advantage by ground, air and naval forces either on the offensive or on the defensive. Its main purposes are (1) screening and (2) signaling.

Screening Smokes.—For tactical and strategic purposes, smoke clouds are formed by firing smoke shells, dropping smoke bombs, burning smoke pots or operating mechanical smoke generators. These clouds are made up of masses of tiny particles that remain suspended in the air and hence produce an obscuring curtain. The behaviour of the smoke is dependent on wind and other natural factors, but the mechanical agencies that are used to create the clouds give them certain initial characteristics. Smoke created by a bursting shell, for instance, is released instantaneously and quickly forms into an expanding, rising puff. Smoke pouring from a continuing source, such as smoke pots, generators and burning-type shells, on the other hand, rises in a long, unbroken stream and remains effective for much greater periods of time. In deciding on the use of smoke under a given tactical situation, the commander must be thoroughly familiar with the prevailing natural conditions of the area in which the target is located and know the possibilities and limitations of the smoke munitions immediately available to him. Otherwise, the employment of smoke might revert to the advantage of the hostile forces.

While the direction and the velocity of prevailing winds exert the major effect on released smoke, humidity and the nature of the terrain also have a bearing on its behaviour. As might be expected, the obscuring power and effective duration of smoke is enhanced under conditions of high humidity. Ordinary ranges of temperature encountered in the field, however, have no perceptible effect. Level and unbroken terrain is reflected in a more evenly spread obscuring cloud above it, whereas smoke over hilly and broken terrain is less predictable because of the prevalence of inconsistent and erratic wind directions and speeds in such areas. In wooded regions smoke clouds persist longer and tend to cling to the treetops. Ordinarily smoke will follow ravines and defiles that crease the terrain in target sectors. A variety of chemical shells produce smoke of varying properties that help overcome, or at least minimize, many of the screening handicaps inherent in the prevailing natural conditions of the battleground. Whenever smoke is used there is need for adequate observation and close co-ordination so that gaps and bare spaces that occur in the curtain can be readily repaired by directing artillery to fire smoke-producing munitions to the proper sectors of the target.

Individual soldiers and military units of all sizes have some means at their disposal for producing smoke. Smoke-producing munitions include the hand grenade and rifle grenade designed for the use of the individual soldier. Shells are made for firing from mortars, howitzers and guns. In the U.S. army, they range in size from those fired by 4.2 in. mortars up to the big 155 mm. guns and howitzers used by the ground forces. Airplanes use either smoke generators or bombs when assigned to screening missions. Generator-produced smoke establishes long, low-hanging, persistent curtains and can be used over water as well as land areas. Naval vessels are equipped with smoke generators to provide smoke curtains for self-concealment. In amphibious operations, guns mounted on ships of war fire gas shells at enemy installations. Under certain circumstances, smoke pots which will float on the surface of the water can be launched.

The most widely used chemical agent in smoke-producing artillery shells is white phosphorus. This chemical is inert when sealed in airtight jackets but burns and produces billows of dense white smoke when the shell bursts and the contents are exposed to the atmosphere. Special petroleum oils, heated and mixed with steam, are the smoke-producing agents used in mechanical smoke generators.

In tactical situations, smoke has many purposes that result in reducing casualties. saving matériel and speeding up operations in favour of the using forces. Its most important functions are to (1) blind hostile observation; (2) reduce effectiveness of enemy fire power: (3) hamper and confuse enemy operations; and (4) deceive the foe regarding the user's tactical preparations. Field tests and combat experience prove that the fire from troops enveloped by smoke is tremendously less effective than that from troops aiming into it. As a consequence. an attacking force can develop an advantage by firing smoke shells directly on hostile defensive positions both before and during an assault. This will not only minimize enemy fire power but will cause confusion among his troops. At the same time smoke conceals from enemy observation the size, deployment pattern. armament and movement of the, advancing forces so that they achieve a certain degree of surprise in the attack. This is particularly important in assaults on strong points such as caves, dugouts. bunkers, pillboxes and machine gun emplacements where success is dependent upon getting close enough to the target so that flame throwers or hand grenades can be used effectively. Before the introduction of modern smoke munitions, attacking forces were obliged to rely on the natural concealment of night and early dawn to create similar advantages.

In the rear areas as well as in the combat zones smoke screens are used to conceal vital targets from observation and air attack Troop concentrations, supply dumps, ports. communication centres, towns and industrial areas can be given this screening security in both daylight and darkness. If the strategic situation indicates the need. smoke curtains can be maintained continuously in friendly locations over periods of weeks or even months by the use of mechanical generators. Smoke screens are sometimes used for deceptive purposes. Spread over strategically valueless areas they divert enemy attention from real targets and tend to draw wasted fire or useless bombing.

Signal Smokes. — Smoke munitions used for signaling or marking purposes contain organic dyes mixed with the basic burning chemicals which produce coloured smoke clouds. These clouds are visible for miles in good weather. Smoke-signal munitions come in a variety of colours. each having its own significance By using different colours or combinations of colours. almost any type of information concerning objectives can be conveyed to friendly forces deployed over wide areas. Coloured smokes are most frequently used to mark targets, to signal the need of specialized attack on specific objectives, to announce the time for attack and to call for artillery fire. Artillerymen often use signal-smoke shells for registering fire on targets. Smoke signals are also used to indicate rallying points and assist members of units in getting oriented in difficult terrain during the heat of battle. In joint air and ground operations, troops use coloured smoke signals to identify themselves and their positions to friendly aircraft. For the use of the individual soldier. coloured smoke chemicals are contained in hand and rifle grenades. They are also used in various sizes of artillery shells as well as in smoke pots.

See also CHEMICAL WARFARE. (M. B. H.)

SMOKE AND SMOKE PREVENTION. The character of smoke varies according to its source, but the smoke that is produced in far the largest quantities and has the most injurious effects is caused by using raw bituminous coal as a fuel.

Most fuels consist of carbon, hydrogen, oxygen and nitrogen, with usually a little sulfur also, while in solid fuels there is also incombustible mineral ash. If complete combustion were attained no fuel would emit smoke. the final products being limited merely to carbon dioxide. water vapour and free nitrogen, all quite innocuous gases. But, if sulfur is present, small quantities of sulfur dioxide are also given off; and this, although not visible, has a pungent smell and, in contact with air and moisture, tends rapidly to be converted into a corrosive acid.

For complete combustion a fuel must be brought into contact with enough air for full oxidation while maintained at a sufficiently high temperature. These conditions are by no means easy to fulfill, and in practice fuels always elude complete combustion. The unburned products vary widely both in amount and in composition according to the nature of a fuel and the way in which it is used. They are moreover, not necessarily in the form of smoke, since with insufficient air carbonaceous materials may emit gaseous intermediate products such as carbon monoxide and unsaturated hydrocarbons: but whether or not smoke is produced, imperfect combustion is always indicative of thermal loss

Gaseous fuels in properly constructed and properly adjusted burners produce neither smoke nor other unburned products in appreciable quantity. An inadequate air supply, however, or the chilling or smothering of the flames, may result in unburned gaseous products, including carbon monoxide and oxides of nitrogen. both highly poisonous; or in extreme cases may even cause the deposition of soot.

Smoke From Solid Fuels. — Because of their relatively high density, the problem of bringing solid fuels into contact with sufficient air for complete oxidation is greatly intensified. and, even with an air supply far in excess of that theoretically required perfect combustion is not feasible. Anthracite, however. which is naturally nearly free from volatile matter, or coke, from nhich the volatile matter of the original coal has been artificially extracted, can be burned, if not completely, at least without emitting smoke. With bituminous coals. on the other hand, some smoke is practically unavoidable; for such coals decompose at temperatures belon the ignition point, evolving combustible gases and condensable tarry vapours. Coal smoke consists of unconsumed distillation products. in association with carbon and tarry matter condensed by premature chilling of flame, together nith dust and ash entrained by the upward rush of hot air and gases from the grate Some of this settles on the walls of the flue as soot; the remainder is carried out through the chimney into the atmosphere with the excess air and gaseous products of combustion, both burned and unburned.

The total home consumption of coal in Great Britain in the second half of the 20th century averaged more than 215,000,000 tons annually. Of this over 60,000.000 tons have gone to meet domestic requirements, the remainder being used industrially, largely for steam raising and for making gas and electricity. Coals of relatively low volatile content are used for steam raising; and nhen due attention is paid to furnace design. stoking procedure and draft control these coals can be burned without much smoke and nith remarkably high efficiencies of steam generation. On the other hand, in certain metallurgical furnaces, etc , it is claimed that a smoky atmosphere is essential. Other sources of industrial pollution are collieries railways, shipping, power stations. coke ovens and gasnorks the clay industries, etc.

Most of the British domestic coal supplies are drawn from highly bituminous seams, and, since they are burned in a very haphazard and careless manner, with little possibility of proper air regulation, it is not surprising to learn that the domestic chimney is on the whole responsible for far more than its proportionate share of smoke and soot. In London, two-thirds of the total smoke is domestic but in centres of iron. steel or pottery manufacture, or in the immediate vicinity of large works, industrial smoke may obviously preponderate. Apart from considerations of its quantity, hen-ever, domestic smoke is in character far more objectionable than factory smoke, as it contains relatively high proportions of tar. nhile boiler smoke consists largely of ash and dust. The sticky nature of tarry soot causes it to adhere tenaciously to anything with which it comes into contact and, since it usually contains free sulfur acids in addition to ammonium sulfate, it has a destructive action upon stone, fabrics, metals and vegetation.

In 1912, under the auspices of the Coal Smoke Abatement society, a voluntary committee was appointed for the investigation of atmospheric pollution. This later became an advisory committee of the meteorological office, but in 1927 was transferred to the department of scientific and industrial research as the atmospheric pollution research committee. Annual reports are published by

H.M. stationery office. The chief aim throughout has been the compilation and collation of systematic information respecting the nature and amount of atmospheric pollution in various localities, as carried out in co-operation with various local authorities.

Town air contains large numbers of suspended solid particles, which of course are not derived exclusively from smoke but include also dust, vegetable matter, etc. These tend gradually to settle down under the force of gravity. The impurities so deposited can be caught in a suitable receptacle and analyzed and, collected under similar conditions in different places, afford material for interesting comparisons. The lowest deposits, measured in the smaller towns or in suburban districts, amount annually to 75–100 tons per square mile; the highest deposits, measured in the heart of large industrial areas, reach ten times these amounts. Altogether, in Great Britain. about 3,000,000 tons of solid matter and about 5,000,000 tons of sulfur dioxide are emitted into the atmosphere every year.

One of the most interesting features is the gradual alteration shown in the composition of the deposit from town to country, particularly in regard to carbonaceous matter and sulfates. In the heaviest deposits the proportion of carbonaceous and tarry matter is relatively high, usually 20%–25% of the total, but in the lightest deposits it may fall as low as 10%. On the other hand sulfates. which (as sulfur trioxide) in city deposits account for only 5%–15% of the total. may rise to 20% in country districts. In London the impurity suspended in the atmosphere is at its minimum between midnight and 6 A.M., subsequently rising rapidly, on the lighting of fires, to a maximum at 9 or 10 A.M.. after which it gradually falls again; pollution is naturally less in summer than in winter, and Sundays are on the whole the cleanest days.

Evil Effects of Smoke.—Smoke damages health, property and vegetation and causes greatly increased expense in general maintenance. washing, cleaning and artificial lighting It is also indicative of a loss of fuel, which in soot alone probably amounts to at least 2,000 000 tons annually in Great Britain, while unburned gaseous products of combustion are responsible for still more serious thermal losses.

The duration of sunshine in such towns as Leeds, Sheffield and Manchester is in the winter months less than half that in outlying districts. In summer the deficiency is less marked but the intensity is at all times impaired. particularly in respect of the ultraviolet rays, which are now recognized as being so essential to health.

Were it not for the action of the nind in spreading smoke and its tendency to rise to the upper layers of the atmosphere, which normally are cooler than those beloa, fog would be an everyday occurrence in thickly populated districts. Still weather, indeed, is in winter usually accompanied by more or less dense smoke fog. or haze, especially since on cold. clear nights radiation to space chills the surface layers of air and is liable to produce in the atmosphere a "temperature inversion," or increase of temperature with height, which checks the upward drift of chimney products. Smoke also contains hygroscopic particles which act as nuclei for the condensation of water vapour and tend to produce wet fogs in chilled air. As might be expected, not only the number of carbon particles but also the amounts of carbonic and sulfurous acid rapidly increase during fog.

The depressing effects of dirt and gloom perhaps scarcely need be insisted upon, but the exact relation between smoke and physical welfare is impossible to assess. because of the large number of other contributory factors. Smoky fog is certainly the signal for an increase in the number of deaths from pulmonary and cardiac diseases. but since such fogs are associated nith special types of weather they are not necessarily its sole cause.

The sulfur acids in soot or rain attack and destroy building materials, particularly limestones, slates and zinc; but sandstones are not so badly affected.

The contrast between town and country gardens makes sufficiently apparent the detrimental effects of smoke upon vegetation. A deposit of soot, apart from the corrosive action of its acid constituents, not only impedes the transpiration of plants but also acts as a screen to sunlight. Acid rain is also directly harmful to plant life. The vitality of any type of vegetation usually suffers progressively as an industrial centre or large town is neared; crops diminish and reproductive powers are enfeebled, while some plants refuse altogether to grow in urban districts.

Prevention of Smoke.—To speak broadly, the prevention of smoke is to be sought both in improved methods of burning raw coal and in pretreatment of coal for the production of potentially smokeless alternative fuels, such as gas and coke.

There are grounds for regarding hopefully the prospects of industrial smoke abatement. The observation of scientific principles in furnace design and air regulation coupled with the adoption of continuous mechanical stoking has made possible the almost smokeless operation of modern large-scale boilers, even when working on bituminous coals; but smoke is less easy to prevent in small hand-fired boiler furnaces.

Nevertheless there is ample evidence to prove that coke is a convenient and efficient boiler fuel, capable of giving results not inferior to those obtainable with coal. Its bulkiness. however, is a disadvantage. There is also taking place, especially in small-scale furnaces, a gradual development of the use of gas and oil. The use of pulverized fuel has also increased, especially in big power stations. In this form solid fuel can be burned completely, but the sulfur products are of course not reduced, and unless special precautions are taken a large proportion of the ash may be carried into the atmosphere as a gritty dust. Gas firing is being successfully adopted in certain branches of the pottery industry, and both gas and electrical furnaces are making headway in formerly smoky metallurgical processes; while for power production the use of electricity is steadily developing. The work of the ministry of fuel and power on fuel economy was expected to react against industrial smoke-emission.

There is little hope of burning bituminous coal smokelessly in domestic appliances despite improvements in the design of grates and other appliances. The Egerton report on the heating and ventilation of dnellings (1945) and the Simon report on domestic fuel policy (1946) dealt exhaustively with this important subject. For certain purposes, such as cooking and intermittent heating, gas or electricity may compare favourably with coal even in running cost; but unfortunately the complete elimination of solid fuel was not immediately practicable in Great Britain in the middle of the 20th century. Gas coke and anthracite suggest themselves as alternatives to coal, but both are somewhat difficult to ignite and, although suitable for use in independent boilers or special grates, they are not altogether convenient in ordinary grates. The coke from low-temperature carbonization is a good household fuel, but is made only in small quantities.

British Legislation Against Smoke.—As early as 1306 a royal proclamation was issued, forbidding the use of coal in London, followed by a commission to punish miscreants "for the first offence with great fines and ransoms, and upon the second offence to destroy their furnaces" A further proclamation issued in Elizabeth I's reign made illegal the burning of coal during the periods when parliament was sitting. Nevertheless its use continued, for the great forests were dwindling before the agricultural needs of an increasing population, and wood was becoming both scarce and dear. In 1648 Londoners unsuccessfully petitioned parliament to prohibit the importation of coal from Newcastle on account of the injury suffered from smoke.

The extraordinary industrial activity of the 19th century gave the coal industry further impetus, and by 1819 the smoke nuisance had become so conspicuous that parliament appointed a committee to enquire how far persons using steam engines and furnaces could erect them in a manner less prejudicial to public health and comfort: but although it was reported that evidence bore out the practicability of smoke prevention, no active steps were taken. Select committees in 1843 and 1845 achieved some practical result: sections were inserted in the Railway Clauses act of 1845 requiring locomotives and in the Town Improvement Clause act of 1817 requiring factory furnaces to consume their own smoke.

Between 1875 and 1926 English law relating to the excessive emission of smoke from industrial chimneys, with the exception of London. was administered under clauses in the Public Health act, 1875. London was covered by very similar but somewhat more severe provisions in its own Public Health (London) act, 1891, while certain modifications of the general clauses of the act of 1875 were introduced in local acts. Scotland also had separate legislation. By mid-20th century legislation was still based on the act of 1875, modified by the Public Health (Smoke Abatement) act, 1926, which was largely the outcome of the work of a departmental committee on smoke abatement. Domestic grates were exempted, but power was given to make bylaws requiring the provision in new buildings other than private dwelling houses of such arrangements for heating and cooking as might be calculated to prevent or reduce smoke emission.

Under some of the subsequent local acts, several towns made plans for establishing "smokeless zones" in which all emission of smoke would be prohibited; and one local authority was planning to subsidize the installation of modern domestic appliances.

The Clean Air act, 1956. went into force (1958), dark smoke emission or lack of dirt and grit-arresting equipment being made offenses. The local authorities could declare smoke control areas in which smoke emission was an offense.

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U.S. PRACTICE

St. Louis. Mo., at mid-19th century passed an ordinance regulating the height of chimneys, and the first smoke case on record in any U.S. court occurred in that city in 1864, when one Whalen was awarded $50 damages in the local court, which declared smoke to be a nuisance. The case was appealed to the Missouri supreme court. which upheld the lower court's decision.

Until the early part of the 20th century, anthracite from the mines of eastern Pennsylvania was the prevailing fuel used in New England and along the northern Atlantic seaboard. Even until World War I, New York city. Philadelphia and Boston were cited as examples of smokeless cities. From western Pennsylvania to the Rockies. the prevailing fuel was high volatile (more than 30%) bituminous coal. Large deposits of such fuel were readily available. For these reasons, agitation about smoke began mostly in midwestern communities.

Chicago began to be concerned about smoke as early as 1874, when a citizens' association interested itself in the problem. The first smoke ordinance in the United States was adopted by the Chicago city council. April 1881, to take effect May 1, 1881. It declared that "the emission of dense smoke from the smokestack of any boat or locomotive or from any chimney anywhere within the city shall be . . . a public nuisance." The penalty for violation was not less than $5 and not over $50. Cincinnati. O., adopted a somewhat similar ordinance a few months later. Within a few years, smoke ordinances were adopted by several midwestern cities. including Pittsburgh, Pa., Cleveland. O.. St. Louis and St. Paul. Minn.

An interesting case which reached the U.S. supreme court originated in Des Moines. Ia.. in 1915. The city of Des Moines had prosecuted a laundry plant for violation of the city smoke ordinance. which became effective September 6, 1911. After conviction. the laundry filed in the U.S. district court, southern district of Iowa, a bill to enjoin the enforcement of the Des Moines smoke ordinance. After receiving an unfavourable decision, the laundry appealed to the U.S. supreme court, which affirmed the district court's decision.

Early in the 20th century the Mellon institute made a comprehensive investigation of the damage caused by smoke in Pittsburgh and its costs to the people. The report showed that the actual cost of smoke to the residents of Pittsburgh amounted to $15–$20 per capita per annum. These costs included waste of fuel, extra cost of laundry and cleaning, damage to clothing, furnishings and structures, damage to merchandise in stores, cost of extra artificial lighting, replacement of metalwork on buildings, cost of cleaning exteriors of buildings, etc. Various later estimates of the cost of smoke to the American people ran as high as $2,500,000,000 annually.

Much of the physical damage caused by smoke is due to the burning of the sulfur in the fuel. The sulfur dioxide formed in the combustion process is a gas. When discharged from a stack, this gas quickly picks up moisture in the atmosphere. The moisture combines with the sulfur gases, together with free oxygen in the air. forming sulfuric acid, a highly corrosive substance. Any soot or dust particles accompanying the combustion gases. act as mechanical carriers of the acid. When deposited on structures, furnishings, clothing, etc., actual damage often results.

For many years, the U.S. bureau of mines acted as a clearinghouse for smoke prevention activities. In 1924 the bureau, in co-operation with the national engineering societies, drew up a standard smoke ordinance as a guide for lawmaking bodies. In the late 1920s and in the 1930s there was agitation for more strict smoke legislation and some standard on dust concentration to combat the increase in emissions of soot, fly ash and cinders. Late in 1939, the American Society of Mechanical Engineers appointed its model smoke law committee, to recommend a standard or model ordinance. This committee was composed of leading fuel and combustion engineers. After many years' work by the committee, the "Example Sections of a Smoke Regulation Ordinance" was adopted by the A.S.M.E. and published in 1949. These sections were used as a guide in writing or revising more than 100 ordinances.

At Donora, Pa., in Oct. 1948 a 5-day smog resulted in the death of 20 persons and the illness of nearly 6,000—43% of the population. This disaster resulted in greatly increased interest in prevention of smoke all over the United States. Agitation for preventive measures was voiced in scores of communities. Many municipalities adopted smoke ordinances or made existing ones more strict. Chicago, in 1907, was the first city to provide that there could be no construction of new fuel-burning plants or reconstruction of old ones without a city permit as to design. This ordinance proved satisfactory and came to be used almost universally. In 1938, Chicago established annual inspections to assure that plants were properly maintained.

Budgets for enforcing smoke regulations vary from about 2 cents to more than 20 cents per capita annually. In general, faster progress is made by those communities with the larger budgets.

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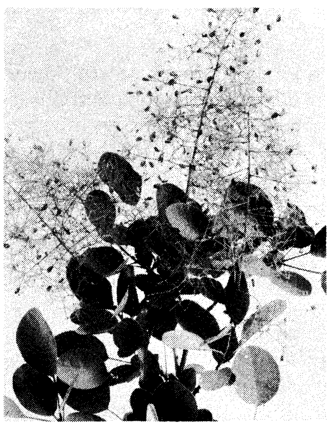
SMOKELESS POWDER: *see* EXPLOSIVES.

SMOKE TREE (*Cotinus coggygria*, formerly *Rhus cotinus*), a spreading shrub, sometimes 15 ft. high, of the cashew family (Anacardiaceae), native to southern Europe and eastward to central China, and widely planted for its feathery flower clusters and attractive foliage. The very similar American smoke tree (*C. americanus*), a tree sometimes 40 ft. high, is found from Kentucky and Missouri southward to Texas. The indigo bush (*Dalea spinosa*, family Leguminosae), sometimes 25 ft. high, native to the deserts of southeastern California adjacent to Arizona and Mexico, is also called smoke tree.



J. HORACE MCFARLAND CO.

COMMON SMOKE TREE (COTINUS COGGYGRIA)

SMOKY HILL RIVER, U.S. river that rises in extreme eastern Colorado, then flows east across the High plains. Blue hills and Smoky hills uplands of Kansas to join the Republican and become the Kansas river at Junction City, Kan. Like most western Kansas streams it carries relatively little water, fluctuates markedly in flow during the year and from year to year and has a normal peak from May to July. At Junction City the average flow is 861 cu.ft. per second. It is 540 mi. long, drains an area of 20,480 sq.mi. and has a valley floor from 1 to 9 mi. wide.

In sections of western Kansas it has eroded highly coloured Cretaceous beds into badlands. Much of the basin has annual rainfall below 20 in., and agriculture depends mainly on wheat, cattle and sorghum. Significant oil fields straddle its middle course. In the early 1960s four flood-control, irrigation and recreation reservoirs were in use: two at Kanopolis and Cedar Bluff and two on the Solomon (tributary) at Webster and Kirwin. (D. S. St.)

SMOLENSK, an *oblast* of the central region, Russian Soviet Federated Socialist Republic, U.S.S.R., having an area of 19,266 sq.mi. Population (1956 est.) 1,166,000 (urban 331,000, rural 835,000). It is bounded on the north by the Pskov and Kalinin *oblasts,* on the west by the Byelorussian Soviet Socialist Republic, on the south by the Orel *oblast* and on the east by the Moscow *oblast.* The central Russian plateau occupies much of the *oblast.*

The Vazuza and Gzhat, tributaries of the Volga, have cut a deep valley opening northward toward Rzhev, but most of the river valleys open toward the western plain. The Dnieper and its tributaries the Vop, Vyazma, Sozh and Desna have their source here but are not navigable, though timber is floated on them. The Kasplya and Mezha, flowing into the Dvina, and some of their affluents, are navigable for small boats. The Ugra, flowing eastward into the Oka, also forms a channel for floating timber.

The plateau region is composed of Carboniferous limestone, the western plain mainly of Tertiary sands, marls and ferruginous clays, covered with boulder clay. Post-Tertiary sands cover some areas, and the marshy depressions, which are a marked feature of this morainic region, and which are a source of malaria, are filled with peat bogs. These are a potential source of wealth in view of the increasing use of peat as fuel in electricity generating stations. There are patches of forest everywhere, most dense in the northwest and north, and thinning out to the southwest. The soil is of a clayey or sandy forest type, which is not favourable to agriculture.

The climate is somewhat modified by proximity to the western oceanic régime; average January temperature at Smolensk 13.5° F., average July temperature 67.2° F., rainfall about 20 in. per annum.

In spite of the poor soil, agriculture is the main occupation, the chief crops being rye, oats, potatoes and flax, with smaller quantities of buckwheat, barley, hemp and makhorka tobacco. Sheep, cattle, pigs and horses are bred. There is also a dairy and poultry industry. The improvement of agricultural methods began before 1917 and was actively carried on afterward.

Industries include flour milling, sawmilling, oil pressing and leather works. There are textile industries at Sychevka and Yartsevo. Apart from Roslavl, which has a population of 25,494, there is no large town other than Smolensk. Every variety of work dependent on the abundant timber supply is carried out, including the preparation of tar and pitch.

The *oblast* was important in early times as a link on the commercial route between Constantinople and the north. Later its position on the west made it the arena of struggles between Lithuania, Russia and Poland. The region suffered severely during the French invasion of 1812, and the peasants afterward remained in dire poverty, partly because of the unequal distribution of pasture. Proximity to the disorders of the western front in 1914–20 added to the distress.

SMOLENSK, a town of the R.S.F.S.R., U.S.S.R., the administrative centre of the *oblast* of Smolensk, situated on the Dnieper river, in 54° 50′ N., 32° 5′ E., at a point where the plateau is deeply entrenched and approaches the river both on the north and south. The ancient *kreml* or fortress was built on high crags on the left bank during the reign of Boris Godunov (1598–1605), but is now in ruins. The town developed owing to its position as a railway junction for five lines. Its industries include copper and iron smelting, the making of machinery for the textile industries, sawmilling, the manufacture of wooden goods, brick and pottery making and brewing. Pop. (1959) 146,000. After the revolution a university was created in the town. Its cathedral was built in 1676–1772. A monument commemorates the Russian composer M. I. Glinka (1885).

Smolensk is one of the oldest towns of Russia, and is mentioned in Nestor's *Chronicle* as the chief town of the Slav tribe of the Krivichis, situated on the great commercial route "from the Varyaghs to the Greeks." It maintained a lively traffic with Constantinople down to the 11th century, when the principality of Smolensk included Vitebsk, Moscow, Kaluga and parts of the present government of Pskov. The princes of Kiev were often recognized as military chiefs by the *vyeche* (council) of Smolensk, who mostly preferred Mstislav and his descendants, and Rostislav, son of Mstislav, became the ancestor of a series of nearly independent princes of Smolensk. From the 14th century these fell under the influence of the Lithuanian rulers, and in 1408 Smolensk was annexed to Lithuania. In 1449 the Moscow princes renounced their claims upon Smolensk, nevertheless this important city, with nearly 100,000 inhabitants, was a constant source of contention between Moscow and Lithuania. In 1514 it fell under Russian dominion; but during the disturbance of 1611 it was taken by Sigismund III of Poland, and it remained under Polish rule until 1654, when the Russians retook it. In 1686 it was definitely annexed to Russia. In the 18th century it played an important part as a basis for the military operations of Peter the Great during his wars with Sweden. In 1812 it was fortified; but the French, after a two days' battle, defeated the Russians here and took the city. Taken by the Germans in World War II in July-August of 1941, it became the central battlefield in the unsuccessful German drive towards Moscow in the autumn of 1941. It was liberated during the Russian advance of 1942–43.

SMOLLETT, TOBIAS GEORGE (1721–1771), British novelist, was born in Dalquhurn, Dumbartonshire. His father Archibald (youngest son of Sir James, the laird of Bonhill, a zealous Whig judge and promoter of the Union of 1707) died in 1723.

Tobias was sent to Dumbarton school, and, after qualifying for a learned profession at Glasgow university, was apprenticed in 1736 to a surgeon in that city. At the age of 18 he crossed the border to conquer England with a tragedy, *The Regicide,* based on Buchanan's description of the death of James I.

The story of the journey is told in the early chapters of *Roderick Random.* The failure of the play—certainly the worst thing he ever wrote—became the stock grievance of Smollett's life. No one would read it, and he would have starved had he not secured a position as surgeon's mate on H.M.S. "Cumberland," and served during the whole of the siege of Cartagena in 1741. The fleet returned to Jamaica, where Smollett fell in love with the daughter of a planter, Nancy Lascelles, whom he married on returning to England. He set up as a surgeon in Downing street, but with little success, and he soon began to devote his attention to writing fiction. His first novel *Roderick Random* (1748) recounts a life of varied adventure in the company of a servant. The author draws on his adventures on the English highway and in the cockpit of a king's ship, revealing the seaman to such purpose that, as Scott says, every one who has written about the navy since seems to have copied more from Smollett than from nature. There was no author's name on the title of the two small volumes of *Random;* it was actually translated into French as being by Fielding. But Smollett went to Paris to ratify his fame, and published his derelict play as "by the author of *Roderick Random.*"

Smollett still designed to combine medicine with authorship, for in June 1750 he obtained the degree of M.D.; and after a visit to Paris published in 1751 his second novel, *The Adventures of Peregrine Pickle,* which was a resounding success, both in England and France. It is no exaggeration to say that the tideway of subsequent fiction is strewn on every hand with the *dissecta membra* of Smollett's happy phrases and farcical inventions; but this novel is marred to an even greater extent by interpolations and personal attacks than its predecessor. His third novel, *Ferdinand Count Fathom*, appeared in 1753, by which time the author, after a final trial at Bath, had abandoned medicine for letters, and had settled down at Monmouth house, Chelsea. The squalor and irony of the piece repel the reader, but it is Smollett's greatest feat of invention, and was the model of all the mystery and terror school of fiction commencing with Radcliffe and Lewis. It was not particularly remunerative, and his expenses seem always to have been profuse. He was a great frequenter of taverns and entertained largely.

To sustain these expenses Smollett organized big and saleable "standard" works for the booksellers, contracting them out to his "myrmidons." He edited *Don Quixote*, a new literary periodical the *Critical* (Feb. 1756) by way of corrective to Griffith's *Monthly Review*, and organized a standard library *History of England*, and a seven-volume compendium of *Voyages*, for which he wrote a special narrative of the siege of Cartagena. In 1758 he projected and partly wrote a vast *Universal History*, and in Jan. 1760 he brought out the first number of a new sixpenny magazine, the *British*, to which he contributed a serial, the mediocre *Adventures of Sir Launcelot Greaves*. By these Herculean labours as a compiler Smollett must have amassed a considerable sum. For the extravaganza, *The Reprisal, or the Tars of Old England* he received £200. In 1762 Smollett edited the *Briton*. He had already been ridiculed, insulted, fined and imprisoned in the Marshalsea. He was now to support the North British favourite of George III in the press, not, we may reasonably suppose, without substantial reward. Yet after incurring all this unpopularity, Smollett was thrown over by his chief, Lord Bute, on the ground that his paper did more to invite attack than to repel it.

The *Briton* expired in Feb. 1763, and again Smollett undertook such tasks as a universal gazetteer and a translation of Voltaire in 38 volumes. In April, however, his only daughter died at the age of 15, and, over-wrought from sedentary strain, he followed the advice of his wife and made a two-years' sojourn abroad, mainly on the Riviera, which Smollett turned to such excellent purpose in his *Travels* (1766), remarkable alike for their acidity and for their insight. On his arrival from Italy, where he had provided material for Sterne's portrait of the distressful "Smelfungus," Smollett seemed to be getting over his pulmonic complaint. But his health was undermined, and a neglected ulcer helped to sap his strength. He resolved on a summer journey to Scotland, and when he proceeded to Bath in 1766 his complaint took a turn for the better. In 1768 he was again in London, and with a return of his vital energy came a recrudescence of the old savagery. *The History* and *Adventures of an Atom* is a clever, but coarse Rabelaisian satire upon the conduct of public affairs in England from the Seven Years' War to the date of publication. He lashes out on all sides without fear or favour. In 1769 he settled at Pisa and then near Antignano, near Leghorn, where during the autumn of 1770, he wrote ***Humphry Clinker***, in the form of itinerant letters. The character drawing, though still caustic, seems riper and more matured. He died at Leghorn Sept. 17, 1771, and was buried there in the old English cemetery.

The chief collective editions are as follows: 6 vols., Edinburgh, 1790; 6 vols., London, 1796, with R. Anderson's Memoir; *Works*, ed. J. Moore, 1797 (re-edited J. P. Browne, 8 vols., 1872); *Works*, ed. Henley and Seccombe (12 vols., 1899–1902); to which must be added a one-volume *Miscellaneous Works*, ed. Thomas Roscoe (1841); *Selected Works* (with a life by David Herbert) (Edinburgh, 1870); Ballantyne's edition of the Novels with Scott's memoir (2 vols., 1821); and G. Saintsbury's edition of the Novels (12 vols., 1895). There are Lives by Robert Chambers (1867), David Hannay (1887) and O. Smeaton (1897). Additional information will be found in the article on Smollett in the *Dict. Nat. Biog.*, Masson's *British Novelists*, H. Graham's *Scottish Men of Letters in the Eighteenth Century*, *Blackwood's Mag.* for May 1900; and the introduction to Smollett's *Travels Through France and Italy* (World's Classics, 1907). *See* also H. S. Buck, *A Study in Smollett, Chiefly Peregrine Pickle* (New Haven, 1925); L. Melville. *Life and Letters of Tobias Smollett, 1721–71* (1926); H. S. Buck, *Smollett as Poet* (1927).

SMOOT, REED (1862–1941), U.S. senator, was born at Salt Lake City, Utah, on Jan. 10, 1862. He was educated at Deseret university and at the Brigham Young academy. Provo Utah. He amassed considerable wealth as a banker and woolen manufacturer. In 1895 he was appointed one of the president6 of the Utah stake of the Church of Jesus Christ of Latter-day Saints (Mormon), and in 1900 was made an apostle. He was elected to the U.S. senate from Utah in 1902. Attempts were made to prevent his entering the senate because of his connection with the Mormon Church, and on the charge that he personally favoured polygamy and was a polygamist. He was allowed to take his seat; but the matter was referred to the senate committee on privileges and elections for investigation.

In June 1906 the committee, by a vote of seven to five, recommended that he be unseated; but, as the personal charges against him had not been proved, the senate in Feb. 1907, by a vote of 42 to 23, refused to remove him. He was re-elected in 1908, 1914, 1920 and 1926. In 1919 Smoot opposed participation by the United States in the League of Nations. Later he served as chairman of the finance committee of the senate, was a member of the World War foreign debt commission, a regent of the Smithsonian institution, an elector of the New York Hall of Fame, and chairman of the public buildings commission, directing the government building program at Washington, D.C., begun in 1927. He served in the senate until 1933.

SMUGGLING, a breach of the revenue laws either by the importation or the exportation of prohibited goods or by the evasion of customs duties on goods liable to duty. Legislation on the subject in England was very prolific from the 14th century downwards. In the reign of Edward III the illicit introduction of base coin from abroad led to the provision of the Statute of Treasons, 1351, making it treason to import counterfeit money as the money called "lushburg." Such importation is still an offense, though no longer treason. After the Statute of Treasons a vast number of acts dealing with smuggling were passed, most of which will be found recited in the repealing act of 1825. The smuggler of the 18th century finds an apologist in Adam Smith, who writes of him as "a person who, though no doubt highly blamable for violating the laws of his country, is frequently incapable of violating those of natural justice, and would have been in every respect an excellent citizen had not the laws of his country made that a crime which nature never meant to be so." The gradual reduction of duties (begun by Pitt) brought smuggling in the United Kingdom into insignificance until the revival of import duties after World War I led to frequent offense. Most of the existing legislation on the subject of smuggling is contained in the Customs Consolidation act, 1876.

The main provisions are as follows. Vessels engaged in smuggling are liable to forfeiture, and their owners and masters to a penalty not exceeding £500. Smuggled and prohibited goods are liable to forfeiture. Officers of customs have a right of search of vessels and persons. Fraudulent evasion or attempted evasion of customs duties renders the offender subject to forfeit either treble the value of the goods or £100 at the election of the commissioners of customs. Heavy penalties are incurred by resistance to officers of customs, rescue of persons or goods, assembling to run goods, signaling smuggling vessels, shooting at vessels, boats or officers of the naval or revenue service, cutting adrift customs vessels, offering goods for sale under pretense of being smuggled, etc. Penalties may be recovered either by action or information in the superior courts or by summary proceedings. In criminal proceedings the defendant is competent and compellable to give evidence. The Merchant Shipping act, 1894, makes any seaman or apprentice, after conviction for smuggling whereby loss or damage is caused to the master or owner of a ship, liable to pay to such master or owner such a sum as is sufficient to reimburse the master or owner for such loss or damage. and the whole or a proportional part of his wages may be retained in satisfaction of this liability. Additional provisions as to smuggling are also contained in the Customs and Inland Revenue act, 1879, and the Customs and Inland Revenue act, 1881. A smuggling contract is generally illegal, but it may be valid; and the vendor may recover the price of goods, even though he knew the buyer intended them to be smuggled, unless he actually aids in the smuggling so as to become *particeps criminis* Contracts to defraud the revenue of a foreign state are, 'according to English decisions, not illegal. There is a German decision, more consonant with international morality, to the opposite effect. The penalties for smuggling in the United States will be found mainly in tit. xxxiv, ch. 10 of the revised statutes. The seaman guilty of smuggling is liable to the same penalty as in England, and in addition to imprisonment for 12 months (sec. 4596) *See* also COAST GUARD.

SMUT AND BUNT, in botany and agriculture, the names given to certain parasitic fungus diseases of various flowering plants, especially cereals and other grasses. Smuts and bunts comprise the order Ustilaginales of the class Basidiomycetes. The name smut refers to the black or brownish powderlike masses of fungus spores which commonly appear in the flowers or heads, but in some cases on the stems, leaves or even roots of host plants. The smut fungi usually give little if any evidence of their presence in the host prior to spore formation. In some cases the fungus mycelium causes hyperplasia (increase in cell division) or hypertrophy (abnormal enlargement of existing cells) of the host, resulting in galls or tumours as exemplified in corn smut. The smuts in general are best typified by the genus *Ustilago,* species of which attack oats, barley, wheat, corn, etc. The loose and covered smuts (in the former the membrane enclosing the infected grain ruptures; in the latter it does not) which destroy the inflorescence of cereals are among the best known of the *Ustilago* types.

Bunt indicates a special group of the inflorescence smuts, caused by species of *Tilletia.* The bunts, or stinking smuts. so called because of their characteristic and unpleasant odour of decaying fish, are best exemplified by the bunt of wheat (Tilletia *caries* and *T foetida).* a classical disease of plant pathology. The bunt fungi invade the host when the latter is in the seedling stage. Their mycelia ramify and grow harmoniously with the host plant to its maturity. At this point the presence of the fungus is detected as it sporulates in the wheat head and completely replaces the grain with powdery masses of black spores.

The principal means for controlling most smuts is by seed treatment, either with chemicals or heat. Soil treatment, the use of resistant varieties and the adoption of certain cultural practices are other important control measures. Seedling-infecring smuts usually are controlled by various chemical seed treatments. The embryo-infecting loose smuts of wheat and barley may be checked by the hot-water or water-soak treatment of seed or by the use of certified smut-free seed.

The economic importance of smut fungi becomes apparent when it is realized that cereals constitute 73% of the total food consumed by man, and that smuts are one of the most important and uidely studied groups of cereal diseases. In the Pacific northwest region of the U.S., where wheat bunt has always been a serious problem, the average annual loss attributed to bunt in the five-year period 1951–55 was $4.500,000. The loose and covered smuts of barley, wheat and oats constantly threaten these cereal crops, especially where they are grown in the more humid or irrigated regions of the world.

Annual losses attributable to corn smut in the U.S. have run as high as 55,000,000 bu.

See FUNGI: *Basidiomycetes* (Club *Fungi*).

A bibliography pertaining to the smut fungi may be found in G. W. Fischcr and C. S. Holton, Biology and Control *of the Smut Fungi* (1957). (E. L. KE.)

SMUTS, JAN CHRISTIAAN (1870–1950), South African statesman and general, was born on May 24, 1870, near Riebeek West, Malmesbury district, Cape Colony, the son of J. A. Smuts and Catharina de Vries. In 1886 he commenced his studies at Stellenbosch, and in 1891 went to Cambridge, where his career was brilliant. In 1895 he was admitted to the Cape Town bar. In Oct. 1895 his first political speech was delivered at Kimberley, where. as a result of the understanding between Jan Hofmeyr and Rhodes, he defended the latter's policy. The Jameson raid (Jan. 1896) changed the whole complexion of South African politics. Smuts ranged himself on the side of the Transvaal, and shortly afterwards joined the Bar at Johannesburg. In 1898, though two years under the legal age, he was made state attorney by President Kruger, and took part in the negotiations with the British agent at Pretoria on the franchise. He accompanied Kruger to the abortive conference with Milner at Bloemfontein in July 1899.

In the early stages of the Boer War, Smuts was employed in legal and organising work, but on the occupation of Pretoria, in 1900, he joined the Boer field forces. From the Eastern Transvaal, where his Government was hard pushed, he made his way to the West, where he fought under De la Rey. Subsequently he acted as commander-in-chief of the Boer and Cape rebel commandoes in the Cape. He was besieging a mining camp in Namaqualand, when Botha sent for him to take part in the peace negotiations at Vereeniging (1902). He threw in his weight on the side of those who urged a compromise, as against the intransigent commandants.

After peace, Smuts became a strong and active protagonist of Botha's policy—loyalty to the new order, and racial conciliation. Practising as a barrister at Pretoria, he spent a good deal of time in the reconstruction of the remnants of the Boer nation and together with Botha and other leaders he met Joseph Chamberlain at Pretoria. The Boers, supported by part of the British population, strongly opposed several points in Milner's policy, *e.g.,* the importation of Chinese coolies for the gold mines, and Smuts was among those who refused Milner's offer of seats in the nominated Legislative Council.

Het Volk.—In 1904 Botha and Smuts founded the political organisation open to both races known as "Het Volk." Early in 1906 Smuts visited London, where he worked for fully responsible government in the Transvaal and Orange Free State, which was granted in 2906. Early in 1907 elections for the Assembly were held. Smuts took a prominent part and was returned unopposed for Wonderboom (Pretoria). As colonial secretary, under Botha, he became the driving force of the Cabinet. In May 1908 Smuts openly declared for the union of the South African colonies. In October of that year, the National Convention, which eventually produced the South African Act, began its work. Smuts was one of the makers of the Act. In May 1910 Union was consummated. Smuts was elected member of the legislative assembly for Pretoria West, and became minister of the interior, mines and defence. In 1911 the South African party was founded at Bloemfontein, where Smuts foreshadowed the political difficulties ahead. Early in 1912 he introduced his Defence bill, which powerfully affected the future of South Africa. A little later Smuts took over the treasury, retaining the portfolio of defence. During the Hertzog crisis, at the end of 1912, he did his utmost to prevent a split, but once the fateful step had been taken, he resolutely supported Botha. In July 1913 a revolutionary strike shook the Rand to its foundations. Botha and Smuts, at great personal risk (and unescorted) saved the situation at Johannesburg, after Lord Gladstone had sanctioned the use of Imperial troops to quell disturbances. In Jan. 1914 an attempted general strike was nipped in the bud by Smuts, who in record time rushed up the commandoes but recently organised under his Defence Act. The deportation of nine strike leaders on the S S. "Umgeni," though authorised by the Cabinet, was chiefly debited to Smuts by his opponents. A double Indemnity bill, covering the tno revolts, led to a violent and protracted parliamentary debate.

World War I.—The outbreak of World War I shifted the South African centre of gravity to Smuts' office. In Sept. 1914, when Beyers resigned as Commandant-General in the midst of the preparations for a campaign against the Germans in South-West Africa. Smuts assumed his functions. The rebellion of De Wet, Maritz. Beyers and others followed. This was suppressed by Botha, acting in the closest collaboration with Smuts at headquarters. In 1915, after a visit to Botha's forces in South-West Africa, Smuts took the leading part in the general election, which was marked by extreme bitterness. He was re-elected for Pretoria West by a narrow majority. Early in 1916 he refused the command offered him in East Africa by the Imperial Government, but shortly afterwards yielded to representations and proved successful in his operations against the German general Lettow-Vorbeck.

Work in London.—In March 1917 Smuts arrived in London to represent South Africa at the Imperial War conference, and was sworn as a privy councillor. After the conference, at a dinner given by members of both Houses of Parliament, he made his famous declaration embodying the concept of a British Commonwealth of Nations. He accepted a seat in the War Cabinet, taking a deep interest in the flying services, and his proposals for their unification were accepted by the Cabinet. Incidentally, he supervised London's air defences. He suggested, and became chairman of, the War Priorities Committee, which settled priority of claims among departments concerned in the war, and allocsted manpower and other resources. Occasionally he visited the Western front, where he conferred with commanders. In Dec. 1917 Smuts met Count Mensdorff at Geneva, and explored the possibility of a separate peace with Austria; but was finally convinced that it was not possible. The following Feb. he spent with Allenby in Palestine, working out plans for a great advance.

After the Armistice, Smuts wrote his Memorandum on the League of Nations, The League of Nations: *A* Practical *Suggestzon* (1918), which received the support of both President Wilson and Mr. Lloyd George. With Botha, he represented South Africa at the Peace Conference, where he was mainly concerned with the Covenant and Dominion status.

South African Politics.—After the conference, he returned to South Africa. In Aug. 1919 he became prime minister of the Union (in succession to Botha). During this period he twice attended the Imperial Conference. In **1921** his visit was notable for the part he played in securing peace in Ireland. During the Conference of 1923 (held while the Ruhr crisis was at its worst), he advocated a fresh attempt to settle the European situation. The suggestion was generally approved, and it helped to prepare the may for the Danes Commission.

In **1920,** repeated attempts to reunite the South African party and the Nationalists failed. The Unionists, under Sir Thomas William Smartt, decided to dissolve their organisation and to join the South African party. The consequences of this fusion lost Smuts a certain amount of support among both English and Dutch. A general election, held on that issue, left him, however, with a working majority, and the combined party did fairly well in Par. liament. In **1922,** however, another workers' revolt on the Rand (which was suppressed by the military and burghers) led to a junction of forces between advanced Nationalists and the Labour element.

In 1924 Gen. Smuts dissolved Parliament, realising that the people were dissatisfied with him. Although he lost Pretoria West, he was elected unopposed for Standerton, Botha's old constituency.

For the next decade Smuts was politically inactive, taking occasion to travel and lecture, while indulging his fondness for philosophy and botany. During this time he published Holism *and Evolution,* a philosophical treatise **(1926)** and *Africa* and *Some* World *Problems* (1930). In 1933 a new Union government came into being under Gen. James Hertzog and Smuts became minister of justice. This post he held until 1939 when Britain's declaration of war against Germany brought him back as prime minister. On Sept. **6** Smuts formed a war cabinet, and the Union proclaimed a state of war with Germany. He was made a field marshal in the British army in 1941. In 1945 Smuts attended the sessions of the United Nations conference in San Francisco, Calif., as a delegate of the Union of South Africa, and he authored the preamble to the U.N. charter. In **1948** he was defeated in the general elections and resigned as prime minister, retaining a seat in the assembly for Pretoria East.

He retired from leadership of his party in June 1950 and died at Irene. near Pretoria, Sept. 11, 1950.

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(N. Le, X.)

SMYRNA (*Izmir*), in ancient times one of the most important and now the greatest of the cities of Asia hfinor, Turkey, has preserved an unbroken continuity of record and identity of name from the dawn of history to the present time.

The Ancient City.—It is said to hare been a Lelegian city before the Greek colonists settled in Asia Minor. The name, nhich is said to be derived from an Amazon called Smyrna, is indubitably Anatolian, having been applied also to a quarter of Ephesus, and (under the cognate form Myrina) to a city of Aeolis, and to a tumulus in the Troad. The Aeolic settlers of Lesbos and Cyme, pushing eastwards by Larissa and Neonteichos and over the Hermus, seized the valley of Smyrna. It was the frontier city between Aeolis on the north and Ionia on the south, and was more accessible on the south and east than on the north and west. By virtue of its situation it was necessarily a commercial city, like the Ionian colonies. It is therefore not surprising that the Aeolic element grew weaker; strangers or refugees from the Ionian Colophon settled in the city, and finally Smyrna passed into the hands of the Colophonians and became the thirteenth of the Ionian states. The change had taken place before **683,** when the Ionian Onomastus of Smyrna won the boxing prize at Olympia, but it was probably then a recent event. The Colophonian conquest is mentioned by Mimnermus (before **600** B.C.), who counts himself equally a Colophonian and a Smyrnaean. The Aeolic form of the name, Σμύρνα, was retained even in the Attic dialect, and the epithet "Aeolian Smyrna" remained long after the conquest. The situation of Smyrna on the path of commerce between Lydia and the west raised it during the 7th century to the height of power and splendour. It lay at the head of an arm of the sea, which reached far inland and admitted the Greek trading ships into the heart of Lydia. One of the great trade routes which cross Anatolia descends the Hermus valley past Sardis, and then diverging from the valley passes south of Mt. Sipylus and crosses a low pass into the little valley, about 7 m. long and **2** broad, where Smyrna lies between the mountains and the sea.

When the Mermnad kings raised the Lydian power and aggressiveness Smyrna was one of the first points of attack. Gyges (c. 687–652) was, however, defeated on the banks of the Hermus; the situation of the battlefield shows that the power of Smyrna extended far to the east and probably included the valley of Nymphi (Nif). A strong fortress, the ruins of whose ancient and massive walls are still imposing, on a hill in the pass between Smyrna and Nymphi, was probably built by the Smyrnaean Ionians to command the valley of Nymphi. According to Theognis (about 500 B.C.), "pride destroyed Smyrna." Mimnermus laments the degeneracy of the citizens of his day, who could no longer stem the Lydian advance. Finally, Alyattes III. (609–560) conquered the city, and Smyrna for **300** years lost its place in the list of Greek cities. It did not cease to exist, but the Greek life and political unity were destroyed, and the Smyrnaean state was organized on the village system (ῴκεῖτο κωμηδόν.) It is mentioned in a fragment of Pindar, about 500 B.C., and in an inscription of **388** B.C. A small fortification of early style, rudely but massively built, on the lowest slope of a hill N. of Burnabat, is perhaps a fortified village of this period. Alexander the Great conceived the idea of restoring the Greek city; the two Nemeses who were worshipped at Smyrna are said to have suggested the idea to him in a dream. The scheme was, according to Strabo, carried out by Antigonus (316–301), and Lysimachus enlarged and fortified the city (301–281). The acropolis of the ancient city had been on a steep peak about 1,250 ft. high, which overhangs the north-east extremity of the gulf; its ruins still exist, probably in much the same condition as they were left by Alyattes. The later city was founded on the modern site partly on the slopes of a rounded hill called Pagus near the south-east end of the gulf, partly on the low ground between the hill and the sea.

The "crown of Smyrna" seems to have been an epithet applied to the acropolis with its circle of buildings. Smyrna is shut in on the west by a hill now called Deirmen Tepe, with the ruins of a temple on the summit. The walls of Lysimachus crossed the summit of this hill, and the acropolis occupied the top of Pagus. Between the two the road from Ephesus entered the city by the "Ephesian gate," near which was a gymnasium. Closer to the acropolis the outline of the stadium is still visible, and the theatre was situated on the north slopes of Pagus. The line of the walls on the east side is unknown; but they certainly embraced a greater area than is included by the Byzantine wall, which ascends the castle hill (Pagus) from the Basmakhanē railway station. Smyrna possessed two harbours—the outer, which was simply the open roadstead of the gulf, and the inner, which was a small basin, with a narrow entrance closed by a rope in case of need, about the place now occupied by bazaars. The inner harbour was partially filled up by Timur in 1402, but it had not entirely disappeared till the beginning of the 19th century. The modern quay has encroached considerably on the sea, and the coast-line of the Greek time was about go yd. farther south. The streets were broad, well paved and laid out at right angles; many were named after temples: the main street, called the Golden, ran across the city from west to east, beginning probably from the temple of Zeus Akraios on the west side of Pagus, and running round the lower slopes of Pagus (like a necklace on the statue, to use the favourite terms of Aristides the orator) towards Tepejik outside the city on the east. where probably the temple of Cybele, the Metroön, stood. Cybele, worshipped under the name of Meter Sipylene, from Mt. Sipylus, which bounds the Smyrna valley on the north, was the tutelar goddess of the city. The plain towards the sea was too low to be properly drained and hence in rainy weather the streets were deep with mud and water.

The river Meles, which flowed by Smyrna, is famous in literature and was worshipped in the valley. The most common and consistent tradition connects Homer with the valley of Smyrna and the banks of the Meles; his figure was one of the stock types on Smyrnaean coins, one class of which was called Homerian; the epithet "Melesigenes" was applied to him; the cave where he was wont to compose his poems was shown near the source of the river; his temple, the Homereum, stood on its banks. The steady equable flow of the Meles, alike in summer and winter, and its short course, beginning and ending near the city, are celebrated by Aristides and Himerius. The description applies admirably to the stream which rises from abundant fountains, now known as Diana's bath, east of the city, and flows into the south-east extremity of the gulf. The belief that the torrent, almost dry except after rains, which flows by Caravan bridge, is the ancient Meles, flatly contradicts the ancient descriptions.

In the Roman period Smyrna was the seat of a *conventus* which included south Aeolis and a great part of the Hermus valley. It vied with Ephesus and Pergamum for the title "First (city) of Asia." A Christian church existed here from a very early time, having its origin in the considerable Jewish colony. Polycarp was bishop of Smyrna and was martyred there A.D. 155. The bishops of Smyrna were originally subject to the metropolitan of Ephesus; afterwards they became independent (**αὐτοκέφαλοι**), and finally were honoured with metropolitan rank.

When Constantinople became the seat of government the trade between Anatolia and the west lost in importance, and Smyrna declined apace. A Turkish freebooter named Tsacha seized Smyrna in 1084, but it was recovered by the generals of Alexius Comnenus. The city was several times ravaged by the Turks, and had become quite ruinous when the emperor John Ducas Vatatzes about 1222 rebuilt it. But Ibn Batuta found it still in great part a ruin when the famous chieftain Aidin had conquered it about 1330 and made his son Amur governor. It became the port of the Aidin amirate. Soon afterwards the Knights of Saint John established themselves in the town, but failed to conquer the citadel. In 1402 Timur stormed the town and massacred almost all the inhabitants. The Mongol conquest was only temporary, but Smyrna was resumed by the Seljuks of Aidin and has remained till the present day in Mohammedan hands. Until the reign of Abdul Mejid it was included for administrative purposes in the *eyalet* of Jezair (the Isles) and not in that of Anatolia. The representative of the Capitan Pasha, who governed that *eyalet*, was, however, less influential in the city than the head of the Kara Osman Oglu's of Manisa. *(See* MANISA.) From the early 17th century till 1825, Smyrna was the chief provincial factory of the British Turkey Company, as well as of French, Dutch and other trading corporations. (W. M. RA.; D. G. H)

For general authorities *see Bibliographzes* under ASIA MINOR. Also B. F. Slaars, *Etude sur Smyrne (1868)*; and W. M. Ramsay, *Letters to the Seven Chuvches* (1904) and article in Hastings's *Dict. of the Bible* (1902).

Developments After World **War** I.—At the peace conference which was held in 1919 Greece put forward a claim to the Smyrna area, assigned it was understood to Italy by the agreement of St. Jean de Maurienne (April 17, 191;)—an agreement which remained unratified owing to Russian objections. Venizelos argued on the Greek claim before the Council of Ten on Feb. 3–4, 1919. The final decision of the Council of Three, authorizing the Greeks to occupy Smyrna. was taken apparently without the knowledge of the Italians. who had withdrawn temporarily from the conference; or of the U.S. expert advisers to President Wilson. The occupation was in theory an Allied occupation. but was generally taken to mean acceptance of the Greek claims. Greek troops occupied Smyrna on May 15, 1919. The first entry of the Greeks was marked by atrocities against the Turkish population.

Under the Treaty of Sèvres, Aug. 10, 1920, it was stipulated that the town of Smyrna and the Ionian hinterland were to be under Greek administration for five years. The Greek claim was based on ethnographical grounds. Reliable population statistics for the area were not available, but U.S. computation of 1914 gave the total population as 1,057,000, including 509,000 Turks, 470,000 Greeks and 78,000 others.

Turkish forces under Mustafa Kemal and the Greeks were soon engaged in hostilities, in which at first the Greeks were successful. Mustafa Kemal, however, continued to consolidate his position in Turkey, while the fall of Venizelos (Nov. 1920) and the return of King Constantine to Greece *(see* GREECE) weakened the sympathies which Greece had enjoyed in Great Britain, its chief supporter among the Allied powers. Negotiations at the London and Paris conferences (1921 and 1922) having failed. the Kemalists drove back the Greek army, which with many thousands of Greek refugees from all parts of Asia Minor embarked hurriedly and left Smyrna, which the Turks entered on Sept. 9. 1922. Under the Treaty of Lausanne (July 24, 1923) Smyrna and the surrounding zone reverted under full Turkish sovereignty.

Meanwhile, the town and district had suffered frightfully under the atrocities of both belligerents, and these sufferings culminated when, a few days after the Turkish entry into the town. fire broke out in the Armenian quarter. Only the wretched Turkish quarter on Mount Pagus was untouched, and more than three-fifths of the city was destroyed, including all the banks, business houses and consulates in the European quarter on the quay. The loss of life was impossible to compute. In April 1928 Smyrna again suffered serious damage by earthquake.

For the modern city, *see* IZMIR.

SMYTH, DAME ETHEL MARY (1858–1944), D.B.E. (1922), British composer, was born in London April 23. 1858, the daughter of Gen. J. H. Smyth. She studied music at Leipzig under Heinrich von Herzogenberg. She produced her first opera *Fantasio* at Weimar in 1898, others being given at Leipzig. Prague and Vienna. Her first opera to be produced in London was *Der Wald,* given at Covent Garden in 1902 which was followed by *The Wreckers* (1909), a vividly romantic work. Her Mass in D. first performed in 1893, was revived 30 years later. *The Boatswain's Mate,* a comic opera, was produced in 1916. She took a prominent part in the suffragist movement, and composed *The March of the Women* (1911). Her compositions include *Fête Galante* (1923) and *Entente Cordiale* (1924) both operas; also chamber music, choruses and songs, all characterised by energy of invention, exuberant vitality and clever workmanship. *See* her brilliant memoirs *Impressions That Remained* (1919); *Streaks of Life* (1921); *A Three-Legged Tour in Greece* (1927); *A Final Burning of Boats* (1928); *As Time Went On* (1935); *What Happened Next* (1940). She died May 8, 1944.

SMYTH, HERBERT WEIR (1857–1937). U.S. philologist, perhaps the foremost Greek scholar of his time in the U.S., was born at Wilmington, Del.. on Aug. 8, 1857. He was educated at Swarthmore (A.B., 1876). Harvard (A.B., 1878), and Gottingen (Ph.D., 1884). During 1884–85 he was instructor in Greek and Sanskrit at Williams college, and then for two years was reader in

Greek at Johns Hopkins university. From 1888 to 1901 he was professor of Greek at Bryn Mawr. In 1901 he was appointed professor of Greek literature at Harvard (later Eliot professor), becoming emeritus in 1925. During 1899–1900 he was professor at the American Classical school at Athens, Gr. From 1889 to 1904 he was secretary of the American Philological association and editor of its Transactions, and in 1904 was elected president. His works include a treatise on the Ionic dialect (1894); Greek *Melic* Poets (1900); Greek *Grammar* for Colleges (1916, 2nd ed., 1957); *Aeschylus,* text and translation (1922–26), in the "Loeb Classical Library"; and Aeschylean Tragedy (1924).

Smyth turned from the linguistic and grammatical studies of his youth more and more to criticism and interpretation. He regarded the diminished influence of Greek studies almost a national misfortune. He died July 16. 1937, at Bar Harbor, Me.

See E. K. Rand in *Yearbook of the American Philosophical Society,* pp. 398–408 (1937). (X.; J. Wh.)

SMYTH (Smith), **JOHN** (c. 1570–1612), English nonconformist divine. commonly called the Se-baptist, was born about 1570, and was educated at Christ's college, Cambridge, where he proceeded M.A. in 1593. He was probably vicar of Hutton Cranswicke in the East Riding of Yorkshire from 1593 to 1600, when he was elected lecturer or preacher of the city of Lincoln. an office of which he was deprived in Oct. 1602. Becoming connected with the Separatist movement he joined the Gainsborough church. and became its pastor[1]. With Thomas Helwys, John Murton (or Morton) and others. he migrated to Amsterdam at the end of 1607 to escape' religious persecution. and in that city practised as a physician, and became the leader of "the second English church." (See Congregationalism.) Under Mennonite influence he became a Baptist (see Baptists). But he and his company were then faced by the dilemma that their own infant baptism did not count, and Smyth solved the problem by first baptizing himself (hence the name Se-Baptist), probably by affusion. and then administering the rite to Helwys and the others. Afterward they decided to join the Mennonites, who were suspicious of a man who had never held one position for long, and demanded a statement of doctrines. which he gave them in 20 articles written in Latin, and in The Last Book of John *Smyth,* culled the Retractation of his Errors, together with a confession of faith in 100 Propositions. Smyth himself died of consumption in Xug. 1612. Helwys and Morton returned to England, and established the first English Baptist churches.

See J. H. Shakespeare, *Baptist and Congregational Pioneers* (London, 1906); H. M. Dexter, *The England and Holland of the Pilgrims* (London and Boston, 1906). (A. J. *G.*; X.)

SMYTH (or Smiti-i), **WILLIAM** (c. 1460–1514), bishop of Lincoln, was a Lancashire man by birth, and probably passed some of his early days at Knowsley under the roof of Margaret, countess of Richmond and Derby, the mother of Henry VII. He appears to have been a member of Lincoln college, Oxford, and in 1485, just after the battle of Bosworth, he was made keeper of the hanaper of the chancery. Two of Edward IV's daughters were entrusted to his keeping; he was a member of the royal council and he obtained many rich preferments. In 1493 he became bishop of Coventry and Lichfield. The bishop was a member of Prince Arthur's council in the marches of Wales: and in 1501, five years after he had been translated to the bishopric of Lincoln. he became lord president of Wales. About 1507 he and Sir Richard Sutton (d. 1524) set to work to found a new college in Oxford. They rebuilt Brasenose hall, added other existing halls to it, and having obtained a charter in 1512, called it The King's *haule* and college of Brasennose. Smyth, who was one of the executors of Henry VII's will, retired from public life just after this king's death; he was, however, president of Wales until his death at Buckden in Huntingdonshire on Jan. 2, 1514. In addition to his liberal gifts to Brasenose college he gave money or land to Lincoln and to Oriel colleges; he founded a school at Farnworth, Lancashire, and he refounded the hospital of St. John at Lichfield. From 1500 to 1503 he was chancellor of Oxford university.

[1]He was never vicar of Gainsborough, and must not be confused with the John Smyth who was imprisoned in the Marshalsea in 1592.

SMYTHE (Smith), **SIR THOMAS** (1558?–1625), English entrepreneur, was pre-eminently instrumental in launching, financing and administering pioneer English joint-stock enterprises in overseas trade, colonial settlement and exploration during the first two decades of the 17th century. A member of the London Haberdashers' and Skinners' companies from 1580. he accumulated a considerable fortune from commerce. Besides holding other official posts, he was incorporator and for some years governor of the East India company, treasurer of the Virginia and Somers Islands (Bermuda) companies, governor of the Muscovy and French companies and ambassador to the tsar (1604–05). He was a prime initiator of voyages to discover a Northwest passage. Smythe's efforts and a good part of his fortune were consistently and selflessly devoted to experiments that underlay England's subsequent imperial and commercial greatness. Although there was some controversy as to his management of the Virginia company, his fame as the entrepreneur and supporter of outstanding ventures is secure. Smythe died at Sutton-at-Hone, Kent, on Sept. 4, 1625.

Bibliography.—Alexander Brown, *Genesis of the United States,* vol. ii, pp. 1012–18 (1890); W. F. Craven, *Dissolution of the Virginia Company* (1932); C. M. Andrews, ***The*** *Colonial Period of American History,* vol. i (1934). (B. E. Su.)

SNAIL, the name usually given to land molluscs of the class Gastropoda which have spiral shells, such as the common snail (Helix aspersa) and the wood snail (*Cepaea* nemoralis). In Scotland both shell-bearing and shell-less land molluscs are known as "snails." Marine gastropod molluscs are sometimes called "sea snails" and the freshwater gastropods (*Viviparus,* Lymnaea, etc.) are known as "pond snails" and "river snails." The shell-bearing Gastropoda ("snails" in the wide sense) are a very large class of animals, embracing some 40,000 living and extinct species, with a world-wide distribution.

Perhaps the most striking feature in the structure of snails is their shell. In the majority this is spiral and consists of several whorls which have a right-handed (dextral) coil. A left-handed (sinistral) coil is found in certain forms, either as an occasional variation of normally dextral forms (*Lymnaea peregra* and *Neptunea antiqua*) or as a fixed generic characteristic (Physa, *Clausilia*). Sometimes the shell is cup-shaped (Patella, the common limpet), tubular (*Coecum*) or plate-like (Scutum). In many land and marine gastropods it becomes internal and degenerate or is eventually lost entirely, and a sluglike form is attained. The land snails belong, with some exceptions, to the order Pulmonata and a very large proportion of them are placed in the family Helicidae, which is one of the largest groups of land invertebrates. They are mainly animals of retiring habits living on green plants or on decaying vegetable debris, though a few (e.g., *Glandina, Streptaxis*) are carnivorous. As a rule, they are more frequently found upon calcareous soils and are certainly rare on "acid" formations. They usually live during the daytime buried out of sight under leaves and, as a certain amount of moisture is necessary for their well-being, they aestivate in hot and sunny weather in crevices or under ground, from which protection they emerge at night or during rain.

Including the "snail-slugs" (Testacella), there may be said to be 125 species of land and fresh, or brackish, water snails in the British Isles. The largest family (indeed, the largest in the phylum Mollusca) is the Helicidae, of which there are 22 species in Great Britain. Among the commonest forms are Helix aspersa, the common or speckled snail, Cepaea nemoralis and *hortensis,* the wood and garden snails and *Lymnaea* peregra, the common pond snail. Certain species (e.g., *Belgrandia marginata*), which are still living in continental Europe, are found in a fossil state in the British Isles. *Paludestrina jenkinsi,* the only mollusc at present known to reproduce itself parthenogenetically (without fertilization), is found very plentifully in Great Britain.

In North America there are numerous species of fresh-water and land snails. Among representatives of the former are about 6j species of Lymnaea and 25 of *Planorbis.* Of the land snails important families are the Pupillidae, with 50 species; the Zonitidae, with 65; and the exceedingly numerous Polygyridae. of which 9 genera and 256 species and subspecies are recognized. Concerning the use of snails by man, *see* GASTROPODA. *See* also Index references under "Snail" in vol. 24.

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SNAKEBIRD (DARTER. AHINGA or WATER TURKEY), a bird belonging to the same order as the cormorant (*q.v.*), which it resembles both outwardly and in habits. The snakebirds, however. are slenderer in form and have an elongated neck and tail. The pointed bill has its edges beset with backwardly directed "teeth."

A. W. AMBLER FROM NATIONAL AUDUBON SOCIETY

AMERICAN SNAKEBIRD (ANHINGA ANHINGA) SHOWING CHARACTERISTIC WING PATCHES OF THE MALE

There is only one genus of snakebirds, *Anhinga,* with four species occurring (one each) in the Americas. Africa, southern Asia and Australia. The male of the American species. *A. anhinga,* often called the water turkey, has a black plumage. glossed with green. with a white line on the neck; the bare skin of the head is both green and orange, and there are white patches on the wings and tail. The bird haunts large rivers and lakes, frequently perching on overhanging branches or snags. It feeds on fish, which it chases and spears with its dagger-like bill; its agility under water is amazing. It often swims with only its head above water. The bird has been observed to play at catch with small twigs. The nest is built in a tree close to the water and is a large structure of sticks. The four eggs have white, chalky shells.

All four species are characterized by the structure of the neck; the first seven neck vertebrae form a curve with its concavity forward; but the eighth articulates with the seventh nearly at right angles; the ninth is directed abruptly downward and the rest form a gentle forward convexity. This mechanism permits great flexibility.

SNAKE FLY, the name given to insects of the order Neuroptera (*q.v.*) of the superfamily Raphidoidea, closely allied to the alder flies, remarkable for the elongation of the head and prothorax to form a neck and for the presence in the female of a long ovipositor. The larva is active, carnivorous and terrestrial, and lives under loose bark of various trees. These insects occur chiefly in the northern hemisphere.

SNAKE RIVER, one of the most important streams in the Pacific northwest of the United States, is the largest tributary of the Columbia river. Its drainage basin of 109.000 sq mi is 30% greater than the total area of Idaho and contains one-half the entire area of the Columbia river basin in the United States. Runoff from Wyoming, Utah, Nevada. Idaho, Oregon and Washington combine in this stream. From elevations of 10.000 ft. the river descends to an elevation of 300 ft. and contributes 36,820,000 ac.ft. of water annually to the Columbia.

The river rises in high, rugged mountains of the continental divide near the southeast corner of Yellowstone National park in Wyoming. It flows south along the eastern base of the Teton mountains, and swings northwest near the mouth of Greys river and enters Idaho. Near Heise. the river leaves the mountains and crosses southern Idaho in a huge, southwesterly curving arc that terminates near the junction of the Boise and Snake rivers on the western edge of Idaho. Turning north, it forms the Oregon-Idaho boundary for 216 mi. From the northeast corner of Oregon it forms the Washington-Idaho boundary to Lewiston, Ida.. and then turns west to join the Columbia near Pasco, Wash. Its total length is 1,038 mi.

The upper Snake river, above King Hill, Ida., is used to irrigate over 1,500.000 ac. of land and to generate electric energy. The main stem is regulated by Jackson lake. Palisades, American Falls, Minidoka and Milner reservoirs. Principal tributaries below Heise are Henrys Fork (the largest). Blackfoot, Portneuf. Raft. Little Wood and Big Wood rivers. The last two and Henrys Fork enter the river from the north. Other north side streams sink into Snake river plains and become part of an immense underground reservoir. Numerous large springs—outpourings of the underground water body—emerge from the canyon walls in Hagerman valley. Twin falls and Shoshone falls, with drops of 125 and 195 ft., respectively, are located downstream from Milner dam.

The central Snake river, from King Hill to Weiser, Ida., is used primarily for hydroelectric generation. Over 1,000,000 ac. of land are irrigated in this section, primarily from tributary streams. Principal reservoirs and their associated rivers are Lucky Peak. Arrowrock and Anderson Ranch on the Boise; Cascade, Deadwood and Black Canyon on the Payette; Owyhee on the Owyhee; and Warm Springs and Agency on the Malheur.

The lover Snake river, from Weiser to the mouth, flows through a 1 mi.-deep gorge known as Hells canyon, one of the deepest river gorges in North America. Salmon river, largest tributary and most important wildlife area of the river system, joins the main stem near the downstream end of the canyon section. (G. V. SK.)

SNAKEROOT. In most countries where snakes abound some root or herb is used by the natives as an antidote for the bites of venomous species, and many herbs have consequently received the name of snakeroot. Botanically speaking, the name properly belongs to *Ophiorrhiza mungos,* a plant of the family Rubiaceae. used in Indonesia for the purpose above indicated. In medicine, however, the roots of *Aristolochia serpentaria, Polygala senega* and *Cimicifuga racemosa* were understood by this name, being distinguished as the Virginian, seneca and black snakeroots. The root of *Aristolochia reticulata* is known in the United States as Red river or Texan snakeroot.

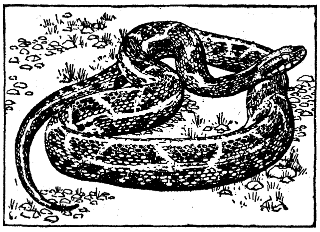
JOHN H. GERARD

WHITE SNAKEROOT (EUPATORIUM RUGOSUM)

The roots or rhizome of *Liatris spicata, Eryngium aquaticum* and *Eupatorium rugosum* have all been used in North America for snake bites, the first two being known as button snakeroot and the last as white snakeroot. The rhizome of *Asarum canadense* passes under the name of Canadian snakeroot. All of these contain acrid or aromatic principles which, when a warm decoction of the drug is taken, exercise a powerfully diaphoretic or, in some cases, diuretic action, to which the benefit, if any, derived from their use may be attributed.

SNAKES, an order (Serpentes) in the class of REPTILES (*q.v.*). They are elongate animals without limbs, or with claw-like vestiges of the hinder pair; without eyelids or external ears, with pointed recurved teeth fused to the supporting bones, with a forked slender tongue which can be withdrawn into a sheath at its base, and with the two halves of the lower jaw not fused but joined by an elastic ligament. Like the lizards, with which they have many affinities, they are one of the dominant groups of reptiles of the present day and at least 2,000 different species are known. Their distribution is cosmopolitan with the exception of New Zealand, Ireland and some of the more recent, completely isolated, oceanic islands such as the Azores and most of Polynesia; as in other groups of terrestrial, cold-blooded animals, the area of permanently frozen subsoil limits their northern and southern range, and the greatest profusion of species and individuals is to be found in the tropics.

In the loss of limbs and the absence of well-differentiated neck, body and tail they may be regarded as degenerate and, by analogy with certain groups of limbless lizards, it seems probable that this type of bodily form arose in correlation with a habitat amongst dense vegetation; under these conditions limbs do not appear to be such efficient organs for motion as the lateral undulations that form the basis of serpentiform locomotion. Contrary to the idea expressed in the conventional representations of snakes, the body is not undulated vertically but laterally, and locomotion is effected by the passage of a series of "waves" from before backwards, each wave in its progress pressing against the surrounding medium and forcing the animal forwards. Such a system is efficacious only when the surrounding medium is sufficiently dense to offer an appreciable resistance to the passage of the waves and the majority of terrestrial snakes possess an additional mechanism. The scales of the lower surface are enlarged to form transverse, overlapping plates, whose free edge is directed backwards, and to each of these plates is attached a pair of movable ribs. When the ribs are moved forwards they carry the scute with them, and as this is smooth and has its leading edge protected by the one in front of it, it slips easily over any irregularities of the surface. But, when the scute is moved backwards its free, hinder edge catches on the slightest projection and so enables the snake to push itself forward. As there may be as many as 300 of these ventral shields, each of which can utilise any slight irregularity, progress is possible over almost any surface.



THE FER-DE-LANCE OF THE WEST INDIES AND SOUTH AMERICA

Probably also correlated with the ancestral habitat is the development of a hard transparent covering over the eye to protect the delicate cornea; in many lizards a transparent covering is developed from the lower eyelid, but in snakes the analogous covering is probably the modified nictitating membrane. In most snakes the outer horny covering of the scales is shed in one piece; sloughing commences at the lips and by vigorous rubbing movements the slough is turned back on itself and the animal works its way out, the old skin being turned inside out in the process. Though the sense of sight is well-developed, hearing must be of a different nature from that of most vertebrates, as there is no external ear or ear-drum; the *columella auris,* which normally transmits vibrations from the ear-drum to the inner ear, in snakes rests with its outer end on the quadrate, the bone which supports the lower jaw; possibly the ear is sensitive, not to air-borne vibrations, but to vibrations transmitted through the substratum on which the animal rests. The sense of smell is well-developed but a snake's most important sensory organ is its tongue; exactly what sense is centred here is not known, but the constant play of this organ makes it evident that the sensations registered by the tongue are of paramount importance in determining the animal's reactions to external conditions.

Snakes are carnivorous or insectivorous and the prey, which under natural conditions must be captured alive, is swallowed whole, the conical re-curved teeth and the divided lower jaw being adaptations to this method of feeding. The prey may be killed by poison or constriction or swallowed alive; it is worked round until the head is in the snake's mouth and then commences the laborious swallowing process. The bones supporting the lower jaw are movable on the skull so that the gape of the mouth is tremendous and this, assisted by the stretching of the elastic ligament between the halves of the lower jaw, permits the swallowing of masses of considerably greater diameter than the snake itself; the teeth of one side of the mouth are hooked into the victim and then, with this as a fulcrum. the other side is pushed forwards a short distance, the teeth engaged and the same action repeated with the opposite side The hooked shape of the teeth permits of their being pushed forward but not easily drawn back, and in this way the snake literally draws itself over its food. Teeth are frequently broken off by the victim's struggles, but by the side of each functional tooth is a series of new teeth, in different stages of development, lying within a special fold of the lining of the mouth, the *vagina dentis;* as soon as a tooth is lost one of the successional series moves into its place and becomes fused to the jaw-bone. Teeth are also the means by which the venom of poisonous species is injected; these "poison fangs" are always situated in the upper jaw either at the front or the hind end and the channel for the venom is either a simple groove or a groove whose edges have met and so produced a tube with openings at the base and the tip of the fang. The venom itself is the product of a modified salivary gland and is a clear straw-coloured liquid containing certain poisonous proteins, the proportions in which each is present varying according to the type of snake. The two principal constituents are a "haemolytic" agent which breaks up the blood corpuscles and attacks the lining of the blood vessels and a "neurotoxic" agent which attacks the nerve centres, causing paralysis, and having a special affinity for the nerves supplying the respiratory apparatus; the predominance of one or other of these two bodies determines the nature of the symptoms of snake-bite. If neurotoxic agents predominate, paralysis, general prostration and difficulty in breathing are the most dangerous symptoms, but if the patient survives this stage, recovery is rapid and there are few severe local symptoms at the site of the bite; when, on the other hand, "haemolysins" are the principal constituents of the venom there is no paralysis, though there are severe constitutional symptoms and prostration, but even if this is not fatal, local symptoms follow with local extravasation of blood and much swelling of the bitten parts, which may suppurate and become gangrenous.

The first aid to be given is the application of a light ligature above the location of the bite, followed by active sucking. It has been found by direct experiment that the application of potassium permanganate to the wound is harmful rather than helpful. It is essential that the patient should not run, and difficult as the advice may be to follow, he should not become excited. Administration of large quantities of stimulants is useless, but small repeated doses may be given if the patient is on the verge of collapse.

"Anti-venins" are now manufactured in most countries where snake-bite is at all common. They are prepared by immunising horses against a particular venom by increasing, regulated doses; the blood serum of the horses is then sterilised and made up into doses ready for inoculation. It has not yet been found possible to prepare a serum that is really efficacious against the venoms of more than one or two snakes, so that. to ensure treatment with the correct anti-venin, an attempt should be made to identify the one responsible for the accident.

Since the reaction to large doses of horse serum may itself be a Severe one, it is essential that anti-venin be administered only under medical supervision.

In serious cases of bite from vipers or pit-vipers, blood transfusions may save the patient.

No snakes have a larynx or vocal chords and, in consequence, none have a true voice; they are all, however, capable of hissing and some of the larger, heavy-bodied species, with a large lung capacity, can do so loudly enough to be heard at some little distance; a few forms have a special piece of cartilage in front of the epiglottis and, when a blast of air is emitted, the vibration of this cartilage produces a sound which has been compared with that of a gently struck tuning fork. Rattlesnakes (*q.v.*) have a special sound-producing apparatus and some vipers can make a swishing noise by the movement of the scales one over the other.

The majority of snakes lay eggs; these are elongate with a parchment-like shell, and are usually deposited in a situation exposed to moist heat. In some groups, however, they are retained inside the body of the mother until the young are fully developed.

The various families, based largely on characters of the skull, may best be considered separately.

1. *Typhlopidae.*—Small, harmless, burrowing, worm-like snakes, with the eyes hidden beneath the scales of the head, with a very short, blunt tail, with small, shiny over-lapping scales, no enlarged scutes across the belly and with teeth only in the upper

jaw; inhabitants of almost all tropical countries. These snakes form burrows in loose soil, and to assist in this operation many have a short spine at the tip of the tail which is dug into the ground to obtain a purchase while the rounded head is thrust forward, or retracted, by a looping movement of the body; insect pupae and larvae, ants and earth-worms, seem to form the staple diet. The commonest colouring is brownish or flesh colour, but a few, for instance the common *Typhlops punctatus* of tropical Africa, are irregularly marked with black and yellow.

2. *Leptotyphlopidae.*—Another family of blind, burrowing snakes very similar to the Typhlopidae from which they differ in having teeth in the lower, but not in the upper jaw; they are found in Africa, southwestern Asia and America. The usual colours are browns or blacks but in *Leptotyphlops* albifrons, the common species of tropical America and the lesser Antilles, the forehead and tip of the tail are white. As the head and tail are also similar in shape, the colouring may be of the "directive mark" type designed, apparently, to enhance the resemblance of the two for the confusion of any would-be attacker.

3. *Anilidae.*—Harmless burrowing snakes, without any distinct neck but with the cylindrical body tapering slightly at either end, with a pair of claw-like vestiges of hind limbs visible on either side of the vent and with slightly enlarged scales on the belly; teeth are present in both jaws. The few members of this family are larger than most burrowing snakes, attaining a size of 2½ to 3 ft.; they seldom appear above ground but take readily to water, and their food seems to consist principally of other snakes and eels; all, so far as is known, are ovoviviparous. *Anilius scytale,* of tropical South America, coloured a beautiful coral-red with more or less complete black rings, superficially resembles some true coral snakes (*Micrurus*); as the latter are all venomous this is often regarded as an instance of mimicry. *Cylindrophis rufus* of Burma, the Malayan region and the East Indies also exhibits what appears to be mimicry, but of a different kind; the upper surfaces are brown or black, with, as a rule, light cross-bars, the belly is white with transverse black bands, and the tail bright red beneath. When the snake is brought above ground the tail is bent sharply upwards exhibiting the brilliant lower surface and if the animal is touched the tail snaps round in the manner of a striking head. Precisely the same tail colour and actions occur also in another burrowing snake of the same regions, *Doliophis intestinalis*, but this animal is venomous, with the largest poison glands of any elapid snake.

4. *Uropeltidae.*—Harmless burrowing snakes similar to those of the preceding family, but without any vestiges of hind limbs and with the tail ending in an enlarged scale which is either rugose or produced into two short points. The "earth-snakes" of Ceylon and the hills of southern India are all burrowers in loose earth in damp, forested regions and feed almost exclusively upon earthworms; those whose breeding habits are known are all ovoviviparous.

5. *Xenopeltidae.*—This family contains but a single species, *Xenopeltis* unicolor of southeastern Asia, a handsome snake with highly iridescent black or dark brown scales, each of which has a lighter edge; the head is small, not sharply marked off from the rest of the body and covered with enlarged shields; there are no traces of hind limbs, teeth are present in both jaws, the tail is short and the belly is covered with transversely enlarged scutes; total length about 3 ft.

6. *Boidae.*—Non-poisonous, often large, snakes with clam-like rudiments of hind-limbs visible on either side of the vent, enlarged scutes on the belly and teeth in both jaws. This family differs from the following in the absence of an extra bone (the supraorbital) in the skull, and in being viviparous.

The majority of boas are arboreal or semi-arboreal, and correlated with this habit the tail is usually more or less prehensile; all kill their prey (chiefly small mammals and birds) by constriction, and all those whose breeding habits are known are ovoviviparous, in contrast with the pythons which usually lay eggs. Though the name "Boa Constrictor" is frequently used to designate any large snake it is strictly applicable only to a single South American species, Constrictor constrictor, which is not particularly large, attaining a total length of only about 11 ft. The genus Boa contains a number of species in tropical America, including the West Indies, and two in Madagascar; *Corallus,* another very similar genus, has a similar distribution. The largest species is the anaconda (Eunectes *murinus*), which inhabits the forests of the Amazon basin and is said to reach a length of 30 ft., though actually, specimens of even 25 ft. seem to be very rare. The animal is largely aquatic and is usually found along the banks of rivers or in swampy regions; it is dark green in colour with numerous, sharply defined, round, black spots and is highly iridescent. In the old world, Enygrus occurs in the islands around New Guinea and on those of Polynesia as far east as Fiji; all the species have prehensile tails. Eryx, with about seven species, is an assemblage of small, sand-loving forms in north Africa, southeast Europe and southwest Asia; none of them greatly exceed 3 ft. in length and all have small heads, merging imperceptibly into their bodies, and short, scarcely prehensile tails.

7. *Pythonidae.*—The giant snakes of the old world mostly belong to the genus Python, the largest being the East Indian Python reticulafus, the reticulated python, in which very large individuals may exceed 30 ft. in iength. The females of the python family, as far as known, brood their eggs. There are various East Indian genera, among which *Chondropython* viridis forms a striking analogue is body form and colouring to Boa canina of South America. The only American python is *Loxocemus* of western Mexico. (See PYTHON.)

8. *Colubridae.*—This family comprises the great majority of snakes and its members show great diversity of habits and adaptations. In the restricted sense in which the name is here used the family may be defined as follows:—typical snakes, without any rudiments of limbs, with the head usually covered by enlarged scales, with enlarged ventral scutes, with teeth in both jaws and poison fangs, if present, situated on the hinder end of the upper jaw and preceded by smaller, solid teeth; distributed over all the temperate and tropical regions. Every kind of terrain is tenanted, from dense tropical forests to deserts and high mountains, and so uniform are the modifications connected with their different habits that, from its appearance alone, it is possible to draw a fairly safe conclusion as to a snake's mode of life. Burrowing forms are invariably small with relatively short tails, with small heads merging imperceptibly into the body and with greatly reduced eyes; desert dwellers are usually rough-scaled, with pallid or sombre colouring; terrestrial species have cylindrical bodies, a distinct neck and moderately long tails; arboreal snakes are greatly elongate with whip-like tails, long, pointed snouts, very large eyes and a more or less compressed body; thoroughly aquatic forms have the nostrils on the top of the snout and fitted with valves which can be closed while the animal is under water and, as a rule, the enlarged ventral scutes, so necessary for locomotion on land, are reduced. Two familiar, but perhaps artificial groups of colubrids can be recognised thus:—

Aglypha, without any grooved teeth.

Opisthoglypha, with one or more enlarged, grooved, poison fangs at the rear of the upper jaw.

These two groups, the one harmless, the other venomous, but, on account of the position of the poison fangs, rarely dangerous to man, almost grade into one another, a few species being known in which the posterior teeth are only slightly enlarged and sometimes grooved and sometimes not. The following classification into subfamilies is still essentially a provisional one. The Colubridae are sub-divisible into six "subfamilies."

(a) *Dipsadinae.*—Arboreal forms with the anterior teeth in both jaws enlarged and without a groove beneath the chin. This groove, present in almost all other colubrids, is part of the mechanism which allows of the two halves of the lower jaw being pushed apart in swallowing bulky objects and its absence in the dipsads is connected with the feeding habits of the group; they appear to feed exclusively on slugs. *Amblycephalus* and *Haplopeltura* occur in southeast Asia and the Malay Archipelago and *Dipsas* and its allies are confined to Central and tropical South America. Aglyphous.

(b) *Acrochordinae.*—Aquatic snakes with valvular nostrils on the upper surface of the snout; they are heavy-bodied animals frequenting fresh-waters and estuaries in southeast Asia and Central America, and feeding on fishes. The enlarged ventral scales are scarcely distinguishable and the common Indo-Malayan *Chersydrus* has the body laterally compressed and equipped with a fold along the lower surface; this fold, simulating a median fin, the compressed body and the absence of ventral shields bespeak an existence spent wholly in water. The less specialised forms with cylindrical bodies and retaining the ventral scutes are still capable of rapid movement on land. Aglyphous.

(c) *Xenoderminae.*—In the scale characters of the body the snakes of this subfamily link the very distinct Achrochordinae, which are entirely aquatic, with the typical colubrid land snakes. They are confined to southeastern Asia and the East Indies. The most remarkable genus, *Xenodermus*, has small scales with three series of much enlarged tubercles. Aglyphous.

(d) *Colubrinae.*—Typical snakes, with well-developed teeth in both jaws, with a dental groove and with, as a rule, lateral nostrils. Aglyphorous. This subfamily is cosmopolitan and its members may be more or less aquatic. arboreal, terrestrial or cryptozoic; as a rule they are oviparous, but some produce fully developed young. Perhaps the most thoroughly aquatic species is *Glypholycus* bicolor which inhabits Lake Tanganyika and in the general shape and the position of the nostrils superficially resembles the Acrochordinae. The common English grass snake (Natrix natrix) is a member of a widely distributed genus whose members are decidedly aquatic, and whose food consists principally of frogs and fishes; N. natrix, widely distributed through northern Europe, is very variable in colour, but is usually a grayish-green with some black markings on the back, traces of an incomplete yellow or orange collar on the neck and chequered black and white beneath; it frequents damp and marshy localities and feeds principally on frogs. Its European relative N. *viperinus*, very common in Spain and Portugal, is more aquatic still and feeds almost exclusively on fishes and the Indian keel backs (N. *piscator*) and the North American moccasins (N. fasciatus) have similar habits. Allied to *Natrix* are the N. American garter snakes (*Thamnophis*), a group of likewise semi-aquatic species. The strictly terrestrial genera, very numerous throughout most of the world except the Australian region, feed chiefly on small mammals, birds, toads and lizards. The rat snakes or racers of Europe and N. America (*Coluber*) the chicken snakes (*Elaphe*) and the Indian rat snakes (Ptyas) are all externally of very similar build and either kill their prey by constriction or eat it alive. Coronella, another similar genus. is represented in Britain by the smooth snake (*C. austriaca*), a species frequently confused with the viper but readily distinguished by its smooth scales and the enlarged plates on the top of the head; the species of this genus feed largely upon lizards, and the distribution of the smooth snake in England corresponds exactly with that of the sand lizard. Other terrestrial genera with specialised feeding habits are the king snakes (*Lam*propelfis) of N. America, and the African Lycophidion. The species of the first-mentioned genus live almost exclusively on other snakes, poisonous or harmless, the victim being killed by constriction; some "mimic" coral snakes in their colour pattern which consists of broad reddish bands edged with black and separated by narrower yellowish or buff interspaces. *Lycophidion* is characterised by enlarged teeth on the front of both jaws, the "canine" teeth being also directed outwards, and this is probably an adaptation to enable them to hold the smooth, hard-scaled skinks that form their principal diet. The American hog-nosed snakes (Heterodon) are remarkable for their superficial similarity to vipers, due to the broad, flat head and stout body; if annoyed they puff themselves up and hiss in true viperine manner. but if this fails to intimidate the enemy they roll over on their backs and "sham dead." Tree-snakes are greatly elongate, slender creatures and are represented by such genera as Dendrophis of southeast Asia and Australia and *Leptophis* of South America; they feed principally on lizards and young birds. Aglyphous.

(e) *Homalopsinae.*—Aquatic snakes with valvular nostrils situated on the top of the snout, and often with the ventral scales much reduced. They are confined to the fresh waters and estuaries of southeast Asia, Papua and North Australia and are all ovoviviparous. Opisthoglyphous.

(f) *Boiginae.*—This subfamily parallels the Colubrinae; its members are cosmopolitan and adapted to the same types of habitats, though in this group arboreal forms predominate. Among these may be mentioned a few which are remarkable for their habits or appearance; the slender, bodily form and elongate head is exaggerated in some, such as *Dryophis mycterizans* of the Indian Region or *Langaha* of Madagascar, by the production of the tip of the snout into a pointed or leaf-like dermal appendage. Many of these tree-snakes are brilliantly green to match the foliage, others brown to harmonise with the branches, but some show brilliant colour patterns which, though conspicuous when removed from their natural surroundings, are almost invisible in the dappled light and shade of the bushes which the animals frequent. *Chrysopelea* ornata of India and Malaya is often black with yellow dots on the centre of each scale and a series of red-centred yellow, tetra-petalous flowers along the back. This species is also famous as the flying snake, a name it has earned by its ability to "glide" to a limited extent; to accomplish this feat the body is held straight and rigid, the ribs pushed outwards to their full extent and the belly drawn in so that a considerable concave surface is produced which checks the fall of the animal and enables it, in an emergency, to descend with safety from a considerable height. Some members of the group, for instance the boomslang (*Dispholidus* typus) of South Africa, have the peculiar habit of expanding the neck to form a vertical "hood" when annoyed. Unlike the horizontal hood of the cobras, which is produced by an outward pressure of the ribs, this vertical "hood" is brought about by inflation of the mind-pipe. In snakes the cartilaginous rings of the trachea are incomplete along the side nearest the backbone, and a strip of tissue between their free ends is very distensible, so that, when air from the lungs is forced into the wind-pipe, this elastic tissue stretches and the neck is inflated.

Terrestrial genera are represented in Europe by *Malpolon*, one of the largest snakes of the continent, in the Mediterranean countries. *Erythrolamprus aesculapii* of tropical America is a very variable species whose many colour varieties mimic coral snakes; sometimes the groove on the fangs may be absent. Africa has many terrestrial forms, of which the commonest are the sand snakes (*Psammophis*), and also several burrowing genera, e.g., *Miodon* of West Africa and *Aparallactus* from the east and south. Some burrowing forms, notably *Apostolepis* in South America. exhibit "directive mark" coloration; the body is yellow, sometimes with longitudinal black stripes, and the head and stumpy tail are black with a few lighter dots, so that the similarity of the two ends is remarkable.

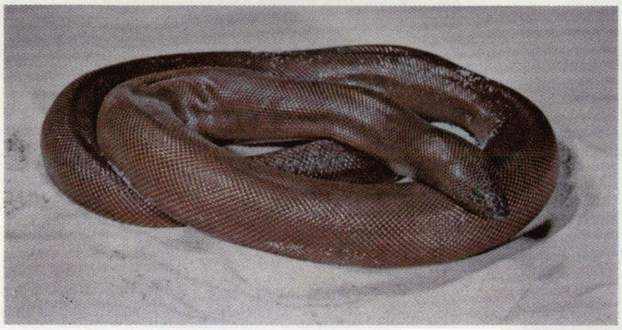
Only a few opisthoglyphs can be considered as dangerous to man; the situation of the fangs renders it difficult for any but the very large species to bring them into play except on the smallest objects. Should, however. a wound be inflicted by one of the larger species, such as the boomslang, the consequences are apt to be dangerous; the venom is largely haemolytic in its action and resembles that of the vipers rather than that of the cobras and their allies. Opisthoglyphous.

9. *Dasypeltidae.*—Terrestrial snakes highly modified for egg eating. A series of neck vertebrae have downwardly projecting processes that pierce the oesophagus to form an egg-shell cutting apparatus. The mouth and neck are enormously distensible and the egg is swallowed whole. When it reaches the "oesophageal teeth," compression of the neck muscles and a back and forth sawing motion cuts the shell, the contents of the egg being forced into the stomach. The shell is then rejected. The teeth are greatly reduced in number in the African genus *Dasypeltis*, which may explain the absence of grooved fangs, present in the Indian Elachistodon.

10. *Elapidae.*—Sometimes regarded as colubrids, these snakes are "proteroglyphous," *i.e.*, have fixed poison fangs in the front of the upper jaw and they always have well-developed ventral shields. Apart from the cobras (*q.v.*), this family contains other genera in the same regions, the true coral snakes of the Americas, and a great variety of forms in Australia. Some of the best

Reticulated python (*Python reticulatus*), one of the largest of all snakes, may reach a length of more than 30 ft. Found in southeast Asia and the Philippines

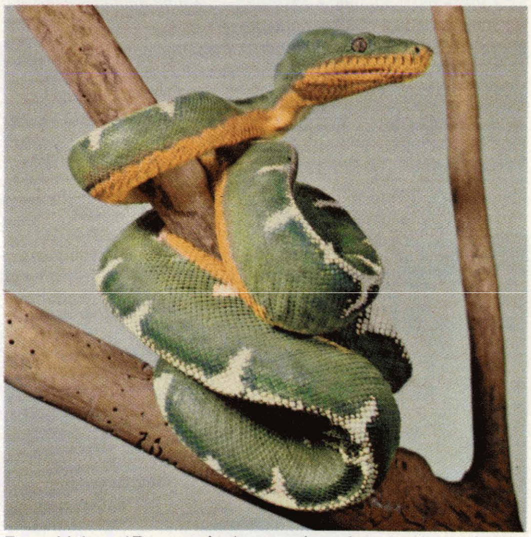
Diamond snake or carpet python (*Morelia argus*) of Australia and New Guinea



Sand boa (*Eryx johni*), a small burrowing snake that lives in sandy regions from north and central Africa to India and central Asia

White Indian python (*Python molurus*), a rare colour freak, not albino, caused by domination of white pigment cells over those of normal coloration

Boa constrictor (*Constrictor constrictor*), widely distributed in South America and found north, along the coasts of Mexico, almost to the U.S. border



Emerald boa (*Boa canina*), an arboreal snake found in the tropical jungles of South America

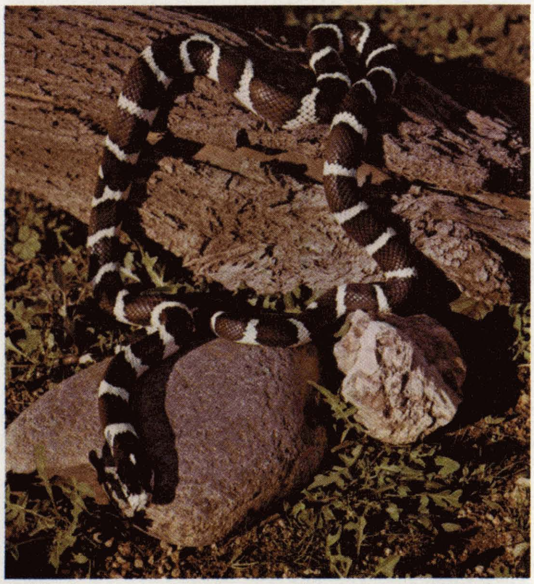
PYTHONS AND BOAS

PHOTOGRAPHS, (TOP LEFT, BOTTOM LEFT) JOHN H. GERARD, (TOP RIGHT, CENTRE RIGHT) CY LA TOUR AND (TOP RIGHT) BROOKFIELD ZOO, (CENTRE LEFT) NATHAN W. COHEN, (BOTTOM RIGHT) EDWARD VAN BAERLE

Eastern hognose snakes (*Heterodon platyrhinos*), showing two of the several oolour variations that are characteristic of this species. Found in sandy areas of most of the eastern and central U.S.

Yellow rat, or chicken, snake (Elaphe obsoleta *quadrivittata*), an arboreal species of the south Atlantic coastal U.S.

Texas rat snake (*Elaphe obsoleta lindheimeri*), found in Texas and western Louisiana. LIke most other obsoleta varieties, it is a large snake and may reaah a length of 7 ft.



California king snare (*Lampropeltis getulus californiae*), one of many *Lampropeltis* species widely distributed in the U.S.

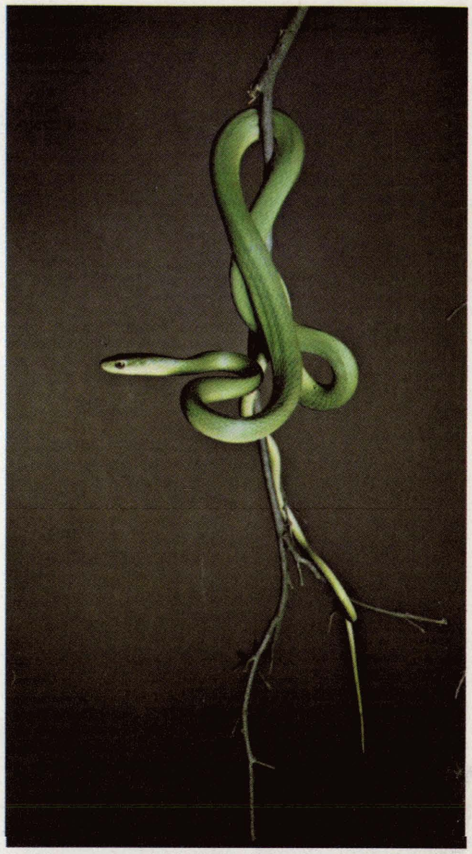
Red milk snake (tarnpropeltis *doliata syspila*). Banded pattern of the harmless milk makes, or king makes, is slmllar to that of some of the venomous coral snakes (Elapidae). Central U.S.

Aesoulaplan snake (Elaphe *longissima*), a chicken snake found in Europe and Asia Minor

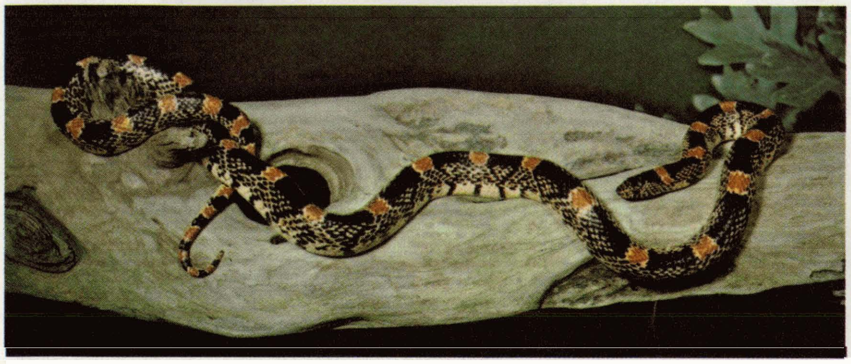
KING, RAT AND HOGNOSE SNAKES

PHOTOGRAPHS, (TOP LEFT, TOP RIGHT, CENTRE LEFT, BOTTOM LEFT) JOHN H. GERARD, (CENTRE RIGHT) WILLIS PETERSON, (BOTTOM RIGHT) JOHN MARKHAM

Eastern yellow-bellied racer (*Coluber constrictor flaviventris*), an extremely fast-moving, smooth snake found chiefly in the Middle West, north of the Ohio valley to the Great Lakes

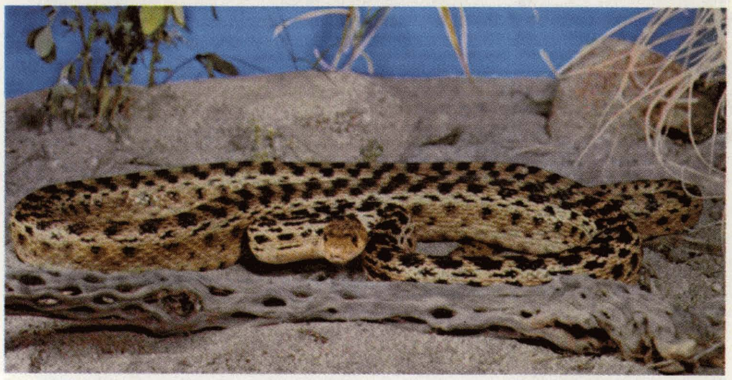


Rough green snake (*Opheodrys aestivus*), a long, slim arboreal species seen in south central and Atlantic coastal states



Texas long-nosed snake (***Rhinocheilus lecontei tessellatus***), a **speckled,** burrowing **snake** found in arid regions of the extreme southwest and northern **Mexico**

Western worm snake (Carphophis ***amoenus vermis***), a small **terrestrial** snake usually found hidden beneath moist **foliage,** rocks or logs



Sonora gopher snake (***Pituophis catenifer affinis***), a **large western bull snake known** for the loud **hissing it makes** when **attacked** or frightened

Western ribbon snake (Thamnophis ***sauritus proximus***), a slender garter snake found In most of the middle western states west of the Mississippi river

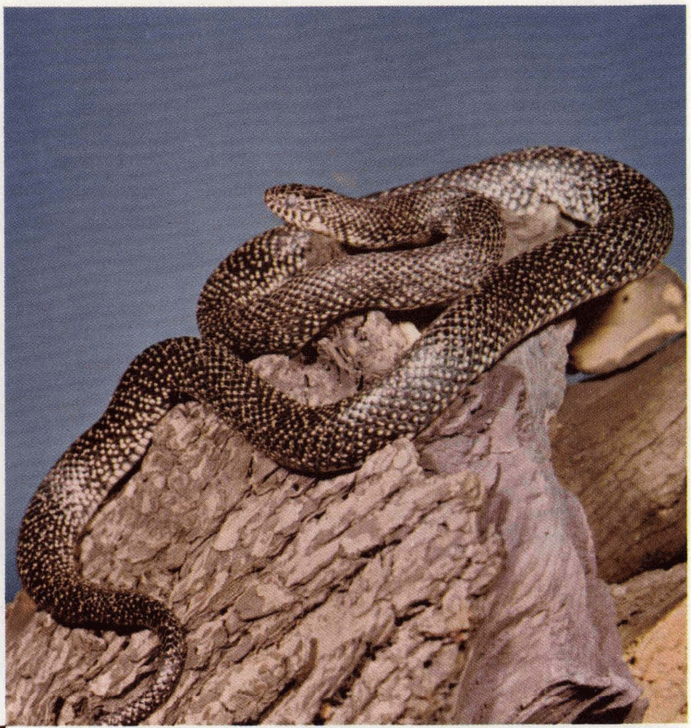
Eastern garter snake (Thamnophis ***sirtalus sirtalus***), a very common snake of the entire eastern half of the U.S. and southeastern Canada

COLUBRIDS: HARMLESS SNAKES OF THE U.S.

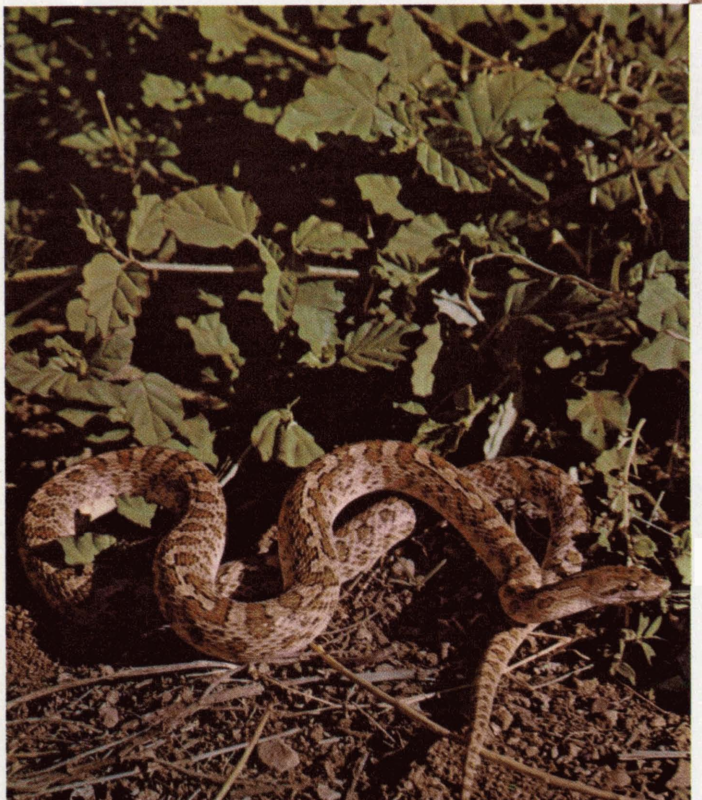
PHOTOGRAPHS, JOHN H. GERARD EXCEPT (CENTRE RIGHT) CY LA TOUR

SNAKE

Sonora king snake (*Lampropeltis getulus splendida*), a largely nocturnal species found In the southwest and north central Mexico. It constricts Its prey, often other snakes

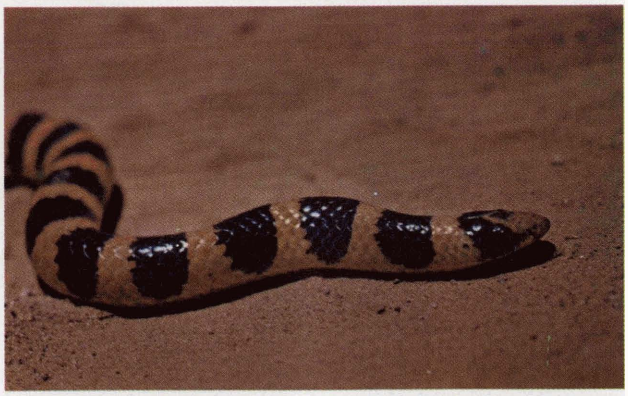


Speckled king snake (*Lampropeltis getulus holbrooki*), another of the snake-eating snakes. Found In the prairie and south central states



Glossy snake (Arizona *elegans*), a burrowing snake usually found in sandy areas of the southwest and northern Mexico

Northern black-headed, or flat-headed, snake (*Tantilla gracilis hallowelli*), a small, secretive species of the middle western states

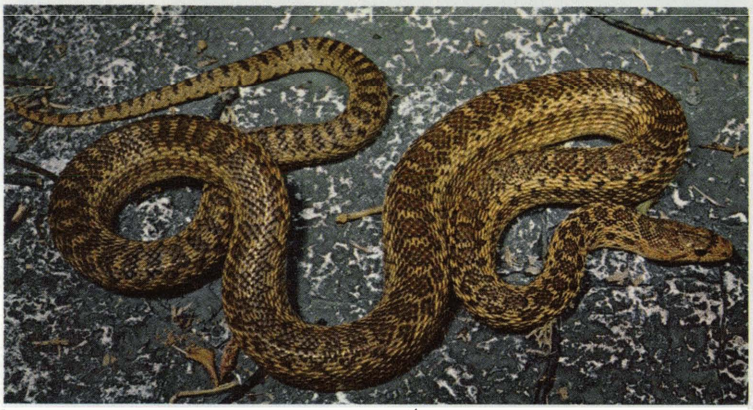


Banded sand snake (*Chilomeniscus cinctus*), a small snake whose snout Is adapted for rapid burrowing into sand. Found chiefly in Arizona and Baja California

COLUBRID SNAKES OF THE U.S.

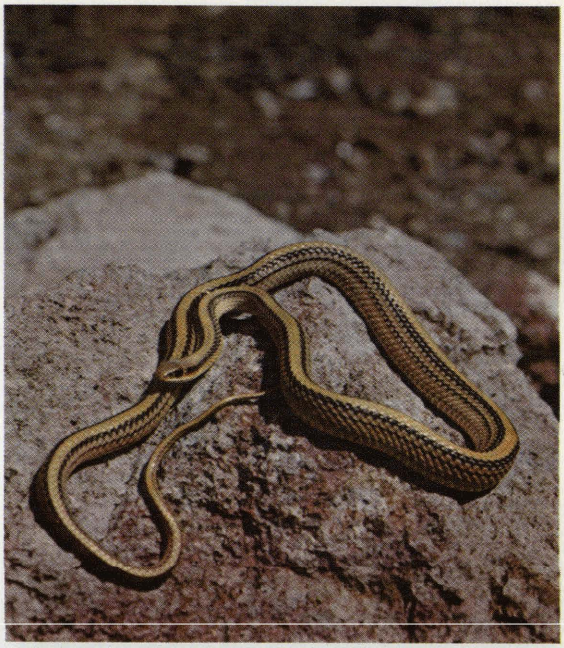
PHOTOGRAPHS, (TOP LEFT, CENTRE RIGHT) JOHN H. GERARD, (TOP RIGHT) JOHN MARKHAM, (BOTTOM LEFT) WILLIS PETERSON, (BOTTOM RIGHT) HYMEN MARX

Western ringneck snake (***Diadophis amabilis***) in its defense posture, coiled with the underside of its tail exposed. Found chiefly on the Pacific coast



Pacific gopher snake (***Pituophis catenifer catenifer***), a constricting bull snake found on the west coast

Eastern indigo snake (***Drymarchon corais couperi***), a relative of the racers, may reach a length of about 8 ft. Found chiefly in Florida. Georgia and Alabama



Texas patch-nosed snake (***Salvadora lineata***), a slender species found most often in rocky terrain in northern Mexico, Texas and Oklahoma

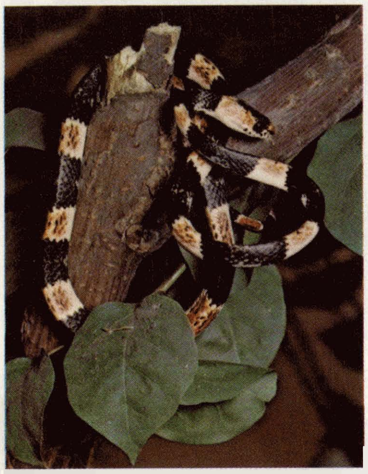
Graham's water snake (***Natrix grahami***), found in streams and quiet water west of the Mississippi river to Texas and north to Illinois

Bull snake (***Pituophis melanoleucus sayi***), a large prairie-dwelling species that will strike when alarmed but is not dangerous to man

HARMLESS SNAKES OF THE U.S.

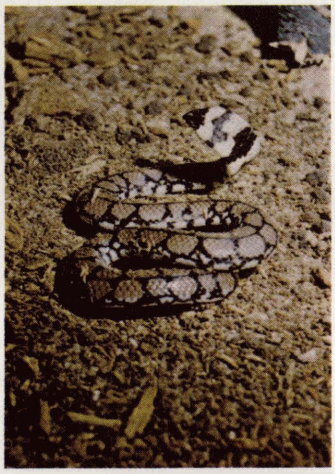
PHOTOGRAPHS. (TOP LEFT) NATHAN W. COHEN, (TOP RIGHT) WILLIS PETERSON, (OTHERS) JOHN H. GERARD

Mangrove snake (***Boiga dendrophila***), a rear-fanged arboreal species found in tropical Asia



Blunt-headed tree snake (***Imantodes cenchoa***), native to Central and South America

Elephant trunk, or wart, snake (***Acrochordus javanicus***), a **loose-skinned aquatic snake—the** only **living** member of **its** family **(Acrochordidae)—found** in southeast Asia



An **anilid snake**, ***Cylindrophis maculatus***, in **its defense** position with **head** hidden and tail curled. Asian

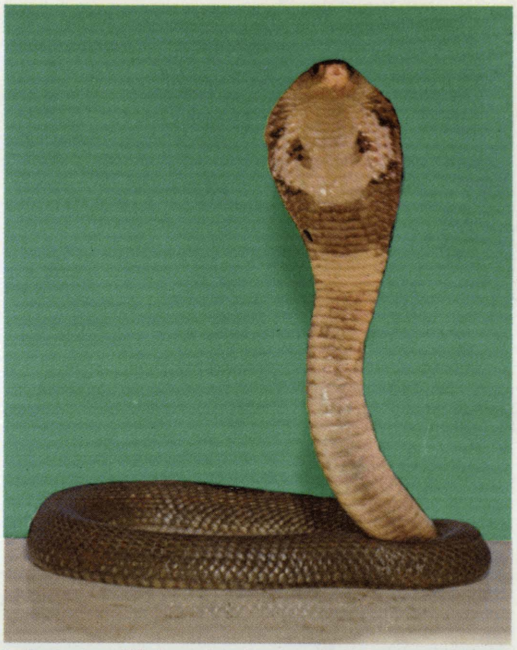
Common water snake of North America (*Natrix sipedon*), very widely distributed throughout the central and northeastern U.S.

Common water, or grass, snake of **Europe** (***Natrix natrix***), another **successful,** widely distributed **species** of **this** genus

COLUBRID WATER SNAKES AND SNAKES OF SMALLER FAMILY GROUPS

PHOTOGRAPHS, (TOP, BOTTOM RIGHT) JOHN MARKHAM, (CENTRE LEFT) CY LA TOUR, (CENTRE) HYMEN MARX (CENTRE RIGHT) G. B. RABB—BROOKFIELD ZOO, (BOTTOM LEFT) JOHN H. GERARD

East Indian coral snake, *Matacora* (formerly *Doliophis*) *bivirgata,* shown exposing the vivid underside of its tall, a defensive maneuver



Indian cobra (*Naja naja*) in characteristic pose, with its neck muscles (hood) extended (front view). Found in Asia and Africa

Head of a black mamba (*Dendroaspis polylepis*), a large, aggressive and extremely venomous African elapid

Vermicella calonota, a small, weakly venomous cobra (harmless to [redacted]) of western Australia

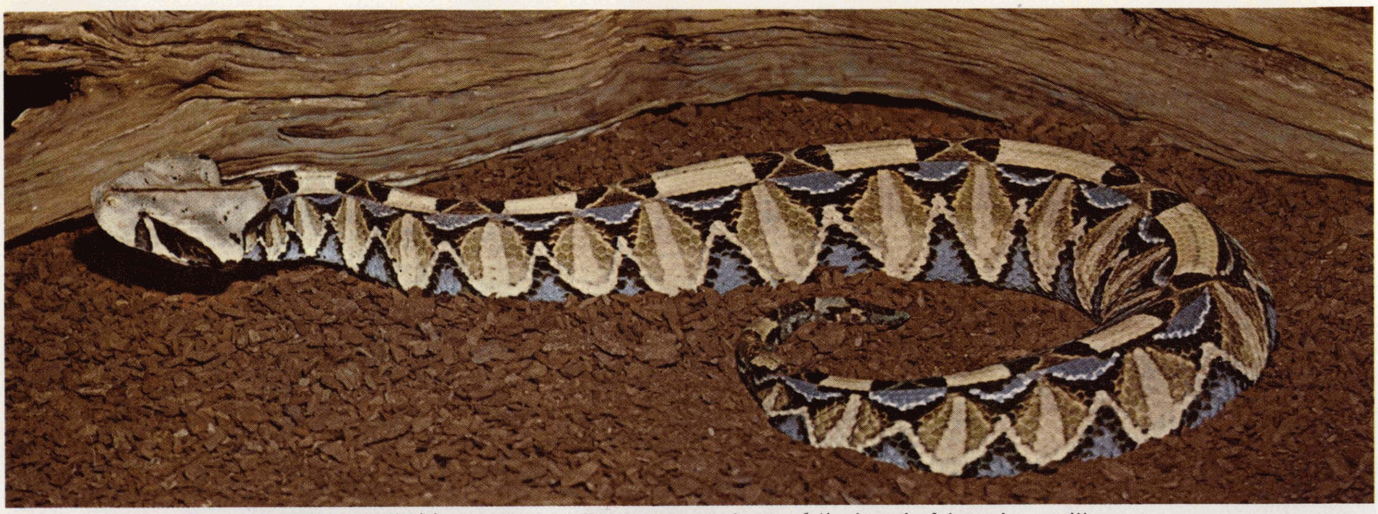
Krait (*Bungarus fasciatus*), found in India and southeast Asia. Large and strongly venomous

Eastern coral snake (*Micrurus fulvius*), found in the southeastern section of the U.S.

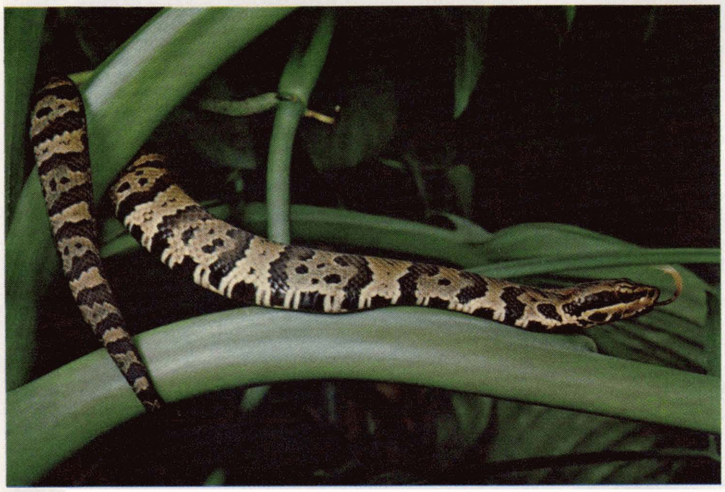
VENOMOUS SNAKES: COBRAS, CORALS AND OTHER ELAPIDS

PHOTOGRAPHS, (TOP LEFT) D. DWIGHT DAVIS, (TOP RIGHT, BOTTOM LEFT) CY LA TOUR AND (BOTTOM LEFT) DETROIT ZOO, (CENTRE LEFT) JOHN MARKHAM, (CENTRE RIGHT) R. MERTENS, (BOTTOM RIGHT) ALLEN D. CRUICKSHANK FROM THE NATIONAL AUDUBON SOCIETY

SNAKE



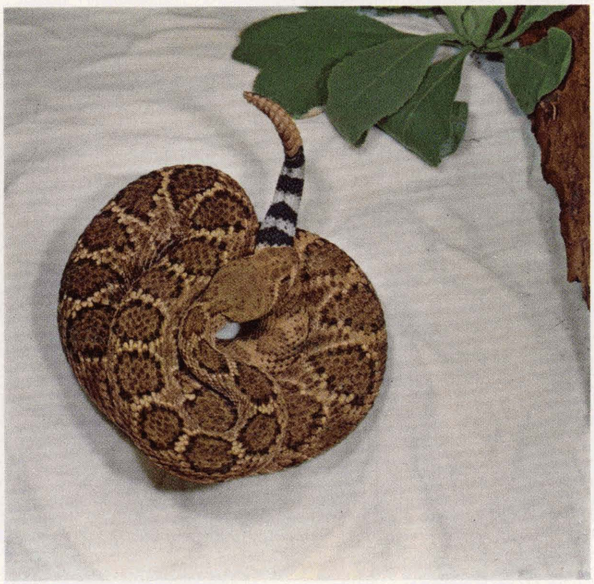
Gaboon viper (***Bitis gabonica***), **strikingly coloured,** is one *of* the **largest** of true **vipers, with** a **length up** to 6 ft. and a diameter of 6 in. **It** is unaggressive but **extremely venomous.** Found in **Africa**



Water **moccasin** or **cottonmouth** (***Agkistrodon*** [or ***Ancistrodon***] ***piscivorous***), a dangerous **aquatic** pit **viper** of the southeastern U.S.

Common **viper** (***Vipera berus***), **known as the adder in England, is** the most widely **distributed poisonous** snake of **Europe, England, Scotland** and Wales

Copperhead (***Agkistrodon*** **[or *Ancistrodon*]** ***concortrix***), one of four varieties that are found In most of the eastern, southern and southwestern **U.S.** Its bite is rarely fatal to man



Western diamondback rattlesnake (***Crotalus*** atrox) showing the **dis-**tinctive tail of the rattlesnakes. The western diamondback is one of the largest and most dangerous of its **type**

VENOMOUS SNAKES: VIPERS AND PIT VIPERS

PHOTOGRAPHS, (TOP) CY LA TOUR AND THE ST. LOUIS ZOO, (CENTRE LEFT, BOTTOM LEFT, BOTTOM RIGHT) JOHN H. GERARD, (CENTRE RIGHT) JOHN MARKHAM known of the latter are the Australian black snake (Pseudechis), which reaches a length of 6 ft. and has a small distensible hood, the tiger snake (Notechis), and the death adder (*Acanthophis*), in which the broad head, with small scales, and the stocky body produce the most viper-like of the elapids. In the Indian region the common hooded cobra and the king cobra are accompanied by other genera, especially the kraits (Bungaras). The large and active mambas of Africa (Dendraspis), whose venom appears to be extremely potent, are both arboreal and terrestrial. The coral snakes (*Micruroides, Micrurus* and *Leptomicrurus*) are the only American representatives. The genus *Elaps,* from which the family takes its name, is a South African snake with black and white rings.

The East Indian *Doliophis* is notable for the enormous development of the glands, which extend backward through the anterior third of the body. The species of Doliophis are brilliantly coloured, and have the further interesting habit of raising the tail when annoyed, to expose its brilliant red undersurface.

The larger snakes of this family are all highly dangerous to man; the venom is chiefly neurotoxic in its action, as compared with the more haemolytic venom of the rear-fanged snakes and of the vipers and pit-vipers.

11. Hydrophidue.—Sea snakes well adapted to aquatic life, with valvular nostrils on the top of the snout, vertically flattened tails, and the ventral shields greatly reduced (subfamily Laticaudinae) or absent (subfamily Hydrophinae). There are about 55 species all told. The snakes of the former subfamily, mainly of the Australian region, come ashore to lay eggs, while the more advanced Hydrophinae, mainly Malayan, produce living young. One of these, the pelagic *Pelamis platurus,* ranges from Madagascar to Panama. It has a striking coloration, with a brown or black back sharply set off from the yellow belly.

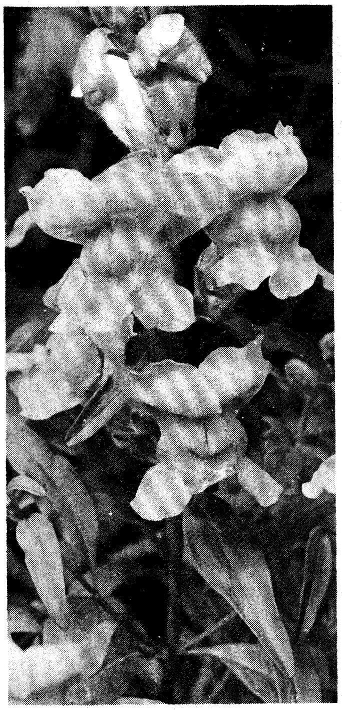
All of the sea snakes are venomous, but the majority are entirely docile, and fishermen, who in some places throw them out of the nets with their bare hands, are rarely bitten. Most of the species are moderate in size, reaching lengths of three or four ft.; the giants of the family may be as much as 8 ft. in length (*Hydrophis cyanocinctus,* for example). Only one species, *Hydrophis semperi* of Lake Taal on Luzon, inhabits fresh water.

12. *Viperidae.*—This family and the following are characterized by large poison fangs situated at the front of the upper jaw, the only teeth on the maxillary bone being the fangs. The maxillary is movable so that the fangs can be erected for use or folded back on the roof of the mouth. In both families the venom is powerful and usually strongly haemolytic in action. The family Viperidae is confined to the old world. The primitive genera *Causus* and *Azemiops* have the large shields on the head of the typical snakes. The African *Atractaspis,* with very large fangs, has a narrow rounded head and cylindrical body. Certain arboreal African forms have a prehensile tail. The puff adder and its relatives, *Bitis* and the true vipers *Vipera,* have much enlarged poison glands, broadened heads, and have lost the normal head shields (see VIPER).

13. *Crotalidae.*—This family is distinguished by the presence of a curious sense organ on the face between the eye and nostril, the "pit," hence the name pit vipers. It includes the moccasin and copperhead of North America with related species in Asia (*Agkistrodon*); the fer-de-lance group (*Trimeresurus*) also American and Asiatic; the bushmaster (Lachesis); and the numerous species of rattlesnakes of the genera *Crotalus* and *Sistrurus.* See also PIT VIPER and RATTLESNAKE. (H. W. P.; K. P. S.)

SNAPDRAGON (ANTIRRHINUM), any herbaceous plant of the genus *Antirrhinum,* of the snapdragon or figwort family (Scrophulariaceae), of which there are over 40 species, scattered over the north temperate zone, especially in the western states of the U.S. The common garden snapdragon, *A. majus,* much grown for its handsome flowers, is a perennial from the Mediterranean region, usually grown as a summer annual; growers for the florist trade, however, force it for winter bloom. It is a stout plant 12–25 in. high, producing pouchlike, irregular flowers in a showy terminal cluster (raceme).

Another species is the beautiful chaparral snapdragon, *A.* coulterianum of California, with purple or white flowers that have conspicuous yellow hairs in the throat of the corolla.


A. W. KERR

A VARIETY OF SNAPDRAGON. ANTIRRHINUM MAJUS

Scores of showy garden varieties have replaced the typical *A.* majus. They are dwarfs (6–9 in. high), intermediates (10–20 in. high) and talls (20–40 in. high).

For outdoor culture seeds are shallowly sown in Aug. or Sept. and wintered in cold frames for transplanting the following spring. In all cold regions this must be done annually, for snapdragons are not frost hardy. When forced for winter bloom, seed is sown in June, and the potted seedlings are transferred to a cool greenhouse in September for blooming in Dec.–Jan., or later if successive sowings are made.

Snapdragon is also the somewhat inappropriate name of *Galvesia speciosa,* closely related to *Antirrhinum,* an evergreen shrub with showy scarlet flowers, found on the islands off the coast of California. (N. TR.)

SNEEK, a town in the province of Friesland, Netherlands. west of Sneek lake, 14 mi. by rail S.S.W. of Leeuwarden, with which it is also connected by canal. Pop. (1957 est.) 19,881 (mun.). One of the former city gates (1615) remains, and in one of the churches is the tomb of the naval hero of the 16th century, Lange, or Groote Pier (Long or Great Peter).

Sneek is one of the great butter and cheese markets of the province.

SNEEZING, a violent expiration of air from the nose and mouth. an involuntary reflex respiratory act caused by irritation of the nerve endings of the mucous membrane of the nose or by stimulation of the optic nerve by a bright light. The irritation may be due to: swelling of the nasal mucous membrane, sneezing often accompanying nasal catarrh; foreign bodies in the nose, as by inhalation of snuff; or allergy. The spray emitted may carry infection to others.

Sometimes spasms of sneezing occur. A venerable and widespread belief survives in the custom of saying "God bless you" when a person sneezes. (F. L. A.)

SNELL, HANNAH (1723–1792), English "female soldier," was born at Worcester, Eng., on April 23, 1723, the daughter of a hosier. In order to seek her husband, who had ill-treated and abandoned her, in 1745, she donned man's attire and enlisted as a soldier in Guise's foot regiment, but soon deserted; she then shipped on board the sloop "Swallow," took part in the siege of Pondicherry and was wounded. Her adventures were told in *The Female Soldier,* or the Surprising Adventures of Hannah Snell (1750).

Hannah Snell died insane in London, Feb. 8, 1792.

SNELL (VAN ROIGEN), **WILLEBRORD** (1591–1626), commonly known as SNELLIUS, Dutch astronomer and mathematician, the discoverer of the law of refraction, was born at Leiden. In 1613 he succeeded his father, Rudolph Snell (1546–1613), as professor of mathematics in the Gniversity of Leiden. In his Eratosthenes *Batavus* (1617), he describes his method of measuring the earth, and gives as the result of his operations between Alkmaar and Bergen-op-Zoom a degree of the meridian equal to 55,100 toises (= 117,449 yd.). His discovery (1621) of the law of refraction was of significance fbr the study of the nature of light (see LIGHT: History).

Snell died at Leiden, Oct. 30, 1626.

SNIPE, a name for certain shore birds of the sandpiper family Scolopacidae. much sought after as game birds. The common snipe, *Capella gallinago* of Europe and America, is 11 in. long with a long ($2\frac{1}{2}$–3 in.) bill, eye placed far back in the head, rather short legs, but long toes, a very short tail, and a complicated pattern of brown, buffs and black on its upper parts. It lives in bogs and wet meadows where it probes for worms.

Secretive, it flushes from the grass with a hoarse cry and zigzags rapidly away. The birds, though usually solitary, sometimes feed and travel in loose flocks. They winter south to Africa, Java and South America. In the spring the male gives a flight song, the pair lines a hollow in the ground for a nest; four spotted eggs are laid and incubated by the female; and the active downy young are cared for by both parents.

There are other, related species in Europe. Asia (some of which migrate to Australia). Africa and South America. A more different species, the jacksnipe, *Lymnocryptes minimus* of Europe, is only seven and one-half inches long. In Europe, dowitchers are also called snipe.

The species of painted snipes, one of Africa and the area of southern Asia and Australia, the other of South America, form a related iamily. Rostratulidae, in which the birds are more brightly coloured: in this family the female is larger and brighter than the male, and takes the initiative in courtship, while the male incubates the eggs. (A. L. RD.)

SNOILSKY, CARL JOHAN GUSTAF, COUNT (1841–1903), Swedish poet, the most notable of a group of early poetic realists, was born in Stockholm on Sept. 8. 1841. At Uppsala university Snoilsky made himself known by his great poetic talent. He went to Italy in 1864 and wrote poems praising the joy and beauty of the Mediterranean landscape. After several years as a diplomatist and civil servant he gave up his career in 1879 and lived abroad, devoting himself to poetry. Deeply affected by social problems, he favoured the breaking down of class barriers and expressed his social anguish and humane liberalism in important poems. From these years also dates his well-known series on figures and episodes from Swedish history. *Svenska bilder* (1886). In 1890 Snoilsky returned to Stockholm, where he died on May 19, 1903.

Snoilsky's poetry is clear and elegant and has, though rather traditional in form, a strong note of realism.

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(*G. SDT.*)

SNORRI STURLUSON (1179–1241), the celebrated Icelandic historian, the youngest son of a chief in the Vestfirðir (western fiords), was brought up by a powerful chief. Jon Loptsson, in Odda, who seems first to have awakened in him an interest for history and poetry. His career begins with his marriage, which made him a wealthy man; in 1206 he settled at Reykjaholt. where he constructed magnificent buildings and a bath of hewn stones, preserved to the present day, to mhich water was conducted from a neighbouring hot spring. He early made himself known as a poet, especially by glorifying the exploits of the contemporary Norse kings and earls; at the same time he was a learned lawyer, and from 1215 became the *lögsögumaðr,* or president of the legislative assembly and supreme court of Iceland. The prominent features of his character seem to have been cunning, ambition and avarice, combined with want of courage and aversion from effort. By royal invitation he went in 1218 to Norway, nhere he remained a long time with the young king Haakon and his tutor Earl Skuli. When, owing to disputes betneen Icelandic and Norwegian merchants, Skuli thought of a military expedition to Iceland, Snorri promised to make the inhabitants submit to Haakon of their own free will. Snorri himself became the *lendrmaðr,* vassal or baron, of the king of Normay, and held his lands as a fief under him. On his return home Snorri sent his son to the king as a hostage, and made peace between Norway and Iceland, but his power and influence were used more for his own enrichment and aggrandizement (he was *lögsögumaðr* again from 1222 to 1232) than for the advantage of the king. Haakon, therefore, stirred up strife between Snorri's kinsman Sturla and Snorri, who had to fly from Reykjaholt in 1236; and in 1237 he left the country and went back to Norway. Here he joined the party of Skuli. who was meditating a revolt. Learning that his cousin Sturla in Iceland had fallen in battle against Gissur, Snorri's son-in-law, Snorri, although expressly forbidden by his liege lord, returned to Iceland in 1239 and once more took possession of his property. Meanwhile. Haakon, who had vanquished Skuli in 1240, sent orders to Gissur to punish Snorri for his disobedience either by capturing him and sending him back to Norway or by putting him to death. Gissur took the latter course, attacked Snorri at his residence, Reykjaholt, and slew him on Sept. 22, 1241.

Snorri is the author of the great prose *Edda (see* EDDA), and of the *Heimskringla or Sagas of the Norwegian Kings,* a connected series of biographies of the kings of Norway down to Sverri in 1177. Snorri's sources were partly succinct histories of the realm, such as the chronological sketch of Ari: partly more voluminous early collections of traditions, as the *Noregs Konungatal (Fagrskinna)* and the Jarlasaga, partly legendary biographies of the two Olafs; and, in addition to these, studies and collections which he himself made during his journeys in Norway. His critical principles are explained in the preface. where he dwells on the necessity of starting as much as possible from trustworthy contemporary sources, or at least from those nearest to antiquity—the touchstone by which verbal traditions can be tested being contemporary poems. He inclines to rationalism, rejecting the marvelous and recasting legends containing it in a more historical spirit; but he makes an exception in the accounts of the introduction of Christianity into Norway and of the national saint, St Olaf Besides his principal work. he elaborated in a separate form its better and larger part, the *History oj St. Olaf* (the great *Olaf's Saga).* In the preface to this he gives a brief extract of the earlier history, and, as an appendix, a short account of St. Olaf's miracles after his death. *See* further ICELANDIC LITERATCRE. and EDDA.

SNOW is the solid form of water which grows while floating, rising or falling in the free air of the atmosphere. It often takes the form of beautiful crystals generally having a hexagonal pattern Snow crystals sometimes come from a cloudless sky since they may form spontaneously or in the presence of suitable sublimation nuclei before there is enough water vapour present in the air to form the common water droplet cloud.

Snow has attracted the attention and admiration of many from ancient times. The word crystal is of Greek origin and is derived from *kryllos,* the word for frost. One of the first indications of man's early awareness that there was more to snow than cold, hunger. trouble, and restricted travel is the biblical reference to the "storehouses of the snow" in the Book of Job xxxviii, 22.

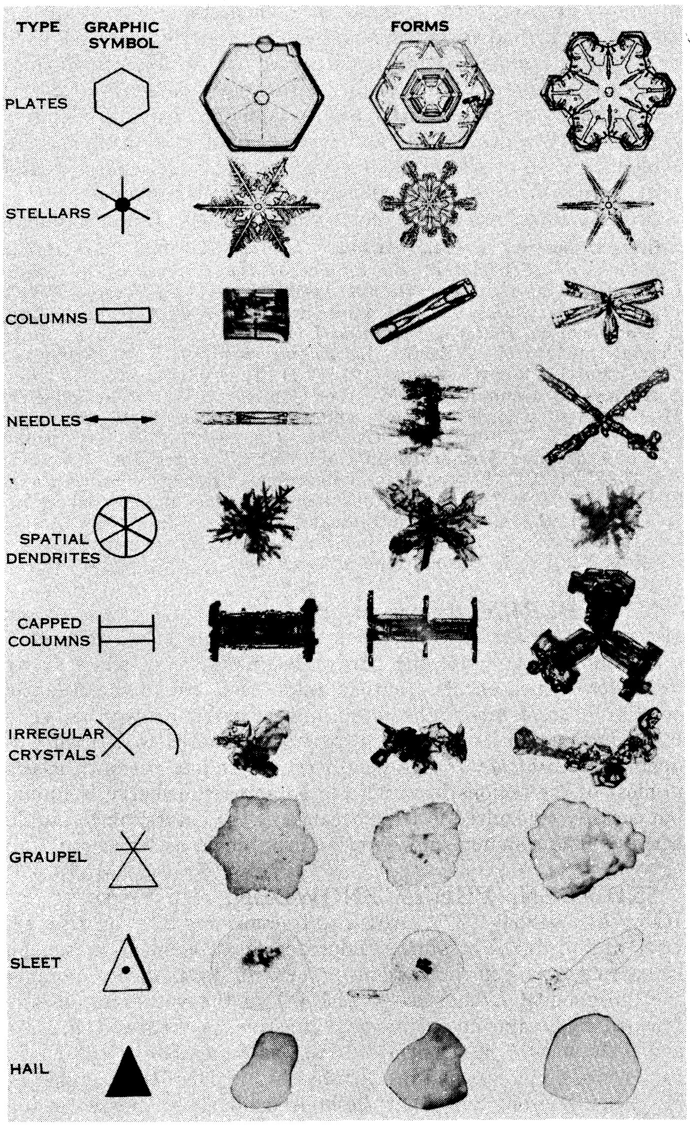
One of the first recorded instances showing recognition of the hexagonal symmetry of snow crystals is ascribed to Olaus hlagnus, archbishop of Uppsala in Sweden who depicted the crystal form in a book on natural phenomena published in Rome in 1555. The development of the microscope increased this knowledge. Robert Hooke of England studied the snow crystal structure and published illustrations of some of the beauty and symmetry he saw in his fascinating book, *Micrographia,* published in 1665. During the middle of the 19th century. poetry and prose mere written about snow and snow crystals. An extremely interesting book of this period entitled *Cloud Crystals* written by "A Lady" and published in 1864 contains scientific fact, poetic fancy and excellent wood cuts shoning some of the basic forms of snow.

Snow Crystals.—It has been said that no two snow crystals are the same. This statement is true in the sense that it is quite unlikely that among all the countless myriads that fall from the sky there are ever two identical in shape, size and absolute number and distribution of water molecules.

Honever, it is no problem during a particular storm to observe two crystals mhich to the unaided eye or even at low power magnification are similar in outline and general structure. The main point to observe in this relation is that there is a bewildering variety of size. shape and pattern. They range from simple, solid triangles and hexagons to the exquisite fernlike dendrites, with all manner of complicated three-dimensional formations.

In an attempt to simplify the task of the research scientist concerned with reaching a better understanding of the fundamental science related to the formation of snow and ice, a classification of solid precipitation was developed in 1951 for international usage. This is shown in fig. 1 which illustrates the typical forms of ten types of frozen precipitation. It is quite feasible to subdivide any one of these ten types into subtypes and for special purposes this is being done. For all practical purposes. however, the types illustrated can be used to describe the precipitation of snow, ice and hail storms.

A considerable amount of the popular interest in snow crystals stems from the pioneer and classic photographic work done by



FROM "ARTIFICIAL STIMULATION OF RAIN,' (1957); REPRODUCED BY PERMISSION OF PERGAMON PRESS, INC.

FIG. 1. — CLASSIFICATION OF FROZEN PRECIPITATION

Wilson W. Bentley, farmer-meteorologist of Jericho, Vt. Bentley became enthralled by the beauty of snow crystals and spent many winters with his camera, recording the varieties and symmetry of the crystals that are such a common feature in the vicinity of his northern Vermont home. Of the more than 5,000 photomicrographs prepared by him. nearly half have been perpetuated in *Snow* Crystals, published in 1931. His persistent efforts. careful observations and beautiful photographs did much to arouse the interest of scientists in snom crystals.

In Europe a similar effort was expended by **A.** B. Dobrowolska of Poland who wrote many scientific articles on this subject. In Japan, the classic work in the study of snow by U. Nakaya of the University of Hokkaido, culminated in his book **Snow** Crystals (1954).

The relationship of snom to ice and the peculiar underwater snow storms caused by frazil ice formations have been studied for many years and are of much economic importance.

The bewildering variations and modifications occurring in snow after it has reached the ground are a specialized study that still continues. The early studies have been uell summarized by G. Seligman. The modern work increases in complexity with much of it in North America under the leadership of the Snow, Ice and Permafrost establishment of the U S. army corps of engineers.

There are many factors controlling the size and shape of snow crystals. One of these—probably the most important—is the supply of water molecules in the air. If the air contains a rich supply of moisture. the snow crystals will grow fast and is likely to have dendritic or fernlike arms. will be large and may clump together with others to form a snowflake. Snowflakes may have 50 or more crystals interlocked nith each other. If a stellar-type crystal forms or falls into a cloud containing a high density of subcooled cloud droplets, it may sweep up some of them which freeze upon contact and cover the crystal until it looks like a miniature snonball. Such particles are called soft hail (*q.v.*) or snow pellets but are most commonly called by the German name *graupel*.

The temperature of the air is another condition controlling the form of the snow crystal. If the air is colder than about −30° C. it contains very little water vapour so that any crystals developing grow very slowly and are likely to be tiny. dense and compact in shape and crystal form. This is the condition nhich produces the crystals of the filmy cirrus clouds that form in the high levels of the atmosphere often at altitudes of five to eight miles over the middle and low latitudes. In the polar regions, cirruslike clouds may be close to the ground due to the intense cold.

At temperatures close to −40° C. (−40' F.) which commonly occur in the polar regions and at levels in the sky above 30,000 ft., ice crystals form spontaneously whenever a sufficient concentration of water molecules exceeds the amount that can exist in vapour form. This is called homogeneous nucleation phenomenon. At all temperatures warmer than −40° and colder than 0° C. (32° F.), heterogeneous nucleation occurs. In this range, special type microscopic or submicroscopic particles floating in the air serve as nuclei for ice crystal formation. Particles in the size range of 0.01 to 10 μ (0.0000025 to 0.0025 in. in diameter) consisting of such materials as volcanic dust, loess, certain types of clays, silver iodide and a special form of copper sulfide serve as effective ice nuclei. Except for the silver iodide and copper sulfide, which become active at temperatures colder than −4° C. most ice nucleating substances are effective in the temperature range of −12° to −25' C. There is much still to be learned about the behaviour and characteristics of such particles.

Effects of Snow.—Like so many of the small things in nature, a snow crystal, when considered as a single particle, is at once beautiful or at least interesting in structural form and seemingly ineffectual as an element of force or destruction. It is only when they occur in quantity—nearly countless numbers—that their presence causes wonder, interest. concern or terror.

Floating in the rare air of the high atmosphere, the tiny, pointed or flat-ended hexagonal columns and thickened hexagonal plates form the coloured halos. pillars, arcs and circles surrounding the sun in orderly array. Formed in the upper parts of turbulent clouds, the reactions between crystals and subcooled water cause the development of electrical charges often manifested as cloud-to-cloud or cloud-to-ground lightning and radio static and lesser degrees of atmospheric electricity. Sweeping over and smashing on airplane wings and fuselage, the snow crystal causes electrification which may appear as St. Elmo's fire on leading surfaces and may illuminate the trailing edges of the wing tips.

Much of the moderate to heavy rain in the middle latitudes starts as snow in the high reaches of the sky and thus is responsible for the precipitation on which most life as we know it is primarily dependent. Snow packs represent a form of water storage that is very useful to man. The heavy winter snows in the higher elevations remain as a slonly melting snow pack long into the summer which feeds the mountain streams flouing into the drier valleys. The interior valleys of California and Oregon, plains of Utah, Colorado, New Mexico, Arizona, parts of Spain north Africa and a number of similar areas which have insufficient precipitation to support crops. are made into fertile agricultural regions by means of irrigation water from nearby massive mountains.

At times snon may become so deep and unstable on the mountain slope as to form a terrifying avalanche or it may become consolidated to form massive layers of turquoise green-blue glacial ice to flow down the mountain as a river of ice *(see* AVALANCHE; GLACIER).

It would not be proper to end the discussion of the massive effects of snow without reference to the beauty of snow and the sport of skiing. With the rapid development in the second half of the 20th century of ski centres and ski lifts of all kinds, and the equipment demanded by the skier, the importance of snow as a valuable commodity in certain areas assumed such value that it became economically profitable to generate snow on cold nights from high pressure air and cold water.

For an account of the history of this sport and description of its development *see* SKIING. *See* also SLEIGH; SNOWSHOES; WINTER SPORTS.

Snow Crystals and Cloud **Modification.**—When the droplets in clouds cool below 0" C. (32° F.), they do not normally freeze but remain in liquid form. These subcooled droplets may cool to −30° C. or colder before they freeze, depending on whether or not they contain freezing nuclei or float near ice crystals. Whenever water subcools, it becomes unstable, so that an ice crystal alongside a liquid droplet will grow at the expense of the droplet. If nuclei suitable for ice crystal nucleation enter a cloud, they grow rapidly and either transform the entire cloud to snow or grow until large enough to overcome rising currents in the air and thus fall out of the cloud.

Since. as shown by V. J. Schaefer in 1946, it is feasible to produce local concentrations of ice nuclei in greater numbers than occur under natural conditions and having a nucleating activity better than naturally occurring particles, scientists aye able to carry out experiments using clouds in the atmosphere for their

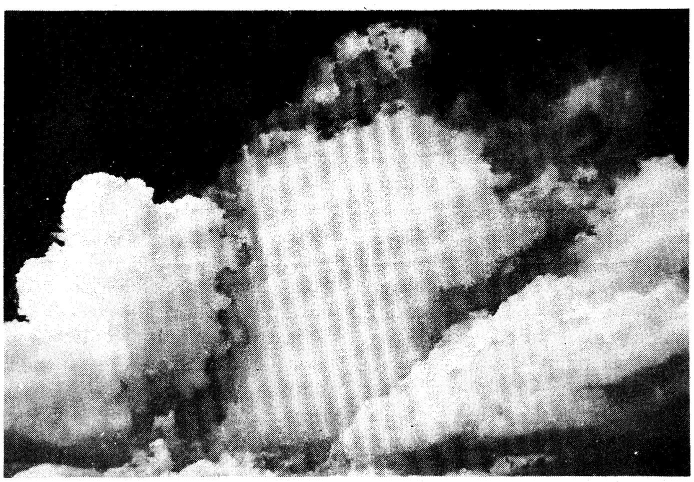


FIG. 2.— PRODUCING SNOW CLOUD (CENTRE) BY SILVER IODIDE SEEDING. UNSEEDED CLOUDS AT LEFT AND RIGHT

subjects. Efforts are being made to take advantage of these opportunities. to prevent damaging hailstorms. to modify lightning storms, to increase snow deposits in the high mountains, to increase rainfall and to moderate or prevent the development of disastrous storms

These local efforts may eventually lead the way to large-scale weather control. Although some evidence has been found that other methods may be useful to modify clouds, the ice nucleus and the snow particle uhich grows on it seem likely to remain of great importance in the science of experimental atmospheric physics.

Snow Crystal Replicas.—The form and appearance of the fragile and evanescent snow crystal may be preserved in minute detail by an extremely simple and effective process of replication. A dilute 0.5 to 3% solution of polyvinyl formal (a plastic) dissolved in ethylene dichloride (a common solvent) is required to make the replica. The solution must be cooled a few degrees below 0° C. (32° F.) before using. A small amount of the replica solution is poured onto a piece of black cardboard. sheet glass or similar material that also has been cooled below 0° C. The wet surface is then placed so that snow falls into it. When the desired number of crystals have fallen into the solution, it is placed in a cold, well ventilated place until the solvent evaporates. This ordinarily requires 5 to 10 minutes. When the sample is dry, it may be warmed up and examined. When properly prepared. each crystal is encased in a thin plastic shell whose inner surface is an exact negative copy of the original crystal. When the crystal melts, the water passes through this thin film. leaving behind a hollow cavity which reflects and scatters light in a manner quite similar to that of the original crystal. Frost, fallen snow and related substances may be replicated in a similar manner.

See also Index references under "Snow" in the Index volume.

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SNOWBERRY, the common name for several species of the genus *Symphoricarpos* of the honeysuckle family (Caprifoliaceae; *q.v.*), but especially for the hardy, deciduous, snow-white fruits of *S. albus* which occurs from Colorado eastward to the Atlantic coast. *S. occidentalis,* the western snowberry or wolfberry, is more northern in its range and extends westward to British Columbia. *S. orbiculatus,* the coralberry or Indian-currant, occurs in most of the regions in which the common snowberry is found, but is easily recognized in fruit because of the coral-pink to purple berries. The common snowberry is also known as waxberry. (J. M. BL.)

SNOWDEN, PHILIP SNOWDEN, 1ST VISCOUNT, of Ickornshaw (1864–1937), British statesman, was born on July 18, 1864, at Cowling, Yorkshire. Educated at an elementary school, he became a clerk in the customs and excise department. Joining the Independent Labour party (I.L.P.) in the year after it was founded. he became one of its most effective speakers and. in 1903 and again in 1917. its chairman. He was a member of the I.L.P. for 34 years, but resigned his membership in Dec. 1927, giving as his reason his conviction that the body ought to be merged in the Labour party and that its continued separate existence was neither desirable nor necessary. His first parliamentary attempts, for Keighley and Blackburn. failed. but in 1906 he was returned for Blackburn as Labour M.P. In the house he at once made his mark, notably on financial matters. When war broke out in 1914 he was in Australia. On his return he at once ranged himself with J. R. MacDonald and shared much of the latter's unpopularity. Defeated in the 1918 election, he won Colne valley for Labour in 1922, and held the seat with increased majorities in 1923 and 1924. His appointment as chancellor of the exchequer in MacDonald's cabinet was a matter of course.

In his budget, introduced in April 1924, while limited by the commitments of his predecessor. Snowden endeavoured to relieve the burden of taxation on the poor by his reduction in the food duties, and by making provision, in his contingent Old Age Pensions act, for the removal of the oppressive features of the thrift disqualification. At the same time, he stood fast by his free-trade principles and repealed the McKenna duties on imported motor-cars. clocks, musical instruments. etc.

At the London conference in July–August 1924. Snomden took charge of the discussions with the bankers which ended in the successful flotation of the German loan in October of that year. He was chancellor of the exchequer again from 1929 to 1931, when he was created a viscount.

Snowden warmly espoused the cause of Ramsay MacDonald when he consented to form a national government with the Conservatives and Liberals to solve the exchange and financial crisis of 1931. In the election of 1931 he hit very hard at his former friends of the Labour party who opposed the new government. This was deeply resented and he became for a time as unpopular with official Socialists as he had once been admired. With characteristic independence he left the government with Sir Herbert Samuel and the Free Trade Liberals in 1932 and for the rest of his life was a lonely figure. In perspective his service to British socialism will probably be regarded as of cardinal importance in spite of the later break.

He was the author of various books, among them A Socialist Budget (1907); A Living Wage (1912); *Socialism* and Syndicalism (London, 1913); *Wages* and Prices (1920); *Labour and National* Finance (London, 1920); *Labour* and the *New* World (1924); *Autobiography* (1934).

SNOWDON (Welsh, Y *Wyddfa*, "view place"; Eryri for the whole range, which modern scholars translate as "high land," the Welsh eryr, "eagle," being of the same root), the highest peak (3,561 ft.) in Wales, situated in Caernarvonshire. Snowdon is the name usually given to the mountain mass, occupying most of the triangle between Llarberis. Pen-y-Gwryd and Beddgelert, culminating in the Wyddfa, the dominating feature of the area: which is easily climbed. The region as a whole, which contains several peaks rising above 3.000 ft.. is called Snowdonia. Formed principally of Ordovician volcanic rocks, slates and grits, Snowdon consists of five sharply ascending ridges converging on the summit, with cirques containing small lakes between them. Surrounding the lakes are the three celebrated passes of Llanberis. Aberglaslyn and Rhyd-ddu. A rack-and-pinion railway (opened 1897) ascends to the Wyddfa summit ($4\frac{3}{4}$ mi.) where there is a hotel, open in summer.

The area is noted for alpine flora. Some of the finest scenery in Great Britain is contained in the 32,282 ac. of Caernarvonshire owned by the National Trust (1955). It includes Carnedd Dafydd (3,427 ft.). the sombre Llyn Idwal (a lake 1,223 ft. above the sea), the head of the pass of Nant Ffrancon, and also the rugged peaks of Tryfan (3,010 ft.), Glyder Fawr (3,279 ft.) and Glyder Fach (3.262 ft.).

See F. J. North, B. Campbell and R. Scott, Snowdonia (London, New York, 1949), for description of area and bibliography.

(J. C. G. J.)

SNOWDROP, any plant of *Galanthus,* a small old world genus of the amaryllis family (Amaryllidaceae). All the plants of the genus have bulbs. linear basal leaves and erect flower stalks about one foot tall. bearing at the top, a solitary, pendulous. bell-shaped white flower. Most especially, the term snowdrop indicates *G. nivalis,* the common snotvdrop widely cultivated in the U.S. and England, often in naturalized masses in the lawn. Other distinct species are the Crimean snowdrop, G. *plicatus,* with broad leaves folded like a fan, and G. *elwesi,* the giant snowdrop, a native of eastern Mediterranean, with large ($1\frac{1}{4}$ in. long) flowers.

ROCHE

SNOWDROP (GALANTHUS NIVALIS), ONE OF THE EARLIEST SPRING FLOWERS

All species thrive in almost any soil or position. The bulbs should be planted in autumn, 3 in. deep and about 3 in. apart, preferably by the hundreds if sheets of early white bloom—often before the winter snow disappears—are desired. (N. TR.)

SNOW LEOPARD: see OUNCE.

SNOW LINE, a line above which snow accumulates, temporarily (seasonal snow line) or perennially. Two types of perennial snow lines are recognized, orographic and regional. The orographic snow line passes through the lowest limit of perennial snow masses lying in protected spots. The regional snow line marks the lowest limit of an essentially continuous snow mantle, and its altitude depends primarily upon temperature and precipitation.

The regional snow line rises from near sea level in polar regions to 20,000–21,000 ft. in the horse latitudes (*q.v.*) and descends to 15,000–18,000 ft in equatorial regions. The orographic snow line may be 2.000–3,000 ft. lower. (R. P. SP.)

SNOW PLANT (Sarcodes sanguinea), a North American saprophytic herb of the family Pyrolaceae, so named because it often blooms in moist places in the vicinity of melting snow. It is closely allied to the Indian pipe (*q.v.*) and, by reason of its bright red or crimson colour throughout, presents a striking appearance.

Snow plant grows in pine woods on mountain slopes from southern Oregon to Lower California and eastward to Nevada. The single. fleshy, scaly stem. 6 to 15 in. high, rises from a ball of brittle roots and bears at its summit a cylindrical cluster of nodding. bell-shaped crimson flowers.

SNOWPLOW. A device for clearing snow from streets, highways, railroad tracks. airfields and the like. There are three general types of snowplows, known as rotary. V and single-blade.

The rotary plow in railroad use is mounted on a carriage that is pushed by one or more locomotives. It consists of several large biades attached to a horizontal shaft powered by an engine mounted on the carriage. A housing is provided for the protection of the engine. the rotary controls and the operating personnel. The plow is forced into deep drifts or slides while the blades are rotating. The snow is sliced from the face of the drift and discharged to one side of the track. The rotary is generally used to remove snow in depths which cannot be handled with the V-plow.

Under some conditions flangers are used to remove snow from the inside of the top of the rail to avoid the formation of ice that might cause derailments.

The rotary plow for highway use is of similar design but is built into a self-propelled truck unit. In some cases pusher trucks may be used for additional power. An adaption of the rotary plow is a unit consisting of two or more augers which feed the snow from the left and from the right to a centre collecting point from which a high-speed rotor discharges the snow to one side of the right-of-way. This unit is frequently mounted on the front of a standard motor grader or special heavy truck.

The V-plow consists of two concave surfaces fastened to a common centre line and sloping upward and to the rear, one to the right and one to the left. The V-plow forces the snow to either side and is used in areas of heavy snow, deep drifts or slides. For clearing railroad tracks the V-plow is mounted on a carriage pushed by one or more locomotives. In some mountainous areas the plows are mounted directly on the front of steam locomotives. The V-plow for highway clearance may be mounted on a heavy-duty truck, motor grader or tractor.

The single-blade plow may consist of a concave surface of varying depth or a straight blade. The former moves the snow in one direction only; the straight-blade type is reversible and may be set to move the snow to the right or to the left. The single-blade plow mounted on a heavy-duty truck is commonly used on highways and airports. The trucks operate at relatively high speed in order to throw the snow well off the travel way. A wing may be attached back of and above the single-blade plow. It may be adjusted to direct the snow well away from the plowed way.

(F. W. ST.)

SNOW SCORPION FLY: see SCORPION FLY.

SNOWSHOES, a form of footgear devised for traveling over snow. Nearly every American Indian tribe has its own particular shape of shoe, the simplest and most primitive being those of the far north. The Eskimos possess two styles, one being triangular in shape and about 18 in. in length, and the other almost circular. Southward the shoe becomes gradually narrower and longer, the largest being the hunting snowshoe of the Crees, which is nearly 6 ft. long and turned up at the toe.

Typical snowshoes worn by lumbermen are about 34 ft. long and broad in proportion, while the tracker's shoe is over 5 ft. long and very narrow.

Snowshoes may be made of a single strip of some tough wood, usually hickory, curved round and fastened together at the ends and supported in the middle by a light crossbar. the space within the frame thus made being filled with a close webbing of dressed caribou or neat's-hide strips, leaving a small opening just behind the crossbar for the toe of the moccasined foot. They are fastened to the moccasin by leather thongs, sometimes by buckles. The method of walking is to lift the shoes slightly and slide the overlapping inner edges over each other, thus avoiding the unnatural and fatiguing "straddle gait" that would otherwise be necessary. Snowshoe racing is common in the Canadian snowshoe clubs, and one of the events is a hurdle race over hurdles 3 ft. 6 in. high. In the thick forests of America, the snowshoe was found more suitable for use than the Norwegian ski (see SKIING). (X.)

Compared with the snowshoe clubs of Canada. the United States interest in snowshoeing is more casual. Still the colleges in the snow belt conduct snowshoe cross-country races, obstacle races and snowshoe hikes. Practically every winter carnival held in the United States includes snowshoe competitions. The Intercollegiate Winter Sports union includes snowshoe dashes and similar races in its programs. (F. K. B.; X.)

SNUFF, a powdered preparation of tobacco (*q.v.*) used by inhalation or by "dipping"; *i.e.,* rubbing on the teeth and gums. The practice of inhaling snuff became common in England around the 17th century, and throughout the 18th century it was universal.

At first each quantity was fresh grated (Fr. *râper,* whence coarser kinds were later known as "rappee"). This entailed the snuff taker's carrying with him a grater; early 18th-century graters made of ivory and other material are in existence. The art and craft of the miniature painter, the enameler, jeweler and gold- and silversmith were bestowed upon the box. Humbler snuff takers were content with boxes of silver, brass or other metal, horn, tortoise shell or wood.

The mull, a silver-mounted ram's head, is a large table snuffbox.

Snuff manufacture, which requires 18 to 20 months, involves grinding the tobacco and subjecting it to repeated fermentations. Snuffs are scented with attar of roses, lavendar, cloves, jasmine, etc.

SNYDERS, FRANS (1579–1657), Flemish painter of animals and still life, was born at Antwerp, where he was baptized on Nov. 11, 1579. He studied under Pieter Brueghel the younger, and afterward under Hendrick van Balen, the first master of Van Dyck. He visited Italy in 1608. On Oct. 23, 1611. he married Margaretha de Vos, the sister of the painters Cornelis and Paul de Vos. He died on Aug. 19. 1657.

Snyders originally devoted himself to painting flowers, fruit and subjects of still life, later turning to animal painting and executing with the greatest skill and spirit hunting pieces and combats of wild animals. His composition is rich and varied, his drawing correct and vigorous, his touch bold and thoroughly expressive of the different textures of furs and skins. Rubens frequently employed him to paint animals, fruit and still life in his own pictures. and he assisted Jordaens similarly. In the lion and boar hunis that bear the name of Snyders the hand of Rubens sometimes appears. Snyders was appointed principal painter to the archduke Albert. governor of the Low Countries, for n-hom he executed some of his finest works. One of these. a "Stag Hunt." was presented to Philip III, who commissioned the artist to paint several subjects of the chase. The Prado museum. Madrid, is rich in the works of Snyders. Others may be seen at the Museum of Fine Arts, Boston, Mass. ("Boar Hunt"); the California Palace of the Legion of Honor. San Francisco ("The Monkey and the Gander"); the Kaiser Friedrich museum, Berlin ("Bear Hunt"): and at many other public galleries.

SOANE, SIR JOHN (1753–1837), English architect, one of the most original architects of his time in Europe. aas born at Goring-on-Thames. Sept. 10, 1753, son of a bricklayer. In 1768 he entered the office of George Dance the younger. surveyor to the City of London. whom in later life he referred to as his "revered master"; in 1772 he went to Henry Holland (*q.v.*) as an assistant; and from 1771 he attended the Royal Academy schools. winning the gold medal in 1776. In 1778 the king's traveling studentship took him to Italy. He cut short his studies abroad because of magnificent promises of employment made to him by Frederick Hervey, bishop of Derry. These were not kept. and he was an only moderately successful country house architect until in 1788 he was appointed. thanks to William Pitt, surveyor to the Bank of England. Various government appointments followed and in 1806 he succeeded Dance as professor of architecture at the Royal Academy; he was knighted in 1831 The list of his works is a long one: some of the finest. which helped establish his reputation, included his rebuilding of the Bank of England (since rebuilt again), his own house at 13 Lincoln's Inn Fields, London (left by him to the nation as a museum) and the Duluich college art gallery, Kent His style is characterized by a tendency to strip classical elements of design down to their structural essentials, the substitution of linear for modeled ornamentation, frequent use of shallow domes and top lighting and an ingenious and often highly imaginative handling of interior space. Soane died on Jan. 20. 1837. in London.

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SOAP may be defined as a chemical compound or mixture of chemical compounds resulting from the interaction of fatty oils and iats with alkali: *i.e.,* the salts of fatty acids. Functionally, soap is a substance possessing the characteristic "soaplike" properties of sudsing. detergency, surface tension lowering. wetting and emulsifying power, curd and gel formation. Modern research has led to the view that these properties may be attained by inserting strongly polar (water-soluble) groups into a wide variety of long-chain molecules. Since 1930 many such long-chain substances. some of them bearing no relation to the fats, have been developed, and some of them (*e.g.,* sulfated alcohols; sulfonates. etc.) are of commercial importance in the field of soaps. The functional consideration of soap brings within its scope these synthetic detetgents (see below) and at the same time excludes the water-insoluble compounds of fatty acids with bases of calcium, iron, aluminum, etc. These latter are better termed "metallic soaps."

Soap appears first to have been made by boiling goat's tallow and causticized wood ashes. as described by Pliny. The resulting soft potash soap was converted into hard soda soap by treating the paste repeatedly with salt. In the 13th century the industry was introduced from Italy and Germany into France. and in the 14th century into England. In America soapmaking was a household art, with few industrial developments until after about 1800.

The processes and extent of the manufacture of soap were revolutionized during the first half of the 19th century as a result of M. E. Chevreul's classical researches on the constitution of oils and fats, and by the introduction of the Leblanc process (invented in 1791) for the manufacture of soda from brine. Large-scale manufacturing operations developed. and the industry rapidly became able to process individual kettles of soap containing from 100,000 lb. to 1,000,000 lb. per charge.

Chemistry of Soap.—All fatty oils and fats are mixtures of glycerides: *i.e.,* compounds (esters) of the trihydric alcohol glycerol (glycerin) and some fatty acid such as palmitic acid. etc. The important investigations of Chevreul (1811–23) established this fact and led to an understanding of the chemical nature of soap. The chemistry involved in soap manufacture may be expressed in the following equation:

$$C_3H_5(OCOC_{15}H_{31})_3 + 3NaOH = 3NaOCOC_{15}H_{31} + C_3H_5(OH)_3$$
$$\underset{\text{(fat)}}{\text{palmitin}} + \text{caustic soda} = \underset{\text{(sodium palmitate)}}{\text{soap}} + \text{glycerin}$$

The reaction of the fat with the aqueous caustic solution is termkd saponification. (The term may also refer to the action of water on a fat to produce fatty acid.) It will be observed that the saponification reaction produces both soap and glycerin. As discussed below, the usual method of manufacture of soap requires a further series of operations to separate the glycerin from the soap and bring the soap to the correct physical form (or phase).

Commercial soap products are essentially soap-water systems, the properties, form and appearance of the product depending in great degree on the proportion of soap to water present. Strictly anhydrous or water-free soap has none of the usual soaplike properties and is not met with in practice.

At room temperature for most of the potash soaps: and at more elevated temperatures for the soda soaps, soap-water systems exhibit a variety of physical forms or phases. These different phases, described below, are the materials with which the soapmaker works and from which his products are derived. For example. true soap solutions (called nigre phase) occur when the proportion of soap to water is under about 30% (varying from soap to soap). In potash soaps the solutions, with some modification with glycerin or alcohol. form the liquid soaps of commerce. (Special compositions of soap solutions containing electrolytes constitute the nigres of the soap kettle.) When the soap-water system contains about 40%–50% water a different phase or form of soap results. This phase is called *middle* soap or gum soap, and when derived from potash is sometimes sold as a soft soap. Middle soap is stiff and viscous. much more so than either more dilute or more concentrated systems. At concentrations approximating 70% soap–30% water a form of soap called neat soap occurs. Neat soap when cooled and solidified is converted into unmilled bar soap. It is the starting material for the vast majority of toilet, laundry and household soaps. since it is produced as the final product of the soap kettle and hydrolyzer, and is then further processed as occasion requires (see below). When neat soap is diluted with water. instead of becoming less viscous, as is the usual rule, it becomes more viscous due to formation of middle soap.

When the soap concentration is raised to a value of about 85% (15% water), under some conditions a waxy form of soap occurs. At lower moisture contents. the now almost anhydrous soap exists in fibre or crystalline form (*curd* phase), and it is in this composition range that most of the beads, powders and flakes are made. The moisture content at which the various forms are obtained depends on the fat stock used in making the soap, on the temperature and on the presence of builders or electrolytes.

Since the great bulk of commercial soap products is derived from saponification with a soda base, it is sufficient to consider further the soda soaps alone. Dilute solutions of the order of 0.1% to 0.5% are used in laundry and dishwashing. Such solutions (nigre phase) are relatively thin and fluid. but more concentrated hot solutions when cooled are either opaque jellies or semisolid masses. The frothing or sudsing of soaps occurs only in the solution (nigre) state. Neat, middle, waxy and solid forms do not foam or suds until water is added to transform them. at least partially, to nigre. Thus while soaps are ordinarily manufactured and sold in one of the concentrated phases. their usefulness in cleansing comes about after their conversion to the nigre or solution state by means of water.

Neat and middle soap are anisotropic, liquid crystalline phases. Nigre is an isotropic. colloidal solution. The solid. crystalline forms of soap are called alpha, beta, delta and omega. each of the latter three contributing its distinctive properties when present in bars. powders and pastes.

The peculiar colloidal and electrical properties of the solution or nigre form of soap have led to the classification of soap as a colloidal electrolyte. At very low concentrations (of the order of .001%) the dissolved soap is hydrolyzed to a degree by the water to form free fatty acid and small amounts of iree alkali. At slightly higher concentrations. acid soap (*e.g.,* sodium hydrogen palmitate) precipitates. and is the cause of much of the cloudiness seen in dilute soap solutions and liquid soaps. The molecules of dissolved soap and soap ions in solutions of the order of 1% concentration begin to clump together to form "neutral colloid" and colloidal "ionic micelle." which may be hydrated. The colloidal ionic micelle (which may be thought of as an electrically charged colloidal particle) and other ions give the solution pronounced electrical conductivity in contradistinction to ordinary colloids.

The behaviour of a pure, single, anhydrous soap when heated is very complex and has led in the past to much confusion about the melting points of soaps. The solid soap when heated is converted in turn at definite transition temperatures to subwaxy soap, waxy soap, superwaxy soap. subneat soap, neat soap and finally to nigre.

Only the compounds prepared from fatty acids of between about 10 and 18 carbon atoms in chain length can be considered soaplike under usual conditions. Indeed, sodium stearate (18 carbon atoms) possesses practically no soaplike properties at room temperature; it is only at temperatures approaching the boiling point of water that this compound behaves as a soap.

Detergent Power.—The washing or detergent power of soap was formerly attributed to the alkalinity produced by hydrolysis of the soap. Though this explanation has been abandoned. no comprehensive substitute explanation based on adequate experimental data has yet been established in its place. The detergent action of soap is an intricate phenomenon in which wetting power. emulsification, grease dissolving, etc., all play a role. A widely held and plausible hypothesis has considered that washing is dependent on an unsymmetrical structure inherent in the soap molecule, one end (polar) being water soluble and the other being insoluble in water and soluble in oil. Such molecules tend to form a concentrated film at the interface between the water and the dirt, each molecule attaching itself at one end to the dirt and at the other end to the water. and hence tending to pull the dirt into solution.

There is much evidence that the micellar (colloidal electrolyte) form of soap must be present for good washing. For example. sodium stearate is a poor washing agent at l o temperatures, being too insoluble to form significant amounts of colloidal electrolyte. When the solution is heated, enough of the soap dissolves to allow formation of the micellar form. On the other hand. sodium laurate is so soluble at ordinary washing temperatures that it exists predominantly as the unaggregated soap ion. having little tendency to aggregate into the micelle. At lower temperatures its solubility is reduced, much more aggregation results and its washing power is increased.

Soap Materials.—Almost any fat can be utilized in the manufacture of soap, but the principal requisite for a successful commercial product is an economical and proper balance of stocks to yield a soap that will exhibit the necessary soaplike properties over the range of conditions likely to be met with. In the section on the *Chemistry of Soap* it was pointed out that the soap properties of a given soap (*e.g.,* sodium stearate) are evident only under certain conditions. This characteristic behaviour necessitates the "blending" of fats to produce a widely applicable product. Thus. tallow is a much used stock in making soap, but tallow alone will not yield a toilet soap that will give a copious lather over a wide range of temperatures in either soft or hard water. Therefore the tallow is commonly blended n-ith a proportion of coconut oil. although palm kernel oil may be substituted. Various blends of oils and fats are used for laundry soaps, and it is safe to say that almost every knon-n fatty oil at one time or another has found its way into soap manuiacture.

The most generally used stocks are, of the animal oils. tallow and grease; of the vegetable oils, coconut, cottonseed, corn, soya, palm. palm kernel and olive. Fish and whale oil were used in soapmaking in increased quantities after the process of hydrogenation (*q.v.*) enabled them to be hardened (and largely deodorized) to proper consistency for soapmaking. Rosin (in saponified form) is an ingredient of yellow laundry soaps. Certain alkaline materials called builders are almost universally present in laundry soaps. The most important are sodium silicate (water glass), sodium carbonate (soda ash) and various phosphates. These materials give increased detergent action for conditions of usage. and are not to be thought of simply as fillers such as starch and barites which are added to cheapen the soap. For saponification of the fats, large quantities of caustic soda are required by the industry. together with lesser quantities of caustic potash for soft soap manufacture. Ammonia. tri-ethanolamine and various organic bases are used to make special soaps.

Manufacturing Processes.—Soap is manufactured by (1) the boiling process; (2) the hydrolyzer process; or (3) semiboiling, in small lots in the household or on the farm.

Boiling Process.—The object of the boiling process is to produce neat soap in purified condition free from glycerin. Neat soap (a special composition of which is called kettle soap) constitutes the starting material for making bars, flakes, beads and powders. The process is conducted in a series of steps called changes, and all the changes occur in the same piece of apparatus; *i.e.*, the kettle, or as it is termed in Great Britain, the pan. The soap kettle is one of the largest pieces of processing equipment used by any chemical industry.

The first step begins with the introduction of the melted fats into the kettle together with some excess of caustic (soda) solution, which is added gradually. The whole mass is boiled with open steam from perforated coils within the kettle. A gradual emulsification occurs. the caustic reacting with the fat (saponification) to form soap and glycerin.

In order to separate the glycerin from the soap, the pasty boiling mass is treated with brine or salt. The contents of the kettle "salt out" or separate into two layers. The upper layer is a curdy mass of impure soap. while the lower layer is an aqueous salt solution containing the glycerin dissolved in it. The basis of glycerin removal thus is the solubility of glycerin and the insolubility of soap in salt solution. The slightly alkaline salt solution, termed "spent lye." is run off from the bottom of the pan or kettle and subsequently treated for glycerin recovery.

The grainy. curdy mass of soap remaining in the kettle after the spent lye has been removed contains any (usually traces of) unsaponified fat which escaped reaction during saponification, and also dirt and colouring matter present in the original oils. The "strong change" is calculated to remove the last traces of free fat, and is carried out by adding strong caustic solution and boiling for several hours.

The final stage (pitching and settling) in the process has for its purpose the transformation of the soap into the neat form and the final removal of dirt and colouring matter. The soap, after the strong change, may be given one or more salt water washes to remove free alkali, or it may be pitched directly following the strong change. In any case the open soap is partially "smoothed" by boiling with addition of water (or open steam condensation) until the correct concentration is attained to cause the kettle contents to separate into two, or sometimes three. layers. The upper layer is neat soap (kettle soap) of an almost constant composition for a soap from a given fat (approximately 70% soap–30% water); the lower layer is a nigre, whose composition varies between about 15% and 40% soap depending on the "closeness" of the pitch. Since colouring matter and dirt generally (also salt, alkali and metal soaps) are soluble in nigre but relatively insoluble in neat soap, and because most of the impurities are dense and tend to settle, the nigre layer removes these impurities from the neat soap. The kettle boiling process requires from 4 to 11 days from the time the saponification starts until the neat soap is ready to be drawn off. Even today the complicated stages of the boiling process are usually conducted by the soap boiler with appearance and taste of the soap as criteria for judging its condition. The utilization of the finished neat or kettle soap in making the final commercial product is described below under Soap Products.

Hydrolyzer Process.—The boiling process requires that individual batches of fat be treated in separate units (kettles). By 1956 continuous processes had replaced the older batch process to the extent of 50% to 75%. Where, in the kettle, alkali was used for saponification, in the hydrolyzer process the fat is "split" into fatty acids and glycerin by means of water at high temperature and pressure in the presence of a catalyst (zinc soap). The splitting reaction

$$\underset{\text{fat}}{(RCOO)_3C_3H_5} + \underset{\text{water}}{3HOH} \rightleftarrows \underset{\text{fatty acid}}{3RCOOH} + \underset{\text{glycerin}}{C_3H_5(OH)_3}$$

is carried on countercurrently, usually in a vertical column 50 ft. or more in height. The molten fat and water are introduced continuously into opposite ends of the column, while the fatty acids and glycerin are withdrawn continuously. The water, almost insoluble in fat at low temperatures, becomes soluble to the extent of 10%–25% at 400°–480° F., the reaction being greatly speeded up by the solubility effect.

In about one hour a given unit of fat passes through the column and is 99% converted to fatty acids. which. as drawn off, are continuously distilled under vacuum to effect purification. They are then neutralized with caustic (NaOH or KOH) containing the proper amount of water to yield neat soap phase. Just as in the boiling process, this phase constitutes the base material for further processing into bars, flakes, powders, pastes or other products.

The operations necessary to obtain final products can be combined sequentially with the hydrolyzer to give a continuous flow from the original fat to the final marketable product, the whole sequence occurring in a matter of hours as contrasted with the 4–11 days required when the boiling process is used. The by-product glycerin is purified and concentrated synchronously with the fatty acid production.

Economy considerations of time, less factory space, improved quality and better control of product characteristics contributed to the introduction of this process into the industry in Europe and the United States.

Semiboiling Process.—The semiboiling process may be thought of as ending when the saponification change is completed. The fat is saponified, usually in small quantities. as completely as possible by boiling with caustic. The saponified mass, containing the glycerin, is run into frames for cooling and solidifying or, in the case of soft (potash) soap. is packed directly into containers. This process has the advantage of allowing. by water adjustment, the direct production of either neat soap, middle soap or in some instances nigre (liquid) soap.

Soap Products.—Hot neat soap phase from either the boiling or hydrolyzer process forms the starting material for a wide variety of products.

Framed Soaps.—These are usually made by pumping molten neat soap into molds or "frames" to cool. The solidified soap is then cut and stamped into cakes. Such soaps contain about 70% soap–30% water. For laundry purposes, builders such as water glass, phosphate, etc., are "crutched" or mixed in before solidification.

Floating Soaps.—Formerly, most of these were made by crutching air into the neat soap before cooling. By 1950, rapid chilling or "freezer" processes were in use in the United States. The molten neat soap was either aerated and then rapidly chilled, or chilled to a semisolid condition and then aerated. The two procedures give bars of somewhat different lather and other characteristics.

Milled Soaps.—Most toilet soaps of the better quality are made by the milling process. Originally developed in France as a way of allowing the cold incorporation of fine perfumes which could not withstand the heat of the crutcher, the milling process is now applied to the bulk of toilet soap manufacture. It produces a glossy, waxy bar of characteristically smooth feel, having more pronounced qualities of lather and solubility thanunmilled soap.

The most widely applied milling process requires that the hot neat soap first be reduced to ribbon or flake form. This is accomplished by allowing the molten soap.to flow between two hollow, rotating metal rolls. The warm roll spreads the soap into a thin film which solidifies and adheres to the cold roll. The film is removed in ribbons. These are dried in an oven to about 12%–16% moisture.

After the dried, cooled ribbons have been broken into flakes they pass into an amalgamator, where perfume, dye and any special ingredients are mixed into them. The amalgamated soap is milled by passing between successive polished metal (sometimes marble) rolls. The perfume and any other added ingredient is thus intimately and evenly pressed into the soap. The sheet of soap from the final milling roll is cut into ribbons and flakes and then subjected to pressure in a "plodder." This is a screw device operating in a cylinder. which forces the flakes together and cements them into a continuously extruded bar or cylinder of soap. The soap coming from the plodder is cut into lengths, which are then stamped into bar or tablet form and wrapped.

Flaked or *Chipped* Soaps.—Soap flakes are ribbons of dried soap broken into short lengths. The development of packaged soap flakes came about mainly between 1920 and 1930. and in the United States was concomitant with the introduction of small-scale household, power washing machines, which created a great demand for soaps that were more soluble than the old bar soaps or chips cut from bars. By 1939 flakes were produced whose thickness was only about 0.002 in. as compared with early products, which were of the order of 0.1 in.

Seat soap forms the basis for soap flakes. The crutched soap, containing builder if desired. to give increased washing effects, is run onto the rolls isee section on *Milled* Soaps). spread into a film or sheet and removed in the form of ribbons. These are then dried to proper moisture (usually 5% to 15%). broken into flakes and packaged. By proper controi of moisture, fat stocks and pressure, an increased transparency is sometimes given the flakes.

Granulated Soaps, Beads and *Powders*.—While flake soaps were a long step in the direction of a product of increased effectiveness in use! there arose about 1926 in this field a new development. involving the application of spray drying methods to neat soap. Early powders and granulated products were made by grinding flakes to the desired fineness: but such products were either slowly soluble when coarse. or lumped and "balled" in water when fine. When hot neat soap is sprayed into a current of heated air, the atomized soap particles dry and puff into expanded bead or bubble form. The puffed particles, of spongy texture. exhibit a very high rate of solution and do not have the dusty quality of other types of powdered soap. Denser, unpuffed particles may also be made by spray drying at lower temperatures.

Medicated Soaps.—Soap itself has germicidal power against some organisms. and many of the cationic synthetic detergents are strongly germicidal. Soap is used as an enema and as an emetic. Substances such as hexachlorophene are sometimes used in soap to suppress the formation of the odorous compounds of perspiration.

Textile Soaps.—In the preparation of wool fabrics soap is required in three stages: scouring of raw wool to remove wool grease, scouring the yarns and cloth after oiling, in fulling or milling. Soap is used for degumming raw silk, for cleansing rayon, silk and cotton before and after dyeing, in the dye bath and in printing. For all these purposes ready solubility is required, and hence soda soaps of low titre (*e.g.*, red oil. olive, corn) and potash soaps are preferred. Synthetic detergents have entered widely into the textile field because of their stability toward acid and hardness in water. They are used in scouring both cotton and synthetic fibres.

Shaving Creams.—Shaving creams are usually mixtures of potash and soda soaps of tallow and coconut oil. The cream is prepared by semiboiling methods. Bar shaving soaps and powders are of similar composition except for water content. which is kept at a minimum. Latherless or brushless shaving creams are not strictly soap at all, but are modifications of vanishing or cold cream formulas. In any type of lather, the water is the principal beard-softening ingredient.

Metallic Soaps.—The term metallic soap refers to the fatty soaps of the alkaline earths and heavy metals. Their chief common characteristic is insolubility in water. hence their application (copper soap, aluminum soap, etc.) as waterproofing agents. The lubricating grease industry uses large quantities of calcium, aluminum and other soaps to produce greases of various types, since another important characteristic of the metal soaps is their ability to gel in mineral oils. The demand for extreme pressure lubricants brought about the development of transparent or clear greases which are usually prepared by addition of aluminum soap. alone or in combination with other soap, to oil of the desired character.

Synthetic Detergents— This term is applied somewhat loosely to water-soluble, surface-active substances with pronounced ability to wash and clean but differing from the true soaps in the important respect of not precipitating in hard water. They differ chemically from the soaps.

Even the casual user of soap notices the scum or precipitate that forms in hard water. leaving a ring around the bathtub, a whitish residue on glassware and a sticky curd in the rinse water of the laundry tub. Not so easily perceived is the relation of this "hard-water scum" and a dull. lustreless condition of the hair after shampooing. yellow spots on laundry after ironing, and heavy usage of soap in the household. All these effects point to a serious defect of the true soaps. namely their reaction to give a precipitate with the calcium and other metal salts constituting the hardness of water. The true soaps also react with traces of acidic compounds to form a precipitate.

The introduction into commercial use of the synthetic detergents was based on their ability to transcend and overcome the hard-water behaviour of soap. In general, the synthetic detergents are unaffected. or very little affected. by hardness or acids; for although they may react chemically with them. the resulting compounds are either soluble or remain dispersed in colloidal form in the solution. Certain other unique and useful properties of the synthetics. such as cold-water solubility and flexibility of formulation, also contributed to their rapid replacement of soap products. By 1957 the synthetic detergents made up more than 70% of the tonnage of soaplike products sold as washing agents in the United States.

From the view of physical chemistry the synthetic detergents fall into three main groups. the anionic, cationic and nonionic types.

Anionic Type.—In the anionic group the long chain part of the molecule when dissolved in water becomes the negative ion or anion. The anionics are by far the most important synthetic detergents for use in washing or laundry products. Many hundreds of different anionic compounds have been suggested, but the most widely exploited have been the sodium alkyl sulfates ($ROSO_3Na$) and the sodium alkyl benzene sulfonates ($RC_6H_4SO_3Na$) (R = hydrocarbon chains containing 8 to 18 carbon atoms).

The production of any single synthetic detergent involves its own specialized chemistry. For example. in production of the sodium alkyl sulfates the raw material may consist of fats such as coconut oil and tallow which are converted to fatty acids by, say, hydrolysis. The fatty acids (or their esters) may then be catalytically reduced by hydrogenation (or by sodium) to the corresponding alcohols. The alcohols are then sulfated with concentrated sulfuric acid, followed by neutralization with caustic to yield the sodium alkyl sulfate together with sodium sulfate, which usually is left in the product. Just as with the true soaps, the product at this stage is a colloidal system of water, salt (Na_2SO_4 or NaCl) and synthetic. Many of the same types of phases exist in the synthetic systems as in soap systems. It is from the manipulation of these phases that the final bars, pastes, powders and liquids are developed.

For reasons of economy, for higher or heavy-duty detergency under widely varying conditions of use, and for desirable product form and appearance, it has been customary to combine the synthetic with builders. Thus the most widely marketed synthetic detergents in granule form contain as little as 15% to 40% of the synthetic combined with phosphate builder in amounts ranging up to 50% of the product. The builder is usually, sodium tripolyphosphate or sodium pyrophosphate, although borates. silicates and other complex phosphates are sometimes substituted. The remainder of the product consists largely of water, salts and in some instances smallquantities of suds builders (such as ethanolamide), brighteners (fluorescent, substantive dyes to give residual whiteness to the fabric), soil redeposition inhibitors (*e.g.*, carboxymethyl cellulose) and perhaps corrosion or tarnish inhibitors.

Synthetic detergents for light duty in fine fabric cleaning. dishwashing, etc.. may contain little or no builder. It is possible with the synthetics to formulate compositions with wide varieties of special properties and to make liquid, powder or bar products designed to produce highly specialized results as to detergency, wetting power, emulsification, sudsing, etc.

Cationic Type.—In this type, when dissolved in water, the long chain part of the molecule is the positive ion or catidn. Such compounds are sometimes called "inverted" soaps, because the long chain ion is opposite in sign of electric charge to that of the true soaps. 4 s with the anionics, many hundreds of compounds have been suggested. An example of a typical cationic is $C_{18}H_{37}NH_3Cl$, called octadecyl ammonium chloride. Although possessing valuable related characteristics, the cationics have been of relatively little importance in detergent products.

Nonionic Type.—In this group the molecule as a whole is surface active, but no ions form when the substance is placed in water. The most widely used nonionics in detergent formulations are the polyoxyethylene derivatives; for example, $RC_6H_4(OC_2H_4)_xOH$.

The use of automatic washing machines led to the development of what are sometimes called low sudsing detergents, since some of these machines wash less effectively when large volumes of suds build up and cushion the agitation effect. Nonionics are useful in such formulations because they give detergent action with production of little and in some instances practically no suds. For this same purpose anionic types of high sudsing ability are sometimes combined with suds inhibitors, or they may be combined with the true soaps to produce less suds and to give other desired properties such as a "soapy" feel to lather.

See also OILS, FATS AND WAXES; ALKALI MANUFACTURE; DETERGENTS AND WETTING AGENTS; GLYCERIN.

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(R. H. FE.)

SOAPBARK, the inner bark of *Quillaja saponaria*, a small tree of the rose family (Rosaceae), which grows in Chile. Reduced to powder, it is employed as a substitute for soap, since it forms a lather with water because of the presence of a glucoside saponin, which has a marked surface tension action. The same, or a closely similar substance, is found in soapwort (*Saponaria officinalis*), in senega root (Polygala senega) and in sarsaparilla.

The saponins are poisonous, having a marked hemolytic (blood-destroying) action.

SOAPBERRY, the common name for the species of the genus *Sapindus* of the Sapindaceae (*q.v.*) family, comprising about 15 species of trees and shrubs bearing pinnate leaves. numerous small, greenish or whitish flowers in large terminal panicles or racemes, and fleshy or somewhat leathery berries containing saponin, a soap-like substance that is used for cleansing by the natives of certain tropical countries. At least three species occur in the United States.

S. drummondi, the western soapberry, is native to the south central and southwestern United States, and *S. marginatus* and S. saponaria are native to Florida and tropical America.

(J. M. BL.)

SOAP PLANTS, the name given to numerous herbs, shrubs and trees which contain the poisonous glucoside saponin. Various parts of such plants form a lather in water and may be used for cleansing purposes, as the soapbark (*q.v.*). Other examples are the soapwort (*q.v.*) or bouncing Bet and the cowherb (Saponaria vaccaria).

In the southwestern United States various plants called *amole* by the Indians are similarly utilized, especially the small agave (Agave heteracantha) and the soaproot (Chlorogalum *pomerid*ianum). Other soap plants of the western United States are the zygadenus and the sand lily (*qq.v.*).

SOAPWORT (*Saponaria officinalis*), a perennial herb of the pink family, Caryophyllaceae (*q.v.*), called also bouncing Bet, widely naturalized in North America, native to Europe and western Asia, common in Great Britain and often planted in borders and rockeries.

It is a stout, smooth, sparingly branched perennial, two to three feet high, with lance-shaped leaves and pink or whitish flowers. borne in dense clusters. The leaves and roots contain saponin, which makes a froth with water, and can be used for washing delicate fabrics. *See* SOAP PLANTS.

SOBAT, a river of north-east Africa. the most southerly of the great eastern affluents of the Nile It is formed by the junction of various streams which rise in the south-west of the Abyssinian highlands and north-west of Lake Rudolf. The length of the Sobat. reckoning from the source of the Baro, the chief upper stream, to the confluence with the Nile is 215 mi. The Baro rises in about 36° 10' E., 7° 50' N. at an altitude of some 7,000 ft. The Baro descends the escarpment of the plateau between great walls of rock, dropping 3.000 ft. in 45 miles. It then flows through a narrow gorge at an altitude of about 2.000 ft., the mountains on either side towering 3.000 to 4.000 ft. above the river bed. Just east of 35" E. the Birbir joins the Baro. Some 40 mi. lower down the hills are left behind and the river flows west across a vast plain. From Gambela, a town on its north bank 20 mi. below the Birbir junction, the river is navigable by steamers during flood time (June–December) to the point of confluence with the White Nile. In about 33" 20' E . 8° 30' N., it is joined by the Pibor. This river issues from the swamp region east of Bor on the Bahr-el-Jebel stretch of the Nile. It is joined from the east and south by various streams from the Kaffa plateau. Of these the chief are the Gelo—which breaks through a gap in the mountains in a series of magnificent cascades—and the Akobo. The Akobo rises in about 6° 30' A'.. 35° 30' E. The whole region of the loner Pibor and Baro is one of swamps, caused by the rivers overflowing their banks in the rainy season. At its junction with the Baro the Pibor is over 100 yd. wide, with a depth of 8 ft. and a speed of 2.3 ft. per second.

Below the confluence of the Pibor and Baro the united stream, now known as the Sobat, takes a decided north-west trend, passing for some distance through a region of swamps. Just beyond the swamps and some 40 mi. below the confluence, is the fortified post of Nasser. From Nasser to the junction of the Sobat with the Nile the river has a course of about 180 miles. As it approaches the Nile the Sobat flows in a well-defined channel cut in the alluvial plains through which it passes. The banks become steep, the slope rapid and the current strong. The Sobat enters the Nile almost at right angles in 9° 22' N., 31° 31' E. It is 400 ft. wide at its mouth and has a depth of 18 to 20 ft. at low water and of 30 ft. when in flood. The colour of the water when in moderate flood is that of milk, and it is from this circumstance that the Nile gets its name of Bahr-el-Abiad, *i.e.,* White river. In full flcod the colour of the Sobat is a pale brick red. The amount of alluvium brought down is considerable. The average volume of water discharged varies from 100 cu.m. per second at low stage in April to 770 in October and November when it is in full flood. For the part played by the Sobat in the annual rise of the Nile see NILE.

The Sobat was ascended for some distance in 1841 by the Egyptian expedition despatched in the previous year to explore the upper Nile. The post of Nasser was founded in 1874 by General C. G. Gordon when governor of the equatorial provinces of Egypt, and it was visited in 1876 by Dr. W. Junker, the German explorer. The exploration of the river system above Nasser was carried out in the last decade of the 19th century by the Italian explorer V. Bottego; by Colonel (then Captain) Marchand, of the French army, who, on his way from Fashoda to France, navigated the Baro up to the foot of the mountains; and by Captain M. S. Wellby, Majors H. H. Austin and R. G. T. Bright, of the British army, and others. By the agreement of May 15, 1902, between Great Britain and Abyssinia the lower courses of the Pibor and Baro rivers to their point of confluence form the frontier between the Anglo-Egyptian Sudan and Abyssinia. (See ETHIOPIA; NILE.)

SOBRAON, a decisive battle in the first Sikh War (see SIKH WARS). It was fought on Feb. 10, 1846, between the British (15,-000) under Sir Hugh Gough and the Sikhs (20,000) under Tej Singh and Lal Singh. The Sikhs had fortified themselves in a bend on the left bank of the Sutlej, with the river in their rear, The battle began with a two-hour artillery duel, in which the Sikh guns were the more powerful and the British heavy guns expended their ammunition. Then the infantry advanced nith the bayonet and after a fierce struggle took the Sikh entrenchments. The Sikh losses were estimated at from 5,000 to 8,000. This battle ended the first Sikh War.

SOCAGE, a species of feudal land ownership whereby a freeman held a fee simple estate as tenant of a lord in return for his rendering periodic services of an agricultural or economic kind to the lord. With the decline of feudalism and the rise of a money economy "free and common socage" became the most desirable form of land tenure because its economic burdens were less onerous and on the restoration of Charles II in 1660 almost all species of tenure were converted by statute into socage tenure. (*See* LAWS OF REAL PROPERTY AND CONVEYANCING.) Free and common socage was also the most common tenure by which the king granted lands in the North American colonies Since tenure has no modern significance in land ownership anywhere in the Anglo-American legal world, socage tenure is no longer important and if its semblances are retained, it is for nonlegal reasons.

Although socage developed under Norman feudalism in England, it is Anglo-Saxon in origin. The term is derived from the Old English word *soc* or soke and is frequently associated with sac, in an alliterative jingle ("sac and soc"). The precise meaning of both terms is uncertain, but they refer to the district in which a lord may hold court, to the right of a tenant to make suit in such a court and to his duty to use the court. The "sokemen" or persons holding by socage tenure nere a class of tenants midway between the military or chivalrous class and the bond tenants or villeins. While personally freemen they performed many agricultural services similar to those performed by the villeins.

If a freeman had to onn land under the theory of feudal tenure, socage was the least objectionable form. Minors inheriting socage lands were not. as in military tenure, wards of the lord of nhom the land was held. but came under guardianship of the nearest relative who could not inherit the lands, and this guardian, unlike the lord in a wardship, could not keep the profits during minority, but had to account to the heir for them Neither, under socage, could the lord or guardian "sell" the minor heir in marriage for his own personal profit.

As in the case of military tenure, honever, the death of the owner required the heir to pay to the lord a relief to claim his inheritance.

At an early time the services that had to be rendered to the lord were commuted into money payments fixed in amount At the time they were fixed, these "quitrents" as they were called, no doubt. represented the economic value of the land The long continuous fall in the value of money meant that in course of time, they became so insignificant as not to be worth the trouble of collection. Sometimes the services nere purely nominal as the result of gifts to younger members of the family, or to friends or as the result of a sale for a capital sum with a nominal quitrent reserved to preserve the form of the tenure.

The 1681 charter of Maryland granted to Lord Baltimore lands to be held in free and common socage yielding to the king as lord, "two Indian arrows of those parts to be delivered every year on Tuesday in Easter week." The feudal service attached to the grant of Pennsylvania was the delivery to the king of two beaver skins annually.

In some American colonies. now part of the United States the king permitted the grantee in socnge to establish his onn manor, that is to regrant portions of the land to tenants in return for an annual rent, although this could not be done in England after 1290.

Thus it is today that some property owners in Pennsylvania render to the present members of the Penn family a red rose at midsummer. The continuation of this service is now ior ceremonial and not for legal reasons. In New Tork and some other parts of the North American colonies, those holding grants from the king sought to impose substantial quitrents on their grantees. Thus even after the Revolution the Van Rensselaer family granted lands on the upper Hudson to a settler "forever" upon a yearly rental of a certain number of bushels of wheat. So distasteful was this feudal concept that these quitrents contributed to rebellions such as Bacon's rebellion in Virginia in 1676, and some major antirent disturbances in New York in the mid-19th century.

(A. DM.)

SOCCER, the name given in the United States and Canada to the game called, with a few minor exceptions, football or association football in all other parts of the world. For a description of the game as played outside America, see FOOTBALL: Association Football (Soccer).

Many different stories are current about where the first games of soccer were played in America. A marker on the Common in Boston, Mass., refers to the fact that the game was played there. There is little doubt that the first intercollegiate "football" game between Princeton and Rutgers mas actually a version of soccer, and it has been fairly well established that the game was introduced into the United States by the British.

Like American football, soccer is played by two teams of 11 men each. employing a round leather- or rubber-covered inflated rubber bladder slightly larger than a volleyball and slightly smaller than a regulation basketball. It is called the booting game for good reason: only the goalkeeper is permitted to touch the ball with his hands while it is in play.

The main propulsion of the ball is given by a player's foot, although he can use any part of his body except his hands and arms to trap, deflect or project the ball. Heading the ball is considered a major movement in the game.

Should a player other than the goalkeeper handle the ball deliberately or unintentionally, a penalty is called against him and the opposing team is permitted a free kick. When the infraction occurs in the penalty area of the defending team, the attackers are allowed a penalty kick from a point 12 yd. out and directly in front of the goal.

A regulation game in soccer consists of two halves of 45 minutes' duration each. In the event that a 90-min. game cannot be played for a specific reason, the time may be shortened, but the halves still must be equal. Some college conferences and scholastic leagues play their games in equal quarters rather than halves, but no regular games last longer than 90 min. unless there is a provision for overtime play in order to determine a winner.

Play.—The maximum length of a soccer field or pitch, as it is known, is 130 yd., with the minimum set at 100 yd.; the maximum width is 100 yd. with the minimum 50 yd. The markings of the pitch include two touch lines (the length of the field) and two goal lines (the width of the field) to make a rectangle. In addition there is a midfield line across the width of the field with the centre kickoff circle (10 yd. in diameter). Before each goal is a penalty area 18 yd. long by 44 yd. wide. Inside the penalty area and also before each goal is a goal area 6 yd. in length and 20 yd. in width. The two goal posts are 8 yd. apart supporting a crossbar 8 ft. off the ground. Normally nets are required to be attached to the goal posts and crossbar and extending behind the goal.

The penalty kick area is denoted by a small (solid) circle directly in front of and 12 yd. from the goal. Quarter circles of 1-yd. radius are marked at each corner for the corner kick. which is given when the defending team last touches the ball before it goes over the defending team's goal line outside the goal. Corner flags, preferably of some bright colour, are placed in the four corners of the field.

To score a goal, the whole ball must pass over the goal line between the two goal posts and under the crossbar, either on the ground or in the air, without being carried, thrown or motivated by arm or hand of an attacking player. If a defending player accidentally kicks or deflects the ball into his own goal, it counts as a goal for the opposing side.

Three types of kicks are awarded for rule infractions including penalty kick and direct free kick from which goals can be scored directly. In order to score on an indirect free kick the ball must be played by another player before entering the goal.

When a ball goes over the touchline. it is awarded to the opponent of the team that last touched the ball before it went out of bounds. A throw-in is taken at the point where the ball went over the touchline. It is the sole instance during a game when a player other than the goalkeeper is allowed to handle the ball. The colleges have amended the throw-in rule to make it a kick-in.

The offside rule is an important rule of the game. A player is offside when there are not two defending players nearer the goal than himself at the time the ball is passed to him, with the following exceptions: from a goal kick; a corner kick; a throw-in; when he is behind the ball when the pass is given; when the ball comes from an opponent; when he is in his own half of the field.

One of the American deviations from international rules is that substitution of players is permitted in American soccer. However, the different governing bodies and sectional leagues have varying limits on substitutions. On the whole, the deviations from the international rules are rather few, which is one of the reasons why soccer lends itself easily to international contest.

Competition and Organization.— Soccer is a relatively simple game to understand, the basic rules being neither complicated nor difficult. It is also an exciting game, with play going on continuously in the open. Compared with American football it is inexpensive to support, and there are no special physical requirements for the participant, hence wide participation is possible. While the popularity of soccer in America has not always been great, it is still expanding in schools and colleges, where it is a seasonal sport, played for about three months in the autumn.

The season of amateur and professional soccer runs for approximately ten months with a layoff during the summer. In certain areas competition is halted during the winter because of poor field conditions.

In addition to the various league and state competitions, three major national tournaments attract entries. The National Challenge cup competition for the DeWar trophy is the open tourney in which professional and amateur teams compete. The event was first held in the 1913–14 season and regularly thereafter. In the 1923–24 season, entries for the National Challenge cup became so numerous that it was decided to inaugurate the National Amateur cup competition to be restricted to amateur teams and amateur players. The National Junior Challenge cup: limited to junior teams, began in the 1934–35 season, but the final game between eastern and western sectional champions is not always played.

The United States Soccer Football association (U.S.S.F.A.), organized in 1913 and successor to other predecessor groups, is the governing body of the sport in America. This includes amateurs and professionals, who are allowed to play side by side on the same teams without any change in status. College and school groups have their own organizations and are merely associate members of the U.S.S.F.A. Leagues and state associations of amateur and professional groups are direct affiliates of the U.S.S.F.A.

Only one organized professional league is recognized, the American Soccer league, which operates chiefly along the eastern coast and includes New York, Newark and Elizabeth. N.J., Philadelphia and Baltimore. In 1960, the International Soccer league was formed to include visiting foreign teams and a New York side.

In the late 1920s and early 1930s, a professional soccer player was able to earn money enough so that he could devote full time to the game. Currently, however, even the highest paid professional cannot support his family by playing. Whereas European players devote regular days and hours each week to practice, few teams in the Cnited States hold regular drills. A team designated to represent the United States in international competition usually has opportunity for no more than one or two practice games, which is reflected in the poor showing of United States teams in such competition. Further, few clubs: leagues or associations have the personnel to conduct programs to promote development of young players.

Soccer in the United States is an amateur rather than a professional sport. Few soccer teams have their own stadiums; most of the big international games are played in baseball parks or municipal or school stadiums. For the most part, however, regular games are played in parks or on open fields. (M. Mi.)

SOCIAL ANTHROPOLOGY. Social anthropology is one of the social sciences engaged in the comparative study of human societies. It is closely related to sociology, which shares the same aim. Many social anthropologists indeed regard themselves as sociologists of a specialized kind. The separation between social anthropology and sociology is on two grounds—of content and of technique. In its content social anthropology has concerned itself primarily with what are known as the simpler, the primitive, the preliterate peoples, while sociology has studied at first hand mainly the more advanced peoples. This division has to some extent disappeared under modern conditions, however, as social anthropologists have begun to investigate advanced oriental and western societies (see *Studies* in *Literate Societies,* below). These studies are usually of small communities such as villages or special groups in factories, or camps of displaced persons, or of special aspects of social life such as kinship. But social anthropology shares with and helps to contribute to sociology a theoretical framework for the study of social life and social systems as wholes. In technique, social anthropology uses above all an intensive type of inquiry which ordinarily involves living among the people to be studied, learning their language as the most effective medium of communication, and observing closely their behaviour in their day-to-day activities. The social anthropologist is interested in what people do, as well as in what they say, and say they do. Such divergencies between word and act are often of great importance to him. So closely may he become associated with the activities of the people whom he studies that he may engage in "participant observation." That is, he co-operates with the people by engaging in their activities himself—going on a fishing expedition, taking part in a religious rite, keeping their tabus, exchanging property with them as if he were a member of the society.

"Social anthropology" is a term formerly used largely to describe British studies, especially of social structures of primitive peoples. It must be distinguished from ethnography, studies of a purely descriptive order, though many works contain material of both kinds. The subject has owed much to the theoretical analyses of sociologists including the European writers E. Durkheim, M. Mauss, M. Weber and V. Pareto, and the later Americans—K. Davis. R. Merton and T. Parsons. Certain branches of the study, particularly in the theory of kinship, were also affected by the work of S. Freud. The major development of social anthropology in the British field has been associated particularly with the names of W. H. R. Rivers. B. Malinowski and A. R. Radcliffe-Brown. Among later contributors of general works are E. E. Evans-Pritchard, R. Firth, C. D. Forde, S. F. Nadel, R. Piddington; and of analyses of particular structures or aspects, A. P. Elkin, M. Fortes, P. Kaberry, M. Gluckman, H. I. Hogbin, E. R. Leach, A. I. Richards, I. Schapera and M. Wilson. European work in the subject during the first half of the 20th century was not so great, but significant contributions were made, for example, by R. Thurnwald, J. P. B. de Josselin de Jong and C. Lévi-Strauss. But essentially the same types of investigation were carried out by Americans and other scholars, usually as part of the studies labelled "cultural anthropology." In the United States the foundations of the subject had been laid by A. Goldenweiser, A. L. Kroeber, R. Linton, R. H. Lowie, P. Radin, R. Redfield and E. Sapir, and studies of a general theoretical order by R. Benedict, F. Eggan, M. J. Herskovits, G. C. Homans, C. Kluckhohn, M. Mead and G. P. Murdock also had contributed to this end. There, comparative work and special analyses of importance had come from many writers, including G. Bateson, J. Dollard, C. du Bois, J. Gillin, A. I. Hallowell, F. M. Keesing, D. G. Mandelbaum, M. Opler, H. Powdermaker, L. Spier, J. Steward. S. Tax, W. L. Warner and L. White. From the orient there had been as yet little development of social anthropology, though A. Aiyappan, H. T. Fei, F. L. K. Hsü and M. N. Srinivas need mention.

It had increasingly come to be recognized by the 1950s that the terms "society" and "culture" refer to different aspects of the same basic material, the actions and relations of human beings in social living. "Society" and "social anthropology" lay more emphasis on the human element—the interpersonal and intergroup relations of men. "Culture" and "cultural anthropology" lay more emphasis on the creative achievement, the objects and ideas nhich are brought into being and transmitted from one generation to another by the acts of men in society. Where the studies differ, cultural anthropology tends to be the wider, embracing, for instance, simple technology and linguistics as well as ethnography and investigation of social structures. But the different emphases shade into one another and there is a large area of common ground. Anthropological opinion was still not unanimous on this point in the 1950s. But the essential unity of the studies in their major fields of interest is shown, for example, by use of the conjoint term "cultural/social anthropology" in an international symposium.

Social Structure and Social Organization. — The basic data for social anthropology are usually defined as social relations. Man as an animal living in society acts in relation to his fellows in pursuing both individual and common ends. These social relations are not haphazard; they have regularities or patterns shown by repetition — as when a man plays with his children every evening after he comes home from work. These social relations also tend to compose a system, those of one kind being linked with, and to some degree determined by, those of other kinds. So a man's regular relations with his children in play are tied in with his relations with them at meals and in the house generally, and depend in large part on his marital relations with their mother. But they may also depend on his economic relations — as when he is forced to go away from home on a job — or on his legal relations — as when a court awards him custody of his children at divorce. The main elements in the interdependent system of social relations, looked at somewhat abstractly, form the social structure.

Social structures are sometimes stated, as by E. R. Leach and C. Lévi-Strauss, to be models representing the main principles of a society or social system in respect of their ideal or formal qualities. Another way of looking at social structures is to regard them less formally as comprising the more permanent groups and other continuing features of the social system (E. E. Evans-Pritchard) or even the network of social relations of the system (A. R. Radcliffe-Brown). These, however, are all linked concepts, since the regularity and permanence of social relations depend largely on the ideal type laid down by the society. and perception of all this involves considerable abstraction of formal qualities by the observer.

The social structure is like the anatomy of the society — it provides its major shape. But the conduct of individuals varies; some follow the rules laid down and others do not; there are choices to be made between various courses of action and decisions to be taken. Not every man abides by the legal and moral rules of marriage in society — nor does every man or woman marry. Some fathers make generous provision for the education of their children and try to guide their social development. Others allow them to fend for themselves. In all fields of social action such different arrangements by individuals occur as the result of the choices they make between alternatives to social action. The total body of such arrangements can be termed social organization.

Linked with these concepts also is the notion of social values, the system of preferences that govern action in any society (see *Values*, below). It is by adhering to the conceptions and principles embodied in the system of social values that the members of the society are enabled to maintain their social structure.

Social Structure of Primitive Societies. — The most obvious difference of a primitive society from our own is in size — it may consist of only a few hundred or a few thousand people, very rarely of hundreds of thousands. But though demographic studies have been shown to be important for structural analysis by M. Fortes and others, size alone is not the most important factor in the structure of a primitive society.

In such a society almost all interpersonal relations are face to face — except where western influence has recently introduced written communication. Rloreover, partly for technical, partly for social reasons, people are apt to move about much less. Hence, any one person is apt to have relationships with fewer people than in our own society and those relationships are likely to be more permanent. Almost every relationship, too, is between people already acquainted; the impersonal day-to-day contacts of western society — as with a sales assistant or a government official — do not occur.

This factor of proximity — expressed formally in terms of neighbourhood associations and local groupings — is extremely important as an element in social relations. The units of household, homestead, hamlet, village, urban ward vary greatly in different societies. But not only do they serve as basis for economic and other co-operation; they may also tend to determine the character of kin grouping by virtue of the property and other rights usually associated with them. In a primitive society, the range of occupations and special social activities is much less than in our society; there is far less differentiation of roles. For example, most of the people are primarily engaged in food getting with fairly similar technical equipment. This means that the types of relationship possible for a given person are far fewer. But the people with whom one is in contact may play several roles. Relationships are many-stranded. The same person may be father, war leader, judge, economic boss, teacher and priest.

This many-stranded quality of relationships in primitive society means that the social anthropologist is faced with a problem of disentangling for analysis. sometimes arbitrarily, various categories of relationship such as economic, political, legal and ritual relatibns. The overlapping of these types or aspects of relationship leads the anthropologist to emphasize the interdependence of their different fields, that is, to seek the function of the relationships in any one field in maintaining the total pattern of the society.

In any society, people arrange themselves in groups — families, villages, clans, professional associations, age sets. In a primitive society, groups tend to be closed rather than open — that is, most groups recruit through birth, and membership is compulsory. But a primitive man does not normally belong to groups having quite different, voluntary membership, as we may belong, say, to a factory. a tennis club and a church congregation. Everyone in a primitive society is compelled to belong to a certain number of groups, and a larger sector of behaviour has to do with group membership than in our own society. The principles of age, sex, neighbourhood and kinship are the common bases of group formation, since there are fewer differences of skill and interest. Since a primitive man or woman is both more dependent on the groups in which he or she has membership, and at the same time less able to withdraw, to change membership, conformity to wishes and standards of other people in one's immediate environment is to a much greater extent a condition of well-being, even of survival, of the individual than in the more advanced societies.

The rate of social change, barring outside influences such as natural disasters or conquest, is slow. though it is by no means true that all primitive societies are static, as has sometimes been assumed. (See Social Change, below.)

Sex and Age Grouping. — All societies make use of the physiological differences of sex and age. The basic division of duties between man and woman seems to be universal — a woman is primarily responsible for young children and for most specifically domestic tasks, while tougher jobs which involve heavier work, greater distances from home or violence — hunting and fighting — are male tasks. The formal control both of internal group affairs and of relations with other groups is almost entirely in male hands — though women may exercise great informal power. The queens or female chiefs who are found among the Lovedu and in a few other societies are not direct exceptions. Either they lack real power or else they are in some way symbolically equated with men. This universal division of function is invariably backed up by a more specific division oi labour between the sexes which varies greatly from society to society. These divisions are felt to be right and natural. Violation of the rules may cause mirth or abhorrence, and very often the tasks of one sex are ritually forbidden to the other. Invariably, as in our own society, the difference of sex is symbolized in differences of dress and etiquette. Sexual differences are emphasized in ritual and in dogma, and the sexual dualism is often carried over into theological and cosmological notions, as among Australian aborigines and as it was in classical antiquity.

The principle of seniority and juniority is equally used for social distinctions. In a few societies old people are regarded as a burden. But almost invariably old age is highly respected.

Where there is no writing, and where the skills and cultural heritage alter little through the generations, the old men are the obvious repositories of wisdom and experience. In its extreme form, the respect for the aged becomes gerontocracy — the rule of the old men. In such societies, old men keep for themselves special privileges, often including rights to marry younger women. thus forcing up the average age of male marriage. Their position is often backed by magical knowledge and ritual respect. Sometimes the age principle is formalized in a system of grades. The change in status from child to adult is marked by a ceremony of initiation (usually including an ordeal). Those initiated together form a special group, an age set, with special rights and obligations. Ritual occasions may mark the movement of a group of agemates from one status to the next.

Among the Australian aborigines a man's advance toward old age is marked by successive initiations into the totemic mysteries, which are fully known only to the old. In some east African societies. as the Nandi. the grade of warriors ritually takes over the status of elders and its members replace their seniors in the direction of tribal affairs. Even where no age sets exist, the principle of seniority is of vital importance. Elder brothers usually exercise authority over younger brothers, and the principle is so important that in many societies words for "elder" and for "younger" are found, but no one word for brother.

Kinship. — Kinship is the social recognition of real or putative biological ties formed by procreation and marriage. The continuity of any society must be ensured by the procreation and training of new members. The family provides legitimacy for the procreation of children and a social unit to undertake their care and training and place them in a defined position in society.

The minimum social unit which is necessary to carry out these functions is the elementary (nuclear, individual) family, consisting of father, mother and children. Almost every person who achieves adulthood is a member of two such families, called by R. Linton the family of orientation, that into which he is born or adopted, and the family of procreation, that in which he or she becomes a parent. The interlocking of these families creates a complex framework of relationships, consisting of consanguineal ties (by blood) and of affinal ties (by marriage). Adoption is the simulation of consanguineal ties. Most human societies make great use of the kinship principle in the ordering of social life. It provides channels for organization of economic, political, judicial and ritual affairs.

The concept of a kinship unit should be separated from that of a domestic unit, though these units overlap in fact. Statistically the elementary family is frequently the norm in residential terms, occupying a single separate dwelling. But in many societies, as in Malaya, a young couple begin married life in one of the parental households rather than in a new home of their own (this latter being called neolocal residence). Where a young couple live with the groom's family. the marriage is termed patrilocal or more correctly virilocal. Where they settle with the bride's family, the term is matrilocal or uxorilocal.

A domestic unit of such kin is referred to as an extended family (expanded family). Where a household consists of two or more siblings, their spouses and children, they may be termed a joint family — fraternal or sororal as the case may be. In some societies, such as rural Turkey, the two types of structure often merge into one another by the death of the parental head. Where a man has more than one wife, they usually live in separate huts or rooms.

A man or woman is born — or adopted — not only into a family, but also into a wider kin group, a descent group. For the purpose of defining this group both parents may be held relevant or only one of them. Where descent is reckoned always through one parent only. the principle is called unilineal, and the group so constituted is a lineage. A patrilineal lineage (patrilineage) consists of the male descendants through males of a common ancestor, together nith their sisters and daughters. Conversely. a matrilineage consists of the female descendants of an ancestress through females, together nith their brothers and sons. A lineage may comprise any number of generations. Even an extended family may be regarded as an incipient lineage. But commonly descent is traced to an ancestor from five to ten generations back. Often the genealogical connections of a large lineage may be invented, or even inconsistent. Lineage structure may be regarded as the result of a branching process. Hence, two or three small lineages whose founding ancestors are brothers will comprise a single larger lineage. From the point of view of a larger lineage, the smaller ones are segments and the whole society is of segmentary structure.

In many unilineal societies, the lineage is exogamous, that is, a man cannot marry a woman of his own lineage. Marriages will then always set up reiationships between lineages. The structure of a society with patrilineages, where a man belongs to the group of his father, is markedly different from that of a society having matrilineages, where a man belongs to the group of his mother's brother.

The prevalent pattern of residence in a society greatly affects the operation of the unilineal principle. Among the Tallensi of the Gold Coast, a patrilineal virilocal people, the pattern on the ground corresponds closely to the lineage structure. Households under brothers or brothers' sons are usually adjacent; households in one area will belong to a larger lineage segment; and so on. Among the Nuer of the south Sudan, the fiction of localized lineages is found, although in fact men often live with matrilateral or affinal kin. In matrilineal societies the problem is more complex. If all the men of a lineage live together, then the children born in the group will belong not to that group but to the various lineages of their mothers. In the Trobriands, this difficulty is met by the sons of a man leaving him to rejoin their mother's brothers on adolescence. If, on the other hand, all the women of a lineage live together, no man of the lineage may be present to direct affairs — unless, as among the Hopi, brother and sister normally live in the same village. Among the Yao of Nyasaland, this problem is met by allowing the eldest brother of each set of sisters to take his own wife to live with his sisters, so that he can take charge of their affairs. In Dobu, a Melanesian island, married couples alternate residence between the lineage of the husband and that of the wife. Among the Nayars of south India, an aristocratic people of high caste, husbands only visit their wives and the joint households contain brothers, sisters and the sisters' children by their visiting husbands. In this case, as often, lineages larger than the joint family do not live adjacently, yet they maintain coherence through common rights and duties, rituals and symbols.

In some societies, both matrilineal and patrilineal descent are recognized for different social purposes. This is known as double unilineal descent. Thus among the Yako of southeastern Nigeria, as C. D. Forde showed, the household and the farming group are based on patrilineages, while matrilineal groups, although not residential, are of great importance in the ritual and political system. With new demands and attractions resulting from western influences, larger kin groups often tend to break up, as more individual rights are asserted. As A. I. Richards and M. Fortes showed for Bemba and Ashanti. in matrilineal systems fathers tend to take over functions traditionally performed by mother's brothers.

Often no very specific descent groups are found but all kin on both sides are recognized equally. This system of kinship is called bilateral. The people recognized as kin are different for each set of full siblings. ("Sibling" means brother or sister — from Old English, *sib*, related by blood or descent.) Though not forming a distinct group for any other purpose, such a body of kin may be responsible for their common kinsman, and be liable if he commits wrong. In other societies. as among the Maori, a person normally belongs to only one specific group, but this may be his father's or his mother's according to his pattern of residence and his interest in land rights.

The word "clan" is widely used in anthropology, often in the older literature in a vague and unsatisfactory way. In fact, it is necessary to define it in relation to the social organization of a particular society. Usually the term clan is used for a group of people claiming unilineal descent from a common ancestor but unable to give a precise genealogy. In the past the clan has been described as an exogamous unit (as it often is) but this strict definition is unnecessary. On the other hand, the word is now confined to unilineal groups, although the Scottish prototype is bilateral.

Descent should be distinguished from inheritance of property and succession to office. Though these may follow the main lines of descent, they do not necessarily do so. Thus certain kinds of property may pass patrilineally in a matrilineal society, or a sister's son may succeed to an office in a patrilineal society. In societies with bilateral descent, succession and inheritance often have a patrilineal bias.

Though in many societies one side of the family is far more emphasized in determining group membership, inheritance and succession than the other, yet it does not follow that in these societies only one side of the family is recognized. Close ties are invariably maintained and keen interest taken in the welfare of all who marry out of a group, and in their offspring. Among the Coorgs of south India, a strongly patrilineal people, a proverb urges a diver for pearls to see that his mother's brother holds the rope. Within any body of kin the principles of generation — or, less ambiguously, of kinship grade — of solidarity of the sibling group and of equivalence of siblings are important regulators of behaviour.

The study of kinship in anthropology began with the study of kinship terminologies by Lewis H. Morgan. Morgan and his contemporaries were interested in classifying systems of kinship terminology into "stages" of human evolution, and equated types of kinship terminology with levels of political and technological evolutionary development. Where they thought that kinship terminology was inconsistent with existing social structure. they supposed a previous state of society which would fit such a terminology. A. L. Kroeber criticized the historical soundness of these arguments, which had gained wide currency. It was particularly A. R. Radcliffe-Brown and B. Malinowski who attacked this whole evolutionary approach and insisted on analysis and comparison of contemporary societies, with the aim of establishing general principles. Speculation about early origins of human institutions, which formerly provided the main drive for the beginning of anthropology, was later abandoned as unprofitable by social anthropologists.

Much attention was given to the study of terminologies. But it is now generally recognized that kin terms cannot be understood without reference to the total pattern of kin behaviour. Nevertheless, the study of terminologies provides us with important clues to the structure of a society. A terminology reveals the way in which people in a society classify their kin, reflects the system of descent groups and provides linguistic symbols for much social behaviour.

Marriage. — All societies recognize the distinction between casual sexual relations, or cohabitation, and a formal union of a man and a woman with the approval of society, for the purpose of establishing a family. Several forms of union are often recognized in one society and no universal definition of marriage can be given.

Marriage necessitates a definite realignment of social relations. A permanent relationship is set up between the two groups involved, through common interest in the partners and in the offspring of the match. There are accordingly rules determining with whom it shall be arranged. Very often such a relationship between families is felt to be inappropriate within a fairly large group, a clan. lineage or village. Such a group is then called exogamous. Exogamy, by ensuring social intercourse between potentially hostile groups, performs an extremely important integrating function. Conversely, rules may exist which bar marriage between groups. The extreme case is that in which marriage outside a specific group is forbidden. The term endogamy is used in these cases, and also more loosely, for a tendency to marriage within a group. Endogamy is apt to be characteristic of religious and ethnic minorities in civilized societies. In India, every small subcaste tends to be endogamous, on ritual grounds.

In primitive societies. strict endogamy is rare. On the other hand, rules specifying the group from which a man must or preferably should choose his wife are extremely common. It is often felt that an affinal tie between two groups should be preserved generation after generation. In unilineal societies this is done by a rule of cross-cousin marriage, by which a man takes his wife either from the group to which his father's sister went or from the group from which his mother came. Such a rule also reduces the disturbance of domestic relationships, since the girl is going to kinsfolk, and they are receiving someone they already know.

In all societies, the formal beginning of a new marriage is marked by ceremony. Exchange of gifts always takes place, even if only of food. In many societies, where groups of men are handing over women, a bride price is paid, that is, the groom's side gives far more than the bride's side. Sometimes the reverse is the case, and dowry is paid, as in the matrilineal Trobriands, where a man is said to be compensated for his services in caring for the children of his wife's lineage.

Monogamy is common in all types of society, and polygamy is normally the exception, even where it is the ideal. But many societies permit a man to have more than one wife—polygyny—and a few permit a woman to have more than one husband — polyandry. Each separate relationship is then usually a separate marriage, though sometimes within a minimum of ceremony. In traditional Mandan society when a man married, he was entitled to marry his wife's younger sisters, as they came of age simply by giving them horses. In polyandry the cohusbands are usually brothers, as in parts of Tibet, or else do not reside with their wife, as among the matrilineal Nayars of south India, who practised both polygyny and polyandry.

In all societies, unregulated extramarital intercourse with a married woman is felt to be wrong — or at least a wrong to the husband. The reaction to adultery varies from a mild claim for damages or divorce to killing both parties. But spmetimes certain kinsmen— a husband's unmarried younger brother or, as in the Trobriands, a brother's son — are privileged. or special licence is allowed on ritual occasions. Premarital intercourse is quite commonly condoned. But premarital pregnancy is always a serious matter, since it threatens to create an illegitimate member of society with no defined position.

Most societies recognize divorce, though in some societies it is almost unknown. Plausible attempts have been made to relate divorce rates to the structure of the household and to the amount of bride price, but no adequate theory has been found. Problems of the definition of marriage and of divorce make comparison of the stability of marriage very difficult.

Rules against incest are found in all known societies. Earlier, incest prohibitions were confused with exogamy, but it is clear that a rule against marriage within a specific group is not the same as a universal rule against sexual intercourse with certain close kindred. Incest is always a sin, that is, it is thought to carry supernatural penalties, and sometimes, as in Tikopia, these are almost the only penalties.

Status and Stratification. — Status is the position which an individual occupies in the social structure, with its attendant rights and duties. The word carries an implication of stratification, position on a vertical scale. This spatial analogy, which is found in most languages as a way of symbolizing social rank. covers several meanings. A man may be said to occupy a "high" position because he is able to control, by order or by influence, other people's conduct; or because, in Kingsley Davis' terms. he derives prestige from holding an important office; or because by his conduct he has earned the esteem of his fellows. Relative status is one of the major factors determining the behaviour of people toward each other.

Moreover, competition for status seems to be one of the main human drives. A man's status is made up of a number of different factors, or it might be said he occupies different status in different social contexts. For example, the position of a man in his kin group helps to determine his position in the community. Among the Hopi. as F. Eggan showed, the lineage. although unnamed, contains the mechanism for transmitting rights to land, houses and ceremonial knowledge and is thus vital for a personal status. Among the Tallensi, M. Fortes stated, a mere lad who, having lost his father, is head of a household, counts as an elder, while a middle-aged man who is still under his father's roof is still formally a child Sometimes status is governed by primarily occupational considerations. Thus in Negro Africa blacksmiths commonly form a separate group of low status.

Status is closely correlated with conformity to the etiquette and morality of the society. In many societies the liberal use of wealth is important in conferring status. C. du Bois stated. for the Alorese, that the manipulation of the wealth-status system often demands great individual effort as well as aggression, chicanery and an excellent memory.

Social classes are social groups arranged in a clearly hierarchical status system, whose members interact on this account mainly within their own group and to a lesser degree with groups of higher or lower status. They are rare in primitive societies. But many primitive societies have some kind of stratification. Even an age-grade system where, as in many East African societies, it plays an important part in directing social interaction, resembles in some ways a class structure. In some unilineal societies, clans may be ranked, from royal clans from which the ruler is chosen to clans which, for some special reason such as slave origin or lowly occupation, rank below the majority.

True class systems obtain in the West African emirates: with urban capitals from which a ruling class. different in dress, speech, etiquette and morality, dominates a semipagan peasantry. One of the most striking class systems in the world is the Indian caste system. Hindu villages are divided into a number of small endogamous groups or subcastes based on traditional occupations, arranged in a hierarchy from Brahmans to Untouchables, though the exact order of the middle subcastes is not always agreed on by all parties concerned. Contact with a lower caste, such as eating or drinking from their hands. bodily contact and so on, pollutes a member of a higher caste and necessitates ritual purification. Escape from caste is thus almost impossible and the whole system is still highly immobile, though western influences have tended to loosen some of the rules.

The concept of status and the concept of class should not be confused. One might say that no two persons in any society are exactly equal in status. and that it is therefore a central concept for anthropology. On the other hand, comparatively few studies of social class had been made by anthropologists by the mid-1950s.

Economic Relations. — Economic relations have to do with the choices men make in matching means to ends. These choices are socially conditioned. So while the members of every society must provide themselves with food and shelter, with other material goods and with services of many kinds including ritual services, in all societies the nature of the goods and services varies. There are two main sets of problems here for social anthropology: What is the system of relations involved in the production, distribution, exchange of these goods and services? In what ways do the economic relations affect the social relations?

In a primitive society economic relations have a more personalized character than in an industrial society. Ordinary western categories of employer. employed, wage earner, capitalist often do not apply. Economic services are contributed not simply to earn a living but as part of a much wider system of social obligations.

In almost all nonindustrial societies the main economic unit is the family or household rather than the individual. All able-bodied members share, under the direction of the head of the household, the routine tasks of getting and preparing food and satisfying other recurring wants, according to recognized patterns of division of work by age and sex. Some tasks require a wider basis of co-operation than the household—a rice transplanting team, a canoe crew or a hunting band. The co-ordination of work may then depend on the rights and duties of kinship, on a central authority in the community or on ritual and magic. B. Malinowski showed this in his analysis of the importance of the gardening magician and his rites in the organization of village agriculture in the Trobriand Islands. When large working parties are assembled, the person whose work is done will offer food or perhaps (as in Africa) beer. He may also make gifts, but these do not usually reflect any precise measure of the service rendered. Later, he will return the service by working for others. Technological specialists generally receive some additional payment, but this is apt to be traditionally fixed.

Property in any society is a bundle of rights against other people. In primitive society the variety of these "bundles" is very great, varying from more or less unconditional ownership of some material objects to highly complex relationships to such things as land, ritual apparatus or magic.

The most important resource to any primitive society is land, and the problems of land tenure are often complex to a western observer. Most peoples, even nomads, have a definite territory to which they have a prior right. In purely hunting and gathering societies, such communal rights possessed by kin groups and local groups are the only rights to land.

In cultivating systems, unless fertile land is available in abundance, rights to exploit a particular piece of land usually vest in kin groups such as lineages or families. But the variety of possible arrangements makes it clear how misleading a naive application of our own notions of ownership may be. Some rights may inhere in other members of the community. Thus in Tikopia, until a land shortage became acute, anyone could cultivate a piece of fallow land, without prior permission of the owner, so long as he gave a nominal gift of the produce to the owner at the harvest. Other rights may belong to the ruler. Among the Lozi, the paramount chief "owns" all the land. In many cases a chief holds it from him, a headman holds it from the chief and the cultivator holds it from the headman. Each "owns" the land in a different sense. In fact, this is as much a political as an economic arrangement — the holding of land is inextricably bound up with political dependence, and a man loses his land if he changes his residence, that is, his political allegiance. Sometimes more definite concepts of ownership may be found. Rights to territory, and also rights of individuals to special plots, are often validated by myth and ritual. It may be unthinkable to part with the land where one's ancestors emerged from the ground or where one's fathers and grandfathers are buried. Other kinds of property are generally owned in a way more familiar to us. Property in food may be personal or household property. The house itself will belong to the head of it, subject to the rights therein of the other members. Tools and implements are usually personally owned. Not only material objects, but titles. songs and dances, magical spells or medicines may be owned, personally or by a group, and many of these can be sold or exchanged

Although in primitive societies, where most essential skills are possessed by most adults. the amount of exchange of goods and services is very much less than in our own. goods still constantly change hands and services are continually rendered to other people. The word "prestation" is a useful one to cover all such goods given and services rendered to others. In most primitive societies, prestations are not normally valued or paid for in the precise way to which we are accustomed. But the account is balanced in the end; indeed. the principle of reciprocity, or basic compensation, was strongly emphasized in the theories of M. Mauss. B. Malinowski. R. Firth and other social anthropologists. A prestation is normally part of an already established relationship between two people. If the parties are of roughly equal status. a return of equal value will be made, directly or indirectly. A voluntary prestation unreturned indicates that the giver is of higher status than the receiver; the basic compensation in this case is prestige.

The exchange or consumption of wealth may not thus have primarily utilitarian motives but be symbolic statements of status or a set of social relationships. Such are the *kula* ceremonial exchanges of the Massim of New Guinea and the pctlatch of the northwest coast Indians. The more valued the objects a man handles. the higher his status in his own community. At the same time, in these exchanges a man may seek to score over his partners by giving them gifts the value of which they cannot equal in return, or returning a gift more valuable than they have received.

These and other exchanges of goods and services may also serve more practical ends. Australian ceremonial exchange systems provide a channel for the distribution of the products of the special local skills over wide areas. In the Trobriands. men of coastal and inland villages exchange fish for yams both ceremonially and by process of barter in an ordinary commercial way. Some primitive societies derive much of their income from trade. Thus the

Manus, a canoe people who live in the Admiralty Islands off the north coast of New Guinea, inhabit unfertile islands which provide them only with fish. and they rely for daily dietary needs on trade, which consists basically of the exchange of fish for sago. In West Africa many people trade extensively, and a money economy is now completely established in many parts. So far does the trading concept go that among the Nupe, S. F. Nadel reported, a man sometimes pays his wife for her duty of marketing the household grain surplus.

Among primitive societies the exchange of goods is often made, easier by the use of certain articles as mediums of exchange. Coconuts, blankets, dogs' teeth, shells have all been used to fulfil some of the functions of a currency. Usually the range of goods and services which can be exchanged against such so-called "primitive currencies" is limited, and the occasions of their use ceremonially prescribed. None of them become the full equivalent of money, that is. a general measure and repository of economic value.

Political Relations. — Political relations are those concerned with preservation of order and the conduct of affairs of public concern within a community or society, and with relations between communities or societies. Political relations are always concerned with the power to control some aspect of other people's behaviour.

Many primitive societies lack any form of legislative or judicial machinery or any group leadership above the level of the village or camp. Since in such societies both internal and external affairs are usually conducted in an orderly fashion, the anthropologist is forced to extend the use of the word "politics" beyond the field of instituted government. But attempts to classify primitive political systems have not proved satisfactory because of their very great variety. In Africa alone they range from societies like the Tonga of Northern Rhodesia, where the village, based on kinship, is an autonomous unit, to the large states such as the Nupe kingdom of Nigeria or the Baganda kingdom of Uganda.

In the political systems of village type, kinship and neighbourhood provide the necessary institutions for the organization of power and authority. But in some societies much larger political groups exist. still without any formal government. These societies make use of the unilineal principle of organization, described above under ***Kinship.*** E. E. Evans-Pritchard's work on the Nuer provides an excellent example. Territorial divisions are called by the names of the branches of the lineage system, although they do not exactly correspond to them. There is no specific authority over the various segments of the lineage. In cases of dispute no one official can order a group to accept compensation and make peace. But an elder with special powers, called by E. E. Evans-Pritchard the leopard-skin chief, is usually able to persuade them to do so. Thus among this independent and quarrelsome people, group relations are ordered according to well-established moral principles.

In many parts of the world chiefs are the heads of governments. The paramount chief of the Bemba of Northern Rhodesia rules over a considerable territory. He has under him advisers, councillors and ritual officers, besides a whole range of courtiers and messengers, and resides in a capital considerably larger than a normal village.

Members of the royal clan rule as lesser chiefs over sections of his territory, with capitals and courts similar to his own. Beneath these are headmen, responsible to the chiefs. In this case, a large number of people, larger than could ever form a single clan, are united in one political society. The extent in area and numbers of such a state depends only on the strength and efficiency of the administration which it devises.

Relations between autonomous groups naturally vary with the size and organization of the group, and with ecological conditions. In primitive conditions, the normal attitude to other autonomous groups is often one of hostility. Even within one political system where there is some specific tie of friendship, intermarriage, common ritual or common opposition to a larger enemy. the constituent groups will express mutual antagonism as well as mutual solidarity.

Wars between primitive communities are conducted according to specific rules. They vary greatly in aim and in ferocity. Between neighbouring groups who are kin to one another, as among the Andaman islanders, killing in such fights may be rare. Women and land, as the Maori used to say, are probably the commonest causes of such fights. Habitual cattle raiding and slave raiding used to be common in many parts of Africa, without any notion of conquest. Wars of conquest are obviously impossible unless the conquerors have a state organization to control their subjects. Great rulers like Shaka (or Chaka), the powerful Zulu king of the 19th century, are rare in primitive society.

Primitive military leadership and organization are often ad *hoc* and informal, though sometimes the war leader may be identical with the chief. Many societies have or had special war leaders with no other political tasks, as among many Amerindian peoples. In eastern and southern Africa warrior regiments often existed, based on an age-grade organization. It was by his reorganization of age regiments and maintenance of them in royal barracks that Shaka was able to gain power and military success.

The maintenance of authority in any nonliterate society must depend on personal contact between ruler and ruled, directly or vicariously. Moreover, all rules and ordinances must be remembered and transmitted orally. A great deal of ceremonial behaviour and story-telling serves this end. The society looks to the past for validation of rules and values, and explicit legislation is very rare. On the other hand, verbal transmission leaves room for continual adjustments of which the society may not be clearly aware.

Informal arbitration is found in all societies, but in many no sanction of force supports a decision, though public opinion may be a strong influence. In some Amerindian societies, as R. H. Lowie showed, the persuasion of an arbitrator can be exercised only by a man who is not a war leader. In more complex societies, a political hierarchy coincides with a hierarchy of courts, with right of appeal to the paramount. In Africa many societies have a constituted court and litigation is common.

At all levels of society, even where, as in Polynesian societies, the thief is treated with very great deference, the political system provides for checks and balances. Sometimes there is provision for an assembly of the whole people, as among certain of the Southern Bantu. Sometimes the chief, as among the Tikopia, has to pass orders through subordinates who, in practice, if supported by public opinion, can tactfully evade these orders. Sometimes, as among the Bemba, the chief depends on the co-operalion of ritual functionaries who can, if necessary, refuse their help. Only when a ruler is able to monopolize force is he able to set up a tyranny, that is, when a fairly complex political and military organization exists. Ritual sanctions behind a ruler may be very strong, but they will equally impose on him strict rules of conduct and limit the free use oi his power.

The cohesion of any group of people depends on their thinking of themselves as a unit. This is only possible through a symbol of their unity. The more powerful the emotional charge, so to speak, of the symbol, the greatei their loyalty to the group. A common and effective symbol of unity is a human symbol, a chief who becomes also a symbol of the society's well-being and fertility. The chief is thus sacred and acquires important ritual functions. In extreme cases he may be thought of as an incarnation of a divine being. Sometimes, as among the Shilluk, his own personal vigour is associated with the weal of the society, and in former times when he was ailing or old he was put to death Alternatively, the religious head of the society and the ruler may be distinct but interdependent persons

Religious rites map also be of great importance in group relations Among the Tallensi there were no chiefs with secular authority, but only ritual leaders. Once a year they all took part in a great ritual festival involving a number oi autonomous clans, who were required during this period to settle all quairels and refrain trom hostile acts. Such arrangements are common among less politically developed peoples.

In all societies, political organization is linked with ritual and symbolism. In primitive societies this aspect of political relations is perhaps the most striking one.

Ritual Relations. — Rites form an important sector of human behaviour. "Rites" may be loosely defined as routine acts or series of acts which are not technically related to immediate purposes, but which are symbolic in character though often believed to have validity in themselves They are usually closely related to a set of myths and dogmas, which explain and help to validate the rites and which they in turn symbolize and keep alive. Ritual behaviour ranges from the worship of God to the concocting of medicines against witchcraft or incantations to render a spear more deadly. Attempts to divide this field have met with difficulties. Many authors have sought to apply the distinction current in our own society between religion and magic. J. G. Frazer suggested that religion is characterized by prayer to a personal power, magic by command to an impersonal force. E. Durkheim identified religion with public and obligatory, magic with private and optional rites. B. Malinowski held that magic is done for immediate practical ends, religion being concerned with general well-being. But each of these criteria would force us to class as magic some rites which are normally called religious, and vice versa. Moreover, as R. H. Lowie, P. Radin, G. Reichard, R. Piddington and many others showed, there are too many borderline cases between prayer and command, between obligatory and optional, between practical and general purposes, for these to be final criteria. The general meanings of "religion" and "magic" therefore remain vague, though more precise classification is possible for particular societies.

All known societies have beliefs in a spirit world. In most primitive societies, their gods and spirits are thought of as belonging to the particular society, and symbolize its unity. Often dead ancestors are important among the spirits, and belief in their pomers thus reinforces lineage or other kinship systems. The myths and dogmas about the spirit world are thought to explain the universe, give an account of man's place in nature and validate the moral law. They also often provide a charter for existing rights and obligations between peoples, and between kinship and local groups, in such matters as the possession of lands or ritual co-operation.

Public rites may be performed simply as worship, or they may have explicit aims such as the fertility and well-being of human society, the fecundity of animals and of vegetable foods or control of the weather. The passage of an individual from one status to another—birth, initiation, marriage, death—are marked by *rites de passage*, rituals which, as the classic work of A. van Gennep showed, have important functions in social integration. Rites may also be important to the social structure in symbolizing social distance, uniting potential enemies, enforcing the cessation of feuds or mars.

The forms which rites may take are too various for description but as examples magic, shamanism and totemism may be mentioned.

Magical rites were analyzed by B. Malinomski into three elements, though not all are always present. The performer, who must be in the correct ritual state, uses certain specified apparatus or medicines; he performs certain routine actions and he recites a spell. In the Pacific area the correctness of the spell is usually vital to success. In Africa more emphasis is laid upon the virtues of medicines. As J. G. Frazer early pointed out, magical rites often symbolize directly the end they'aim to compass.

Communication with the spirit world is important in all primitive religions. Among its many forms is shamanism, a widespread phenomenon with rites of mediumship and divination—the term is derived from a Siberian word for a "master of spirits." Usually in trance state, the shaman diagnoses causes of illness and expels the evil from the patient by spirit means. His technical and ritual practices often appear to give some relief to the sick person. The role of shaman also seems to provide an occupation and status for aberrant personalities in the society.

Frequently spirits are either identified with animals or even plants or are thought to have special connections with them. In this way, man puts himself in a social relationship with his natural environment. The most striking form of this type of belief is totemism. A clan, lineage or other social group has a special ritual relationship with one or more species of animal or plant or, more rarely, a natural phenomenon such as rain, with which there is an ancestral identification in some form. Many of the Australian tribes have highly developed myths and rituals connected in this way with the fertility of natural species. Following the earlier work of B. Spencer, J. Gillin and C. Strehlow, the intricate relationships involved have been analyzed by A. R. Radcliffe-Brown, A. P. Elkin, W. L. Warner, P. Kaherry, W. E. H. Stanner and R. and C. Berndt and others.

Ritual prohibition or tabu, a word borrowed from Polynesia, has been much discussed by anthropologists. A man's totem is often tabu, in the sense that hc may not kill or eat it. Tabus are often associated with a notion of sacredness—it is dangerous, for example, for a commoner to touch a Polynesian chief—or with pollution. Corpses, excrement, menstruation, for instance, are often polluting agencies which require those affected to perform special purification ceremonies. The concept of sacredness and the concept of pollution are related, as W. Robertson Smith pointed out—in fact, in some societies they appear to be indistinguishable.

Belief in witchcraft or sorcery is common. Sometimes a man or woman is believed to achieve power to harm or kill others simply by rites; somtimes he is believed to inherit or acquire special malignant pomers of a supernatural order. E. E. Evans-Pritchard distinguished these as sorcery and witchcraft. B. Malinowski shomed how sorcery may have para-legal functions, in the form of magic against thieves, for example, or vengeance magic supporting the pomers of a chief. Most personal misfortunes, especially sickness and death, which are not attributed to the action of spirits, are diagnosed as witchcraft or sorcery and the diagnosis is frequently backed by oracles. The system of thought is self-validating and constantly borne out by events since, though no one normally admits to sorcery or witchcraft, some kind oi evidence can always be found to give colour to the accusation. Witchcraft accusations are found to occur at certain points of tension in the social structure. So, as C. Kluckhohn and others showed, witchcraft beliefs canalize and provide a cathartic for anxiety and hostility. They also provide a strong sanction against deviant, especially malicious, behaviour.

From an individual point of view, ritual and belief clearly provide people with important means of adjusting to their environment. Here the inherent variability of the religious systems is of great importance. Religious dogma and mythology is a society's form of metaphysics and theology. It should not be assumed that. it is inflexible. Scepticism, reflection, unconscious modifications in transmission and even trial and error with ritual procedure are reported from many societies. But the system of belief provides a limiting framework within which speculation is necessarily confined.

Social Control.—Social order consists in the conformity of the individual members of a society to a set of rules of conduct. People act in conformity with rules for two main reasons. Most oiten, they wish to do so or are conditioned to do so without conscious choice. But where deviation from the rules offers immediate or personal advantages, then such a course of action must involve also outweighing penalties if conformity is to be preserved. Social control, therefore, involves both the training of members of society and the system of rewards and punishments which operate to produce conformity in behaviour.

Education of a formal sort is rare outside civilized, literate societies. In most primitive societies, a child learns by constant imitation, by participation in activity and by correction when it does wrong and praise when it does right. Many U.S. anthropologists such as R. Linton, M. Mead, J. W. Whiting, C. du Bois, came to concentrate from various points of view on the theory of child training, seeking to describe the growth in each society of a "basic" personality which both summarizes and explains the types of behaviour current in that society.

Ritual forms one of the major ways in which strong reactions of approval and disapproval are inculcated into and maintained in the members of a society. Thus *rites de passage* (see *Ritual Relations*, above) serve to emphasize moral rules, always through symbolism and oiten through explicit instruction. In initiation ceremonies, the solemnity of the occasion may be heightened by the infliction of pain—circumcision or scarification.

The expected reaction of a group or part of a group, directly or through its representatives, to unusual conduct is called a sanction. Where the conduct is specially approved of, the sanction may be called a premial sanction, and where, as is more often the case, the conduct is disapproved of, the sanction is called repressive.

Sanctions are sometimes formal, that is, carried out by recognized officers of the community according to recognized procedures—through police and law courts or through a church. More often they are either informal—the unplanned result of individual reactions—or an organized but informal penalty such as the singing of songs of ridicule, or ostracism.

Most control over conduct is unplanned. If a person deviates from the conduct expected of him by those with whom he has relationships, then these relationships will change and the deviator will suffer. Thus, if a Trobriander fails in his part in an exchange relationship, he not only loses the co-operation of his partner, but mill be unable to establish a new partner relationship. It is plain that in a small community, where everyone's behaviour is well known and most relationships are lifelong, this kind of informal sanction can be very strong. Failure to conform, apart from material consequences, means loss of esteem and status in a person's immediate group.

Even formal sanctions do not necessarily involve judicial procedure. Action by a chief, by a secret society, by a professional body or by a religious leader may be taken without any formal weighing of evidence or statement of law.

Conduct is often controlled by expectations of a different sort—the expectation that a certain action mill produce undesirable consequences apart from any human agency. Such actions are tabu. The belief in dire consequences is probably less a deterrent than a symbolic expression of strong social disapproval. More generally, divine punishment is often said to follow some or all kinds of moral or ritual lapses, that is, sins. Sin may also be directly punished by society, especially if it is believed to endanger the well-being of the whole community.

The moral rules of any community are usually supported directly or indirectly by its cosmology and by its religious myths and dogmas; the moral order of human society has its validation in the moral order of the universe.

Social control is thus seen to be imbedded in the social system, a by-product, as it were, of kinship, economic, political and ritual relations. It is only in the field of law as such that social control has its own institutions.

R. Thurnwald and A. R. Radcliffe-Brown suggested the limiting of the use of the word "law" to societies where some kind of court exists, with control of organized force to back up its decisions. It follows from this definition that many societies have no law at all. On these grounds B. Malinowski, H. I. Hogbin and others objected to it, and R. H. Lowie, following K. N. Llewellyn and E. A. Hoebel, defined law in terms of action by a person against breach of a norm with communal approval or sanction. But, as I. Schapera showed, if such a broad definition of law be adopted, to include all binding custom, there is still need to separate out those aspects where formal judicial procedures obtain.

Law may be divided into two kinds: public action by the society or its representatives to punish an act regarded as a threat to the whole society, corresponding to modern criminal law; and the settlement of private disputes, corresponding to modern civil law. In primitive societies the first is rare and is often confined to serious ritual offenses endangering the whole society, especially incest, and witchcraft or sorcery. On the other hand, private disputes cover much that in our society is criminal behaviour—homicide and theft, for example.

Specific legislation in a primitive society is rare. Where courts are found, the conduct of cases differs greatly from our own. Although most cases are in the form of private disputes, the court will not hesitate to lecture both sides on their moral responsibilities—the law coincides closely with the ethical notions and public opinion oi the society. Oaths and ordeals are used to establish evidence, and hearsay evidence is admissible. Professional pleaders are unusual. In punishment, fining is common but imprisonment rare. Banishment or exile from the society is often the most severe penalty.

Oral Tradition.—By oral tradition is meant the body of stories, including folk tale, legend and myth, which are transmitted by word of mouth from one generation to another and kept mainly in memory, not in writing. Great collections oi such traditional material have been made from almost every area of the world. The stories have been analyzed for style, character, incident and plot. As the result of the work of many writers—to mention only F. Boas, A. Aarne, Stith Thompson, R. B. Dixon, K. Luomala—a great deal is known about the classification, distribution and spread of the leading themes and about the way in which such stories are used.

The earlier view of such verbal material was that it has two primary functions. One is its quality as art, a series of imaginative constructs giving rein to fantasy, to narrative interest and to sense of dramatic form. From this aesthetic point of view these stories have been described as "oral literature." The other function is that of providing a history. It mas thought that by pruning away of incidents clearly belonging to the realm of the marvellous or of the irrelevant, a main stem of fact would be left, embodying in either descriptive or figurative form events of significance in the past of the people concerned.

The modern interpretation of oral tradition by social anthropologists emphasizes other functions. In particular, stress is laid upon its current meaning for the society which remembers it, rather than upon its retrospective interest. The traditions are kept alive because they embody claims to status, to land, to ritual and political privileges. Various people in the society, often the heads of kinship groups, regard themselves as the owners of particular traditions, the only persons entitled to recite them or allow them to be recited or to say whether a version is correct or not. They quote these stories, or incidents in them, to settle disputed points of precedence or to back up their arguments. From this point of view it is seen to be important for the anthropologist not so much to try and establish any single version of a tradition as "accurate," and still less to try and combine versions to get a synoptic "historical" account, but to study each version in context. To understand the significance of a tale it is necessary to know the social position of the person telling it and the social circumstances in which the tale is regarded as relevant by the people concerned.

Oral tradition can then be a powerful social force. The appeal to the past is not merely to explain the present, but also to validate it. This is especially so in myths, the stories which are regarded as sacred and which in all societies provide a basis ior social and ritual organization and moral rules. As B. Malinowski and others showed, an important aspect of the functions of myth is in endowing social action with greater value either by tracing it back to a higher, better, more supernatural reality of initial events, as in a "golden age," or by contrasting it with a past in which customs were the moral reverse of the present. Even the explanatory or aetiological myths of protophilosophical character examined by P. Radin have a sociological significance. They help to buttress the status of a kinship group by providing it with an unimpeachable genealogy going right back to the very origin of the land itself. M. J. Herskovits suggested that while Polynesian mythology which deals with creation and an orderly development of nature may be related to the stress these people lay on a hierarchy of rank, the lack of any such evolutionary concepts by North American tribes may be linked with their more democratic classless structure.

The emphasis on the sociological context of tradition was developed by E. E: Evans-Pritchard and M. Fortes in their studies of time perspective in segmentary social structures. They show how there is a direct correlation between time perspective recognized by the society and the structure of the social units. Genealogies are telescoped, and past events are placed in relations of structural relevance rather than on a scale of historical time, so fitting the lineage relations.

Values.—The study of social relations necessarily means taking account of the values of the people concerned. Social anthropologists have always paid some attention to values, usually under the head of beliefs, ideas or institutions. A. R. Radcliffe-Brown in 1922 described what he termed the "social values" of the Andamanese by considering the effects on their social organization of their interest in certain kinds of objects. The social value of fire to them, ior instance, is illustrated by the ceremonies in which they pay respect to it and recognize its importance in their social life. But the precise definition of what is meant by values had not pet been generally agreed upon in the 1950s. In a broad sense they may be described as the preference qualities assigned to objects and actions in social contexts, having regard to relationships between means and ends. More narrowly, following C. Kluckhohn, they may be defined as conceptions of the desirable which influence the selection from available modes, means and ends of action.

Some values are explicit, that is, they can be formulated in words. In many Oceanic societies a sister's child has special value for its mother's brother, who is expected by the social code to give particular attention to such nephews and nieces, care for their welfare, make them gifts and take charge of them in crises of life. This set of values can be stated by the people in moral rules and opinions. But some values are implicit, tacit premises implied in action. Thus the Navaho have as an implicit value the conception of harmony or balance among the various parts of the universe—a value expressed in much Navaho behaviour but expressed in words only rarely, and by singers, who are the intellectuals of the society.

Problems in value study—such as the relation of values to behaviour, the conformity and nonconformity of individuals to the predominant values of their society, the relation between explicit and implicit values, the processes whereby values change—were receiving much more attention from anthropologists by the middle of the 20th century than before. One of the most ambitious and important of these studies in the field was the Rimrock project undertaken by C. Kluckhohn and associates—a comparative study of the values of five neighbouring societies in New Mexico.

A iurther problem of theoretical and practical interest, which R. Redfield and S. F. Nadel in particular discussed, is the degree to which anthropologists are influenced in their observations and interpretations by their own personal values. (For practical implications of this see ANTHROPOLOGY, APPLIED.)

Studies in Literate Societies.—The methods of intensive field research and systematic analysis of social relations developed by social anthropology proved so strikingly successful in bringing a new understanding of primitive or preliterate societies that some anthropologists applied them to the study of civilized or literate societies. In fact, the earlier anthropologists, who saw themselves as historians oi human institutions, had already made free use of materials from the ancient civilizations, especially Greece and Rome. Moreover, the transition from primitive to civilized was made easier by the rapid spread of literacy and western influences in general in Africa, Oceania and other parts of the formerly primitive world.

Studies by social anthropologists of rural communities of the "folk culture" type—to use R. Redfield's term—were pioneered by Redfield in Middle America, C. M. Arensberg in Ireland, J. Embree in Japan, H. T. Fei, Li An-Che and F. L. K. Hsü in China, A. Aiyappan in south India, R. Firth in Malaya, E. E. Evans-Pritchard in Cprenaica. In urban communities the problems of isolation of field of study have been more acute, and the approach to conventional sociological methods has been closer. But urban anthropological studies have been carried out, some with special attention to the industrial problems raised through the work of Elton Mayo, by W. L. Warner and associates, J. West, H. Powdermaker, E. D. Chapple and others. Urban African problems have been studied by E. Hellman, M. Hunter, G. Wilson and C. Mitchell. Among the special problems, within a primarily urban field, which are of interest to the social anthropologist are those of family organization, child training and child care, to which much stimulating work was contributed by W. H. R. Rivers and C. G. Seligman earlier, and later by R. Benedict, E. Sapir, M. Mead, C. Kluckhohn, I. A. Hallowell, R. Linton, J. Gillin, M. Opler, D. M. Schneider. (For summary by W. Caudill see Anthropology Today, edited by A. L. Kroeber I A particular type of study, related in various ways to the others, is the anthropological investigation of American Negro and other special ethnic groups, as by M. J. Herskovits, R. Landes, J. Dollard, H. Powdermaker, A. Davis, K. L. Little, S. Patterson, M. Freedman, as part of a wider interest in racial relations.

Social Change.—But it is not only in studying civilized societies that the anthropologist is facing new problems. In his own traditional field, practically no societies remain within possible reach which have not been influenced by western civilization. The social anthropologist has accordingly included in his range of interest studies called culture contact or, later, social change.

Social change takes place in all societies at all times. But when *a* small primitive society comes into contact with western civilization, the changes are bound to be rapid and may be catastrophic. New techniques alter patterns of work and co-operation, the arrival of money greatly accelerates exchange, providing a universal measure of value and rendering wealth storable. New avenues of employment open up. Missions and many kinds of government and other developmental agencies increasingly introduce new values and affect the institutional life of the native people. Some degree of social disintegration is oiten the result, and social controls lose their force. In extreme cases, such as African shanty towns, crime and disease increase greatly. On the other hand, some societies make a relatively successful adjustment, raising the material levels of living of their members and increasing the scale and complexity of their economic and political organization without any radical alteration in morale. But in every case the new social situation is not simply a mixture of primitive and civilized ways but a fresh social phenomenon demanding special study. Techniques have to be devised to handle a much greater range of data, a greater variation in social action than is usually included in an anthropological monograph. New social forms, such as the so-called nativistic cults or "cargo cults," may demand more subtle interpretation.

Nowadays most social anthropologists include data on social change in their studies. But while the static theory of social systems is fairly well worked out, in general framework, by social anthropology, an adequate dynamic theory is still largely lacking.

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SOCIAL CONTRACT, in political philosophy, a term applied to certain theories of political obligation. Although similar ideas can be traced back as far as the Greek Sophists, social contract theories had their greatest currency in the 17th and 18th centuries. and are associated with such names as Thomas Hobbes, John Locke and Jean Jacques Rousseau (*qq.v.*). What distinguished these theories from other doctrines of the period was their attempt to justify political authority on grounds of individual self-interest and rational consent. The method used was to demonstrate the value and purposes of organized government by comparing the advantages of civil society with the disadvantages of the state of nature, a hypothetical condition characterized by a complete absence of governmental authority. The purpose of this comparison was to show why and under what conditions government is useful, and ought therefore to be accepted by all reasonable men as a voluntary obligation. These conclusions were then reduced to the form of a social contract, from which it was supposed that all the essential rights and duties of citizens could be logically deduced.

Although social contract theorists were agreed as to method. the conclusions they drew from it were widely different. According to Hobbes (*Leviathan*, 1651), the state of nature was one in which there were no enforceable criteria of right and wrong Each person took for himself all that he could; man's life was "solitary, poor, nasty, brutish and short." The state of nature was therefore a state of mar, which could be ended only if men agreed to give their liberty into the hands of a sovereign. who was thenceforward absolute. on the sole condition that the lives of the citizens were safeguarded by his power. Locke (the second of two *Treatises on Civil Government*, 1690) differed from Hobbes insofar as he described the state of nature as one in which the rights of life and property were generally recognized under natural law, the inconveniences of the situation arising from insecurity in the enforcement of those rights. He therefore argued that the obligation to obey civil government under the social contract was conditional upon the protection not only of the person but also of private property. Rousseau (*Du contrat social*, 1762) held that in the state of nature man was unwarlike and even timid, and that his rational powers were too little developed to enable him to have any conception of rights and duties. Laws resulted from the combination of men nho agreed for mutual protection to surrender individual freedom of action, and thereby acquired for the first time a sense of moral and civic obligation. In order to retain its essentially moral character, government must therefore rest on the consent of the governed, the *volonté générale* ("general will"). Other social contract theorists provided yet other interpretations of the common theme.

These theories are historically important for the part they played in the development of modern ideas of government especially the idea of government by popular consent. Toward the end of the 18th century, however with the rise of modern historicism they became increasingly unacceptable, not so much because of their content as because of the abstractly rationalistic terms in which they were formulated. The more perceptive social contract theorists, including Hobbes had always recognized that their concepts of the social contract and the state of nature mere unhistorical. and could be justified only as hypotheses useful for the clarification of timeless political problems David Hume, in particular. is absolutely explicit on this point. But as people grew increasingly interested in history, and tried to understand political problems in terms of the historical origins and growth of specific institutions, the earlier types of abstract analysis seemed ever less relevant. Thus the term social contract fell gradually into disuse, and ceased to play a significant part in the vocabulary of modern politics (F M W)

SOCIAL HYGIENE is a term usually restricted to imply hygiene with respect to sex problems alone. Many branches of medicine. economics and government are concerned intimately with sex problems, but these, as such. are not included in social hygiene. Nor do the different attitudes taken toward sex problems in different parts of the world enter into the question, though obviously such points merit consideration. To a large extent social hygiene is a product of civilization, yet in many ancient civilizations of high order social hygiene was but little prosecuted. Rather it is a product of the health and morality which are functions of certain types of civilization. Thus in the Mosaic code, social hygiene in its modern sense is evident to a far greater extent than it was in Athenian civilization.

The measures employed in the program of social hygiene are educational. legal and protective and medical. Educational measures aim to promote understanding of sex problems and of the best methods in dealing with them; to promote sex education; and to promote the training of teachers, leaders of religious and social agencies and parents. Legal and protective measures are concerned with the repression of prostitution and with promction of sound legislation. effective law enforcement and improvements in the police departments, courts and institutiqns caring for sex offenders. Medical measures aim at the prevention and cure of venereal disease, through education, provision of facilities for diagnosis and treatment, follow-up casework. research and training of practitioners of medicine.

SOCIAL INSECTS. True social insects are those that live in populations exhibiting division of labour for various functions among mature individuals separated into reproductive and sterile castes. Societal organization has evolved independently in several groups of insects. Best known are the social wasps (*see* WASP), social bees (*see* BEE; BEEKEEPING) and ants (*see* ANT) of the order Hymenoptera and termites (*see* TERMITE) of the order Isoptera. In each of these groups, the reproductive caste (males. females, kings. queens, imagoes) is structurally and functionally distinct from the sterile castes (workers, soldiers) with vestigial reproductive organs. The mechanisms of integration are analogous and not homologous (*see* HOMOLOGY) in each of these separately evolved societal systems. Both sexes are represented in the various castes of termites. but the sterile castes of the social wasps, bees and ants are composed wholly of nonreproductive females developed from fertilized eggs while the functional male develops parthenogenetically from an unfertilized egg.

SUBSOCIAL INSECTS

The true social insects arose from subsocial insects that in each case have sexual and familial adjustments with a division of labour between adults and young, but do not have a division of labour between adults of the same sex. The social wasps emerged from the predatory solitary wasps related to *Eumenes* and *Odynerus* (subfamily Eumeninae of the family Vespidae) that store food or progressively feed paralyzed caterpillars to their larvae in burrows or constructed nests. The social bees arose from solitary bees and these in turn from solitary wasps close to the family Sphecidae. The ants form a family, Formicidae, all members of nhich are social. They are related to the solitary vespoid wasps, but there is no living family from which the ants evolved. Bethylid wasps of the genus *Scleroderma* exhibit subsocial behaviour nith either winged or wingless adults. although winged males and wingless females are most common. The termites arose from roaches. probably in early Mesozoic times. Subsocial behaviour is found among nood-eating roaches of the genus *Cryptocercus* that live in integrated families and harbour nood-digesting flagellate protozoa belonging to related groups that serve the same function in the primitive termites.

A number of other subsocial insects are known nith various elaborations of group and family organization, but these have not evolved into true social systems. Among the best known are earwigs (order Dermaptera). webspinners (order Embioptera). true bugs (order Hemiptera: Heteroptera), tent caterpillars (order Lepidoptera) and several families of beetles (order Coleoptera) including the Carabidae. Cucujidae. Staphylinidae, Platypodidae. Scolytidae, Tenebrionidae. Passalidae. Scarabaeidae and Silphidae. A chronological sequence of forms with somewhat different functions occurs in the aphids (suborder Homoptera), but these are not classified as social or subsocial because of the temporal separation of morphological types. A possible sequence from the solitary insect through family organization to the truly social system was outlined by C. D. Michener and M. H. Michener (1951): (1) the mother drops her eggs at random wherever she finds herself, with no regard for the needs of the young; (2) the mother places her eggs in, on or at least near suitable food for the young; (3) the mother places her eggs in a specially constructed nest provided with a supply of food; (4) the mother remains with her eggs, often appearing to protect them from enemies; (5) the mother remains with her offspring as well as with her eggs so that a family group results; (6) the mother remains with her eggs and young, feeding the progeny with especially collected food; (7) the mother remains with her eggs and then feeds her young which. on maturity, co-operate with her in caring for additional broods. Although all of these relations of mother to the eggs and young are to be found among various living insects, there is no question that the examples are often unrelated and that the behaviour has evolved convergently. It is possible that some of the social

Hymenoptera actually evolved through most of these stages, but in the roach to termite evolution, the male and female remain together and the mother is not the exclusive parent in the resultant families and societies. Also great social differences occur when the food is wood and cellulose in contrast to the diet of the predatory solitary wasps and the primitive social types that arose from them.

A theory of the origin of termite society was suggested by the studies of L. R. Cleveland (1934). The American wood-eating roach. *Cryptocercus punctulatus,* harbours a number of species of cellulose-digesting flagellate protozoa in its highly adapted hind intestine The roach is dependent upon the protozoa for its major food supply while most of the protozoa are dependent upon their roach hosts for their restricted habitat and for their food of wood particles. Once the protozoa are acquired by the roach they are never lost entirely and the individual then can live alone for its entire life: However, protozoa can only be transferred in fecal pellets to a recently hatched nymph from infected molting nymphs. Sexually mature adults do not molt and could not reinfect the recently hatched young. It is apparently necessary for the adults, recently hatched nymphs and molting nymphs to live together in an integrated family organization. Sexually mature adults cannot found a new colony alone, but new colonies can arise by a budding process from pre-existing colonies. This particular roach does not have unnecessary wings in the adult stage of either sex. The termites arose from a primitive type of roach that possessed four membranous wings. The adult termites can found a new colony without accompanying nymphs because the protozoa can be passed by means of liquid feces from the nonmolting adults to the recently hatched nymphs or to the recently molted nymphs that have lost their protozoa. At the same time, adults must live with their young and the young with each other to facilitate the transmission of the protozoa upon which they are dependent for the digestion of their principal food. Termite protozoa, in contrast to roach protozoa, never encyst but are also anaerobic and cannot live for long outside the bodies of their hosts. All species of termites in the four primitive families (Mastotermitidae. Hodotermitidae, Kalotermitidae and Rhinotermitidae) are dependent upon protozoa, but the highest family (Termitidae), which contains about three-fourths of all species of termites, does not harbour cellulose-digesting protozoa and has acquired other methods of cellulose digestion not yet fully understood.

A study of the subsocial insects shows that dependence of the young upon the adults and upon each other has resulted in the natural selection of group integration and specialization of function. The unit of selection is the group, rather than the individual alone, and further selection has guided evolution to a high degree of social co-ordination in several independent branches of the evolutionary tree.

TRUE SOCIAL INSECTS

Social Wasps.—The social wasps include more than 1,000 species, all members of the family Vespidae. The true social wasps belong to three subfamilies, the Polybiinae, Polistinae and Vespinae. They are primarily predaceous. They may also feed on nectar. fruit and other sweet substances. The new world genus *Brachygastra* (=*hTectarina)* stores honey in its paper cells. Social wasps in general construct paper nests composed of chewed dry wood mixed with saliva. These nests usually consist of combs in one or more layers, rarely of vertical strings of cells. The cells are generally hexagonal in shape and the layers may be covered with an outside envelope of a paper or cardboard consistency. Nests may be found in cavities in the soil or vegetation, or hanging from leaves, branches or the eaves of buildings. Eggs, larvae and pupae are found in the brood cells.

Some of the tropical stenogastrin wasps construct a vertical series of single cells attached to a leaf by a strand. The oriental genus *Stenogaster* has a few primitive social species that construct small nests with a few horizontally attached cells. The female progressively feeds the larvae which eventually pupate in sealed cells, and the daughter wasps remain with the mother after emergence. The primitive African genus *Belonogaster* has larger colonies with a small degree of division of labour between older egg-laying females and younger foraging and nest-building females without differentiation into a distinctive worker caste. True sterile workers appear in *Polybia* and new colonies are founded by the swarming of several queens with many workers—a type of colony establishment found only in tropical wasps.

The most familiar social wasps are the temperate species of *Polistes* (Polistinae) and the vespine genera *Vespa, Vespula* and *Dolichovespula.* These temperate wasps and hornets have colonies lasting only through a single season. and colony founding occurs only in the spring by an ovenvintering fertilized queen. A few more primitive species have polygynous colonies with several reproducing females. but by far the majority are monogynous with a single queen and a large number of workers. New fertile females appear only in the fall when males are also produced. The entire colony perishes in the fall except for the over intering mated females. each of whom may became the queen of a new colony in the spring. The *Polistes* queen builds a few cells attached to a single stalk hanging downward in a sheltered place. often under the overhanging eaves of a house or shed. As the workers appear, new cells are added horizontally until a fairly large comb with as many as 500 hexagonal cells is formed. The comb of *Polistes* is naked, without a paper envelope. *Vespa* and *Vespula* found their colonies in the same manner as *Polistes,* but their nests usually consist of several combs in storied layers, the whole covered by a paper envelope that is destroyed and rebuilt as the population grows. The nests may be built in animal burrows, in hollow branches or trunks of trees or hanging from branches or houses. The brood cells open below as is characteristic of both primitive and highly social wasps. The queen cements an egg to the upper end of each cell. The larva hangs downward in each cell and is progressively fed with chewed up portions of insects caught by the queen or the later developed workers. The mature larva spins a cocoon and caps its cell before pupation. The adult emerges from four to six weeks after the egg is laid, and with numerous workers present the queen may devote herself entirely to egg laying.

The young grubs stimulate nursing activity from the adult queen or workers by emitting secretions from their mouths. Social facilitation through the exchange of nutrient substances or through tactile and chemical stimulation is termed trophallaxis and is characteristic of social insects in general.

Socially parasitic wasps have evolved from their social ancestors in both *Polistes* and *Vespula.* Social parasitism has appeared independently many times among the major groups of social Hymenoptera. The so-called cuckoo wasps have lost the worker caste. The cuckoo queen first invades an established host colony and during the ensuing battle many of the host workers are killed. Ultimately the host queen is also killed. A parasitized colony will not develop host males and fertile females in the late summer, but the cuckoo brood will be fed by the surviving host workers and will ultimately develop fertile males and females of the social parasite.

L. H. Taylor (1939) postulated the stages in the evolution of social parasitism among wasps as follows: (1) intraspecific, facultative temporary parasitism in which queenless nests are invaded by queens of the same species; (2) interspecific, facultative temporary parasitism in which queenless nests are invaded by queens of different, but closely allied, species with gradual replacement of the host workers; (3) interspecific, obligatory temporary parasitism in which the invading queen has lost her ability to found her own nest, but develops her own brood of workers; (4) interspecific, obligatory permanent parasitism in which the worker caste is lost.

Social Bees.—Truly social bees constitute about 5% of the total of well over 10.000 species, and there is little question that the social adaptations are an evolutionary specialization. The functional adaptations of the mouth parts, hairs and leg structures for nectar and pollen transportation and feeding evolved long before the origin of the worker caste, but many specializations of the species and genera of workers evolved subsequent to the origin of social behaviour. Short-tongued bees are ancestral to long-tongued bees, burrowing and simple architecture is ancestral to the use of wax and complicated architecture, and the storage of honey in special cells evolved later than the storage of a paste of pollen and nectar.

The Bombidae or bumblebees are probably the most primitive of the true social bees. About 300 species are found in the north temperate and arctic regions and a few extend into the tropics. As is the case with the temperate social wasps, the fertilized female of *Bombus* overwinters in a sheltered niche and seeks a favourable site for a nest in the spring. Most species of *Bombus* find empty mouse nests or animal burrows in the soil or in fallen logs, but a few may construct nests on the surface in thick vegetation. After the nest site is selected, the solitary queen gathers pollen and nectar, mixes them into a paste and builds a circular wall of wax around the lump of paste placed on the floor of the nest cavity. Wax is produced from both dorsal and ventral abdominal glands. She lays several eggs on the lump of paste and closes over the wax cell with her jaws. Soon after the first batch of eggs is laid, the queen builds a large "honey pot" of wax at the entrance to the nest, and in this she stores honey for her own use. The eggs hatch in about four days and the larvae soon eat the paste. The queen opens the end of the cell and progrersively feeds the growing larvae with a liquid mixture of pollen and honey. The waxen cover over the larvae is enlarged as the young grow, and around the 11th day the full-grown larvae spin separate cocoons. While the first brood is developing, the queen not only feeds and guards the larvae, but also warms them with her body heat. The adult norkers that emerge with the help of the queen from the first cocoons are always smaller than the queen, but vary considerably in their size range. They soon relieve their mother of her foraging role, enlarge the nest, build new cells, store honey in newly constructed cells or old cocoons and tend the young larvae. The workers may lay eggs, but these only develop into males because the workers never mate. In the late summer, abundantly fed larvae develop into fertile females and ovenvinter after mating. At the height of the population in the late summer, the whole colony may number from 100 to 600 bees. All die in the fall with the exception of the impregnated females. In the tropics, bumblebees form perennial colonies and s arming occurs.

Socially parasitic bumblebees belonging to the genus *Psithyrus* lack the worker caste and also lack the pollen-collecting apparatus on the legs. Each species has a single host species or a favourite species of *Bombus* with which it lives. *Psithyrus* seems to have evolved from *Bombus,* and some species of *Bombus* have queens that on occasion invade the nests of their own species rather than found independent colonies of their own. The European species of *Psithyrus* resemble the host species of *Bombzrs* in colour and size, but the North American *Psithyrus* do not exhibit the same degree of resemblance. The queen of *Psithyrus* kills the *Bombus* queen and usurps her place in the *Bombus* colony. The *Bombus* workers tend the eggs of the *Psithyrus* queen until they develop into overwintering *Psithyrus* queens.

The stingless bees of the family Meliponidae are tropical and subtropical. The genus *Melipona* is confined to the new world while the large genus *Trigona* is found in all of the tropical regions of the world. Although without a defensive sting. these bees can be very annoying by swarming over the intruder, buzzing, and biting exposed areas of the skin. The worker caste is distinct from the queen, not only in the loss of egg-laying capacity, but also in the possession of functional pollen-gathering structures on the legs. The colonies are monogynous until virgin daughter queens are developed, and new colonies are formed by the young impregnated queen accompanied by a swarm of workers. In *Melipona* the cell containing a developing queen cannot be differentiated from those containing young workers or males, while in *Trigona* the queen cell is distinct from the others (H. F. Schwarz, 1948). The nests are usually found in cavities in trunks or branches of trees. and more rarely the nest cavity may be subterranean. Commonly ground nests and arboreal nests of termites serve as shelters for a stingless bee nest, and the constructions of other animals may also be used. The bees typically seal off the nest cavity from the surrounding material by mud or waxen partitions Wax is produced from dorsal abdominal glands. The entrance to the nest may be simple or an elaborate funnel constructed by the bees. Brood combs may be in clusters or in layered stories. Honey and pollen is stored in globular clusters of pots, and in a few species the pots with honey differ from those containing pollen. The adult bee population varies among species from a few hundred to as many as 80,000. The meliponid bees in general store the larval food in brood cells that are soon sealed and the developing larvae are not fed progressively as they are in other social bees. Meliponid bees have evolved a robber species that regularly steals food from other bees.

W. E. Kerr (1950) gave evidence of the genetic distinction of workers compared to queens in the genus *Melipona.* All other social bees including the genus *Trigona* have trophogenic determination (determination by food) of the female castes. Because of the phylogenetic position of these somewhat advanced bees, it may be assumed that genetic infiltration occurred during evolution and triggered the original physiological mechanisms of caste determination.

Social life among bees reaches its highest development in the honeybees or domestic hive bees of the genus *Apis. Apis* contains only four species and all except the domestic honeybee *(Apis mellifica)* are found only in the tropical orient. The family Apidae contains only this one genus and the other social bees already discussed are included in separate families, which together with the solitary bees constitute the superfamily Apoidea. The common honeybee has been introduced into almost all countries of the world and it is occasionally established in the natural habitat where it successfully competes with native social bees. Colonies of honeybees were brought to the new world by the Jamestown colonists in 1607.

The castes are distinct and easily distinguished. The drone (male) differs from the female castes by its blunter abdomen and its large eyes that almost touch at the top of the head. The queen can be recognized by her large abdomen which extends beyond the closed wings, and by the reduction of the pollen-transporting structures on her legs. She is capable of laying over 3,000 eggs in a single day. The reproductive organs of the workers are usually rudimentary and the occasional egg laid by a worker is never fertilized and can only produce a drone.

The colonies are perennial and established by a large swarm of workers accompanying a queen. The population of a thriving colony may contain 50,000 to 80,000 workers. The combs are composed of wax secreted from ventral abdominal glands. Each comb contains many hexagonal cells arranged in two series back to back, and many combs may hang vertically with sufficient space between them to enable the bees to move freely. Honey is stored in combs separate from the brood cells; the brood cells are of three types—small ones for worker brood. slightly larger ones for drone brood, and very large cells constructed for the larvae of new queens. The queen cells are few in number, ovoid and irregular in form, and are only constructed by the workers when needed. In addition to wax, the bees collect propolis—a sticky substance exuding from buds of trees—which is used for filling up crevices and for gluing the combs to their base. The queen lays an egg in each brood cell previously constructed by the workers. A fertilized egg is laid in each worker cell or queen cell and an unfertilized egg is laid in each drone cell. Probably some stimulus from the size of the cell wall opens or closes the passage from the spermatheca where the sperms are stored and thus enables or prevents sperms from entering the oviduct through which the eggs pass from the ovaries. Eggs hatch in about 3 days, workers develop in about 21 days, drones in 24 days and the queen in about 16 days. Young larvae, irrespective of caste, are fed a secretion from the salivary glands of the workers that is rich in protein and other substances. This so-called "royal jelly" is progressively fed queen larvae until they pupate, but the drone and worker larvae are nourished, after the third or fourth day, only with "bee bread," a mixture of pollen and honey.

The trophogenic determination of female castes in the honeybee is better known and more distinctive than for the other social insects, but, with modifications and gradations, it is probably the basic mechanism of caste determination except for the genetic determination already noted in the genus *Melipona.* The queen lives from five to eight years and performs no other functions than reproduction and colony founding as an essential part of the swarm. She may lay as many as 2,000,000 eggs during her lifetime. Soon after emergence a new queen takes her nuptial flight accompanied by a number of drones. Mating usually takes place in the air and the fertilized queen returns to the nest of her origin. At the time of the first swarm, it is usually the old queen that accompanies the swarm to the new colony site. but if a second swarm occurs during the season, it is usually headed by a new queen.

At the end of swarming and nectar gathering, the honeybee colony exterminates the drones by depriving them of food, ejecting them from the hive and occasionally killing them directly. Drone elimination also occurs among the Meliponidae. This control over population numbers of drones is a most remarkable social phenomenon. After emergence, the worker bee shows a temporal succession of activities. The first stage of about two weeks is that of a nurse bee attending and feeding the brood and building the comb. The second period of about ten days is occupied with household activities, receiving and ripening the nectar, storing the honey, cleaning the hive, guarding the entrance and secreting wax. In the last period the functions are those of a field bee for 20 to 30 days during which it forages for pollen and nectar. In case of need, a worker in the early period of field foraging may return to its preceding activities as a nurse or house bee, so the temporal division of labour is not strictly rigid in sequence. Summer-hatched workers live for about one to two months, but those harched in autumn live through the winter on stored honey and resume their work in the spring.

In most social insects, trophallaxis, or the exchange of nourishment, facilitates social interaction and is probably a major stimulus for mutual attraction, particularly between young and adults. Young wasps, ants and termites give off secretions which their nurses avidly lick. and the nurses in turn feed the young with collected food: secretions and sometimes even excretions. The larval honeybees do not secrete liquids that attract their nurses, so far as is known. However, the nurse workers progressively feed the young with collected food somewhat modified when regurgitated in the form of honey and predigested pollen. The salivary secretion or "royal jelly" fed to all larvae soon after hatching is rich in proteins, fats and carbohydrates. T. C. Schneirla (1946) included the exchange of olfactory and tactile stimuli in the concept of trophallaxis. and there is little doubt that the sense organs of taste, smell and touch are used for interaction in all social insects including the relations between nurses and larval honeybees.

A remarkable system of communication was discovered among honeybees by K. von Frisch (1950, 1955). A scout field worker may learn to associate food with colour in a range from ultraviolet to, but not including, scarlet red. The bees that have discovered a rich source of food also attract other bees by an odour emitted from a scent gland on the abdomen. After returning to the hive, the scout bee tnay be accompanied by a number of workers back to the food source. Odour of the food is also imparted to the hive bees. The scout may communicate the distance, direction and amount of food by means of a food dance on the comb, even though the scout is experimentally removed following the dance. If the food is 50 m. or less from the hive, the scout performs a turning dance, first in one direction and then in the other direction. If the distance is between 50 and 100 m., the dance includes a short straight run between the turns and the abdomen is wagged during this straight run. At distances greater than 100 m., the number of turns decreases per unit of time while the wagging motions increase in intensity. The time or the effort needed to reach the food seems to be the basis for the bees' estimation of distance and the dance varies with head winds, tail winds or hills rather than with absolute distance. If the food is toward the sun, the straight run is vertically upward on the comb. A downward run indicates a direction away from the sun. A deviation of 10° to the right of the vertical indicates the direction of the food 10° to the right of the sun. Any angle to the right or left of the vertical corresponds to the angle to the right or left of the sun. If the comb is on its side, the straight run of the dance is in the direction of the iood. If the sun is shaded by clouds. the bees are capable of orientation in relation to the position of the sun by means of their sensitivity to polarized light intensities. The amount of food is indicated by the vigour of the dance. Small amounts or dilute food do not stimulate dancing behaviour, while larger amounts or sweeter concentration produce more energetic dances that stimulate a isrger number of hive bees to seek the food. The hive bees that react to the dance of the scout follow the dancer with their antennae and heads and at intervals between dances the scout may feed the followers with a little nectar. Although this type of communication has been called the "language" of the bees, and it demonstrates learning by association, there is no learning of symbols comparable to human communication. Both the dance and the response to the dance are unlearned and instinctive. implying hereditary behaviour.

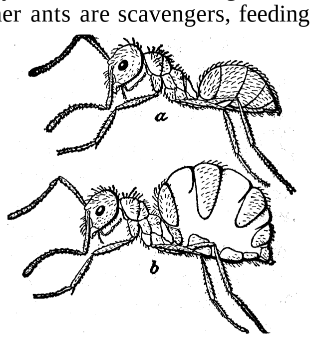
Ants.—Social life among the Hyinenoptera attains its highest level in the ants. All ants are social, but varying degrees from relatively simple to relatively specialized may be found in the phylogenetic series of subfamilies. genera and more than 5,000 species. Nearly 600 species and subspecies are recorded from the United States (W. S. Creighton, 1950). The nests of ants are commonly found in excavated galleries in the soil or fallen logs, but many ants are moundbuilders on the surface of the ground, or are arboreal, with nests in natural or prepared cavities of plants or constructed of paperlike carton composed of plant materials chewed and mixed with salivary secretions. Ants may become highly adapted to plants with natural cavities in their leaf petioles, thorns. twigs, trunks or roots. Such plants that regularly attract ants are known as ant plants. Evolutionary adaptation, however, seems to be largely in the ants rather than in the plants. The ants of the genus Oecophylla in tropical Africa and the orient construct their arboreal nests of leaves attached by means of silk spun from the salivary glands of the larvae. Some workers hold the leaf edges together while other workers holding larvae in their jaws weave the silk-secreting larvae back and forth from one leaf to the other. Ant nests on the whole are more loosely organized than the cells and combs of social wasps and bees.

Eggs are laid by the queens and gathered by the workers in masses, often in nursery chambers in the nests. The eggs hatch into legless larvae or grubs with proportionately small heads (in general. characteristic of the higher Hymenoptera) but often with specialized "pockets" in which iood pellets are placed by their nurses or with specialized glands that secrete attractive substances licked by their nurses. Larvae are transported to favourable temperature and moisture conditions in the nest and may be sorted according to size and stage of development.

The sterile caste of primitive ants is composed of wingless workers of one size (monomorphic). In the ponerine ants, the worker is structurally close to the queen, but lacks simple eyes, wings and well-developed ovaries. Occasionally workers may lay eggs that invariably develop parthenogenetically into males. The more advanced ants in all of the subfamilies, including a few ponerines, may have workers of different sizes (polymorphic) and in some genera nutritive and protective functions may be somewhat divided in structurally specialized worker and soldier castes. Some species retain only one or two of the worker types found in their polymorphic ancestors. Large soldiers may retain many worker roles or they may specialize for protection only. In two unrelated genera in different subfamilies (*Colobopsis* and *Cryptocerus*) the soldier plugs the doorway of the nest with its truncated head, allowing the workers of the colony to pass in and out but rejecting all foreigners. The factors that cause differential development of the various female castes are not clearly understood, but it may be presumed that either quantity or quality of food may be involved. The potentiality for the special types of polymorphism must have a genetic basis, because rhe caste types are characteristic of species, genera and groups of genera.

Males mate with the females during the nuptial flight (mating is often on the ground), and the single copulation stores viable sperm in the spermatheca that may fertilize millions of eggs for as long as 15 years. After mating, the queen breaks off her wings and seeks or excavates the first chamber in the ground, under the bark of a dead branch or in some other appropriate place. The large thoracic wing muscles are absorbed and assist in nourishing the first larvae, which are fed by salivary secretions. The new queen may eat some of her own eggs during the early stages of colony founding before the new and usually dwarf workers emerge to take over the food-gathering activities. Each stage in the life cycle from egg through larva and pupa may take two weeks or more, although a few ants emerge as adult workers in as little as 35 days from the laying of the egg. In a few very primitive ponerine ants of Australia, the fertilized female forages for insect food and feeds her young with chewed up pieces of prey, but the large majority of ants including most ponerines never revert to the solitary behaviour of their ancestral wasps. In a few instances, notably in the new world army ants, the queen is wingless and resembles a worker in her structure. New colonies are formed by budding from the old colony, a newly developed and fertilized queen together with a large number of workers separating from the old colony. In some cases *(Formica ulkei)*, the new queens may be accepted back into the old nest after the nuptial flight, and new colonies are formed by a budding of the populations. Some species of *Formica* are temporary social parasites, the new queen invading the nests of another species of the same genus and replacing the host queen. The social parasites *(Anergates atratulus)* have no workers and no independent colonies from their host ants *(Tetramorium caespitum)*.

The food of ants is much more diverse than that of the social wasps or bees. Primitive ants resemble their solitary wasp ancestors in preying upon living insects. A few may specialize on a single kind of prey (*Termitopone commutata* on termites of the genus *Synterntes*). The army and driver ants of the new and old world are raiders on animal prey, mainly insects of the earth surface. These primitive predatory ants retain the sting of the ancestral wasps. Many of the higher ants are scavengers, feeding alike on dead insects, dead animals of various sorts and decaying fruit. Some of these scavenger ants supplement their diet with the sweet secretions of homopterous insects such as the Coccidae, Aphidae, Membracidae and Psyllidae. Shelters are sometimes constructed for these "ant cows" and occasionally caterpillars of the family Lycaenidae may also be tended and sheltered. The "honey ants" of the genus *Prenolepis* (fig. 1) exhibit a remarkable specialization of "pastoral" activities. Honeydew obtained from aphids may be stored in the crops of some workers until they become so distended with the sweet liquid that they become immobilized. In some species they hang on the ceiling of the subterranean burrow and function as animated honey jars. These distended workers are called repletes, but so far as is known they are morphologically identical with the other workers in the colony. Harvesting ants collect, husk and store seeds in special granaries. In some species the soldiers or major workers appear to function solely as seed crushers. The fungus-growing ants belong to a tribe, Attini, of the subfamily Myrmicinae. The correlation of structure and behaviour in a supergeneric taxonomic category is an obvious indication that the fungus-growing "agricultural" behaviour is an inherited instinct. The fungi are cultivated in chambers in the nest, usually under the ground. Primitive fungus growers use a substratum of insect feces for the garden. The more advanced species harvest pieces of leaves from living plants and transport them to their underground nest chambers where small workers chew up the leaves into a moist mulch that is formed into a spongelike base in which the fungus mycelium grows. The gardens are tended by the small workers and ultimately produce small spherical swellings that are cropped and used for food. The species of fungi seems to be unique for each type of ant, but much further study is necessary before the evolutionary relationships of the fungi can be established. Before her nuptial flight the queen of *Atta* takes a pellet of fungus mycelium with some of its substrate in a pouch below the mouth. After impregnation she excavates a burrow in the soil and carefully tends the incipient garden on the floor of her sealed chamber, often manuring the fungus with her own feces. The eggs are laid in the developing garden, and the larvae are fed on the fungus or on some of the eggs. The first small workers appear in 40 days or more and soon start foraging for leaves to be used to nourish the fungus gardens. When larger workers appear, the smallest workers are confined to the nest. In a few years the largest workers and soldiers are developed and the soldiers function only to protect the nest from invaders.



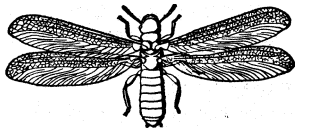
FROM WHEELER, "ANTS" (COLUMBIA UNIVERSITY PRESS)

FIG. 1.—AN ANT (PRENOLEPIS IMPARIS) MAGNIFIED

(A) An ordinary worker; (B) a worker greatly distended with a saccharine matter

The slave-making ants of the genus *Formica* (subgenus *Raptiformica*) and its relative, *Polyergus,* present one of the most astonishing of social relationships. All species of *Raptiformica* do not make slave raids, but the European *Formica sanguinea* and several of its North American relatives are often found with slaves belonging to other species of *Formica*. The slave-making colony is founded by a queen invading a nest of the slave species and adopting some of the slave brood. The resultant workers feed and attend the slave-making queen and her brood as they would their own. When the temporary parasitic brood emerges as workers, they will start making raids on slave species in the vicinity and by this means replenish the dwindling population of slaves. These raids are rather casual and may have evolved from predatory hunting by ancestral species. The loosely organized army of slave makers finds the nest of the slave species, invades it against some resistance and captures the grown larvae and pupae with an occasional young adult worker. These are carried off to the home nest, raised as slaves and perform the nutritive and shelter-building activities of the colony. The facultative slave makers are capable of living and performing their own work without slaves. The proportion of slaves in colonies of slave makers varies among species and also among colonies of the same species. The amazon ants of the genus *Polyergus* of Eurasia and North America are obligatory slave makers and are always found in mixed colonies. The slave raids are made by workers (sometimes called soldiers) that have no other function. One or two hundred slave makers emerge from their nest and travel together in an excited milling manner reminiscent of the predatory raiding bands of army ants. The direction taken by the slave raiders is a straight line to the nest of a neighbouring species of *Formica*. There they crowd around the opening of the nest and enter as rapidly as possible, occasionally removing small pebbles or obstructions that block their passage. Any *Formica* worker offering resistance is immediately killed by the sickle-shaped mandibles of the amazon ant. After 10 or 15 minutes, a line of amazons returns to its nest carrying larvae, pupae and a few slave workers. These ultimately develop into mature slaves and perform the activities of the colony as if it were their own. In observation nests it is found that one slave can keep ten slave makers well fed. but slave makers starve in the presence of abundant food if they are deprived of slaves. Slave making has evolved independently among unrelated ants. Two species of myrmicine ants of the genus *Harpagoxenus* enslave ants of the genus *Leptothorax*. Slave making among ants is fundamentally different from human slavery, as is readily demonstrated by the fact that ant slaves are always of a different species or genus than the enslaving ants.

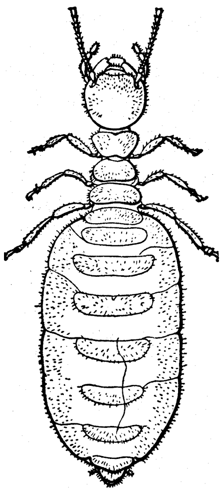
Inquiline species or "guests" occur in the nests of both the social insects and many other animals. Ant nests, however, harbour a great variety of insects with varying types of relationship to the hosts. Inquilines that live in ant nests without close relations to the ants may be called myrmecocoles, while those that have evolved adaptive dependence upon the ant society are called myrmecophiles. Numerous groups of insects and a few other animals have independently evolved predatory and scavenger behaviour in ant nests, but the most specialized myrmecophiles enter into trophallactic relations with the ants and often possess excretory glands that produce substances that attract the host ant. Tufts of hairs, called trichomes, that disperse liquids and scents from glands at their bases have convergently evolved in myrmecophilous Stapliylinidae, Pselaphidae, Paussidae and Histeridae.



FROM MARLATT ENTOMOLOGICAL BULLETIN (U S DEPT. OF AGRICULTURE)

FIG. 2.—RETICULITERMES FLAVIPES, FULLY WINGED MALE

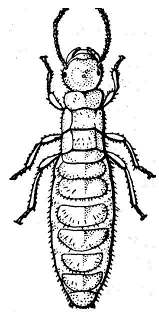
The plant and animal inhabitants of ant nests exhibit web relationships of great variety and many degrees of specificity. The biocoenoses, or relationships, of ants, including the host relations to predators, parasites, scavengers, trophobionts, myrmecocoles, myrmecophiles and nest inquilines, form interspecific community units of great complexity. There seems little doubt that natural selection has directed the evolution of independent genetic systems' toward adaptive interdependence, exploitation and mutualism.



FROM BANKS AND SNYDER. "REVISION OF THE NEARCTIC TERMITES" (SMITHSONIAN INSTITUTION)

FIG. 3.—RETICULITERMES FLAVIPES, APTEROUS QUEEN MAGNIFIED ABOUT FIVE TIMES, WITH ABDOMEN SWOLLEN WITH EGGS WITHIN

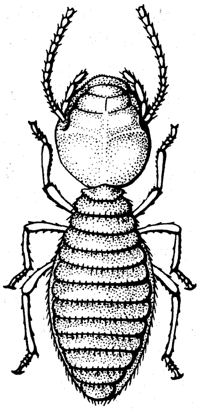
Termites. — Termites, sometimes inappropriately called "white ants," show a remarkable convergence (tendency to similarity) to the ants in their social life. The order to which they belong (Isoptera) is derived from roaches, a group of insects considered among the most primitive of living forms in their structure and development. The termites share many structural and developmental characters with their roach relatives. All develop by gradual metamorphosis through nymphal stages. The primitive Mastotermes of Australia, unlike the more advanced families, has a large folded anal lobe in the hind wing and lays its eggs in the oöthecal mass similar to the roaches. All termites are social, but gradations from simple to complexsocial organization occur among the living groups. Like the ants, all known fossils are Tertiary with the exception of one Permian species of doubtful assignment. Circumstantial evidence (A. E. Emerson, 1954) indicated evolution of advanced types occurred in Mesozoic times. Although it has been stated that important social advances have not occurred in ants and termites since early or mid-Tertiary, there is no reason to believe that major social evolution has ceased. Many genera of termites now living probably had already appeared in the Cretaceous, but some modern genera give indications of origin in the Miocene or possibly later. Over 2,000 species are now recognized, grouped into 168 living genera and 5 families. Sixty-eight fossil species are known. All termites possess soldiers for defense except for two genera (Anoplotermes and *Speculitermes*) in which soldiers have been lost secondarily. Most primitive termites do not have an adult worker caste, the function of feeding and caring for the colony being performed by the workerlike nymphs. Notably in the highest family (Termitidae), an adult worker caste functions for nutriment and nest building with soldiers specialized for protection and with kings and queens specialized for reproduction. There is every reason to believe that soldiers differentiated before the adult worker caste evolved, while the contrary is indicated among ants.



FROM BANKS AND SNYDER, "REVISION OF THE NEARCTIC TERMITES" (SMITHSONIAN INSTITUTION)

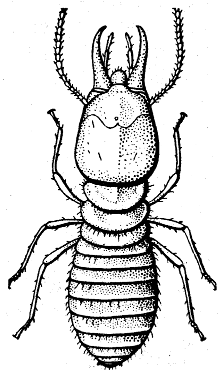
FIG. 4.—RETICULITERMES VIRGINICUS, BRACHYPTEROUS QUEEN. MAGNIFIED ABOUT FIVE TIMES, WITH SHORT WING PADS

Winged males and females (fig. 2) differ from their ancestral roaches by possessing a breakage suture at the base of the wings. After the colonizing flight, the wing beyond this suture is broken off in a fraction of a second, leaving only the base of the wing ("scale") on the thorax. The male is attracted to the female by her odour and follows her in tandem as she seeks a crevice or excavates a chamber in dead wood or in the earth. Among the higher termites, the queen develops enormous ovaries and soft parts of the abdomen and after several years of growth is capable of laying 8,000 eggs a day continuously for many years. The kings and the queens of some of the primitive termites grow little from their size at the time of the colonizing flight. The king lives with the queen throughout life, and copulation occurs at short intervals. Upon the loss of the primary king or queen, reproductive nymphs with or without wing pads may develop reproductive capacities and substitute for the original pair. These "supplementary" reproductives (fig. 3 and 4) are developed when needed in many species. and it is thought that inhibiting or activating agents in exchanged secretions ("social hormones") play a part in such development. Soldiers have reduced or undeveloped wings, eyes and reproductive organs of either sex. Primitive soldiers (fig. 6) have enlarged mandibles and head musculature used solely for defense. A remarkable nasute soldier (fig. 7) is characteristic of the more advanced genera of the subfamily Nasutitermitinae. In this soldier, the front of the head is prolonged into a sort of squirt gun for the forceful ejection of a sticky and irritating secretion from a large head gland. This defense is highly effective against most predatory ants. Specialized soldiers in the advanced genera of another subfamily (Termitinae) have asymmetrical snapping mandibles for defense. In some instances two or three differently formed types of soldiers are found in the same colony. The most extreme case of two soldier types is found in the genera Rhinotermes and *Dolichorhinotermes* of the new world tropics. The major soldier has large defensive mandibles, but the minor soldier has reduced mandibles incapable of inflicting a wound on an attacking ant. The secretion of a large gland in the head and body emerges from an opening at the base of the elongated grooved labrum, or upper lip. The fluid runs out on the labrum until it rests on hairs at the tip where it volatilizes as a repellent gas.



FROM BANKS AND SNYDER, "REVISION OF THE NEARCTIC TERMITES" (SMITHSONIAN INSTITUTION)

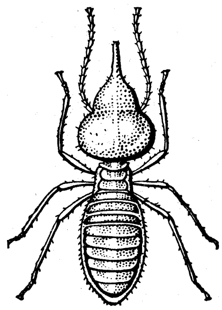
FIG. 5.—GNATHAMITERMES PERPLEXUS WORKER. MAGNIFIED ABOUT TEN TIMES



FROM BANKS AND SNYDER, "REVISION OF THE NEARCTIC TERMITES" (SMITHSONIAN INSTITUTION)

FIG. 6.—PRORHINOTERMES SIMPLEX, SOLDIER, MAGNIFIED ABOUT 10 TIMES

Working nymphs of the primitive families Mastotermitidae, Hodotermitidae and Kalotermitidae are not structurally specialized. Their mandibles are similar to those of their roach ancestors, and are used primarily for chewing wood. A few hodotermitin termites have "workers" that range over the surface of the ground harvesting dead grass or plant materials which they store in elaborately constructed subterranean nests. Most primitive termites are damp-wood or dry-wood eaters, living in their excavated galleries in stumps or dead branches of trees. Many of the Kalotermitidae invade dry wood in houses and cause considerable economic damage. These termites build simple partitions from excrement, but do not construct elaborate visible nests. The Rhinotermitidae



FROM BANKS AND SNYDER, "REVISION OF THE NEARCTIC TERMITES" (SMITHSONIAN INSTITUTION)

FIG. 7.—NASUTE SOLDIER OF TENUIROSTRITERMES TENUIROSTRIS, MAGNIFIED 15 TIMES

are more advanced in social organization than their more primitive relatives (Hodotermitidae). Their nests are usually in fallen branches or logs on the ground and only a few (*Coptotermes*) exhibit much architectural ability. They dig soil burrows some distance from their nest which contains a large queen. and they may also build covered tunnels leading from the nest to their source of food. The most advanced family (Termitidae) contains three-fourths of the known species and exhibits a variety of social specializations. The queens are usually large, some extreme specimens attaining a length of four inches. True workers are present. resembling the working nymphs of the lower families. The workers collect wood or leaves for food and feed the other castes and young. Some harvest grass. and a few feed upon organic materials in the soil. One subfamily (Macrotermitinae) of the old world tropics, with about 250 species, cultivates fungus on excrement built into elaborate fungus gardens. Various types of nests are constructed by the Termitidae. Some are excavations in the soil. Others are mounds rising above the soil and forming conspicuous features of the landscape. Large mounds may rise 2j to 30 ft. above the surface in great conical hills. The mound nest of the meridian termite of northern Australia (*Amitermes meridionalis*) is about 10 to 12 ft. high with a width of 8 to 10 ft. on the north-south axis, and only about 2 ft. on the east-west axis. The top of the mound is sharp. The nest shape probably stabilizes the radiant heat from the sun during the tropical day. Globular arboreal nests constructed by cementing particles of wood and excrement with saliva are characteristic of the genus *Nasutitermes* found throughout the tropics. Probably the most elaborate architecture is found in the genus *Apicotermes* of tropical Africa. Nests of different species of this genus are subterranean and have geometrically arranged ventilation pores in the walls constructed of claylike excrement by the workers. An evolutionary series of nest types (R. Schmidt. 1955) indicates a remarkable history of the nest-making instincts. These nests not only show an evolutionary series of instinctive group behaviour. but they exhibit social symmetry, replication, homology, recapitulation and vestigial patterns of behaviour.

No social parasites analogous to those among the social Hymenoptera are known among termites, nor do any species make slaves of others, probably because of the cellulose-eating adjustments in contrast to the predatory ancestry of wasps, bees and ants. A few inquiline termites are known that always nest in the nests of other termites. Termes *fur* and Termes *inquilinus*, respectively, nest only with Constrictotermes cyphergaster and Constrictoternzes cavifrons in South America. S. H. Skaife (1955) stated that Termes *winifredae* of South Africa is only found in the nests of other termites. Although the mound nests of termites often contain a number of termite species, obligatory inquilines are rare, and the few inquiline species are attacked viciously by their hosts if the partitions separating them are broken.

The advanced termites harbour in their colonies a host of termitophilous beetles. flies, bugs and caterpillars with remarkable exudatory organs adapted to trophallactic exchange. The most common characteristic of the most specialized termitophiles is a swollen or physogastric abdomen, the soft portions exuding glandular secretions that are avidly licked by the termites. Many termitophilous larvae belonging to several orders of insects may show "exudatoria" or prolonged glandular structures, and a few adult beetles, such as the staphylinid *Spirachtha* and the scarabaeid Scarabaeinus, have conspicuous glandular appendages that develop subsequent to emergence from the pupal case. The studies of C. Seevers (19j7) demonstrated a reciprocal evolution of the termitophiles and their hosts that has probably been advancing together since Cretaceous times.

In spite of the defensive soldier, a large number of animals have evolved special adaptations for preying upon termites. Some large ponerine ants of Africa and South America confine their diet to termites, their sting efiectively overcoming the biting jaws of the soldier termites. The spiny anteater of Australia (Monotremata), the banded anteater of Australia (Marsupialia), the aardvark of Africa (Tubulidentata), the scaly anteaters of Africa and the orient (Pholidota) and the new world anteaters (Edentata) are examples of convergent adaptation to a diet on termites. All these animals have reduced or undeveloped teeth. long cylindrical tongues coated with a sticky saliva and strong forelegs that can burrow into termite nests, whether in the soil, on the surface of the ground or high in the branches of trees Some of these anteaters have prehensile tails enabling them to seek their prey in the tree tops. A great many other animals, both vertebrate and invertebrate, are specialized predators on termites whose concentrated social populations offer a rich food supply to those animals capable of overcoming the defenses of the nests and the protective adaptations of the soldier caste.

GENERAL REMARKS ON INSECT SOCIETIES

Social organization with division of labour among adult castes has evolved four times among the insects with subsequent elaboration of the social system in each of the separate branches. Subsocial family systems are much more numerous and have doubtless evolved group systems many times in various orders.

The insect society may be compared to an individual organism possessing group attributes that collectively indicate a fundamental biological unit (A. E. Emerson, 1952). An individual cellular or multicellular organism is an open system with orientation, adaptation and interaction with its environment; it maintains a relatively steady state with self-regulation of optimal conditions of existence; it has a capacity of reproduction based upon exact self-duplication of genes with genetic continuity between generations; it exhibits functional specialization of its parts with integration of the parts into a whole; and it exhibits temporal development and temporal evolution with an order and regulation of its temporal dimensions, including the capacity to change and adjust. Levels of organismic systems occur. some of which may include units of a lower level as parts of a higher level system. The insect society is a high level, intraspecies supraorganism composed of individual multicellular organisms. but exhibiting all of the organismic properties mentioned above. The protoplasmic contact between the parts, characteristic of the cellular and multicellular levels, is absent in the insect society except through genetic continuity. but integration is achieved through behaviour interaction by means of sensory stimulus and response. Some biochemical integration is possible, however, through trophallactic exchange. Analogous similarities between levels. such as the evolution of sterile somatic cells in the organism and sterile castes in the social insect colony, result from natural selection of whole units favouring division of labour, integration and improved homeostasis. Communication through behavioural specializations and trophallactic exchange is characteristic of insect societies. However, improvement of division of labour with consequent improved efficiency, and improvement of integration and co-operation with consequent complexity of organization, are means to an improved self-regulation of optimal nutritional, defensive and microclimatological conditions (homeostasis). All the detected trends of the evolution of social insects are toward improved homeostasis, and the evolution of all organismic levels of integration seems to indicate a universal trend for all living systems toward improved homeostasis. Homeostasis must be construed as dynamic and characteristic of many types of individual and group systems (Emerson, 1954). The level of organization may also be between species with the unit composed of integrated species exhibiting ecological division of labour. Interspecies biocoenoses without germinal continuity between the species composing the system, but with natural selection of genetic traits of the component species through their relationships to each other and their environments. are particularly well illustrated by the social insects, their nest constructions, and the array of adapted animals and plants found living together arid together controlling their physical and biotic environment through geological time.

The societies of man are analogous to insect societies in such common attributes as division of labour among adults of the same sex, communication and integration of individuals into more inclusive organismic systems (social institutions. tribes. nations, etc.) and an evolutionary trend toward increased self-regulation or homeostasis of more optimal conditions of existence. In these senses, human societies are social supraorganisms. They differ in the basic behaviour integration, however. Organisms and insect societies are integrated largely by genetic replication and inherited physiological and behaviour co-ordination. Humans have a social heredity, a social reproduction and a social organization based upon learned symbolic communication. No animal has symbolic communication in this human sense. One of the most elaborate social communication systems known is that described for the honeybee. but the honeybee has an inherited instinct for responding to food quantity, quality and position by its dance on the comb, and the response by other bees to the dancer is likewise instinctive and genetic. Human language is composed largely of symbols learned through experience and education. 'There are no genes for a particular language, for a particular style of architecture or for a particular type of agriculture. Among the social insects, complex gene patterns determine communication, architecture and agriculture. For these reasons, evolution of insect societies is slow. while evolution of cultural traits is rapid; social systems of the insects are relatively simple. while social organization of humans is relatively complex. insect organization is more stereotyped and automatic. while humans exhibit much greater versatility and functional adaptability The human brain has evolved a great capacity for learning and intelligent thought and this ability has led to greater social and ecological homeostasis through social co-operation and organization. With the small insect body. the development of a brain of human dimensions is impossible. and even if the insect had such a capacity for learning, it could probably learn little of benefit during its relatively short life cycle compared with the long individual life of the human. Through the millions of years of their germinal evolution, however, insects largely have eliminated destructive individual competition and intraspecies warfare. Co-operation between individuals in a society is smooth and efficient, and all individuals seem to work for the welfare of the group.

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SOCIALISM. The words socialist and socialism came into use in Great Britain and France soon after 1825, and were first applied to the doctrines of certain writers uho were seeking a complete transformation of the economic and moral basis of society by the substitution of social for individual control and of social for individualistic forces in the organization of life and work Socialist seems to have been used first in Great Britain *(Co-operative Magazine,* 1826) to describe the followers of Robert Owen, and the word *socialiste* in France *(Globe,* 1832), with reference to the followers of Claude Henri de Rouvroy, comte de Saint-Simon. In Great Britain the followers-of Owen officially adopted the name Socialists in 1841. The nord socialism was popularized as the antithesis to individualism by P. Leroux and J Reynaud in their *Encyclopédie nouvelle* and in their other viritings. and by 1840 had come to be used freely in Europe to describe the schools of Saint-Simon, Franqois Fourier. Owen and others who attacked the existing system of commercial competition and put forward proposals for a new way of life based on collective control. Later, these early schools of socialism were categorized by Karl Marx and Friedrich Engels as "utopian socialism," in contrast with the "scientific socialism," based on the materialist conception of history, of which they were the pioneers.

Later writers, delving back into the past, found anticipations of socialist doctrine in many earlier theorists, and applied the name over a wide field—for example, to Plato among the ancients, to a number of medieval writers. to Sir Thomas More *(Utopia,* 1516), T. Campanella *(City of the Sun,* 1623) and other utopia makers, and to such 17th-century social critics as the cur6 Jean Meslier in France and the Leveller Gerrard Winstanley *(The Law of Freedom,* 1652), Peter Chamberlin *(The Poor Man's Advocate,* 1649) and the Quaker John Bellers in England. Among 18th-century writers the name is applied to Gabriel Bonnot de Mably *(Entretiens de Phocion sur le rapport de la morale avec la politique,* 1763) and Morelly *(Code de la nature,* 1755), the foremost critics of economic and social institutions among the philosophers who prepared the way for the French Revolution.

Among those who took part in the Revolution the name socialist is given to Jacques Pierre Brissot (1754–93), the Girondin leader, and sometimes to Jacques René Hébert, and above all to Franqois Noel (Gracchus) Babeuf (1760–97), leader of the Société des Égaux, whose unsuccessful attempt to overthrow the Directory government in 1796 is commonly regarded as the starting point of the modern socialist movement. Babeuf's revolutionary group set forth the first practical program, and the *Manifeste des égaux* was the first socialist pronouncement. Babeuf and his followers regarded socialization of land and industry as necessary to complete the revolution begun in 1789. They proclaimed the equal natural right of all men to the enjoyment of the goods provided by nature, the universal obligation to labour and the universal right to education, and the necessity of abolishing both riches and poverty in the interests of human happiness.

Babeuf sought to establish his system by revolution carried through under a revolutionary dictatorship. His ideas were popularized later by his collaborator, Philippe Michel Buonarroti (1761–1837), whose *Conspiration de Babeuf* (1828). translated by Bronterre O'Brien. influenced the English Chartists. His views on landed property had something in common with those of the British 18th-century land reformers (Robert Wallace, 1697–1771; William Ogilvie, 1736–1813; Thomas Spence, 1750–1814; and Thomas Paine, 1737–1809), but he went far beyond them in the amplitude of his social designs. Spence is nearest to him. and the Society of Spencean Philanthropists, formed by Spence's followers in 1812. can he claimed as the first organized socialist body in Great Britain. Spence stood for the collective ownership of the land by local communes, which would take over the government and provide by federation for the simple needs of administration under a communal system Paine, on the other hand, was not a socialist, but a social reformer who. apart from his doctrines about land, anticipated many modern social service projects in part ii of his *Rights of Man.*

Nor can William Godwin (1756–1836) be rightly described as a socialist. In his *Political Justice* (1793) he declared for the abolition of all government, and advocated a free society in which property would go to those who could make the best social use of it Godwin believed in the possibility of a completely rational social system without government, based on right education in moral and social principles. He inspired much later socialist as well as anarchist thinking, and had a considerable influence on' Owen's ideas as well as on those of the British radicals of the 1790s, including Wordsworth. Southey and Coleridge in their early days. Shelley's *Prometheus Unbound* was largely based on the ideas of Godwin, whose daughter he married.

The Saint-Simon and Fourier Doctrines. — Socialist thought took a quite different turn with the comte de Saint-Simon (1760–1825), a French aristocrat whose outlook was formed not only by the French Revolution but also by a keen awareness of the impending revolution in industrial technique and in the role of science in human affairs. Saint-Simon held that the new social forces that had been unloosed by political revolution and scientific advance called imperatively for planned organization and control in the general interest, and was the first to see clearly the dominant importance of economic organization in the affairs of modern society and to grasp the concept of economic evolution as the key factor in social adjustment. In his most important works (*Introduction aux travaux scientifiques du XIXe siècle*, 1807; *Nouvelle Encyclopédie*, 1810; *De la Re'organisation de la société européenne* [with the historian Augustin Thierry], 1814; *L'Industrie*, 1816–18; *La Politique*, 1820; *Catéchisme des industriels*, 1823–24; *Nouveau Christianisme*, 1825) he put forward. not a system, but a series of originative ideas which were worked up by his disciples into a system. He stood, not for a struggle between employers and workers, but for a community among the productive classes against the parasitic nonproducers, on a basis of social ownership of the means of production and their administration by men of the requisite scientific and business knowledge. He believed in unequal rewards, corresponding to real differences in quality of service, and in the conferring of large powers on a directing authority constituted on a basis of merit. The state. he held, was under an obligation to provide work for all, and all were under an obligation to labour for society according to their powers. Saint-Simon vigorously denounced the exploitation to which the labourer was subject under the existing system of property rights. and anticipated Marx in holding that the property relations sustained by any social order conferred upon it its essential character. He believed that human society tended in the march of history toward a system of universal association. which would be the guarantee of peace; and he regarded the Roman Catholic Church as having been a step toward this association. Holding its doctrines outmoded. he put forward in his *New Christianity* (1825) a nontheological religion for the new era, based on science and expressing his faith in a "science of sciences" — a field of thought in which he was the predecessor and inspirer of Auguste Comte. Saint-Simon's great contribution to socialist thought was his insistence on the duty of the state to plan and organize the use of the means of production so as to keep continually abreast of scientific discovery. and his insistence on the master functipn of the industrial experts and organizers, as against the politicians and the mere "men of business," in the society of the future.

François Charles Marie Fourier (1772–1837) was a younger contemporary of Saint-Simon. His first book, *Théorie des quatre mouvements,* was published in 1808 and was followed by others in which he repeated and expanded the same ideas (*L'Association domestique et agricole,* 1822, *Theorie de l'Unité universelle; Le Nouveau Monde industriel et socie'taire,* 1829; *La Fausse industrie morcelée,* 1835-36). Fourier is best known as the advocate of the *phalanstère*, a form of co-operative settlement which he believed to be the essential unit of social organization. It was to consist of 1,500 or 1,600 persons — a number which Fourier held to be the minimum for securing a right mingling of the many different tastes and temperaments. It was to be at once a working unit and a community of persons living together in a single great building; but the members were not to be equals in income or status, and each was to be rewarded for his own share in the common labour. Moreover. Fourier accepted property rights, providing for the division of the total product five-twelfths to labour, four-twelfths to capital and three-twelfths to special talent. His proposed division was in fact more favourable to labour than this makes it appear; for he advocated a very high rate of interest on small investments of capital, falling very sharply as the amount belonging to any one holder increased. In effect. he contemplated that most people would be capitalists as well as workers.

Fourier's system rested on the belief that most forms of labour could be made highly attractive if they were rightly organized, and that no one need, or should, be made to work at anything except of his own free will. He held that everyone should have many different jobs, never spending more than an hour or two consecutive!~at the same work, and that all work should be organized by groups or series of workers, between whom there would be natural emulation to do well. He stressed the predominance of intensive agricultural and horticultural work both over other forms of agriculture and over manufacturing labour. which he believed should be cut down to a minimum by making things to last and by the elimination of unnecessary products. The "dirty work" he said should be done by children, to whom it could be made attractive by the spirit of emulation and service. He advocated education through doing things rather than through learning about them, and gave children a large part in the work of his utopia. He stood for the equality of men and women, regarding the advancement of women as the crucial test of social progress.

Fourier's theories were based throughout on a psychological approach. He believed that civilization erred in seeking to repress the passions. which could by right social organization, under his system, be allowed to work beneficently, as God had meant. He claimed that his system would work without any need to change human nature: which he regarded as immutable. Fourier's methods of expounding his doctrines were often fantastic, but men found much sound sense in his writings. He was entirely opposed to state action for the establishment of his system, holding that its basis must be wholly voluntary. and believing this to be possible because he thought he had discovered the form of association that really fitted in with men's natural desires. Though usually regarded as a socialist, he is in reality rather the ancestor, jointly with Owen. of voluntary producers' co-operation.

Both Saint-Simon and Fourier were the inspirers of influential schools of thought. The disciples of Saint-Simon created a formal school, headed after his death by Armand Bazard (1791–1832) and Barthélemy Prosper Enfantin (1796–1864), who separated when Enfantin developed the religious sides of his master's doctrine on extravagant lines. including a form of community living which involved "free love." This aberration over. Enfantin. like others influenced by Saint-Simon (notably the famous engineer, Ferdinand de Lesseps), became a leading industrialist. while Comte went on to build his positive philosophy on Saint-Simonian foundations. Of Fourier's disciples, the most important was Victor Prosper Considérant (*La Destinée sociale*, 1834–38; *Manifeste de l'école sociétaire,* 1841), and in England Hugh Doherty (*The Morning Star*, 1840). In the United States Fourier greatly influenced Albert Brisbane (1809–90), C. H. Dana, Horace Greeley, Margaret Fuller, Hawthorne and Emerson; and the famous Brook Farm community (1841–47), described in Hawthorne's *Blithedale Romance,* was largely Fourierist in inspiration.

Owenism. — Robert Owen (1771–1858), generally regarded as the founder of British socialism, had much in common with Fourier. but approached the social problem from an essentially different angle. A highly successful master cotton spinner, at the head of the great factory at New Lanark which he made a model for good labour conditions. Owen was a powerful critic of the manufacturing system introduced by the Industrial Revolution and of the exploitation of labour which it involved. He denounced competition as leading necessarily to this exploitation, and advocated in its place a co-operative system based on villages of co-operation in which men and women would work and live together on a basis of communal enjoyment of the fruits of labour in both field and factory. Fourier advocated differences of individual payment and the allowance of interest on capital. Owen was prepared to allow interest until the owners of capital voluntarily gave it up, as he believed they would; but he favoured fully communal living in his villages and elsewhere payment to producers on a basis of "labour-time" instead of money — that is, of the time necessary for the various kinds of work, which Marx later called "socially necessary labour time."

The basis of Owen's doctrine was that the social character of men (*i.e.*, their social behaviour) is made for them and not by them: it is the product of environment and education and can be changed by improving these things. Me was led to denounce all established religions because they taught that men were responsible for their evil doings, instead of attributing them to bad environment, and he set out to preach social rather than moral reformation. These views were first expounded in Owen's *New View of Society* (1813–14) and more fully in his *Report to the County of Lanark* (1821). They came into prominence after the end of the Napoleonic wars. when Owen appealed to the government both for factory legislation to protect the workers and for state action to cure unemployment by setting up villages of co-operation. Unlike Fourier. Owen did not exclude state action: he appealed first to the state and then. when it failed to respond, next to private philanthropists and subsequently to the working classes directly.

Owen's views attracted a large working-class following. From about 1830 to 1834 he was in effect the leader of a vast trade union movement aiming at the emancipation of labour by setting up co-operative productive societies, labour exchanges (for the exchange of the products of different trades on a basis of labour time). and great national associations, such as the Guild of Builders, designed to take over whole industries. On the collapse of this movement in 1834 Owenism remained the creed of a substantial body of followers. who turned back to the attempt to establish villages of co-operation. Some of these had been tried already—New Harmony, in the U.S.. in 1825; Orbiston, in Scotland, in 1826; and Ralahine, in Ireland. in 1831. A last Owenite community mas started at Queenwood, in Hampshire, in 1839, on a basis that incorporated some elements of Fourier's doctrines. It failed in 1845; and Owenism thereafter gradually faded away, giving place on the one hand to secularism and other forms of "rational religion" and on the other to the great successful movement of consumers' co-operation, instituted in 1844 by the Rochdale Pioneer's Co-operative society, who were ardent Owenites. *(See* CO-OPERATIVES.)

Meanwhile, in France, Fourier had a successor in utopia building in Étienne Cabet (1788–1856), author of *Voyage en Icarie* (1842) and of an unsuccessful attempt to found a community in Texas and later in Illinois. Cabet's work was much influenced by Sir Thomas More's *Utopia.* It presented the picture of a perfectly symmetrical state. owning all the main industries and dividing the product on a basis of equality. Cabet's rulers were to be chosen by popular election, hut were to have large powers, analogous to those of Saint-Simon's industrial leaders. Cabet borrowed some of the features of Fourier's *phalanstères*, but departed from Fourier in laying great stress on the state and on uniformity of dress. status and behaviour among the citizens. Like Saint-Simon, he put much emphasis on the role of science and, like Fourier, on education, which, with Owen. he regarded as the means of training children in the right social ideas. Pending the establishment of Icaria, he was a strong advocate of minimum wage laws and of progressive taxation of the rich.

First Anticapitalist Writers. — Cabet was the last of the group of utopia makers who represent socialism in its first phase of evolution. Saint-Simon. though contemporary with this group, does not belong to it; and Owen is notable not only as a utopia maker, but even more as a leader of great working-class movements and an acute critic of the doctrines of orthodox political economy. In this last field he was the first of a group of writers who took the accepted principles of classical economics and based on them anticapitalist or socialist deductions. Owen's *Report to the County of Lanark* in many respects anticipates Mars; and Owen's leading follower in the realm of theory. William Thompson (1785–1833) (*Principles of the Distribution of Wealth Most Conducive to Human Happiness*, 1824), develops further the doctrine that, as labour is the sole true source of value, the labourers by hand or brain should receive in common the entire product. to be distributed on a basis of the greatest practicable social equality. Thomas Hodgskin (*Labour Defended Against the Claims of Capital*, 1825; *Popular Political Economy*, 1827; *The Natural and Artificial Right of Property Contrasted*, 1832) similarly turned the doctrines of the Kicardians against capitalism, but, following Godwin, arrived at anarchist rather than socialist conclusions about the new social order. Apart from Godwin, the sequence of British anticapitalist writers began with Charles Hall *(The Effects of Civilisation,* 1805) and continued with the Spencean Thomas Evans' *Christian Polity* (1816), Piercy Ravenstone's *Doubts on the Correctness of Some Opinions Generally Entertained on the Subject of Political Economy* (1821) and John Gray's *Lecture on Human Happiness* (1825). The Christian Owenite John Minter Morgan contributed *On the Practicability of Mr. Owen's Plan* (1819). *The Revolt of the Bees* (1826) and *Hampden in the Nineteenth Century* (1834); and William Thompson followed up his magnum opus with *An Appeal of One-Half the Human Race* [women] (1825), *Labour Rewarded* (1827) and *Practical Directions for the Establishment of Communities* (1830). T. R. Edmonds' *Practical, Moral and Political Economy* (1828), John Gray's *The Social System* (1831), J. F. Bray's *Labour's Wrongs and Labour's Remedies* (1838–39) and Mary Hennell's *Outline of the Social Systems and Communities Founded on the Principle of Co-operation* (1844) are the other leading works of the British Owenite and anticapitalist schools. Most of these writers mingled socialist deductions from Ricardian economics with ingredients drawn from Owen's co-operative doctrines. Bray wrote in England. but was born in America.

After the collapse of the Owenite trade-union and co-operative movements in 1834, the emphasis in Great Britain shifted to Chartism. with its demand for parliamentary reform based on manhood suffrage and annual parliaments. *The People's Charter,* published in 1838, crystallized this program, behind which was the driving force of acute economic distress arising out of the new Poor law of 1834 and the prolonged industrial depression that began in the 1830s and continued into the "hungry '40s." Chartism, resting on economic distress, had no clearly defined economic program: it was a hunger revolt, without much theoretical basis in its early stages. Under the leadership of Feargus O'Connor (1794–1855) it developed in the 1840s a "back-to-the-land" program based on individual peasant holding in collectively acquired land settlements (O'Connorville, Charterville), as against the Owenite advocacy of collective tillage in villages of co-operation. The Chartist land scheme collapsed in 1848. and thereafter Chartism broke up into a number of sects, with which it will be more convenient to deal later.

French Socialism. — While Chartism was running its course in Great Britain, socialism was taking on new forms in France after the revolution of 1830. The revolt of the Lyons weavers in 1831 is often regarded as the starting point of the French proletarian movement; and under the monarchy of Louis Philippe began the insurrectionary career of Louis Auguste Blanqui (1805–81), who passed more than 40 years in prison for various conspiracies. Blanqui. whose essential writings were collected in 1885 as La *Critique sociale,* was the successor of Babeuf in the advocacy of the seizure of power by a revolutionary minority, which would at once proceed to institute a socialist system. He organized conspiracies in 1836 and again in 1839. Released in 1848, he promptly attempted a new conspiracy, and was in prison until 1859. In 1861 he was again imprisoned for four years. In 1870 he headed the extreme left in Paris, but was imprisoned by Louis Thiers before the Commune. in which his followers played an important part. Blanqui's theories of revolutionary dictatorship contributed much to the French syndicalist doctrine of *la minorité consciente*, but were opposed by the Marxists, with their rival theory of mass dictatorship of the proletariat as a whole.

Blanqui was always the leader of small groups of ardent socialist revolutionaries. Under Louis Philippe, the main body of French working-class and socialist opinion followed. not him. but either Louis Blanc (1811–82) or Pierre Joseph Proudhon (1809–65). Blanc can be claimed in many respects as the forerunner of modern social democratic doctrines. His most important work, *L'Organisation du travail* (1839), demanded that the state should give full recognition to the "right to work," and should provide capital for "national workshops" (*q.v.*) to be managed collectively by the workers under public ownership. In the revolution of 1848 Blanc became a member of the provisional government, but was unable to get his ideas carried into effect, the so-called "national workshops" started by his opponents being mere relief works which were meant to fail so as to discredit his proposals. Blanc went into exile when Louis Bonaparte came to power, and spent many years in England. writing a series of important books on British social and political conditions. His other main socialist writings are *Le Socialisme: droit au travail* (1849); *Catdchisme des socialistes* (1849) and *Histoire de dix ans, 1830–40* (1840). Blanc was the originator of the socialist formula "From each according to his abilities: to each according to his needs." He stands for a socialism resting on public ownership, combined with workers' control in industry, and for a democratic parliamentary system as the instrument of socialist advance.

The idea of co-operative workshops, without that of state control, was also actively urged in the 1830s by the follower of Saint-Simon. Philippe Benjamin Joseph Buchez (1796–1865), who became the foremost advocate in France of Christian socialism and largely inspired the English Christian socialists. His views are embedded in his periodical. *L'Européen,* and in his *Essai d'un traité complet de philosophie* (1839) and *Traité de politique et de science sociale* (1806).

Much more important than Buchez was that singular genius, P. J. Proudhon (1809–65), whose work belongs essentially to the history of anarchism rather than of socialism. From *Qu'est-ce que la propriété?* (1840), with the startling answer "*La Propriété, c'est le vol*" ("Property Is Theft"), to *De la capacité politique des classes ouvrières* (1865). Proudhon poured out a spate of books in which he mingled devastating criticism of the institutions of capitalism with emphasis on the inherent capacity for self-organization of the working class. He became the leading advocate of *mutuellisme,* whether it took the form of co-operative societies or labour banks or trade societies, or any form of working-class organization in which might be descried the germ of the classless, nongovernmental society of the future. Proudhon called himself a socialist as an opponent of capitalism and individualism and private property; but his positive doctrine always laid the main stress on personal freedom and voluntary association in a society freed from the tyranny of monopolist property rights. He favoured personal property and inheritance under a moralized system of property rights designed to exclude exploitation, and laid great emphasis on the abolition of interest and the provision of free credit to the producers. His best-known books, in addition to those already cited, are *Systbme des contradictions économiques ou, Philosophie de la misère* ("The Philosophy of Poverty") (1846), which provoked a famous reply from Marx: *Misère de la philosophie* ("The Poverty of Philosophy") (1847); *Confessions d'un révolutionnaire* (1849); *Idée générale de la révolution au XIXe siècle* (1851); *La Révolution sociale* (1852).

Proudhon was addicted to complicated logical arguments, based iargely on the idea of inherent "contradictions" in capitalist society. He used, or, as Marx held. misused, the Hegelian dialectical method extensively. He was not a system maker but a critical and suggestive writer of great force. Marx classed him as a *petit bourgeois,* because he had little grasp of historical evolution or of the power of great industry, and because his mutualist doctrines were taken up by the declining class of small-scale producers and were inapplicable to large-scale capitalist conditions. Proudhon's ideas had great influence on the development of French syndicalism and he ranks, with Mikhail Bakunin, as the principal philosopher of 19th-century anarchism.

Marxism.— Up to the 1840s socialism developed almost exclusively as a French and British mevement. Industrial evolution was much more advanced in Great Britain than elsewhere; and France had been. from the 18th century, the principal seedbed of revolutionary political ideas. In Germany, which was politically divided and economically much more backward, socialism began as a movement when the more radical followers of Georg Hegel came into contact with advanced French social ideas in the course of the '30s and '40s. Johann Fichte (1762–1814), has sometimes been claimed as an ancestor of German socialism. because he exalted, as a nationalist and a social reformer, the claims of the state; but there is no substance in this view, unless all statist doctrines (including modern national socialism) are to be regarded as socialist.

German socialism really begins with the materialist philosophy of Ludwig Feuerbach (1804–72), who much influenced Marx, and with the "left" Hegelians, such as Bruno Bauer (1809–82), Moses Hess (1812–75) and Karl Grün (1813–87). Beginning as a realist or materialist critique of religion and of the established German philosophy *(see* Karl Marx and Friedrich Engels, *German Ideology),* this "left" Hegelianism, in which Marx was brought up, broadened out under French influence into Marxist "scientific socialism," taking the materialist conception of history, first clearly formulated by Karl Marx (1818–83) and Friedrich Engels (1820–95) in the *Communist Manifesto* of 1848, as its essential foundation. This famous manifesto, the starting point of the modern socialist and communist movements, was issued in the "year of revolutions," 1848. by the Communist league, which Marx had created on the basis of the Gennan societies of exiles that had been preaching various forms of utopian socialism from the late '30s. Wilhelm Weitling (1808–71) *(Guarantees of Harmony and Freedom,* 1842) was the principal leader of this pre-Marxist German socialist movement, but was pushed out of the way by Marx and Engels as a moralist-utopian as soon as they had formulated their essential ideas. The League of the Just (1836–47) gave place to the Communist league, which at its congress in Dec. 1847 authorized Marx and Engels to draft the *Communist Manifesto.*

The Communist Manifesto.— This most celebrated of all socialist documents is the first clear proclamation of the revolutionary role of the proletariat, or working class. It sets out from an interpretation of all human history as a sequence of vast class struggles for power. Behind these struggles, and as their cause, lies the development of the "powers of production," or, in other words, of man's command over the forces of nature. Every stage in this development demands a corresponding organization of social forces for its exploitation—a particular arrangement of property rights and class relationships. sustained by an appropriate political and ideological system. This political and ideological system, however, though it is used to enforce obedience to the class conditions required, is not their cause but their result. The driving force lies in, the powers of production themselves; and, as these develop, a disharmony arises between them and the social and political structure based on what they were at an earlier stage. This disharmony expresses itself in class struggles and leads to social revolution, which, when it comes, rapidly destroys the obsolete social structure and replaces it by a structure in harmony with the changed needs of the time. Such social revolutions involve and include revolutions in ideas as well as in institutions: they are the major turning points of human history.

Marx and Engels were far from supposing. as some of their critics have taken them to suppose, that all historical events could be explained in terms of this formula. It applies only to the great revolutions of history, and not to day-to-day events outside moments of historic crisis. Nor did Marx and Engels ever suggest that men are moved only by economic or self-interested motives. That is not the point, which is that, whatever may be the motives that move men, they are impelled by historical necessity to adapt their social structures and ideas to the requirements of the development of the powers of production. "Man," Marx writes, "always makes his own history," but he goes on to say that man makes it within the limiting conditions set by the problems and material realities of his own time and place.

The *Communist Manifesto* throws out, on the basis of this conception of history, a resounding challenge to the governing class, which is warned that the proletarian revolution is on the march. It includes also a searching criticism of other schools of socialists who fail to take their stand upon the principle of the class war. The work of the utopian socialists is passed under review; the followers of Proudhon are castigated; adverse comment is passed on Christian socialism and on the so-called "professorial socialism" which was becoming fashionable among a school of German economists. The communists, on the strength of their understanding of the historical role of the proletariat, put themselves forward as the natural leaders of the coming revolution, and sweep aside the *petit bourgeois* radicals whom they regard as in process of being rapidly superseded by the development of economic forces. This is not meant as an adequate summary of the Communist *Manifesto*: there is no space to deal with it adequately. All that can be attempted is to select the points most important for the history of socialism.

The defeat, in Germany and all over Europe, of the revolution of 1848 naturally involved a setback for European socialism. The Communist league disappeared; the leaders of socialism were again scattered and mostly in exile. But from this time on Marxism, though not yet fully developed as a system, found adherents in most of the leading countries. In England it influenced the later stages of Chartism, which became more consciously socialist as it ceased to be a mass movement. Of the Chartist leaders the three who have some claim to a place in socialist history are George Julian Harney (1817–97), Ernest Charles Jones (1819–69) and James Bronterre O'Brien (1805–64). Harney, who first published the *Communist Manifesto* in England, was a revolutionary who looked back to 1789 and regarded the proletarian revolution as the necessary completion of the French. He was influenced by Marx, but presently Marx discarded him as too unstable, and transferred his hopes to Ernest Jones, who became the principal English exponent of Marxism in his speeches and journals (Notes for the People, 1851–52; The People's Paper, 1852–58). O'Brien, also much influenced by the French Revolution and especially by Babeuf, never became a Marxist. Originally an Owenite, he developed into a state socialist, looking forward to nationalization of the land, public utilities and industries subject to monopoly. His principal work is his unfinished "Rise, Progress and Phases of Human Slavery" (in Reynolds' Political Instructor 1849, republished 1885). By 1860 Chartism in these later forms had flickered out, and socialism hardly existed in England except in the form of sympathy for utopian socialism in the writings of John Stuart Mill and some other leading economists.

Christian Socialism. — There had been in England, however. in 1848 and the following years a movement for what was called "Christian socialism" (*q.v.*) but was in fact rather co-operativism. This was mainly due to John Malcolm Ludlow (1821–1911) who had been much influenced by Philippe Buchez, Louis Blanc and the development of co-operative workshops in France, and succeeded in enlisting John Frederick Denison Maurice (1805–72), Charles Kingsley (1819–7j), Edward Vansittart Neale (1810–92), Thomas Hughes (1822–96) and others in support of a movement to set up similar workshops in England, on a definitely Christian basis. The English Christian socialists were moved by horror at the appalling conditions prevailing in the workshops and factories and at the un-Christian spirit of the spreading industrial system, but were skeptical of the Chartist remedy of political reform. Kingsley announced that in his view the "French cry, Organization of Labour" was worth a dozen of the People's Charter. Immediately, the Christian socialists set out to establish small working associations which they financed, in the hope of sowing the seeds of a neu social order. These soon failed; but they were led to give great help to the growing consumers' co-operative movement, especially in securing for it a legal status under the Industrial and Provident Societies act of 1852. Later, the Christian socialists made many further attempts to foster producers' co-operation and also to secure the acceptance of profit sharing and copartnership in capitalist industry. They also transferred their activities to education, founding the Working Men's college in London (1854) ; but by the later 'jos the Christian socialist movement, as such, had practically ceased to exist.

Christian socialism developed also on the continent. in somewhat different forms, largely connected with the Roman Catholic Church. In France. its forerunner was Bishop Claude Fauchet (1744–93), the Girondin, who preached a form of Christian communism at the time of the Revolution. Hugues Félicité Robert de Lamennais (1782–1854), co-founder of *L'Avenir* (1830–32), can also be regarded as a forerunner (Paroles d'un croyant, 1834). Buchez, as we have seen, influenced Ludlow; and there has always been in France a Catholic social movement with some affinity to Christian socialism. The movement, honever. developed much more strongly in Germany. partly under the influence of the Protestant Victor Aimé Huber (1800–69), founder of the Association of Christian Order and Liberty and leading advocate of co-operative production, and partly under that of the Roman Catholic bishop Baron Wilhelm Emmanuel von Ketteler (1811–77), who also advocated co-operative production as a means of curing the ills of capitalism and promoting reconciliation of classes. The movement spread to Austria and Belgium. but, like English Christian socialism, it belongs rather to the realm of social reform than to that of socialism in the usual sense of the word.

Also on the borderline of socialism is the German economist, politician and landowner Karl Rodbertus (1805–75) (Social Letters, 1850–51; Illumination of the Social Question, 1875), who expounded the subsistence theory of wages and the labour theory of value, and proposed state action to increase the labourer's share in the product by preventing the owners of capital from appropriating the fruits of rising productivity. Rodbertus regarded society as in process of evolution from the wage system to one in which the means of production would be publicly owned, and private property would survive only in respect of income, which would correspond to the value of each man's labour. He also threw much light on the theory of economic crises, and considerably influenced the later formulation of Marx's ideas.

A much more central figure in the development of German socialism is Ferdinand Lassalle (1825–64), founder of the Universal German Working Men's association (Allgemeiner Deutscher *Ar*beiterverein) (1863), the first organized German Socialist party, in opposition to the Liberal party headed by Franz Schulze-Delitzsch. Lassalle, who was a great orator, caused this body to spread with extraordinary rapidity, but he was killed in a duel the year after its definite formation. It languished in his successors' hands and was finally fused in 1874–75 with the rival Marxist Social Democratic party formed in 1866 under the leadership of Wilhelm Liebknecht (1826–1900) and August Bebel (1840–1913). Lassalle laid great stress on the "iron law of wages," *i.e.*, the theory that wages tended under capitalism always to subsistence level, and attacked proposals for credit associations, consumers' co-operative societies and similar bodies as useless to help the workers in face of this inexorable law. Instead. he urged that "the working class must become itself a monster employer," not in little producers' co-operative societies, but by taking over large-scale industry "in the massed and concentrated form of the factory, with its enormous advantage in productivity." As the workers could not do this by voluntary action, it mas necessary to invoke the power of the state, which "exists only to expedite and assure the march of culture." The state should place the necessary credits at the disposal of the associated workers, who should proceed to take the conduct of industry into their own hands, and should receive, in addition to their wages, dividends based on the profits of the several collective undertakings. The state, says Lassalle, "is the consolidated people"; but it can be made an instrument for the proposed change only by universal and direct suffrage, which must therefore be won by means of universal association and agitation. Under universal suffrage, the state will stand ready to execute the people's will (Open Letter to the German Working Men's Association, 1863). Lassalle was thus an advocate of socialization, to be achieved by means of political agitation and action, through a democratization and democratic conquest of the machinery of the state. But he was also, pending this democratization, ready to appeal to the existing state to extend help to the workingmen's associations. He discussed his plans with Bismarck, who undoubtedly learned something from Lassalle both in constituting the German Reich and later in introducing the social measures sometimes called "Bismarckian state socialism."

The First International. — Meanwhile Marx, in London, had published in 1859 his Critique of Political Economy — virtually an advance sketch of Capital, and containing a plain exposition of the essentials of the materialist conception of history. The first volume of Capital appeared in 1867 — the only volume published during Marx's lifetime. But before this Marx had succeeded in bringing into existence in London the International Working Men's association, or "first international" (1864) (see INTERNATIONAL, THE), consisting at the outset mainly of continental exiles and British trade-union leaders who sympathized with foreign revolutionary aspirations, however little they were disposed to foment revolution in their own country. The project of an international association had come in the first instance largely from the followers of the liberal nationalist leader Giuseppe Mazzini; but Marx succeeded in pushing them aside and in securing a body ready to follow his own lead. He drafted the address and statutes, and soon branches were founded in a number of European countries, including Germany. France, Belgium, Italy, Switzerland and Spain. The new international played a considerable part in the labour troubles of the later '60s in France and elsewhere; and the outbreak of the Franco-Prussian War in 1870 found it active all over western Europe. In France and Belgium it was at first largely dominated by the followers of Proudhon and the Belgian collectivist socialist Jean Guillaume César Alexandre Hippolyte Colins (1793–1859), in Germany by the Marxists. in Italy and Spain and parts of Switzerland by the anarchists, of whom the Russian Mikhail Bakunin (1814–76) became the acknowledged leader. The first international held congresses in London (1865), Geneva (1866), Lausanne (1867), Brussels (1868), Basel (1869) and, after an interval caused by the war, at The Hague (1872). Its statutes and addresses were widely drawn, to attract adherents from a number of different schools: and its general council was composed largely of British trade-union leaders, who left the running to Marx and the group of exiles he had gathered round him. In 1867 there was a struggle between the Marxists and the followers of Proudhon, who were driven out; and thereafter until 1871 Marx was practically in control.

The testing time for the first international came with the proclamation of the Paris Commune in 1871, after the defeat of France by Prussia and the fall of Napoleon III. Marx had advised his French followers against the rising, but when it took place he rallied at once to its defense. In Paris. members of the first international took part in the Commune side by side with the followers of Blanqui and of Proudhon. The Paris Commune was the first occasion on which the working class actually achieved political power, albeit only for a few weeks; and the rising was of immense symbolic importance for socialists everywhere. Marx, in the manifesto upon it (published as The Civil War in France, 1871) which he wrote in the name of the international, seized on its significance for the strategy of socialism as a whole. The proletariat, he held, could not assume power merely by taking over the existing apparatus of the bourgeois state. It needed to break the old state in pieces and to construct in its place a new proletarian state of its own. He praised the Communards for what they had done in this way, while criticizing them for having proceeded too slowly and too mildly to meet the need. At a time when the entire capitalist world'was denouncing the Commune for its revolutionary excesses, Marx stressed rather the hesitancy and the clemency with which the proletariat had employed its new power.

There was acute controversy in socialist and labour circles about the Paris Commune. Marx's defense was too strong meat for many of the English trade-union leaders who had hitherto lent their names to the lnternational Working Men's association; and in all countries the more timid or reformist adherents of socialism were scared off. The defeat of the Commune by Thiers and the reactionary French national assembly which wiped it out in blood was fatal to the international, already torn asunder by the dispute between the Marxists and the anarchist, or antipolitical. followers of Bakunin. At the Hague conference of 1872 Marx, in order to get rid of what had become an embarrassing child and to prevent its appropriation by the followers of Bakunin, obtained a vote removing the seat of the international to the United States, where, after lingering nominally for a few years, it was ingloriously wound up. The followers of Bakunin maintained for a time their rival international in Europe; but it struck no lasting roots except in Spain.

The question posed by Marx in connection with the Paris Commune—should the proletariat aim at conquering the bourgeois state in order to use it as the instrument of proletarian power, or should it set out rather to destroy the bourgeois state and replace it by a new, proletarian state of its own?—continued to divide the socialist movement. This very question came to a head when it was proposed, a few years after the Commune, that the German followers of Marx and of Lassalle should combine to form a single Social Democratic party. Lassalle, as we have seen, had stood for the conquest and use of the state, which he had regarded as needing only to be based on universal, direct suffrage in order to become an instrument of social progress. Marx, on the other hand, held that the bourgeois state was incapable of such conversion, and indeed that every state was essentially a class institution, made in the image of a particular ruling class—so that each class, on coming to power, would need to break the state of its predecessor and make a new state of its own as the instrument of its "dictatorship." This is the theory of the dictatorship of the proletariat, which the Bolsheviks claimed to apply in the Soviet Union after 1917.

Social Democracy.—Liebknecht and Bebel, Marx's leading supporters in Germany, were not prepared in 1875 to jeopardize union with the Lassalleans by insisting on this principle. The Gotha program, on the basis of which the German socialist forces were united in that year, accepted by implication Lassalle's view of the state. Marx, to whom the draft was sent, protested violently in a memorandum to the German Social Democrats (subsequently published as Critique of the *Gotha* Programme); but the leaders in Germany actually suppressed his criticism. and pushed the amalgamation through. The German Social Democratic party thus came to birth with a contradictory set of objectives. Most of the language of its program was that of Marxism, but embedded in it was the objective of winning power by taking over the control of the bourgeois state, rather than by overthrowing it, together with an advochcy of co-operative production on the lines proposed by Lassalle. In effect, the German Social Democratic party became a parliamentary party, aiming at the assumption of political power by constitutional electoral means. Its leadership, however, was in the hands of men who regarded themselves as devout Marxists but who refused to accept the dictatorship of the proletariat as part of the essential Marxian doctrine.

This was of vital importance for subsequent socialist history, for over most of western Europe German social democracy became the model on which national Social Democratic parties were organized. In France Jules Guesde (1845–1922), after several years of agitation, was joined by Marx's son-in-law Paul Lafargue (1842–1911) in founding the Marxist Parti Ouvrier Français in 1880. In Belgium the followers of César de Paepe (1842–90) formed a similar party, but closely linked up with the trade-unions and co-operative societies, in 1885. In Spain Pablo Iglesias (1850–1925) created a Marxist party, in rivalry to the anarchists, in 1879. In Scandinavia, the Danish party dates from 1879, the Norwegian from 1887, the Swedish from 1889 and the Finnish (the first to secure a parliamentary majority) from 1899. The Italian Socialist party dates from 1892, the Polish Socialist party from the same year and the Dutch Social Democratic party from 1893. The Russian Socialist party was founded, as the Emancipation of Labour group, by G. V. Plekhanov (1856–1918) and P. B. Axelrod (1850–1928) in 1883. Thus Marxian socialism spread over Europe during the final quarter of the 19th century. In some countries. such as Russia and Poland (mainly under Russian rule), the political conditions made parliamentary activities impossible, and the parties maintained a decisively revolutionary and underground character. In most countries, however, they became national parliamentary parties, compelled by the exigencies of electioneering to put forward programs of social reform. to be pressed for in advance of the full conquest of political power and the establishment of a socialist system.

In Great Britain the attempt to establish a Marxist party mas made by Henry Mayers Hyndman (1842–1921), who was chiefly responsible for founding the Democratic federation in 1881. This body had at first only a semisocialist program, as it was attempting to attract into its ranks the radical workingmen's clubs which had followed Charles Dilke and Joseph Chamberlain in their radical phase. Rut in 1884 the federation became the Social Democratic federation and adopted a completely Marxist program. The same year it split, William Morris (1834–96), the socialist poet and artist, and others, with the support of Engels, breaking away to form the Socialist league. Neither of these bodies attracted a large following; but their influence was felt indirectly in the great outburst of strikes among the less skilled workers about 1889 and in the formation of new trade-unions, with a largely socialist outlook, among the dockers (London dock strike 1889), gasworkers and other classes of previously unorganized workers.

At the same time there arose among the miners, under the leadership of James Keir Hardie (1856–1915), a movement for the legal minimum wage and the legal eight-hour day, backed by the newly formed Miners' Federation of Great Britain (1888). The socialists, notably John Burns (1858–1943) and Tom Mann (1856–1941), placed themselves at the head of the less skilled workers, adding the demand for the "right to work" to those for the minimum wage and the eight-hour day. Hitherto British trade-unionism had been for the most part attached to the Liberal party under W. E. Gladstone; but from the late '80s there arose a widespread movement for independent labour representation, and the local bodies formed on this basis joined forces in 1893 in the Independent Labour party (I.L.P.) under the leadership of Keir Hardie, with an evolutionary socialist program. Powerfully reinforced by the *Clarion*, founded in 1891 by Robert Blatchford (1851–1943), whose *Merrie England* (1894) sold more than 1,000,000 copies, the I.L.P. set out from the first to induce the trade-unions to enter politics on the socialist side. In 1900 it was successful in bringing into existence the Labour Representation committee as a federation of trade-unions and socialist bodies, but without a fully socialist program.

Fabianism.—We must now retrace our steps to 1884. The Social Democratic federation, after the split, fell almost completely under Hyndman's control and pursued a narrow and doctrinaire form of Marxism which alienated the trade-unions interested in immediate reforms and drove one working-class leader after another out of its ranks. Morris' Socialist league, which had seceded partly as a protest against Hyndman's dictatorial methods and partly because it objected to the running of Socialist candidates aided by Tory gold in order to split the Progressive vote. turned aholly antipolitical and was captured by anarchists. who drove William Morris out of it and deprived him of his paper, the *Commonweal,* in which originally appeared his socialist romance, *News From Nowhere* (1891).

In the same year as the Socialist league (1884), the Fabian society was founded, of which Sidney Webb (1859–1947) and George Bernard Shaw (1856–1950) speedily became the outstanding leaders. The Fabians were a small group of intellectual socialists, standing for an evolutionary conception of socialism in sharp contrast with Marxism and endeavouring, by progressive reforms and the nationalization and municipalization of industries, to turn the existing state into a "welfare state." The name they adopted was derived from that of Quintus Fabius Maximus, known as Fabius the Delayer because of his deliberate, long-range strategy. They declared themselves the inheritors of the Benthamite tradition of promoting "the greatest happiness of the greatest number," and maintained that this principle now pointed to extensive state intervention as plainly as it had once seemed to point to *laissez faire*. In *Fabzan Essays* (1889) and in a host of well-informed Fabian tracts the society laid down its essential doctrine and the practical applications of it; and the Fabians also proclaimed a policy of "permeation," by which they meant a readiness to get their ideas taken up by any party or person that would listen to them. Their work considerably influenced the policy of Keir Hardie's Independent Labour party, and their hold on the norking-class movement was strengthened by the careful and constructive studies of trade-unionism and other working-class organizations carried out by Sidney Webb in collaboration with his wife Beatrice Webb (1858–1943). The Fabians can be regarded as the group which first clearly worked out the philosophy and practical implications of that form of "gradualist" socialism which became in practice the policy of the Labour and Socialist parties in most of the countries with parliamentary constitutions, whatever theoretical doctrines they continued to proclaim as the basis of their faith. *(See* also SOCIALISM: PRIKCIPLES AND OUTLOOK; FABIAK SOCIETY.)

Socialism in the **U.S.**—In the United States, socialism followed a different course. After the decline of Owenism and Fourierism which had at one time a considerable hold, socialism practically died out. The single tax doctrines of Henry George (1839–97) obtained a large folloning in the 1870s and helped to prepare the way for socialism, which was reintroduced mainly as the doctrine of immigrants from various European countries. each bringing with him his particular brand. Largely under German influence, the Socialist Labour party was formed in 1877 and ran its first presidential candidate in 1892. It continued to grow until 1898; but then came a split. Daniel De Leon (1852–1914), its leader. insisting on its duty to form a socialist trade-union movement in opposition to the American Federation of Labor. which was strongly antisocialist. De Leon was a Marxist of the extreme left, following Marx's view of the state and the necessity for the dictatorship of the proletariat, and his attempts at industrial unionism were the forerunners of the later attempt to create the Industrial Workers of the World (1905) (*q.v.*), with the difference that De Leon aimed at industrial unionism closely linked with a revolutionary Socialist Labour party, whereas the Chicago I.W.W., led by W. D. ("Big Bill") Haywood, was antipolitical and syndicalist in outlook. In 1901 the seceders from De Leon's S.L.P. joined forces with other groups to form the American Socialist party, under the leadership of Eugene V. Debs (1855–1926), and the new party soon greatly outnumbered the S.L.P., polling nearly 1,000,000 votes for Debs in the presidential election of 1912.

Modern National **Developments.**—Meanwhile, the developing Socialist parties in uestern Europe were being compelled to define their political attitudes. In France, the Parti Ouvrier had split in 1882 into two sections. Guesdists, or Marxists, and Possibilists, the followers of Paul Brousse (1844–1910), with a more moderate program. The Possibilists split again in 1890, when a left wing broke away under Jean Allemane (1843–1935). The followers of Blanqui held together in a separate Comité Révolutionnaire Central; and yet another party, the Independent Socialists, grew out of a group originally created in 1885 by Benoît Malon (1841–93), the author of an extensive *History of Socialism* (1881–84) and the apostle of Le *Socialisme intégral*—the title of his best known book (1891–92). The Independent Socialists attracted a group of highly influential leaders. including among them Jean Jaurks (1859–1914) and Alexandre Millerand (1859–1943). All these groups wooed trade-union support; but the French trade-unions, under the influence of Fernand Pelloutier (1867–1901), held aloof from politics and went over gradually to the doctrines of revolutionary syndicalism and direct action, which were definitely proclaimed, with the general strike, as its policy at the Lyons congress of 1901. This tendency was already well established when, in the middle 1890s, all France was set in turmoil by the Dreyfus affair. This famous affair caused a big reorientation of political forces, including the establishment in 1899 of the ministry of "republican defense" of Pierre Marie René Ernest Waldeck-Rousseau, in which the socialist Millerand was offered and accepted office. The ensuing dispute led to the regrouping of French socialism in two rival parties, the Parti Socialiste de France (Guesdists and Blanquists) and the Parti Socialiste Français (Broussists, Allemanists and Independents), the latter supporting the participation of socialists in a progressive capitalist government. The split lasted until 1905, when the rival parties joined forces in the Parti Socialiste Unifié, under Jaurks, which pursued a stormy course up to the outbreak of World War I in 1914. The assassination of Jaurks, the outstanding leader of French socialism, on the eve of war in that year was a severe blow to French socialism and opened the door wide to fresh dissensions.

The rift in French socialism occurred on the practical question of socialist participation in a capitalist government. In Germany the dispute, with the same fundamental basis, took a different form. In 1891 the German social democrats, in their new Erfurt program, eliminated the Lassallean clauses of the Gotha program of 1875, In 1899 Eduard Bernstein (1850–1932) published ***Die** Voraussetzungen des Sozialismus,* translated under the title *Evolutionary Socialism,* in which he declared the need for a fundamental revision of Marxist doctrine. Bernstein had lived long abroad, first as an exile in Switzerland and from 1888 as correspondent in

London of the Social Democratic *Vorwärts;* and he had been greatly influenced by Fabianism and by the British Independent Labour party. Bernstein denied the imminent collapse of capitalism, the progressive crushing out of the middle classes, the concentration of capital in fewer and fewer hands, the "increasing misery" of the working class and the necessarily reactionary character of the state. He affirmed the importance of working for immediate social reforms rather than for revolution, and asserted that the gradual movement toward socialism was everything, and the ultimate goal of socialism in effect nothing. He attacked the orthodox formulation of the materialist conception of history and emphasized the importance of noneconomic and moral factors in the making of social change; and he regarded the Marxian theory of value as a merely abstract concept remote from actual conditions. Finally, he denied that the industrial proletariat could hope, by itself. to conquer political power and, relying on parliamentarism as against dictatorship, pleaded for a moderate socialism which could be regarded as the heir of liberalism and for an appeal to men and women of all classes rather than to the workers alone.

The demands of "revisionism" led to a tremendous controversy, in which Karl Kautsky (1854–1938) appeared as the principal champion of Marxist orthodoxy. The revisionists were defeated at the congress of the German Social Democratic party, and the letter of Marxism was faithfully preserved. But in practical politics the German Social Democrats to an ever increasing extent accepted Bernstein's precepts, though the very limited elements of democracy in the German constitution greatly limited their practical influence and effectively prevented them, up to 1918, from being confronted with any such problem of participation in the government as had disturbed the French Socialists in 1899.

The rise of national Socialist parties in the leading countries was followed by attempts to create a new socialist international. Periodical international socialist congresses were held from 1889; and in 1900 the International Socialist bureau (the second international) was set up to act as a permanent link between the national parties. Unlike the first international, however. it was not a centralized body claiming to dictate policy to its sections, but a loose federation of independent parties, each claiming to follow its own line in accordance with national conditions. It was much occupied with the questions of antimilitarism and the prevention of war, but refused to endorse the policy of the general strike against war sponsored mainly by the French, and succeeded only in passing ambiguous resolutions which furnished little practical help in the crisis of 1914.

The years immediately before World War I were a period of great labour unrest in many countries. They were marked by a reaction against parliamentary social democracy, by a rapid growth of trade unionism in various forms and by the development of new doctrines of direct action and syndicalism radiating mainly from France. The French syndicalists proclaimed the preponderance of economic over political power, and contended that parliamentarism necessarily involved compromise and a weakening of the will to revolution. The workers, they maintained, must fight their battle on their own terrain—that of industry—by strike action, which could be used to secure political as well as industrial concessions. They must act alone, without invoking the aid of politicians, and must take as their aim the transference of industry into their own hands. The French syndicalists, influenced by Proudhon and Pelloutier, looked forward to the reorganization of France into self-administrating communes under the control of the workers' *syndicats* and *unions de syndicats,* loosely federated nationally and internationally on a basis of pure "workers' control." They were strongly antimilitarist and antipatriotic, favouring the general strike both as a measure against war and as a means of accomplishing the social revolution. In the hands of certain theorists, notably Georges Sorel (*Réflexions sur la violence,* 1908) and Hubert Lagardelle *(Le Socialisme ouvrier,* 1911), the general strike was elevated to the rank of a "social myth," powerful in inspiring the workers to resolute action, even if it never happened in the form supposed.

This syndicalist doctrine owed much to anarchism and had much in common with the anarchist-communism of the great Russian revolutionary Prince Peter Kropotkin (1842–1921), author of *Fields, Factories and Workshops* (1899), *Mutual Aid, a Factor of Evolution* (1902) and other books of wide international influence. It was much like the doctrine maintained in Spain by the Iberian Anarchist federation (F.A.I.) and the Spanish National Confederation of Labour (C.N.T.). Transplanted to the U.S., where capitalism was much more advanced and centralized, it assumed a different form, the attempt to form a single, all-inclusive big union, designed to overthrow capitalism by revolutionary direct action, and to take the great industries into the workers' hands through the Industrial Workers of the World. In Great Britain it appeared in an industrial syndicalist movement led by Tom Mann *(The Industrial Syndicalist,* 1912) and in a modified form in guild socialism. an attempt to reconcile state socialism with the syndicalist doctrine of "workers' control." *(See* SYNDICALISM.)

Guild socialism (*q.v.*), first preached by A. R. Orage (1873–1934) and S. G. Hobson (1868–1940) in the *New Age* about 1911 (see *National Guilds,* by Hobson and Orage, 1912), spread rapidly during World War I, under the auspices of the National Guilds league. The guild socialists stood for state ownership of industry, combined with "workers' control" through delegation by the state to national guilds including all the workers by hand and brain and organized internally on democratic lines. About the state itself they differed, some believing that it would remain more or less in its existing form, and others that it would be transformed into a federal body representing guilds, consumers' organizations, local government bodies and other social structures (G. D. H. Cole, *Guild Socialism,* 1920; S. G. Hobson, *National Guilds and the State,* 1920). Guild socialism was much stimulated during World War I by the rise of the left-wing shop stewards' movement, demanding "workers' control" in the war industries. After the war, the building workers, led by Hobson and Malcolm Sparkes, founded building guilds which built houses for the state; but after the slump of 1921 the state withdrew financial help, and the movement collapsed. The shop stewards' movement also disintegrated when the war ended; and the guild socialist movement fell to pieces, leaving behind it an effect in the incorporation of some element of "workers' control" into the programs of trade unionism and of the Socialist and Labour parties.

Over most of the world, World War I sharply divided the socialist forces. In Great Britain, France and Germany the majorities in the Social Democratic and Labour parties supported their respective countries, whereas in Italy and Russia the majorities were against the war. In Great Britain there was no formal split, but the Independent Labour party, while remaining part of the federally organized Labour party, opposed the war. In Germany, in 1915, the Social Democratic party virtually split, a minority breaking away to become the "Independents," under Kautsky and Hugo Haase, and a group further to the left, the *Spartakusbund* (Spartacus union), appearing a little later under Karl Liebknecht (1871–1919) and Rosa Luxemburg (1870–1919), one of the principal latter-day theorists of Marxism *(The Accumulation of Capital,* 1913). In France, *majoritaires* (for the war) and *minoritaires* (antiwar) waged incessant conflict without positively forming rival parties. In Italy Benito Mussolini broke away from the Socialist party to lead a militant prowar group, which formed the nucleus of the Fascist party. In Poland Joseph Pilsudski, previously a Socialist, sided with Germany in the hope of securing Polish liberation from Russia, while Rosa Luxemburg's followers, who had formed a Polish Social Democratic party in 1893, sided with the Bolsheviks in opposing the war.

Russian Socialism.—The outbreak of the Russian Revolution in 1917, followed by the Bolshevik revolution later in the year, exercised a deep influence on the socialist movement throughout the world. Russian socialism, at the time of the revolution, was divided into four main parties—Social Revolutionaries and Left Social Revolutionaries, active mainly among the peasants, and Bolsheviks and Mensheviks, the rival Social Democratic parties, into which the Social Democratic party of Plekhanov and Axelrod had split. Conditions in Russia were so different from those in western Europe that Russian socialism had followed a largely independent course. The earlier Russian exponents of socialism, Alexander Herzen (1812–70), Peter Lavrov (1823–1900) and Nikolay Chernyshevsky (1828–89), sought to apply western socialist ideas to Russian conditions, whereas Bakunin applied ideas that were indigenously Russian to the conditions of the west. Herzen believed that the survival of the commune as the basis of Russian village life made Russia, despite its industrial backwardness, an appropriate country in which to institute the socialist revolution, which he conceived as above all else a peasant revolution. Chernyshevsky developed these ideas, regarding the overthrow of tsarism and the landlord system and the institution of political democracy as the first steps toward agrarian communism. Lavrov (Letters on History, 1868–69), the philosopher who inspired the Narodnik (People's) movement among the Russian intellectuals, preached a gospel of self-devotion by the educated classes to the cause of the people, and then looked forward to the achievement of socialism by the leavening of the people with socialist ideas, which could be built on the foundations of the communal tradition of Russian village life. Out of the Narodnik movement sprang the Narodnaya Volya, the idealist movement of organized terrorism which was responsible in 1881 for the assassination of Alexander II. This in turn was the precursor of the Socialist Revolutionary party, which came into formal existence in 1901 and, representing many different tendencies, was by far the largest of the Socialist parties at the time of the revolution of 1917. From it split off, under M. Spiridonova, the Left Social Revolutionary party, which joined the Bolsheviks in the second revolution, and for a short time occupied a place in the soviet government.

As against the Social Revolutionaries, whose main appeal was to the peasants, the Russian Social Democrats had their strength among the urban workers. Russian factories were relatively few, even in 1917, but the few were mostly very large and used mass-production methods. The urban proletariat was small, but highly concentrated, and lived under conditions of intense exploitation. We have seen how in 1883 Plekhanov and Axelrod took the lead in setting up in Geneva the Emancipation of Labour group, based partly on local societies established inside Russia in the '70s. This group spread the knowledge of Marxism in Russia. In 1895 Vladimir Ilyich Ulyanov (Lenin; 1870–1924) united the groups in St. Petersburg (Leningrad) into an Emancipation of Labour society, which put itself at the head of the industrial struggles then in progress. Out of this and other local bodies arose the Russian Social Democratic party, which was formed at Minsk in 1898 but did not take definite form until after the foundation of *Iskra* ("The Spark") (1900), a social democratic journal published abroad in which Lenin collaborated with Plekhanov and Axelrod.

The second (and first real) conference of the Social Democratic party was held in Brussels and London in 1903, and adopted a revolutionary program largely drafted by Lenin, including an assertion of the rights of national self-determination, a series of demands for land reform in the interests of the peasants, and a pronouncement in favour of the dictatorship of the proletariat. A dispute arose over the conditions of admission to the party, Lenin demanding a closely knit, disciplined party, whereas the majority favoured open membership for anyone who accepted the declared principles. The leader of the majority against Lenin was Julius Ossipovich Zederbaum, known as Martov (1873–1923), subsequently the leader of the Mensheviks. But on the other issues Lenin's group won, and they were thereafter knomn as the Bolsheviks (majority) whereas Martov's followers mere the Mensheviks (minority). In 1904 the split became definite: the Bolsheviks and hlensheviks holding separate congresses and organizing two rival parties. The basic difference was that the Mensheviks wished to create a Social Democratic party on the model of the national parties in western Europe, and to work in alliance with the bourgeois left for a democratic revolution, holding that the time for socialism in Russia would come when the country had passed through a regime of capitalist democracy, whereas the Bolsheviks wanted a centralized and disciplined party that would aim directly at power and would seek to rouse the peasant masses to rally to the side of the industrial proletariat. The Bolsheviks were prepared to work with the bourgeois left for democratic revolution, but set out to capture at once the leadership of the revolution and refused to make concessions to the bourgeoisie in order to enlist its help.

This is not the place to tell the story of the Russian Revolution —of the disintegration of the large but amorphous Socialist Revolutionary party. the conquest by the Bolsheviks of a majority in the revolutionary soviets of workers and peasants, and the crushing out of the Mensheviks on the Bolshevik assumption of power. (See RUSSIA.) What is relevant here is that the Bolshevik revolution was based throughout on Lenin's interpretation of Marxism, putting in the forefront the dictatorship of the proletariat, the complete destruction of the old state machine and the creation of a new proletarian state as the instrument of the dictatorship (Lenin, The State *and* Revolution, 1917; The Proletarian Revolution and *Kautsky* the Renegade, Eng. trans., 1920). This view of Marxism was combated not only by the Mensheviks in Russia but also by most of the leading social democratic theorists in western Europe, notably Karl Kautsky (The Dictatorship of the Proletariat, 1918; Eng. trans., 1920), and by Émile Vandervelde (1866–1938), the Belgian president of the Labour and Socialist international, which was established in 1920 and reorganized in 1923 as the successor of the pre-1914 second international and continued its traditions practically unchanged, as well as by the British leaders.

The Bolsheviks sent out to the workers of the world a new *Communist Manifesto* (1919) and set out to organize a new third international—the way for which had been prepared by the antiwar international Socialist conferences held at Zimmerwald (1915) and Kienthal (1916), and by the attempt to organize a world conference at Stockholm in 1917—with the design of stirring up revolution throughout the world. At this stage it was widely believed that the Russian Revolution could not succeed in establishing itself unless it were speedily followed by socialist or communist revolutions in the advanced capitalist countries. Leon Trotsky (1879–1940), at that time Lenin's closest collaborator and the creator of the Red army, was especially associated with this view, which was part of his doctrine of "permanent revolution." Trotsky was also an advocate of rapid Russian industrialization as a means of consolidating the power of the revolution and an opponent of concessions to the peasants, which he held would delay this process.

Communism, as developed theoretically by Lenin and later by Joseph Stalin (1879–19j3) and others, was no new doctrine. It was Marxism, applied practically without change to the conditions of contemporary Russia. It could be so applied, because Russia in 1917 was still much like the countries of western Europe at the time when Marx and Engels formulated their essential doctrines. Western social democracy, while it retained its nominal allegiance to Marxism. had in fact so modified Marx's doctrines, especially about the state and dictatorship, as in effect to deny them. It had been working in practice for the peaceful democratic conquest of state power, and for an evolutionary socialism that would set out to use the existing state machine and to transform it gradually. The Russian socialists could not possibly have attempted so to use the tsarist state machine, as was plainly shown in the events that followed the abortive Russian revolution of 1905. They could only seek to overthrow it and to replace it either by a state modeled on western parliamentarism (the Menshevik policy) or by a state based on proletarian dictatorship (the Bolshevik policy). The western social democrats, wedded to parliamentarism, supported the Mensheviks and denounced the Bolsheviks as betrayers of democracy. whereas the Bolsheviks denounced them as counter-revolutionaries and traitors to the socialist cause.

The world revolution hoped for by the Bolsheviks did not come, but neither did the crushing out of the Russian Revolution by the capitalist countries. Through many vicissitudes, the Soviet power was able gradually to consolidate its strength. Trotsky was driven into exile; Stalin became the unquestioned leader and set out to, as he conceived of it, build up socialism nithin a single country under the successive five-year plans and the statute of nationalities, which conferred wide autonomy on the many peoples of the Soviet Union. In 1930 the policy of agricultural collectivization was taken seriously in hand, a form of village co-operative (the *kolkhoz,* or "collective farm") replacing individual peasant cultivation. Industrialization was pressed on fast, and in World War II the Soviet Union plainly demonstrated its might and power of survival. In 1935 Sidney and Beatrice Webb. the theorists of Fabianism, surprised many by publishing their monumental work (Soviet *Communism:* a New *Civilisation*) largely in support of the policies and achievements of Russian Communism. This did not mean that they regarded the Soviet form of revolution as applicable to western Europe They did. however, sharply differ from the social democratic theorists in regarding it as having justified itself fully under Russian conditions.

Later European Developments.—Meanwhile, in the west, the end of World War I brought with it a great increase in the strength of the Social Democratic parties. In Great Britain, the Labour party had been up to 1918 only a small minority group. Profiting by the disintegration of liberalism, it reorganized itself in 1918 under Arthur Henderson (1863–1935) as a nationwide party standing for evolutionary socialism (see its manifesto. Labour and the New Social Order, 1918. written by Sidney Webb). By 1924, under James Ramsay MacDonald (1866–1937), it formed the first (minority) Labour government, which lasted only a year. In 1929 it returned to office. again in a minority. but the second Labour government collapsed in the crisis of 1931, MacDonald seceding with others to form a "national" coalition government. During the 1930s Labour gradually regained strength. It remained a moderate, evolutionary socialist party, and was a partner in the nar coalition formed in 1940. In 1945, in the election that followed hard upon the end of the European phase of World War II. the Labour party for the first time gained a considerable clear majority over all other parties, winning not only the industrial areas, but also most of the suburban residential districts near London and other big cities. Labour thereupon formed its third government, with a definite mandate for the policy of evolutionary socialism on nhich it had fought the election. This policy was set out in its manifesto, Let Us Face the *Future* (1945). In Feb. 1950, by a narrow majority, a Labour government was again elected, but in 1951 the Conservatives regained office.

In Germany, the fall of the Hohenzollerns and the proclamation of the Weimar republic raised the Social Democrats to the position of the first party in the state. But they made no attempt to establish socialism and were soon involved in suppressing left Socialist and Communist groups. The German workers became disastrously divided into rival Social Democratic and Communist parties: and severe economic distress reinforced feelings of national humiliation in stimulating the rise of Adolf Hitler's Nazi, or National Socialist, party, which ultimately seized power in 1933. "National Socialism" (*q.v.*) was not a form of socialism. but its bitterest enemy The so-called "Socialist" element in it consisted in its exaltation of the claims of the national state, regarded as a metaphysical being beyond good and evil, above all individual or sectional claims; but in practice it worked as the ally of large-scale capitalism and militarism and remorselessly crushed out all free ;\orking-class organization. It was the national state, organized to the limit for imperialist war and conquest—the very antithesis of the socialism which it is the function of this article to describe. After 1939, however, Naziism won the allegiance of a few notable socialist renegades, such as the French neosocialist Marcel Déat.

Fascism (*q.v.*), of which Naziism was the German variety. made its first appearance in Italy. under the leadership of Mussolini. Italian socialism, which had opposed the war, adopted a semirevolutionary line after 1918. The Italian workers in 1920 occupied the factories but made no attempt to turn their industrial struggle into a political revolution. Their defeat prepared the way for the march on Rome, by which Fascism seized power in 1922. Italian Fascism, like German Naziism, glorified the state, to which it professed to give a corporative form, based on corporations representing industries and professions. (See CORPORATE STATE.) In fact, behind this facade. it meant dictatorial control by the Fascist party, working in alliance with large-scale capitalism and suppressing all independent working-class or political organizations.

In France. after 1918, the communists were a majority in the Socialist party. which they converted into a Communist party. A large section broke away and reconstituted the Socialist party (known as S.F.I.O.—Section Française de l'Internationale Ouvrière), of which Léon Blum became the leader. In Fiance, as in Germany, socialism was greatly weakened by the conflict between communists and socialists, and the position was made worse by the development of two rival trade-union movements. At length, in 1935–36, the trade-union split was healed, and both communists and socialists allied themselves with the radicals in the popular front. A wave of strikes followed, and many concessions were gained. But the front broke down, and French politics were in disorder at the outbreak of World War II. Following the collapse of 1940, most of the French socialists joined the resistance movements associated with Gen. Charles de Gaulle, and the communists, while maintaining their separateness, took part in the Gaullist and postwar coalition cabinets from 1944 to 1947. In the latter year they were excluded from the government.

In Spain, where the working-class forces were traditionally divided between socialists and syndicalists (with a strong anarchist element, chiefly in Catalonia), a popular front, extending to the radicals, achieved power in 1931, but was overthrown in the ensuing civil war by the Fascist counterrevolution under Gen. Francisco Franco, supported by Germany and Italy, while the western parliamentary countries stood aloof. The U.S.S.R. gave some help. but on conditions that split the socialist forces. In Austria, where the Social Democrats, headed by Otto Bauer (1881–1938), a leading theorist of the movement, were the strongest party in Vienna but had little hold on the Catholic countryside, a Catholic semi-Fascist dictatorship was set up by Engelbert Dollfuss in March 1933, and in Feb. 1934 a rising of the Viennese workers was crushed and the Socialist movement was disrupted or driven underground. In 1938 the Nazis seized Austria and incorporated it in "greater Germany," applying the entire apparatus of suppression.

The social democratic movement enjoyed its only successes between the wars in Scandinavia, especially in Sweden, where. under the leadership of Karl Hjalmar Branting (1860–1925) and later of Per Albin Hansson (1885–1946), it carried through a moderate policy of liberal semisocialism with considerable economic success. Denmark had a similar experience; and in Norway, where socialism was on the whole farther to the left, much progress was also made. The Scandinavian parties made no attempt to introduce socialism, but adopted advanced policies of social reform and economic planning without disturbing the institutions of capitalist property. Their fortunate economic position made this possible to a degree not possible elsewhere. In eastern Europe, under the tutelage of the U.S.S.R.. Socialist parties by mid-century had disappeared or had been absorbed by the Communist parties.

In the U.S., socialism remained backward. The U.S. Communist party took away a good deal of the former support of the Socialist party, but failed to gain a really large following. The American Federation of Labor remained strongly antisocialist and even more anticommunist, refusing all association with the trade-unions of the U.S.S.R. The newer Congress of Industrial Organizations, which arose in 1935 as the result of a breakaway from the A.F. of L., had a more leftist though hardly less anticommunist policy, but did not result in the growth of any nationwide Labour party, although Labour parties arose in a few states, notably New York. The U.S. produced no great socialist thinker, though Upton Sinclair became world famous for his socialist novels (The Jungle, 1906; The *Brass* Check, 1919; Oil, 1927) and there was much acute social criticism, notably in the work of Thorstein Veblen (1857–1929) (Theory of the Leisure Class, 1899; Theory of Business Enterprise, 1904). In Canada, socialism made advances after the establishment in 1932 of the Co-operative Commonwealth federation, the Canadian Labour and Socialist party, which appealed to farmers as well as industrial workers.

In Australia the Labor party, based mainly on the trade-unions, was a powerful political force. It formed the government in 1941 and remained in power for eight years. In New Zealand the

Labour party, having won the elections of 1935, remained in power also until 1949. In South Africa, on the other hand, mainly because of the divisions between African and white workers, socialism made no headway.

Eastern Socialism. — In the far east, Chinese socialism began with Sun Yat-sen (1866–1925), the leader of the revolution of 1912, whose famous Testament is an application of socialist principles to Chinese conditions. The Chinese National party. the Kuomintang, was at the outset partly under socialist inspiration; but following the rise of a Communist movement in China, under Russian influence, there were violent dissensions leading to civil war (1929) until the Chinese communists came to power in 1949–51. The new regime, although closely allied to the Soviet Union and entirely dominated by the Communist party, was adaptable enough to use the services of noncommunists, including small capitalists as well as socialists, in many specialist services and branches of production. Great projects of industrial development were embarked upon with Soviet help, and rapid progress was made with various forms of rural collectivization and co-operation. Many in the west hoped that Chinese communism would before long deviate sharply from the Russian model, but Chou-en-lai (chairman of the state administrative council), in his world tour of 1956–57, was careful to emphasize China's entire solidarity with the Russians, and gave no encouragement to these hopes.

In Japan a Socialist party was formed in 1901 but was speedily suppressed, and there was renewed persecution during the Russo-Japanese War of 1904–05, which the socialists opposed. After 1918 there was for a time a renewal of socialist activity; but no stable socialist movement was established, and by the 1930s the movement had again been wiped out by militarist persecution, or driven wholly underground. Japanese socialism became politically important after 1945, establishing itself as the leading opposition force in the postwar parliament.

Meanwhile, in India, independence put into power a Congress party government, headed by Jawaharlal Nehru, himself a socialist; and this government's second five-year plan, issued in 1956, included large provisions for public investment as well as for welfare development. The Indian National Congress became formally committed to a sort of democratic socialism as a long-term objective, but continued to be largely under nonsocialist leadership and to claim to stand for national unity. The Indian Socialist party operated at first inside the Congress, but presently seceded from it and thereafter experienced considerably fluctuating fortunes and underwent a split in 1955, when a section headed by R. M. Lohia broke away from it. Its outstanding leader was J. Prakash Narayan (*q.v.*). The Communist party was outside the Congress throughout, and achieved considerable strength in some parts of the country, notably in Bengal and the south.

In the Arab countries substantial Communist and Socialist parties made their appearance; but nationalism remained the predominant issue, and the socialists were active mainly in the left wing of the various nationalist movements, though in Syria and Lebanon, as well as in Egypt, social questions — especially land reform — were forcing their way to the front.

In Indonesia the communists became a powerful opposition group; the socialists after playing a considerable part in the early years of independence subsequently lost ground. Burma established itself under broadly socialist rule.

The Asian Socialist parties, after refusing to join the postwar Socialist international, established an Asian Socialist international of their own, which entered into fraternal relations with it.

Socialism at Mid-20th Century. — The wartime alliance between the Soviet Union and the west temporarily eased animosity between European socialists and communists but did nothing to overcome their fundamental differences. Later, such factors as the communist seizure of power in Czechoslovakia, the Korean crisis and Stalin's growing despotism caused further deterioration of this relationship. But the death of Stalin led to a substantial modification of Soviet totalitarianism by 1956, in which year the 20th congress of the Communist party of the Soviet Union was marked by a sharp denunciation of Stalin's methods and by a recognition of the possibility of advance toward socialism by nonrevolutionary methods in certain countries.

Immediately great debates opened both inside the Communist parties of all countries and among left-wing democratic socialists, who foresaw some prospect of improving international working-class relations and of further approaches toward world *détente*. As against this the western socialist parties and the Socialist international uniting them maintained their anticommunist vehemence. The suppression of the Hungarian revolution in Nov. 1956 suggested that the Soviet government was potentially as ruthless as ever and by hardening anticommunist feeling in the west thoroughly confused the over-all situation.

The issue of parliamentary democracy continued to occupy socialist thinkers. In Yugoslavia and, subsequently, Poland one-party rule appeared capable of substantial liberalization; nevertheless democratic socialists continued to stress the virtues of free elections and rival political parties. Doubtless these were indispensable wherever their traditions were established; it was not clear whether they could be insisted upon in countries lacking parliamentary experience and where nonrevolutionary advance was blocked by feudal and absolutist rule. Nor was parliamentary progress toward socialism possible in countries such as France and Italy where the working-class movement was divided into factions unable to co-operate in any way.

Interpretation of Socialism. — The foregoing historical account has been designed to describe the socialist movement by denotation, rather than to attempt any precise definition of socialism, which cannot indeed be accurately defined. Socialism is essentially at once a movement and a theory, and takes different forms under different historical and local conditions. It is fundamentally a movement aiming at a classless society based on the socialization of property in the essential instruments of production and appealing primarily to the working class as the exploited class whose historic mission it is to bring the class system to an end. This description (it is not meant as a definition) admits of many different views of the methods of social and economic organization appropriate to a socialist society and of the steps to be taken for its establishment.

Socialism can be either statist or libertarian, Marxist or "liberal," revolutionary or gradualist, cosmopolitan or only internationalist in a sense that lays stress on the importance of the national unit.

Marx drew a sharp contrast between "utopian socialism," basing itself on moral principles conceived as absolute. and "scientific socialism," resting on the materialist conception of history, with its corollary, the class struggle. As Bfarxism developed, the first great controversy was between the Marxist advocates of disciplined and centralized proletarian mass action and the anarchist (or later syndicalist) upholders of the theory of local mass spontaneity and federalist "free communism," sponsored by the followers of Bakunin and, in a less revolutionary sense, by those of Proudhon (the mutuellistes).

Still later, after the rise of social democracy, the controversy shifted to the question of whether socialists should set out to capture and use the existing state (Fabianism, evolutionary social democracy) or should seek to destroy the existing state and build up a new one by means of proletarian dictatorship (bolshevism, communism).

In these controversies, means and ends were mixed up together. It was partly a question of revolutionary versus evolutionary methods, partly a question of parliamentary democracy versus dictatorship, partly a question of libertarianism versus centralized state authority. Naturally, doctrines and emphasis varied from time to time and from country to country. Marxism, in its emphasis on the scientific basis of the materialist conception of history, tended at the extreme to throw over altogether the moral basis and to regard morality simply as a reflection of the forces of economic evolution. It is, however, difficult to see why anyone should trouble to work for socialism merely because he believes that it is in the line of historical evolution, or unless he also believes it to be good and that what is good ought to be pursued. Moral indignation is not the least of the weapons in Marx's own powerful armoury..

In essence, what Marxism opposes is the view that socialist judgments of value can be reached a priori, without taking account of the conditions of time and place. Man makes his onn history; but the choices open to him are limited by the circumstances in which he has to act, and among these the condition of the "powers of production" holds a key place.

Socialism is essentially a movement for the promotion of the well-being and happiness of individual men and women (the "greatest happiness of the greatest number"), and not of any metaphysical entity such as the state, which should exist only to promote the ends of individuals. That these individuals are grouped in classes, and that social action in its major manifestations takes a class form in no wise invalidates this generalization, which is common to all schools of socialists (but not to "national socialists" or to some forms of so-called "Christian socialism"). Anarchist communism, social democracy and Leninist, though not Stalinist, communism all aim in their several ways at the establishment of a classless society and at the liberation of the human spirit, as well as at the abolition of physical want. Communist dictatorship, however perverted in practice, is intended only as a transitional measure, leading up to the "withering away" of the state. The ideal of world-wide human brotherhood and liberty is common to all schools of socialists, by whatever route they attempt to advance toward it. This holds good even for those socialists who reject "idealism" as a bourgeois doctrine and insist on speaking in terms of class rights and historical necessity rather than of humanistic ideals.

See also CHARTISM; CHRISTIAN SOCIALISM; COMMUNISM; FABIAN SOCIETY; GUILD SOCIALISM; INTERNATIONAL, THE; MARX, KARL HEINRICH; and other related articles as well as biographies of prominent socialist figures.

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SOCIALISM: PRINCIPLES AND OUTLOOK.' Socialism, reduced to its simplest legal and practical expression, means the complete discarding of the institution of private property by transforming it into public property and the division of the resultant public income equally and indiscriminately among the entire population. Thus it reverses the policy of Capitalism, which means establishing private or "real" property to the utmost physically possible extent, and then leaving distribution of income to take care of itself. The change involves a complete moral *volte-face.*

In Socialism, private property is anathema and equal distribution of income the first consideration. In Capitalism. private property is cardinal and distribution left to ensue from the play of free contract and selfish interest on that basis, no matter what anomalies it may present.

I

Socialism never arises in the earlier phases of Capitalism, as, for instance, among the pioneers of civilization in a country where there is plenty of land available for private appropriation by the last comer. The distribution which results under such circumstances presents no wider departures from a rough equality than those made morally plausible by their association with exceptional energy and ability at the one extreme, and with obvious defects of mind and character or accidental hard luck at the other. This phase, however, does not last long under modern conditions.

All the more favourable sites are soon privately appropriated, and the later comers (provided by immigration or the natural growth of the population), finding no eligible land to appropriate, are obliged to live by hiring it at a rent from its owners, transforming the latter into a *rentier* class enjoying unearned incomes. which increase continually with the growth of the population until the landed class becomes a money-lending or capitalist class also, capital being the name given to spare money.

The resource of hiring land and spare money is open to those only who are sufficiently educated to keep accounts and manage businesses, most of whom spring from the proprietary class as younger sons. The rest have to live by being hired as labourers and artisans at weekly or daily wages; so that a rough division of society into a proprietary class. a middle or employing and managing class, and a wage proletariat is produced. In this division the proprietary class is purely parasitic. As the operation of the economic law of rent makes this class richer as the population increases, its demand for domestic servants and luxuries creates parasitic enterprise and employment for the middle class and the proletariat, withdrawing masses from productive industry and fortifying itself politically by a body of workers and employers who vote with the owners.

Meanwhile, the competition of employers for custom, which leads to the production of a dozen articles to satisfy the demand for one, leads to disastrous crises of feverish overproduction alternated with periods of bad trade ("booms" and "slumps"), making continuous employment of the proletariat impossible. When wages fall to a point at which saving also is impossible, the unemployed have no means of subsistence except public relief during the slumps.

It is in this phase of capitalistic development, attained in Great Britain in the 19th century. that Socialism arises as a revolt against a distribution of wealth that has lost all its moral plausibility. Colossal wealth is associated with unproductiveness and sometimes with conspicuous worthlessness of character; and lifetimes of excessive toil beginning in early childhood leave the toiler so miserably poor that the only refuge left for old age is a general workhouse. purposely made repulsive to deter proletarians from resorting to it as long as they have strength enough left for the most poorly paid job in the labour market. The inequalities become monstrous: hard-working men get 4s. or 5*s*. a day (post-war [World War I] rates) in full view of persons who get several thousands a day without any obligation to work at all, and even consider industrial work degrading. Such variations in income defy all attempts to relate them to variations in personal merit.

Governments are forced to intervene and readjust distribution to some extent by confiscating larger and larger percentages of incomes derived from property (income tax, super-tax, and estate duties) and applying the proceeds to unemployment insurance and extensions of communal services, besides protecting the proletariat against the worst extremities of oppression by an elaborate factory code which takes the control of workshops and factories largely out of the hands of their proprietors, and makes it impossible for them to exact grossly excessive hours of labour from their employees, or to neglect their health, physical safety, and moral welfare with complete selfishness.

This confiscation of private property incomes for public purposes without any pretence of compensation. which is now proceeding on a scale inconceivable by Victorian ministers, has destroyed the integrity of private property and inheritance; and the success with which the confiscated capital has been applied to communal industries by the municipalities and the central Government, contrasted with the many failures and comparative costliness of capitalist industrial adventure, has shaken the super-

'This article by George Bernard Shaw is presented for its historical interest as the expression of a leading figure in the Socialist movement, although his analysis does not tally at all points with equally widespread notions and practices of Socialist theory.—Ed.

stition that private commercial management is always more effective and less corrupt than public management. In particular, the British attempt to depend on private industry for munitions during the World War of 1914–18 nearly led to defeat; and the substitution of national factories was so sensationally successful, and the post-war resumption of private enterprise, after a brief burst of illusory prosperity, uas followed by so distressing a slump that the reversal of the relative efficiency prestige of Socialism and Capitalism was vigorously accelerated. leaving Capitalism unpopular and on the defensive. whilst confiscation of private capital for communal enterprise and nationalization of the big industries grew steadily in popularity in and out of Parliament.

This change in public opinion had already deeply penetrated the middle class because of the change for the worse in the position of the ordinary employer. He, in the 19th century, was admittedly master of the industrial and. after the reform of 1832, of the political situation. He dealt directly and even domineeringly with the proprietary class, from which he hired his land and capital either directly or through agents who were his servants and not his masters. But the sums required to set on foot and develop modern industrial schemes grew until they were out of reach of ordinary employers. The collection of money to be used as capital became a special business, conducted by professional promoters and financiers. These experts. though they had no direct contact with industry, became so indispensable to it that they are now virtually the masters of the ordinary routine employers. Meanwhile. the growth of joint-stock enterprise was substituting the employee-manager for the employer, and thus converting the old independent middle class into a proletariat and pressing it politically to the left.

With every increase in the magnitude of the capital sums required for starting or extending large industrial concerns comes the need for an increase in the ability demanded by their management: and this the financiers cannot supply: indeed, they bleed industry of middle class ability by attracting it into their onn profession. Matters reach a point at nhich industrial management by the old-fashioned tradesman must be replaced by a professionally trained and educated bureaucracy; and as Capitalism does not provide such a bureaucracy the industries tend to get into difficulties as they grow by combination (amalgamation). and thus outgrow the capacity of the managers who were able to handle them as separate units.

This difficulty is increased by the hereditary element in business. An employer may bequeath the control of an industry involving the subsistence of thousands of workers. and requiring from its chief either great natural ability and energy or considerable scientific and political culture. to his eldest son without being challenged to prove his son's qualifications. though if he proposes to make his second son a doctor or a naval officer he is peremptorily informed by the government that only by undergoing an elaborate and prolonged training, and obtaining official certificates of qualification. can his son be permitted to assume such responsibilities. Under these circumstances, much of the management and control of industry gets divided between routine employers who do not really understand their own businesses. and financiers, who. having never entered a factory nor descended a mine shaft. do not understand any business except the business of collecting money to be used as capital and forcing it into industrial adventures at all hazards. the result being too often reckless and senseless over-capitalization, leading to bankruptcies (disguised as reconstructions) which reveal the most astonishing technical ignorance and economic blindness on the part of men in high repute as directors of huge industrial combinations. who draw large fees as the remuneration of a mystical ability which exists only in the imagination of the share-holders.

II

All this steadily saps the business prestige of Capitalism. The loss of popular faith in it has gone much farther than the gain of any widespread or intelligent faith in Socialism. Consequently, the end of the first third of the 20th century finds the political situation in Europe confused and threatening: all the political parties diagnosing dangerous social disease, and most of them proposing disastrous remedies. National governments, no matter what ancient party slogans they raise. find themselves controlled by financiers who follow the slot of gigantic international usuries without any public aims and without any technical qualification5 except their familiarity with a rule-of-thumb city routine quite inapplicable to public affairs, because it deals exclusively. with stock exchange and banking categories of capital and credit. These, though valid in the money market when conducting exchanges of future incomes for spare ready money by the small minority of persons who have these luxuries to deal in. would vanish under pressure of any general political measure like—to take a perilously popular and plausible example—a levy on capital. Such a levy would produce a money market in which there were all sellers and no buyers, sending the Bank Rate up to infinity, breaking the banks, and bringing industry to a standstill by the transfer of all the cash available for wages to the national treasury. Unfortunately, the parliamentary proletarian parties understand this as little as their capitalist opponents. They clamour for taxation of capital; and the capitalists, instead of frankly admitting that capital as they reckon it is a phantom, and that the assumption that a person with an income of £5 a year represents to the State an immediately available asset of £100 ready money, though it may work well enough as between a handful of investors and spendthrifts in a stockbroker's office, is pure fiction when applied to a whole nation, ignorantly defend their imaginary resources as if they really existed, and thus confirm the proletariat in its delusion instead of educating it.

The financiers have their own *ignis fatuus,* which is that they can double the capital of the country. and thus give an immense stimulus to industrial development and production. by inflating the currency until prices rise to a point at which goods formerly marked £50 are marked £100, a measure which does nothing nationally but enable every debtor to cheat his creditor, and every insurance company and pension fund to reduce by half the provision for which it has been paid. The history of inflation in Europe since the World War of 1914–18, and the resultant impoverishment of pensioners and officials with small fixed incomes, forces the middle classes to realise the appalling consequences of abandoning finance and industry to the direction of unskilled, politically ignorant, unpatriotic "practical business men."

Meanwhile, the mobility of capital leads to struggles for the possession of exploitable foreign territories ("places in the sun"), producing war on a scale which threatens not only civilization but human existence; for the old field combats between bodies of soldiers. from which women were shielded, are now replaced by attacks from the air on the civil population, in which women and men are slaughtered indiscriminately, making replacement of the killed impossible. The emotional reaction after such wars takes the form of acute disillusion. which further accelerates the moral revolt against capitalism without. unfortunately, producing any workable conception of an alternative. The proletarians are cynically sulky. no longer believing in the disinterestedness of those who appeal to them to make additional efforts and sacrifices to repair the waste of war. The moral mainspring of the private property system is broken; and it is the confiscations of unearned'income, the extensions of municipal and national communism, above all the new subsidies in aid of wages extorted from governments by threats of nationally disastrous lock-outs and strikes, which induce the proletariat to continue operating the capitalist system now that the old compulsion to work by imposing starvation as the alternative, fundamental in Capitalism, has had to be discarded in its primitive ruthlessness. The worker who refuses to work can now quarter himself on public relief (which means finally on confiscated property income) to an extent formerly impossible.

Democracy, or votes for everybody, does not produce constructive solutions of social problems; nor does compulsory schooling help much. Unbounded hopes were based on each successive extension of the electoral franchise, culminating in the enfranchisement of women. These hopes have been disappointed, because the voters, male and female, being politically untrained and uneducated, have (*a*) no grasp of constructive measures, (*b*) loathe taxation as such, (*c*) dislike being governed at all, and (*d*) dread and resent any extension of official interference as an encroachment on their personal liberty. Compulsory schooling, far from enlightening them, inculcates the sacredness of private property, and stigmatizes a distributive state as criminal and disastrous, thereby continually renewing the old prejudices against Socialism, and making impossible a national education dogmatically inculcating as first principles the iniquity of private property, the paramount social importance of equality of income, and the criminality of idleness.

Consequently, in spite of disillusion with capitalism, and the growing menace of failing trade and falling currencies, our democratic parliamentary oppositions, faced with the fact that the only real remedy involves increased taxation, compulsory reorganization or frank nationalization of the bankrupt industries, and compulsory national service in civil as in military life for all classes, dare not confront their constituents with such proposals, knowing that on increased taxation alone they would lose their seats. To escape responsibility, they look to the suppression of parliamentary institutions by *coups d'état* and dictatorships, as in Italy, Spain, and Russia. This despair of parliamentary institutions is a striking novelty in the present century; but it has failed to awaken the democratic electorates to the fact that, having after a long struggle gained the power to govern, they have neither the knowledge nor the will to exercise it, and are in fact using their votes to keep government parochial when civilization is bursting the dikes of nationality in all directions.

A more effective resistance to property arises from the organization of the proletariat in trade unions to resist the effect of increase of population in cheapening labour and increasing its duration and severity. But Trade Unionism is itself a phase of Capitalism, inasmuch as it applies to labour as a commodity that principle of selling in the dearest market, and giving as little as possible for the price, which was formerly applied only to land, capital, and merchandise. Its method is that of a civil war between labour and capital in which the decisive battles are lockouts and strikes, with intervals of minor adjustment by industrial diplomacy. Trade Unionism now maintains a Labour party in the British Parliament. The most popular members and leaders are Socialists in theory; so that there is always a paper programme of nationalization of industries and of banking, taxation of unearned incomes to extinction, and other incidentals of a transition to Socialism; but the trade union driving force aims at nothing more than Capitalism with labour taking the lion's share, and energetically repudiates compulsory national service, which would deprive it of its power to strike. In this it is heartily seconded by the proprietary parties, which, though willing enough to make strikes illegal and proletarian labour compulsory, will not pay the price of surrendering its own power to idle. Compulsory national service is essential in Socialism, which is thus deadlocked equally by organised labour and by Capitalism.

It is a historic fact, recurrent enough to be called an economic law, that Capitalism, which builds up great civilizations, also wrecks them if persisted in beyond a certain point. It is easy to demonstrate on paper that civilization can be saved and immensely developed by, at the right moment, discarding Capitalism and changing the private property profiteering state into the common property distributive state. But though the moment for the change has come again and again it has never been effected, because Capitalism has never produced the necessary enlightenment among the masses nor admitted to a controlling share in public affairs the order of intellect and character outside which Socialism, or indeed politics, as distinguished from mere party electioneering, is incomprehensible. Not until the two main tenets of Socialism—abolition of private property (which must not be confused with personal property), and equality of income—have taken hold of the people as religious dogmas, as to which no controversy is regarded as sane, will a stable Socialist state be possible. It should be observed, however, that of the two tenets, the need for equality of income is not the more difficult to demonstrate, because no other method of distribution is or ever has been possible. Omitting the few conspicuous instances in which actual earners of money make extraordinary fortunes by exceptional personal gifts or strokes of luck, the existing differences of income among workers are not individual but corporate differences. Within the corporation no discrimination between individuals is possible: all common labourers, like all upper division civil servants, are equally paid. The argument for equalizing the class incomes is that unequal distribution of purchasing power upsets the proper order of economic production, causing luxuries to be produced on an extravagant scale whilst the primitive vital needs of the people are left unsatisfied; that its effect on marriage, by limiting and corrupting sexual selection, is highly dysgenic; that it reduces religion, legislation, education, and the administration of justice to absurdity as between rich and poor; and that it creates an idolatry of riches and idleness which inverts all sane social morality.

Unfortunately, these are essentially public considerations. The private individual, with the odds overwhelmingly against him as a social climber, dreams even in the deepest poverty of some bequest or freak of fortune by which he may become a capitalist, and dreads that the little he has may be snatched from him by that terrible and unintelligible thing, State policy. Thus the private person's vote is the vote of Ananias and Sapphira; and democracy becomes a more effective bar to Socialism than the pliant and bewildered conservatism of the plutocracy. Under such conditions the future is unpredictable. Empires end in ruins: commonwealths have hitherto been beyond the civic capacity of mankind. But there is always the possibility that mankind will this time weather the cape on which all the old civilizations have been wrecked. It is this possibility that gives intense interest to the present historic moment and keeps the Socialist movement alive and militant. (*G.* B. S.)

SOCIALIST PARTY (U.S.). On March 29, 1900, representatives of the Social Democratic Party of America, of which Eugene V. Debs (*q.v.*) and Victor L. Berger were leading members, met in New York city with representatives of the moderate branch of the Socialist Labor party led by Morris Hillquit, Max Hayes and others, and agreed to nominate Socialist candidates for president and vice-president in the 1900 campaign. Their nominees were Debs, former president of the American Railway union, for president, and Job Harriman, California attorney, for vice-president. The two groups waged a joint campaign that resulted in a vote of 96,878 for the Socialist ticket.

Following the campaign the two groups issued a call for a "unity convention" to be held July 29, 1901, in Indianapolis, Ind., with the view toward officially launching a united party. At this convention the older groups dissolved, and formed the Socialist party to serve as "the party of the working class and those in sympathy with it" dedicated to the bringing about of "a system of collective ownership by the entire people of the means of production and distribution." The immediate demands in the party's platform included planks for woman suffrage, old-age pensions, unemployment insurance, health and accident insurance, the increase of wages, the reduction in working hours, direct legislation, and public ownership of public utilities.

During the next 11 years, from 1901 to 1912, the party grew steadily in numbers and influence. Its dues-paying membership increased from 16,000 to 118,000; its presidential vote, with Debs as candidate, from 96,000 to nearly 900,000; its representation in public office from zero to more than 1,000, including 56 mayors, over 300 aldermen, numerous state legislators and one congressman, Victor L. Berger from Milwaukee.

The year 1912 likewise found the party engaged in a vigorous internal struggle with the followers of William D. Haywood, leader of the Industrial Workers of the World (I.W.W.), who emphasized direct, industrial action, including sabotage and the general strike, as a means to a co-operative social order, based on syndicalistic principles. The majority of the party adhered to their belief in parliamentary action and amended the constitution to exclude from membership advocates of sabotage and violence. In 1913 Haywood was expelled from the party's executive committee. The controversy led to the withdrawal of numerous "direct actionists" from the party.

In the following year, 1914, the European war broke out. Some Socialists felt that the United States should immediately enter the war on the side of the Allied powers. The majority took the position, as did millions of other Americans, that the United States should remain neutral and later offer itself as mediator or arbitrator, with a view toward bringing about a just and lasting peace. In 1916 the party nominated Allan L. Benson, writer and antimilitarist, as its presidential candidate and rolled up a vote of more than 585,000.

When the U.S. entered the war in April 1917, the Socialist party at its St. Louis convention declared "its unalterable opposition to the war just declared." During the next year many of the party's journals and meetings were suppressed by the government, and Debs was arrested for delivering an antiwar speech at Canton, O. and sentenced to a federal penitentiary for ten years. While Socialist activity came to a standstill in many parts of the country, it took on renewed vigour in other sections. In New York city, Morris Hillquit, Socialist candidate for mayor on a platform that called for an early and democratic peace, received a record vote of 146,000. He helped to bring into office ten assemblymen and seven aldermen.

On Nov. 7, 1917, the Russian Bolsheviks staged their successful revolution. Many members of the Socialist party were of the opinion that the United States was ripe for a similar revolution and urged the adoption by the Socialist party of Bolshevik tactics and the joining of the Communist International. To aid their cause, they swelled the party membership rolls with recent immigrants from countries of eastern Europe who were better acquainted with the institutions of their homelands than with those of the United States.

The struggle over socialist *v.* communist tactics culminated in the Chicago convention of the party in late Aug. 1919. The left wing elements in the party were defeated and withdrew to form the Communist and Communist Labor parties. Though the party's membership during the struggle was greatly reduced (numbering 26.766 after the convention), the party's vote in 1920 with Debs, still in prison, again as its nominee, exceeded 900,000.

During the early 1920s labour was faced with widespread unemployment, with a concerted attack by employers on the trade union movement, and with attempts of the government to suppress civil rights. At the same time government corruption reached new heights. As a result of these and other conditions. many trade unions turned to independent political action as one method of fighting reaction and an unstable economy. In 1922 a number of leaders of organized labour, particularly in the railway trades, led by William H. Johnston, president of the machinists, formed a Conference for Progressive Political Action. Hillquit was invited to represent the Socialist viewpoint on the conference's governing board. The conference called with others a convention to meet in Cleveland on July 4, 1924, to nominate a Progressive presidential candidate. It nominated Sen. Robert M. La Follette of Wisconsin.

In his acceptance speech, La Follette expressed his belief that a new party would be born following the election. Socialists, seeing in this campaign the beginning of a Progressive or Farmer-Labor party, supported the La Follette ticket, which also received the endorsement of the executive council of the American Federation of Labor. Although the Progressive ticket received nearly 5,000,000 votes, no new party materialized and the Socialists returned to their traditional policy of supporting Socialist candidates, while continuing to work for a national farmer-labour political alignment.

Debs, five times Socialist presidential candidate, died in 1926, two years after the La Follette campaign. In the 1928 elections the party turned to Norman Thomas, writer, lecturer, former Presbyterian minister and co-executive director of the League for Industrial Democracy, as its new standard bearer. In that year, when many were predicting that the "new capitalism" was guaranteeing to the country permanent prosperity, Thomas received but 267,200 votes. Four years later, however, in the midst of the depression, his vote increased to 884,781.

During the next four years various factions developed within the party. They differed in opinion as to "the road to power" and the possibility of limited co-operation with the Communists in the fight against world fascism and reaction. This controversy led in 1936 to the withdrawal of several hundred party members and their organization of a Social Democratic federation. The 1936 convention decisively repudiated any political united front with the Communist party. During the next few years antagonism to the Communist party was progressively sharpened by the American Communists' support of Stalin's policies.

During this four-year period (1932–1936), the Franklin D. Roosevelt administration, in its drive to surmount the depression, embodied in its "New Deal" legislation many immediate demands of the Socialist party platform in the fields of social security, housing, public power and labour-management relations. The enactment of section 7-a in the National Industrial Recovery act gave an impetus to labour in its drive to organize many of the giant industries, while labour leaders came into more cordial relationship with the president of the United States than ever before in the nation's history. As a result of these developments, many trade unions felt politically obligated to give active support to the Democratic administration, and made it increasingly difficult for their members to remain active in the Socialist party and other minority political groups. In the 1936 campaign, therefore, labour's support fell off and the vote for Thomas decreased to 187.720.

During the 1940s and 1950s the party continued to nominate presidential candidates—Thomas in 1940, 1944 and 1948, and Darlington Hoopes, Pennsylvania lawyer and former Socialist assemblyman, in 1952 and 1956. After the outbreak of World War II, and before Pearl Harbor, Socialists opposed America's entrance into the war. When war was declared by the U.S. the majority of Socialists gave it their critical support, while urging the maintenance of civil liberties, democratic controls over war and postwar collectivism and the winning of the earliest peace that promised permanency, followed by the establishment of an inclusive international organization.

In its presidential campaigns the party emphasized increasingly that its economic goal was not the public ownership of all industry, but an economy aimed at equality of opportunity in which public, co-operative and private ownership existed side by side. The 1956 platform urged "the ownership by genuine cooperatives and publicly owned and democratically managed corporations," of public utilities, banks, insurance companies and certain basic industries. Its immediate demands included the expansion of public educational, health, recreational, housing and social security services; the conservation of natural resources; the strengthening of labour legislation; the end of racial discrimination; economic and cultural aid to underdeveloped countries; and international agreements for disarmament with strict inspection and controls.

In 1957 the Social Democratic federation reunited with the Socialist party, forming the Socialist party-Social Democratic federation (S.P.-S.D.F.). Frank Zeidler, mayor of Milwaukee, was elected chairman of the executive committee. A few months after the merger the party was readmitted as a full member into the Socialist International. In 1958, emphasizing its increasing role as a political educational, rather than an electoral organization, the party voted to permit its individual members to enter the primaries of other parties and to support labour and avowedly progressive candidates of other political parties. In 1960 the majority of the party decided against the nomination of a presidential candidate, but campaigned for the party platform, emphasizing the necessity of an honest, meaningful political realignment. While the party's electoral successes have been less than its founders had hoped, since the beginning of the century the party has served as a potent educational force in the social and political life of the nation. (H. W. L.; N. M. TH.)

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SOCIAL PSYCHOLOGY: see PSYCHOLOGY, HISTORY OF.

SOCIAL SCIENCES. The social sciences are concerned with the orderly investigation of the behaviour of man in society with the aim of cumulating a body of relevant theory. Theories concerning group behaviour, whether economic, political or social, are legion. They are implicit in men's actions, transmitted in customary beliefs and elaborated in literature. The distinctive quality of social science is that it attempts to formulate such theories unambiguously and in a way which permits the testing of theory against fact.

Method.—Much of the difficulty in science, contrary to popular misconception, is not to produce theory but to test it. For this reason, together with the relatively low level of development of their subjects compared with the natural sciences, social scientists tend to be as much concerned with method as with result in their inquiries. Indeed what John Maynard Keynes said of economics is likewise true of all social science: "It is a method rather than a doctrine, an apparatus of the mind, a technique of thinking, which helps its possessor to draw correct conclusions." Moreover, though the social sciences may be defined as the study of man in society, it must not be concluded that this is held to be the only method available for the understanding of social phenomena. On the contrary, much insight into the nature of communities, associations, classes, nations and races comes from the poet, the novelist, the traveler and the moralist. The social sciences can claim a special place in the vast body of writing on social life only insofar as they aim to produce generalizations which are verifiable because arrived at by scientific procedures.

The lack of maturity of the social sciences compared with the physical and biological sciences is often attributed to the use of quantification in the latter and its relative absence from the former. Certainly science is refined by measurement, and the conversion into numbers of such concepts as social distance, moral density or political allegiance sets peculiarly intractable problems. Nevertheless it must be recognized that the use of quantitative methods distinguishes the natural from the social sciences only in degree; such methods are used with conspicuous success in economics and demography. and statistical techniques form part of the indispensable equipment of all modern social scientists.

More generally it is characteristic of the modern development of the social sciences that they are modeled on the aims and methods of the natural sciences. What these aims and methods are remains, to some extent, a matter for debate and throughout the 20th century, especially in America, there has been much criticism of misguided imitation of the natural sciences in the quantitative pursuit of the trivial, the substitution of scientism for science. and susceptibility to "testomania and quantophrenia." as Pitirim A. Sorokin said in his *Fads and Foibles in Modern Sociology and Related Sciences* (1956). Nevertheless it is increasingly recognized that there is a unity of method in all generalizing or theoretical sciences which is sometimes called the hypothetico-deductive method and which is admirably expressed in the writings of Karl Popper, for example, in *Poverty of Historicism* (1957), *Logic of Scientific Discovery* (1959) and *The Open Society and Its Enemies* (1945).

"What is important to realise is that in science we are always concerned with explanations, predictions and tests and that the method of testing hypotheses is always the same. . . From the hypothesis to be tested—for example a universal law—together with some other statements which for this purpose are not considered as problematical—for example some initial conditions—we deduce some prognosis. We then confront the prognosis whenever possible, with the results of experimental or other observations. Agreement with them is taken as corroboration of the hypothesis, though not as final proof; clear disagreement is considered as refutation or falsification." (Karl Popper. *Poverty of Historicism,* p. 132, Routledge and Kegan Paul, London, 1957.)

Three Examples.—This brief statement of the fundamentals of theory and method in all science, natural or social, may be illustrated by reference to three examples, one from economics, one from sociology and one from political science. The first comes from Lord Keynes's *General Theory of Employment, Interest and Money* (1936). The pre-Keynesian or neoclassical theory of the level of employment and wages held (1) that the demand for labour is determined by the marginal product of labour and (2) that the supply of labour is determined by the marginal disutility of work. These two schedules when put together would determine the wage of labour and, in consequence, would assure full employment, apart from "frictional" and voluntary unemployment. From this theory it could be deduced that the mass unemployment in the United States in 1932, for example, must have been due basically to a refusal by the unemployed to accept wages corresponding to their marginal productivity. This deduction or prognosis, Keynes argued, was not supported by the facts. He therefore set to work to show that the classical postulate—that the general level of real (as distinct from monetary) wages is determined by the character of the wage bargain—%<-asan illicit assumption which limited the validity of classical theory to the special case of full employment. He then tried to generalize the theory by putting forward a new hypothesis concerning the forces which determine the general level of wages. income and employment, emphasizing, in particular, the level of effective aggregate demand. In the new theory some initial conditions—for example the skill and quantity of available labour and the existing technology—were taken for granted. The level of employment (and the national income) was then explained in terms of variations in three variables—the propensity to consume, the marginal efficiency of capital and the rate of interest—which determine the rate of investment and saving. In contrast to "classical" theory, the rate of interest was explained not in terms of savings and investments but as a function of a new concept of liquidity preference together with the quantity of money. In this way it was possible to deduce the existence of underemployment equilibrium in an economy.

A second example may be taken from the work of the German sociologist Max Weber. His theory that the development of western bourgeois capitalism was necessarily preceded by Calvinist and other Puritan religious movements as creators of indispensable psychological preconditions offers an illustration of theoretical advance by methods akin to those used in the natural sciences. Weber started from the then well-established Marxist theory of the genesis of capitalism through an emerging *bourgeoisie* seizing favourable opportunities for capital accumulation, the creation of a propertyless proletariat and the exploitation of a new technology permitting factory production. He then extended the theory by showing that these "material" conditions, though necessary, were not sufficient. They existed elsen-here, whereas Calvinism or its equivalent social counterpart of capitalism did not. As a result Weber contributed to the cumulation of theory in the social sciences. From the point of view of method Weber's work is one of the best examples of the use of history as a kind of natural laboratory for the testing of a hypothesis. He first established, in his famous essay on "The Protestant Ethic and the Spirit of Capitalism" (1904), that there is a high degree of congruence between the ethic of Protestantism and the organization of economic activity in capitalist societies. He then turned to an immense comparative study of other religions and other civilizations to seek for the negative instance of indigenous capitalism without the ascetic spirit of Protestantism. Of course the vagaries of history could not provide more than a rough approximation to the rigorous controls of an experiment in chemistry, and the Weber thesis remains controversial; but the plan of the work is an impressive demonstration of Popper's doctrine of the unity of method in science.

The third example, taken from political science, begins with German economist and sociologist Robert Michels' "Iron Law of Oligarchy" expounded in his *Political Parties* (1911), which held that political parties and other membership organizations inevitably tended toward oligarchy, authoritarianism and dictatorial leadership. This example again illustrates the paradoxical nature of science as advancing by looking backwards critically at the existing state of theory and specifying the limits within which its hypotheses are valid. Thus a later American study (Seymour M. Lipset, Martin Trow and James Coleman, *Union Democracy* [1956]) produced a set of specific hypotheses concerning the factors which will support or undermine member participation and democratic control in private organizations and thereby showed the limited conditions under which Michels' law applies and replaced a somewhat vague generalization by a clearer set of related propositions. The later study also illustrates a method increasingly followed in social science in that it used the economy of investigating the deviant case in order to delimit application of a hypothetical generalization—in this case the International Typographical union, as the one outstanding exception to tł · general rule among private organizations of government by one-partv oligarchy. The results constituted another example of cumulative research, the purpose of the study being, as the authors remarked, "not to 'refute' Michels or other previous workers in this area, but rather to refine and build on their insights and findings, paying them the respect of using them more often than we quote them."

Historical Origins.—All science can be traced back to antiquity. In the modern world the disparity of achievement between the natural and the social sciences is sometimes put down to the youth of the latter, or on a more sophisticated view, to the relatively small number of hours spent on it. But it is doubtful whether either explanation is borne out by the facts. What is certainly true, however, is that the sciences of man and of nature have been the objects of oscillations in the attentions of scientifically minded men. In the contemporary world the natural sciences are plainly dominant. From roughly the beginning of the 17th century the advance of first the physical and later the biological sciences has not only outstripped that of the social sciences, but has been the basis of a continuous revolution in human life. There have been previous dramatic advances in the material and cultural conditions of mankind—for example the Neolithic revolutions of some seven or eight thousand years ago which gave men control over their food supply through the development of the techniques of cultivation—but none of these stages in social evolution are comparable, as judged for instance by their effect on population size, with the rise of modern industrial society based on the application of natural science. Nevertheless the inferiority of the social sciences is not inevitable and indeed it is arguable that, at least at one stage in the development of Greek science, the works oi Plato and Aristotle had put politics ahead of physics.

lhe crucial period in the growth oi the modern disparity between the sciences was the 150 years from the beginning of the 17th century. Scientific interests had penetrated but never dominated the humanism of the Renaissance. Niccolò Machiavelli's *Prince* (1513) stands out as a monument to the release oi men's minds irom medieval preoccupations and is still read by the modern political scientist. But, as natural scientists, Leonardo da Vinci, Tycho Brahe, Kepler and Copernicus in the 15th and 16th centuries have to be seen as precursors of the great astronomers and physicists of the 17th century, above all oi Galileo and Newton. Even in the 20th century the social sciences are often said to await a Galileo, and only mathematical economics is thought of as having passed through its Newtonian revolution.

Again it must be emphasized that the remarkable concentration of human intelligence on the sciences of nature in the century and a half aiter 1600 was not absolute. In the same period the Italian Giambattista Vico had published his *Principles of a New Science Dealing With the Nature of Nations, Through Which are Shown Also Sew Principles of the Natural Law of Peoples* (1725) in which he set out to study human history by the methods which Francis Bacon had proposed ior the study of the world of nature. In Vico's *Scienza Nuova* we find, as Edmund Wilson has put it *(To the Finland Station,* Doubleday, p. 2, 1940), "the modern sociological and anthropological mind waking amidst the dusts of a provincial school of jurisprudence of the end of the 17th century and speaking through the antiquated machinery of a half-scholastic treatise." But Vico's vision was not shared by his contemporaries and his work was leit to be rediscovered by Jules Michelet a century later. Similarly in England in the 17th century the scientific pursuits of the Royal society had as a minor theme the study of human life by similar principles of empirical science. Sir William Petty's population studies, John Graunt's analysis of mortality rates in the London plague and Edmund Halley's construction oi the first liie table mark the beginning of an English tradition oi "political arithmetic" which, adding moral and administrative concern for the consequences of urban industrialism to its scientific interests, has flourished down to the present day.

However, the beginnings oi modern social science may be traced directly to the 18th century Enlightenment with the first flowering of rationalism in France and the stern pursuit of a secular moral philosophy in Scotland. The revival oi interest in society at this time also illustrates the general truth that social science is the child of social change. The rise of capitalist society with its attendant social upheaval of urban growth, industrialism and mobility of men and ideas, imparted a powerful impetus to social enquiry. In France, through the work of the physiocrats, economics was launched as an empirical science, and in books like Voltaire's *Age of Louis XIV* (1751), the notion of progress was involved in the study of history and society in a way which broke sharply with medieval thought and to a degree which was unshaken until the rise of functionalism in anthropology at the beginning of the 20th century. The second half of the 18th century also saw notable advances in Scotland by a remarkable group of moral philosophers connected with the Scottish universities including Adam Smith, John Millar, Francis Hutchison and Adam Ferguson — all influenced by a growing mood of skepticism and empiricism in philosophy of which perhaps the greatest exponent was David Hume. Adam Smith's *An Inquiry Into the Nature and Causes of the Wealth of Nations* (1776) remains, with Karl Marx's *Das Kapital* (1867) and Alfred Marshall's *Principles of Economics* (1890), to this day among the great comprehensive treatises in economics, but the Scottish moralists also contributed in their lesser known works some of the foundations of modern sociology, psychology and anthropology. Thus, ior example, John Millar's *Observations Concerning the Distinction of Ranks in Society* (1771) is probably the first scientific analysis of social stratification, and Adam Ferguson's *An Essay on the History of Civil Society* (1767) is an admirable early example of the comparative study of social institutions.

Specialization and Synthesis. — In the 19th century the location of initiative in the social sciences shifted irom Scotland to Germany and other European countries. During the course of the century what would now be thought of as the main divisions of social science—economics, anthropology, sociology, political science and social psychology — began to emerge and, toivard the end of the century, to receive academic recognition. The 19th century was also characterized by an opposite tendency toward the construction of a synthesis of social science, especially at the hands of Auguste Comte, Karl Marx and Herbert Spencer.

In economics the first three-quarters of the century was devoted to the building of the synthesis of theory known as "classical economics" — a term invented by Marx to reier to Ricardo and his predecessors but which was Iater extended to include also the followers of that tradition, notably John Stuart Mill and Alfred Marshall, This phase came to an end with the clarification of the doctrine of marginalism *(see* ECONOMICS: *The Marginal Utility Analysis).* In the last quarter of the century attention was transferred to methodological problems and especially to the *Methodenstreit* controversy in Austria and Germany between Karl Menger and Gustav von Schmoller, the latter asserting that economics could be no more than a historical science in the sense that its laws could only apply to the unique circumstances of particular historical periods; the iormer insisting on the status of economics as a theoretical science searching ior universal laws governing the behaviour of supply, demand, price and the level oi employment. The victory of Menger's point oi view has since proved to be an emancipating iorce not only for economics and economic history in Germany but ior the social sciences everywhere. On the other hand the models of rationality (*e.g.* "economic man") which permitted conspicuous advances in 19th century economics leit problems for the 20th century development of theory in the social sciences, particularly that of finding a place for the nonrational determinants oi human behaviour. For the most part these tasks fell to sociology and psychology, but economic theory itself was also extended to include problems of choice and expectations through applications of the mathematical theory of games.

The 19th century also saw considerable advances in those branches of the social sciences which were oriented more toward biology and history. The social scientists of this period inherited the 18th century achievements of Linnaeus and Bouffon in the classification of living organisms and the Lamarckian hypothesis that the hierarchy of species was due to a natural process of evolution. In seeking to classify and date types of culture and to formulate generalizations concerning the social evolution of man, scholars like Lewis Morgan *(Ancient Society* [1877]) in the United States, Herbert Spencer *(Principles of Sociology* [1876–96] and *Descriptive Sociology* [1873–1934]), Sir Henry Maine (*Ancient Law* [1861]) and Sir Edward Tylor *(Primitive Culture* [1871]) in England, Johann Bachofen *(Das Mutterrecht* [1861]) in Switzerland and F'riedrich Ratzel *(Volkerkunde* [1885]) in Germany laid the ioundations for modern comparative anthropology and sociology. Spencer gave modern sociology most oi its terminology (the word sociology is attributed to Auguste Comte), advanced the theory of supraorganic evolution beiore Darwin's *Origin of Species* appeared in 1859 and attempted a comprehensive classification of societies according to their social structures. Morgan too produced a developmental theory of cultural evolution through three "ethnical periods" — savagery, barbarism and civilization. Maine followed the same line of inquiry in respect to legal and political institutions and Bachoien did similar work on kinship systems, attempting in particular to establish that matriarchy was an earlier evolutionary iorm than patriarchy.

These advances in the social sciences, though the basis for specialization in ethnology, physical anthropology, comparative sociology, etc., also linked the social sciences to geology, paleontology and biology. In other words they linked history to natural history to yield a scientific account of the vast sweep oi human fortune since the first appearance of man over 500,000 years ago. There is no more exciting reading in all the literature of the social sciences than the modern summary oi this branch of knowledge which is to be found in the writings of V. Gordon Childe *(Man Makes Himself* [1936], *Social Evolution* 119511). These integrative developments were iurther stimulated by Darwin who had himself been influenced in his thinking about natural selection by the previous work oi social scientists and particularly by Thomas Malthus' *Essay on the Principle of Population* (1798). Thus sociology and social anthropology became recognized and, under the banner of the great synthesizing idea oi evolutionism, respected as worthy to march in intellectual company with economics.

There were also other movements toward a synthesis of the social sciences in the 19th century, including earlier the positivism of Auguste Comte and later the elaborate conceptualizations of German sociology. But the most powerful of these, and itself much influenced by classical economics and evolutionary theory, was Marxism. If biological and cultural evolution explained the development of nature and the primitive history of man, Marx seemed to offer the laws of motion governing not only the past but also the future of civilized societies.

Thus, by the beginning of the 20th century the social sciences gave promise oi iollowing quickly on the heels of the biological sciences into scientific maturity and academic acceptance. True, the basis ior existing generalizations was being challenged and especially the theories of progress and unilinear evolution. But there was widespread optimism that the emerging specialties, or specialisms, would provide evidence for a more soundly based general sociology, the role of which in the 20th century would be to correct the bias of each particular discipline and relate it to the general body oi theory. Meanwhile the universities were opening their doors to the scientific newcomers. Political economy had gained recognition in all the major countries by 1830. Edward Tylor was appointed as an anthropologist at Oxford in 1884. The University of Chicago recognized sociology irom its foundation in 1890 and all of the social sciences were to be studied at the London School of Economics and Political Science founded in 1895. In Germany in 1897, Max Weber went to teach at Heidelberg and, in France, Emile Durkheim held a chair of education at the Sorbonne from 1902.

20th Century **Developments.**—If the outcome in the 20th century has fallen short of Victorian hopes, and certainly the continued advance in the power oi natural science with its unending implications for social, economic and political change has lent urgency to the challenge faced by the social sciences, the advance oi the sciences of man nonetheless has been considerable. The grand theoretical structures of 19th century evolutionism, Marxism and Comtean sociology have not' survived. But four modest plants of 19th century origin were established in sturdy growth.

First may be cited a tendency for high standards of empirical method to spread throughout the specialisms in alliance with modest theory (sometimes called middle-range). The revolt against overambitious theorizing may be seen, for example, in the antievolutionary movement championed by the Polish-born British anthropologist Bronislaw Malinowski and by such men as Franz Boas in the United States. The subsequent trend in anthropology toward the detailed study of particular societies and communities within complex societies, using meticulous methods of observation and recording, has produced numerous examples of empiricism at its best. Social surveys in the 20th century have amassed great quantities of carefully collected data on the social structure of urban industrial societies while political science has built up a store of precise knowledge on voting behaviour, political parties, pressure groups and the social composition of political elites, against which may be tested new theories of political behaviour.

Perhaps the greatest benefit of this period of concentration on more modest and detailed work was that the old and still valid problems oi economic growth and social development could he approached anew after World War II. The urge toward improved standards of life through the spread of industrialism over the "underdeveloped" areas of the world stimulated renewed search for theories of political, social and economic development adequate to encompass the accumulated body of iact. The problem oi economic growth loomed large in postwar economic writing as may be seen from such examples as W. Arthur Lewis' *Theory of Economic Growth* (1955), *W. W.* Rostow's *The Stages of Economic Growth* (1960), or Simon Kuznets' *Six Lectures on Economic Growth* (1959).

This substantive concern with industrialization and social and political development has had integrating effects in the social sciences in that no one specialism is adequate to tackle the problems involved. The consequent tendency to a breakdown of specialist boundaries has involved the second trend which has been characteristic of the 20th century, namely the spread oi a sociological approach into the various specialisms; *i.e.*, the recognition of the interdependence of the social, political and economic iorces which determine behaviour. Historical studies have also been affected by this development. Thus Richard Hofstadter's *The Age of Reform* (1955) is an example of a sociological orientation in history and Neil Smelser's *Social Change in the Industrial Revolution* (1959) is a direct application of sociological theory to the Lancashire cotton industry between 1770 and 1840. Similarly, books like David Apter's *The Gold Coast in Transition* (1955) illustrate the use oi sociological theory in the analysis oi political change. It is from the interpenetration of the established disciplines that a new synthesis of theory is looked for and, indeed, at least one 20th century attempt to build a unifying conceptual iramework ior sociology. anthropology and social psychology has appeared in the writings of Talcott Parsons (*The Structure of Social Action* [1937], *The Social System* [1951]).

The third noteworthy development has been the rise of several branches of psychology having relevance ior the analysis of social behaviour. Among the more important oi these are psychoanalysis, behaviourism, Gestalt theory and the study of individual differences. Above all the influence of Freud on the social thought of the 20th century is comparable only with that of Marx and Darwin in the 19th century. Quite apart irom his voluminous clinical writings Freud made direct excursions into anthropology *(Totenz and Taboo* [1918]) and social psychology *(Group Psychology and the Analysis of the Ego* [1921], *Civilization and Its Discontents* [1930]). But no branch of the social sciences has escaped the influence of psychoanalytical ideas. They were introduced into political science by Harold Lasswell in his *Psychopathology and Politics* (1930) in a way which gave iresh impetus to the neglected insistence by earlier writers like Graham Wallas (*Human Nature in Politics* [1908]), Arthur F. Bentley *(The Process of Government* [1908]), and Charles Merriam (*New Aspects of Politics* [1925]) on the relevance of psychological and sociological factors in the study of political man. Psychoanalytical ideas were carried further into social anthropology by Abram Kardiner and into sociology by Talcott Parsons.

Movements in psychology other than those inspired by Freud and his earlier associates have made contributions both to theory and more especially to rigorous methods of experiment, testing and measurement. Examples include the contribution of Clark Hull to learning theory (*4 Behavior System* [1952]), Wolfgang Köhler's work on perception *(Gestalt Psychology: an Introduction to New Concepts in Modern Psychology* [1947]), Kurt Lewin's influential *Field Theory in Social Science* (1951), and Donald Hebb's integration of Gestalt theory with neurophysiology in his *Organization of Behavior* (1949). Out oi these movements there has also developed a recognized specialism of social psychology concerned with such topics as the scientific study of attitudes, public opinion, the social determinants of perception and motivation and the interaction processes of small groups; and each of these topics boasts a considerable literature.

The fourth line of advance in 20th century social science has been the steady improvement and extension of quantitative methods. At the end of the 19th century mathematical and statistical techniques for social analysis were in their iniancy. Simple quantification had always been part and parcel of demography and the political arithmetic tradition. But, at least until after World War I, mathematical economics was not taken seriously in the English speaking world, being largely confined to France, Italy and Switzerland and such men as Léon Walras, Augustin Cournot and Vilfredo Pareto. Thus the first systematic exposition of economic theory in mathematical terms, Walras' *Éléments d'économie politique pure* (1874–77), was not available in English until 1954. However, during the course oi the 20th century mathematical treatments have tended to displace literary discussion and statistical techniques have generated a new discipline of econometrics and transformed research in economics, sociology and political science. Sampling procedures based on probability theory were introduced between World Wars I and II to make social surveys, public opinion polls and electoral studies both economical and reliable. Psychological research has developed refined methods of factor and multivariate analysis, tests of ability and aptitude and assessments of the significance of differences in the distribution oi attributes between groups. Advances in computor technology have also revolutionized the possibilities of complex large scale analysis of social phenomena.

See also ANTHROPOLOGY; ECONOMICS; SOCIOLOGY; SCIENCE; SCIENTIFIC METHOD.

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SOCIAL SECURITY.

The main purpose of any plan for social security is insurance against interruption and destruction of earning power and for special expenditure arising at birth, marriage or death. Social insurance and social security are based on a common principle: protection against those hazards of life which threaten health or economic existence. In order that the protection afforded in any contingency may be reasonably adequate, not only must the rate of the benefit meet some standard of adequacy, but the benefit itself must be payable as long as the loss resulting from the contingency persists and be available whenever the contingency occurs, subject only to such limitations of rate and availability as are necessary to prevent substantial abuse on the part of claimants. There are thus three aspects to the question of adequacy of protection: (1) the rate of benefit; (2) the duration of the benefit; and (3) the qualifying period of work or contribution which must have been fulfilled at the time the contingency occurred.

After a brief historical sketch of the growth of social insurance, this article is divided into the following sections:

I. United States
II. European Social Security Systems
III. Social Insurance in Great Britain and the Commonwealth

The Growth of Social Insurance.— In Great Britain until late in the 19th century relief of poverty incurred through any cause could only be given under the poor laws (*q.v.*) or by private charity. The position was even worse in some other European countries where this matter was left almost entirely to the church. In many countries some provision was made independently of the state by the workers themselves through mutual provident associations; but only part of the field was covered by this means. In 1883 a compulsory scheme of insurance was introduced in Germany and this was extended in 1889 to cover permanent incapacity. The example of Germany was followed by Austria in 1888 and by Hungary in 1891. About the beginning of the 20th century. public opinion in most European countries began to favour some organized provision to meet the contingency of sickness among the workers. In Great Britain compulsory health insurance began in 1912, following the National Insurance act of

1911, and was made general in 1920. The first Old-Age Pensions act giving noncontributory pensions at the age of 70, subject to a means test, was passed in 1908. In 1925 came the act which started contributory old-age, widows' and orphans' pensions. Unemployment insurance was put on a fresh basis by the Unemployment act, 1934, which set up at the same time a national system of unemployment assistance. (For the first U.S. Social Security act, see I. *United States,* below.)

In the meantime the local machinery for the relief of destitution had been changed by a transfer of the responsibilities of the ad *hoc* boards of guardians to the major local authorities who undertook this work as part of their general local government activities. The granting of assistance on the basis of need, as distinct from national insurance benefit, became increasingly the responsibility of a centrally financed board. This development culminated in the abolition of local outdoor relief and the assumption of total responsibility in this field by the National Assistance board under the National Assistance act, 1948. In most other countries, however, assistance or relief still remained a local responsibility.

Separate provision for special types of disability—such as blindness—was made from time to time but it was the tendency for this also to be included in a comprehensive scheme. With the growth of social insurance went development of medical treatment; services for the welfare of children; and much voluntary provision for death and other contingencies through industrial life offices, friendly societies and trade unions. In no country does social insurance cover all needs, and all contingencies and assistance provided under a local or national scheme is normally available to those persons in need who are not entitled to some form of insurance benefit and, in some countries, as in Great Britain, for the supplementation of such benefit. Whereas social insurance implies that grants are made to contributors according to a formula relating payments into and out of an insurance fund, assistance rates have some relation to the cost of living or to a minimum subsistence level. In the German Federal Republic, unemployment assistance rates are fixed in relation to the earnings of the unemployed person during his last employment, and are about 10% to 15% below the rates of unemployment benefit; in Great Britain national assistance rates are generally higher than benefit rates.

After World War II attention was given to social security in most European countries, as in other parts of the world. The International Labour conference, at its meeting in Philadelphia, Pa. (1944), had urged that the sphere of protection of income-security schemes should be progressively enlarged in order to ensure that every worker having dependents should have at least the means of subsistence in every common contingency that might cause the involuntary loss of earnings or make them insufficient for the necessities of life. The matter was also mentioned in the Universal Declaration of Human Rights, adopted by the general assembly of the United Nations on Dec. 10, 1948.

The extension of social security by the middle of the 20th century can be seen in the fact that social security schemes were gradually being brought into operation in the more progressive Asian countries. One of the most comprehensive was in Israel where an act of 1953 provided for old-age and survivors pensions at a fixed rate subject to revision according to the cost-of-living index. Allowances were also provided for mothers who were either insured workers themselves or the wives of insured workers, at the rate of 75% of wages for 12 weeks absence from work before and after confinement. Contributions for maternity insurance were 0.8% of wages, shared by the worker and the employer. Under accident insurance 75% of wages was paid to the injured worker; for permanent disability there was a pension of from 10% upward. Contributions for accident insurance were paid by the employer at the rate of 0.5% to 3% of wages according to the degree of danger to which the worker was exposed. (JN. M.)

I. UNITED STATES

In the United States the general public is often confused as to the meaning of "social security." But its nature may be determined in part by the programs included in the Social Security act. When that act was passed in 1935 a Social Security board was designated as the agency to administer five programs: the federal old-age Insurance system, a program for federal co-operation with the states in unemployment insurance, and federal assistance to the states for public assistance to the needy aged, needy blind, and dependent children. The other programs included in this act—provision for maternal and child health services, services for crippled children, child welfare services, vocational rehabilitation and assistance to the states for public health—were to be administered by other federal agencies. In 1939 the Federal Security agency was created and five organizations were placed under its jurisdiction—the Social Security board, the public health service, the office of education, the Civilian Conservation corps and the National Youth administration. By the middle of 1943 the last two organizations were liquidated. In 1940 the Food and Drug administration was transferred to this agency. In 1946 the Social Security board was abolished and its functions transferred to the federal security administrator, who established the Social Security administration to carry on the programs of the Social Security board; in the same year the children's bureau, which to that time had been responsible for certain health and welfare provisions of the Social Security act was transferred from the department of labour to the Federal Security agency. In 1953 the department of health, education and welfare was established, with a secretary of cabinet status. The Federal Security agency was abolished and all its functions transferred to the new department. Under this reorganization the Federal Security agency became the Social Security administration in the department of health, education and welfare.

A broad definition of social security might include many of the functions performed by the department of health, education and welfare and many other types of social legislation—wage and hour laws, other types of labour legislation, public housing, recreation and general public assistance—and this list might be extended. This section discusses social insurance in the U.S., the special types of public assistance for which grants to states are administered by the Social Security administration and the assistance to states for health and welfare services that are included in the Social Security act. Although provisions with respect to two social insurance programs are found in the Social Security act, two other social insurance laws entirely within the jurisdiction of the states must also be included—workmen's compensation and state disability insurance. Social health insurance would, of course, be included in this definition. In the United States, however, except for the workmen's compensation laws and the few disability insurance laws, social insurance legislation has not been applied to this type of protection. There exist many private health insurance plans, but these are not properly considered to be social insurance.

Social Security Legislation to 1935.—The development of social security legislation was slow and uneven in the United States. The recognition of social welfare as a governmental problem was late in developing.

Both social attitudes and government organization held back legislation in this field. During the 19th-century period of expansion, the vast land resources of the U.S. offered most people a chance to obtain a livelihood. The old agricultural economy set the pattern of life except in larger towns and cities. Commerce and industry were conducted on a relatively simple scale, in general, though business was expanding and mass production was beginning.

Those years were characterized by a generally accepted belief that personal initiative and industry were all that was necessary for the achievement of material success. This attitude tended to support the traditional belief that indigence is always synonymous with incompetence, and any governmental aid given the financially unfortunate carried with it the taint of pauperism. The traditional concept of public welfare as a function of local rather than state or federal government tended to retard progress. Gradually there was a weakening in the old exclusive reliance on the town or county to provide for all welfare needs, and as needs increased the states came to recognize that they would have to share responsibility with local communities.

Special assistance programs for certain categories of the population had been established in many states by 193j. Social insurance was much slower in developing. Workmen's compensation, which had its real beginning in 1908, was the first type of social insurance to be developed in the United States, and with the minor exception of an unemployment insurance bill passed by Wisconsin in 1932, it was the only form of social insurance in the United States until the Social Security law was enacted in 1935. (See *Unemployment Insurance* and Industriul Injuries, below.)

Social Security Act

In June 1934 Pres. Franklin D. Roosevelt in a message to congress called for legislation to safeguard men, women and children against misfortune. A committee on economic security subsequently drew up recommendations for a social security program. The Social Security act was signed into law on Aug. 14, 193j.

The Social Security act initiated one of the most comprehensive programs for social welfare ever undertaken through direct legislation. It established a federal old-age insurance system and made provision for federal co-operation with the states in unemployment insurance systems and in programs for giving financial aid to three groups of the needy—the aged, the blind and dependent children. The measure also extended federal aid. available to the states, for four health and welfare services and for vocational rehabilitation. On May 24, 1937, the supreme court of the Cnited States upheld the state unemployment insurance laws and provisions for the payment of federal old-age benefits and taxes levied by the act.

It was recognized from the first that in a program of such proportions changes would have to be made as experience and study pointed the way for improvement. On the basis of reports made by the Social Security board and by the Advisory Council on Social Security, and after extended public hearings, the Social Security act amendments of 1939 were passed in August of that year. The results of these amendments were liberalization of the protection provided by the program and improvement of its administrative procedures.

Old-Age and Survivors Insurance.—The old-age and survivors insurance program established by the original Social Security act was designed to provide a basic retirement income after the age of 65 for wage earners insured under the system. Prior to consideration of the Social Security act there had been created various retirement plans for public employees, and private pension plans had also been adopted by some business organizations. In 1930, however. the number of employees affected by private pension plans was only about 3,500,000.

The Social Security act of 1935 provided old-age insurance for many types of wage earners. and later amendments covered new occupational groups. The estimated average number of insured workers was 24,000,000 in 1940; by the late 1950s the number had increased to approximately 75,000,000.

Coverage.—Chiefly because of the administrative difficulties involved in their inclusion, certain types of employment were at first excepted from coverage under the system. Some groups or their employers also resisted inclusion then and later. The act of 1935 provided the folloaing exceptions: agricultural labour; domestic service; casual labour not in the course of the employer's trade or business; service as an officer or member of a crew of a documented vessel; employment for any federal, state or local government or its instrumentality; and service for certain religious, charitable, humane and educational institutions not organized or operated for profit. Employment after the age of 65 was also excepted. Railroad employment was excepted because it was covered by the separate system for railroad workers under the Railroad Retirement act.

Under the amendments of 1939 some of the employments previously excepted were brought under the system. These included maritime service on U.S. vessels and employment in national banks, building and loan associations and certain similar organizations. The exception of employment after the age of 65 was removed as of Jan. 1, 1939, thus enabling many workers previously ineligible because of age to qualify for monthly benefits and others to increase the amount of their benefits.

Certain additional exemptions were provided by the amendments: agricultural labour was defined so as to extend exemptions not only to farming activities but also to certain closely related services. Certain part-time or intermittent employment providing only nominal wages. such as services for fraternal and other nonprofit organizations, and services of newsboys under age 18 were excepted by the amendments. as were family employment and service by employees of foreign governments.

Cnder the 19jo amendments coverage was broadened to include the self-employed (except farmers and those in certain professions) and regularly employed agricultural and domestic workers; voluntary coverage was permitted for employees of nonprofit institutions and employees of state and local governments not already under a retirement system. Certain civilian federal government employees not under a retirement system and workers in Puerto Rico and the Virgin Islands were included, as well as members of small occupational groups under a broader definition of employee.

Amendments in 1954 extended coverage to about 10,000,000 additional workers. The largest group of newly covered workers was self-employed farm operators, and coverage was given to additional members of state and local retirement systems and to larger numbers of farm and domestic workers.

In 1956 coverage was extended to several additional groups of the self-employed. Larger numbers of farm owners and operators were brought within the coverage of the act. and except for doctors of medicine all self-employed professional workers were included under these amendments. Coverage was also given to almost 3,000,000 members of the uniformed military services. Beginning in 1957, 92 out of roo jobs were covered under old-age and survivors insurance on a contributory basis.

Contributions (Taxes).—From the beginning, old-age and survivors insurance was financed by an equal contribution (or tax) from the employee and his employer. The 1935 act provided that the contributions were to begin in 1937 at 1% from employer and employee and increase 0.5% every three years to 1948 when the tax would have been 2.5%. This schedule called for a final 0.5% increase in 1948 which would have resulted in a tax of 3% from both the employer and the employee. Wages in excess of $3.000 in a year for any one year from any one employer were excepted from these taxes. The amendments of 1939 eliminated the 0.5% increase for the years 1940–42, and because of subsequent acts of congress the tax did not actually increase to 1.5% until Jan. 1, 1950.

Under the 1950 amendments the 1.5% tax on wages was retained for three more years, and the tax for self-employed persons was set at 2.25%. At the same time the maximum income on which these taxes were to be imposed was raised to $3.600. In 1954 the contribution rate was set at 2% of wages and 3% of self-employment income until 1959 with a schedule of gradual increases to a maximum of 4% of wages and 6% of self-employment income in 1975. In 1955 the maximum taxable income was increased to $4,200 and in 1957 the schedule of rates was increased by 0.25% to cover the cost of disability benefits. The tax on wages in 1957 was, therefore, 2.25% from the employer and his employee and 3.375% from self-employed persons. The schedule called for gradual increases in the 2.25% rate to 4.25% (6.375% from the self-employed) in 1975 and after.

Financing.—Under the act of 1935 an old-age reserve account was established in the United States treasury. Congress was charged with the duty of appropriating yearly to this account an amount sufficient as an annual premium to provide for the payments required under the old-age insurance system, the amount to be determined on a reserve basis in accordance with accepted actuarial principles. The act specified that reserve funds in the account must be invested in government obligations or government-guaranteed obligations bearing 3% interest.

The 1939 amendments provided much more liberal benefits to all persons who qualified for benefits in the early years and extended protection to certain dependents and survivors of insured persons. In order to compensate in part for the cost of these additional benefits, the benefits for single individuals with long periods of coverage were reduced by the 1939 amendments. Those amendments increased the cost of the program in the early years, but an actuarial study estimated that the long-range cost of the 1939 amendments would be at least as low as that of the original act and probably lower.

Although the 1939 amendments increased the cost of benefits in the early years, congress froze the contribution rate at 1% until 1950. In spite of this freezing, the trust fund grew more rapidly than had been expected, partly because of high wartime employment and earnings. and partly because of increased employment opportunities for older persons. The total assets in the trust fund were $11,816,000,000 at the end of 1949. Between 1950 and 1956 there were three changes in the benefit formula, the first of which nearly doubled the benefits, while the other two allowed more moderate increases. Although individual benefits increased substantially and contributions remained at 1.5% until 1954 and were then raised to 2%, the total assets in the fund continued to increase. Throughout most of 1956 and early 1957 the total assets were about $22,500,000,000. In 1957 a disability trust fund was also established and in Oct. 1957 the assets in this fund were $548,000,000.

Benefits —The system established by the act of 1935 provided for payment of monthly benefits, beginning in 1942, to insured workers 65 years of age or over when they retired Benefits were based on the employee's total wages during this qualifying period (exclusive of amounts in excess of $3,000 received in one year from any one employer). The formula used to determine benefits at this time as well as later was weighted in favour of the low-paid worker; i e., the lower-paid worker received a benefit representing a larger proportion of his wage than did the higher-paid worker. The maximum monthly benefit was set at $85, the minimum at $10. A lump-sum payment equal to 3.5% of the employee's total wages was provided for those reaching age 65 without qualifying for monthly benefits; and a death payment of similar amount was provided subject to deduction of any benefits the worker might have received during his lifetime.

The 1939 amendments made material changes in the benefits provided under the system. The principal revisions were: advancing initial payment of monthly benefits to 1940 instead of 1942; increasing benefits during the earlier years of the system and increasing security for the family group by providing monthly benefits for certain dependents and survivors of insured employees. Because of the extension of the system to afford protection for the families of workers, the title mas changed to old-age and survivors insurance Under the amended system the basis on which benefits were determined was the employee's average monthly wage.

From 1939 to 1950 the average monthly wage was determined by dividing a worker's total accumulated wages, exclusive of amounts in excess of $3,000, by the number of months he could have worked under the system; *i.e.,* the number of months between 1936 (or his 22nd birthday if later) and the quarter in which he became eligible for benefits or died In 1950 the benefit formula was amended to include in the computation wages up to $3 600 a year and to make it possible to determine average monthly wage on the basis of employment after 1950. The reason for this change was that the coverage was greatly expanded. and thus those persons newly covered would have had little or no earnings in covered employment betneen 1936 and 1950. In 1955 the maximum wage taken into account in computing benefits was increased to $4,200 a year.

In addition to increases in the maximum earnings on which benefits were based, the formula for determining benefits was several times revised to provide larger benefits. Between 1940 and 1950 benefits were related not only to wages but to years of coverage. There was a 1% increase for each year of coverage. A worker with an average monthly wage of $200 a month in the period 1940–50 would have received a benefit of $41.20 per month if he had been in covered employment for three years, and if he had been in covered employment up to 1950, his benefit would have been $45.20. In 1950 the benefits were increased, but the additional sum for years of coverage was eliminated; thus, the worker who qualified for benefits received the same amount regardless of years of coverage. A person with earnings of $250 a month would have received $72.50 per month and if his earnings were as much as $300 per month, his monthly benefit would have been $80. The benefit formula was again changed in 1952 and in 1954. After the 1954 amendments the man with $250 monthly earnings could receive $88.50, but if his earnings were as high as $350 a month his benefits would be increased to $108.50 a month. Average old-age benefits were $22.60 a month in 1940, $26 in 1949, $43.86 in 1950 and $64.48 in Nov. 1955. There were also changes in the minimum and maximum monthly benefit payable. The minimum benefit for an insured person was $10 from 1940 to 1950, $20 in 1950 and $30 after 1954. Similarly. there were changes in the maximum benefits. In 1940 the maximum benefit to the insured worker could have been $60 (assuming 50 years of coverage) ; this maximum was gradually increased and was $108.50 after 1954. Maximum family benefits also increased from $85 in 1940 and were $200 after 1954. There was also a provision that the benefit could not be more than 80% of the average monthly wage.

The act as passed provided benefits for the insured person and no other. With the 1939 amendments supplementary benefits became available for certain family members and certain survivors in the case of death of an insured person. Beginning in 1940 benefits equal to one-half the retired worker's benefit were paid to a wife 65 years of age and over and to unmarried dependent children under 16 years of age or under 18 if regularly attending school. To survivors the nionthly benefits were three-quarters of the monthly benefit rate for a widow 65 years or over or for a widow of any age with dependent children as defined above. Benefits equal to one-half the worker's benefit were paid to these dependent children and. if there were no other persons eligible for benefits. to dependent parents. With the 1950 amendments the wife of a retired worker. regardless of her age, was entitled to benefits if she had a child in her care. For the first time benefits were payable to a dependent husband (age 65 or over) of a retired or deceased insured woman. Benefits for dependent parents and for the first survivor child were raised to 75% of the insured person's benefit.

Under the 1956 amendments women could elect to receive benefits between the ages of 62 and 65. If a retired woman elected to take her benefit at age 62. the benefit would be reduced by 20%; in the case of a wife the reduction would be 25%. There were smaller reductions in these benefits for those who elected to receive benefits at ages 63 and 64. Widows could receive such benefits at age 62 with no reduction in amount.

The amendments of 1954 included a "disability freeze" that permitted a person totally disabled for six months or longer to have this period disregarded in determining eligibility for benefits and amount of the benefit. The 1956 amendments for the first time included disability insurance benefits payable to totally disabled persons from the age of 50. Disability benefits also were to be paid to dependent children 18 years of age and over if they became disabled before the age of 18. In addition to the monthly benefits described above, from 1940 to 1950, if there was no survivor entitled to monthly benefits, a lump-sum death payment equal to six times the worker's monthly benefit rate was paid to certain relatives or to the person who paid the burial expenses. After 1950 lump-sum death payments equal to three times the worker's monthly benefit amount were paid in the case of all insured deaths. Under the 1939 act the maximum lump-sum death benefit was $360 (assuming 50 years' coverage). The 1950 amendments set a maximum of $240. and after 1952 it was $255.

Eligibility for Benefits.—After 1939 there were two types of requirements as to the length of coverage in order to be eligible for benefits. One was described as "fully insured" and the other as "currently insured" status. An employee was fully insured if he received $50 in covered employment in each of 40 calendar quarters: or if he received $50 in each of enough calendar quarters to equal half the quarters elapsing between Dec. 31, 1936 (or his attainment of age 21, if later). and the quarter in which he died or attained the age of 65, and in no fewer than six calendar quarters. Any calendar quarter in which he earned at least $50 was considered a "quarter of coverage." Such quarters of coverage counted toward benefits even if they occurred before the employee was 21 years old or after he was 6j. but they had to be subsequent to 1936. The requirements for fully insured status remained the same except that the 1950 amendments provided that fully insured status could be attained by coverage for half the calendar quarters after 1950 instead of after 1936.

If an insured wage earner died without meeting the requirements necessary to be fully insured. but received $50 or more a quarter for at least six calendar quarters during the three years prior to his death. he would be currently insured. and monthly benefits were provided for any minor children and for the widow if she had such children in her care.

In general. all benefits were available to those with fully insured status, but the less restrictive requirement of being only currently insured allowed benefits to widows of any age with children in their care and to children of deceased workers.

The law as originally passed denied benefits to any person working regularly in covered employment. The amendments of 1939 allowed benefits if earnings in covered employment were less than $15 a month. In 1950 benefits were paid if earnings in covered employment were less than $50 a month. and in 1952 the maximum earnings in covered employment that could be disregarded increased to $7j. The 1955 amendments permitted benefits to be paid if earnings in both covered and noncovered employment were as much as $1.200 a year. Between 1950 and 1955 benefits were paid regardless of earnings after the age of 75, and from 1955, after the age of 72.

Unemployment Insurance. — The provisions of the Social Security act relating to unemployment insurance mere designed to stimulate adoption of state systems that would insure employees against total loss of income during periods of unavoidable unemployment. Because of constitutional problems this appeared preferable to a wholly federal system of unemployment insurance. In a number of state legislatures. unemployment insurance bills had already been presented before congressional consideration of the Social Security bill in 1935. But the disadvantage in interstate competition had deterred state action in all states except Wisconsin. By levying a federal tax on employers and then allowing credit against the tax for contributions to a state unemployment fund, the federal act helped to remove the interstate competitive factor, and by June 30, 1937, all states had enacted unemployment insurance laws. Under the terms of the act. wide latitude was allowed the states in adopting unemployment insurance systems. However. the state laws followed certain general trends.

Financing. — The unemployment insurance provisions of the Social Security act levied a payroll .tax on employers with eight or more employees. certain types of employment excepted. The rate of this tax was set at 1% of wages up to $3.000 per year in 1936, 2% in 1937 and 3% thereafter. Federal legislation in 1954 required employers of four or more employees to pay this tax beginning Jan. 1956. Against this federal tax, employers were allowed credit for the amounts they contributed to unemployment insurance funds under a state law approved by the Social Security board. The maximum credit allowed was 90% of the amount of the federal tax. The tax paid to the federal government met necessary administrative costs. The federal law allowed an employer credit for any reductions in his state rate of contribution due to favourable experience in regard to payment of unemployment benefits. As a result of the experience-rating provisions in 1955, the average employer contribution to state unemployment insurance funds was 1.2% of taxable payroll. The employer's contribution, like the federal tax, was ordinarily based on the first $3.000 of earnings. In 19jj. however, there were four states that had raised the taxable wage base to $3.600. Employee contributions were at one time required by nine states, but by 1958 only Alabama and New Jersey required these contributions.

All money collected by the states for unemployment insurance is deposited in the U.S. treasury in the unemployment trust fund to be drawn upon by the states to pay benefits. Until an amendment was enacted in 1954, the unemployment tax paid to the federal government became part of the revenue of the federal treasury. and funds necessary for administration were appropriated annually. Tax collections consistently exceeded these appropriations, and thus part of these funds were not available for the employment security program. A 1954 amendment earmarked these taxes collected in excess of administrative expenses, and the funds became available for noninterest-bearing loans to states whose funds fell below a specified level. This amendment substantially increased a continuing ability to pay benefits in states with relatively high levels of unemployment.

Coverage.—The 1939 federal law excepted from the employer's tax wages paid for the following services: agricultural labour; domestic service; shipping on navigable naters of the Cnited States; employment for the immediate family; federal, state and local government service; and employment by certain religious, charitable and educational organizations not organized or operated for profit. Railroad employment, covered by the Federal Railroad Unemployment Insurance act was excepted from the unemployment compensation provisions of the Social Security act. as well as from state unemployment compensation laws.

The amendments of 1939 extended coverage of the federal unemployment insurance tax to include wages paid for employment by national banks. building and loan associations and similar employments. In 1946 maritime employment was included. In 1954 a federal unemployment insurance law provided compensation to federal employees for wage loss because of unemployment. Most of the state laws closely followed the occupational exclusions of the federal unemployment tax act. Twenty-eight states also folloned the federal tax act and required contributions of employers of four or more workers. Eighteen extended coverage to employers of one or more employees. however. and the remaining laws covered employers of tno or three norkers.

When the norkers covered by the 1954 federal amendments and the 1955 amendments to the state acts were included, the covered group represented about 61% of the labour force and 80% of workers earning wages or salaries.

Benefits. — From the beginning all state laws provided that weekly benefits be related to the weekly wage of the individual covered uorker. In 1939 average benefits in the country as a whole were about 40% of the average wage of covered aorkers, and although benefits increased substantially thereafter, the increases lagged behind rising wages. Thus. in 1954 the average benefit mas only about one-third of the wage.

Between 1954 and 1957 many states increased benefits. In spite of these increases, however, in 1957 fewer than 5% of the nation's covered workers received benefits equal to 50% or more of average weekly wages in covered employment, and in 13 states, with 30% of the covered workers. a claimant earning the average weekly wage in the state received less than 40% of his wages.

Both the amount of the benefit and the length of time for which benefits are paid have differed substantially among states. In Nov. 1957 average neekly benefits for the United States as a whole were $29 44 but they varied from $19.89 in North Carolina to $39 58 in Nevada. As unemployment insurance developed in the United States it was a program for relatively short periods of unemployment. In the early years of this legislation most laws provided benefits for a maximum of 16 weeks. By 1957 nearly 60% of the states set the maximum at 26 weeks and only three at less than 20 weeks. Only one law provided benefits for as long as 30 weeks. Although there was a tendency in the direction of uniform duration of benefits for all claimants. a majority of the laws paid benefits for shorter periods to some workers. A aaiting period of one week was required before benefits become payable in all but four states (where the waiting period was eliminated). On June 15, 1958. the "temporary unemployment compensation act" became effective.

All the state laws denied benefits to claimants who were unavailable for work or were unable to work; were involved in a labour dispute, voluntarily left their jobs or refused work without good cause; or were discharged for misconduct.

When a worker applied for unemployment benefits he registered at a state employment office, reported to that office each week as evidence that he was able and willing to work and was obliged to accept any "suitable" employment (as defined by the state) offered him.

Public Assistance.— The act of 1935 made provision for granting federal funds to the states to aid them in giving financial assistance to three groups of needy persons—the aged, the blind and dependent children. In contrast with social insurance benefits, which are available to all persons who qualify as to age, disability or inability to find a job and who meet the requirements as to length of time in covered employment, public assistance is available only after proof of need—a means test. The states adopt and administer their own public-assistance plans, but each state plan must be submitted to the Social Security administration for approval. Standards for approval of state plans specified by the federal act of 1935, furthermore, were designed to assure efficient administration and equitable distribution of assistance.

The act of 1935 placed the amount of federal funds available to the states for old-age assistance and aid to the blind at one-half the state's total assistance payments, up to a monthly federal-state maximum of $30 to each recipient. For aid to dependent children, the act provided federal grants equal to one-third of the amount paid by the state. As a basis for computing the federal share of aid, the act set a maximum of $18 a month for the first child and $12 for each additional child in the same home. A dependent child was defined as one who is under age 16 (18 if in school after the 1939 amendments), is without parental support because of the death, disability or continued absence of a parent from home, and who is living in his own home or with certain near relatives.

In the two decades after 1935 the federal grants to states for public assistance were increased several times, and in 1950 these grants also became available for aid to the needy who are permanently and totally disabled. Under the 1956 amendments the amount of federal funds available for needy persons who were aged, blind or disabled was four-fifths of the first $30 of average monthly payment per recipient plus one-half the balance up to a maximum of $60. In the case of dependent children the federal government shared in the monthly allowance up to a maximum of $32 for the first child and the relative with whom the child lived and to $23 for each additional child. The federal share was fourteen-seventeenths of $17, that is, $14, plus one-half the balance up to the maximum. The federal government also made grants to the states that covered one-half the cost of administration.

Public assistance grants with federal financial participation went into effect in all states for the aged, the blind and dependent children, and there were 48 approved programs for aid to the permanently and totally disabled. In order to secure federal funds the state law had to meet certain administrative and eligibility standards set by the federal act. Each state, however, was free to determine the amount of the assistance grant and its own eligibility conditions so long as they were not more restrictive than those required for approval by the federal act. The state laws thus differed considerably, some being distinctly more liberal than others, both in respect to eligibility conditions and to the amounts of payments.

As more aged persons as well as children became eligible under the old-age and survivors insurance program, there was a considerable effect on the public assistance program for these two groups. After 1951 there were more aged persons receiving retirement benefits under the federal old-age and survivors insurance law than under old-age assistance, and by 1956 about twice as many received old-age insurance retirement benefits. The number of children receiving benefits under the old-age and survivors insurance program increased greatly after 1940, and this reduced the number of children who would have received public assistance.

Health and Welfare Services.— The Social Security act of 1935, in addition to its provisions for social insurance and public assistance, included federal grants to assist states in developing maternal and child health services, services for crippled children and child welfare services. In order to receive federal funds for these purposes, financial participation by the state and a plan approved by the secretary of health, education and welfare were required. At the federal level, these programs were administered by the children's bureau of the Social Security administration. During the period 1935–56 the sums granted for these purposes were increased several times.

The act of 1935 also provided funds for distribution to the states to assist them in extending public health services. The approval of the surgeon general was required for all state programs, and the federal public health service assisted the states in improving them. In the late 1950s grants were made to states for general public health, tuberculosis control, cancer control, venereal disease control, mental health and heart disease control.

Federal grants to states for vocational rehabilitation were made after 1920. The Social Security act of 1935 continued this program and increased the grants. The purpose of this legislation was to assist the states in providing disabled persons with the necessary services and aids to enable them to engage in remunerative employment. Any person who had a physical or mental disability and could reasonably be expected to become employable was eligible to participate in the program. This, like the other programs mentioned above, required the financial participation of the state.

Other Social Welfare Measures

Industrial Injuries.— It was not until about 1900 that the tremendous losses due to industrial accidents in the United States began to be recognized, and it was nearly a decade later when the first workmen's compensation law was passed. Prior to this legislation, if an injured worker sued his employer he had to prove that the employer was negligent. The court procedure was slow, costly and uncertain.

Workmen's compensation legislation was based on a new legal and economic principle. The concept of individual fault was abandoned, and the cost of industrial injuries was considered to be part of the cost of production, not because the accident was the fault of the employer, but rather because accidents are the result of the inevitable hazards of modern industry.

The first U.S. workmen's compensation law was passed by Maryland in 1902, but this law was declared unconstitutional two years later. The real beginning of this legislation was in 1908, when congress passed a compensation law covering civilian employees of the federal government. From that time state legislation developed rapidly, and by 1915, 30 states had enacted workmen's compensation laws. By 1920 all but six states had this type of legislation, and in 1948 workers in every state were protected.

Although there is great variability in the state workmen's compensation laws, it is possible to indicate some general principles that have been adopted in most of them. No law covers all workers, and accurate coverage statistics are not available, but it was estimated that in 1952 nearly four out of five civilian wage and salaried workers were covered by workmen's compensation. The largest groups of workers not covered by state laws were domestic servants, casual labour, interstate railroad and agricultural workers.

Workmen's compensation benefits in the United States have generally been financed exclusively by the employer. In all the laws except that of Louisiana, the employer has been required to give assurance of his ability to meet his compensation obligations. This could be done by a private insurance company or a state insurance fund, or by proof of ability to carry his own risk called "self-insurance." Most other types of social insurance require that this protection be provided by a government insurance organization. In the United States employers could insure with private insurance companies except in eight states where they were required to use a state insurance fund. In 11 states where there were state funds, employers were allowed to choose a private insurance company.

All the workmen's compensation laws provided cash and medical benefits for insured workers, and in all but two states these benefits also were provided for occupational disease. The laws vary greatly with respect to both cash and medical benefits. Although most of the state laws expressed the intent that the cash benefit be two-thirds of the wage, there were also limitations as to the maximum benefit that would be paid. For this reason, in 1953 a person in receipt of the average 1952 wage was paid less than 50% of his wage under two-thirds of the laws.

Although medical benefits are provided by all the laws, the amount of medical and hospital care varies greatly among the states. Two-thirds of the laws placed no limits on the amount or on the time during which medical benefits would be paid. The remaining one-third of the states, however, had restrictions of these kinds.

Temporary Disability. — Attempts were made to secure enactment of laws providing cash payments for temporary disability resulting from nonoccupational illness and injury. The first law of this kind was passed by Rhode Island in 1942. In 1946 the Railroad Unemployment Insurance act was amended to provide disability benefits, and by 1950 three additional states — California, New Jersey and New York — had passed this type of law. These laws, in general, protect the workers who are covered by unemployment insurance.

Temporary disability insurance in California and Rhode Island was financed entirely by employee contributions. In New Jersey and New York. employers paid part of the cost; for railroad workers these benefits were financed entirely by contributions from employers under the Railroad Unemployment Insurance act, uith no additional or separate contribution for disability insurance.

In Rhode Island all contributions were paid into a state fund. and the funds for railroad workers are deposited in the federal unemployment trust fund. As in the case of workmen's compensation insurance, California, New Jersey and New York permitted the employer a choice between carrying this insurance in a state fund or a private insurance company; they also allo ed self-insurance.

Cash benefits provided under these laws are on the whole similar to the benefits provided for unemployment. California was the only state in which the disability insurance system included hospital benefits. Any person eligible for disability insurance received $12 a day for each day of hospitalization ordered by a physician up to 20 days in any disability period.

Social Insurance for Special Groups. — Retirement and unemployment insurance are provided by special legislation for railroad workers. The Railroad Retirement act was passed in 1934 but was declared unconstitutional the next year. It was not until 1937 that an act was passed whose constitutionality was not challenged. This act with subsequent amendments included the same types of benefits as were provided under federal old-age and survivors insurance, but higher contributions were required and the benefits, in most cases, were more liberal for railroad workers. Railroad workers and their employers together contributed 12 5% of wages up to $4,200 a year. A railroad porker with 30 years of service at $3,600 a year received a benefit of $165.60 a month. and a worker with similar service under the federal old-age and survivors insurance program received $108.50 a month. Railroad workers with wages of $4,200 after 1954 received still larger benefits. Because railroad workers with relatively short periods of service in the industry would receive lower benefits than under old-age and survivors insurance, an amendment was passed in 1951 that provided benefits equal to those under old-age and survivors insurance for this group of railroad workers.

A federal railroad unemployment insurance law was passed in 1938, and as mentioned above this legislation after 1946 also included temporary disability benefits. These two types of benefits were financed by a tax on employers fixed at 3% of the first $3,000 of wages until 1954 and after that date on the first $3,600. After 1948, however, because of high employment and a large reserve, employers were permitted to pay a tax much lower than 3%, the actual tax on the employer being 0.5% of wages. The Railroad Unemployment Insurance act is similar in many respects to the state acts. The average benefits, however. are higher (about $35 a week in the mid-1950s in contrast with an average benefit paid under the state unemployment insurance laws of about $26) Another difference between this federal act and the state laws is that all railroad employers pay the same tax rate. whereas the state acts allow the individual employer's contribution to vary on the basis of the amount of unemployment of his workers.

There are many different types of retirement systems for employees of state and local governments. After 1951 it was possible for employees with no retirement systems of their own to be brought under the federal old-age and survivors insurance law on a voluntary basis. After 1954 employees covered by a state or local retirement system could be brought under federal old-age and survivors insurance.

A federal civil service retirement system was established in 1920, but it was improved and liberalized many times. The vast majority of employees of the federal government were covered by this system. In 1950 the federal old-age and survivors insurance law was amended to cover a considerable group, mainly temporary employees. of the federal government who were not covered by the civil service retirement system. The civil service retirement system was financed by contributions of 6% of the employee's total wage or salary. The government made no specific contribution but assumed responsibility for any deficiencies in the fund. The benefits were based on total wages and on length of service. They were in most cases much larger than those paid under federal old-age and survivors insurance, although civil service benefits might be lower for employees with short periods of service.

(A. J. A.; E. H. Hn.)

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II. EUROPEAN SOCIAL SECURITY SYSTEMS

As it is not possible to refer fully to all the various systems operating in different countries, the British system introduced in 1948. which was generally more comprehensive than others. is described in some detail below as an example, but first the general principles governing other European systems will be explained. In some countries provision for pensions was less adequate than for unemployment, injury and sickness, mainly on account of the heavy expenditure involved, though improvement in this respect was achieved.

The fixation of the level of short-term benefit depends on the policy, or sometimes the financial position, of the country concerned. In some countries, such as Belgium, France and the German Federal Republic, the view was taken that the rate of benefit should be such as to enable the individual to maintain his previous standard of living by being calculated on the basis of wages, normally at about 50%. In many countries family allowances made these rates more adequate than the figure of 50% would suggest. In France, benefit for temporary disability was reckoned at a minimum of 50% of wages and in some cases at 66% of the average for the last three years; the old-age pension varied between 20% and 40% according to the age of retirement. In the U.S.S R. benefit was fixed at from 50% to 100% of wages according to the type of employment and length of service. In many countries — as in Great Britain — the principle adopted was the provision of benefit at a flat rate.

Rates of benefit in some countries, such as the Netherlands, were geared to the cost of living, but in other countries, such as Great Britain, a fresh act of parliament was required before rates could be increased. In the countries of northern Europe (Denmark. Iceland, Finland, Norway and Sweden) social security plans began to evolve at the end of the 19th and during the first half of the 20th century. In Spain a compulsory old-age insurance scheme. for lower-paid workers only, was instituted in 1921; compulsory maternity insurance in 1929; and invalidity insurance in 1933. But implementation of the various schemes was slow because of political troubles. An act passed in 1945 under which the state undertook to put into force legislation affording complete social insurance and protection to the family had not been fully implemented by the late 1950s.

In some countries pensions were payable to the widow of an insured person or of a pensioner irrespective of her age. whether she was an invalid, employed, or hon many children she had. There were limitations, however, in not a few of the pension insurance schemes; either the widows' pension was payable only from a certain age or the widow had to be an invalid; or she might not undertake any paid employment or exercise an independent occupation; or she had to have a certain number of dependent children. The amount of the nidows' pension was fixed in various ways; in many countries it consisted of one-half to six-tenths of the pension payable to the husband. Orphans' pensions varied from four-tenths to one-half of the pension payable to an insured person.

Accident insurance contains elements of both sickness and pension insurance; the family of an insured worker was usually afforded protection during his treatment under the same conditions as under sickness insurance. Even when an insurance scheme did not generally provide for dependents other than the wife and children it was usual in accident insurance to provide for parents and grandparents if they had been supported by a person who died as the result of an accident. Such provision was sometimes subject to a means test.

Social insurance may pay regard to the problem of housing and in some countries the social insurance reserves were used for housing projects. This served two purposes: to create new houses in nhich new families might be founded and at the same time to provide an investment for social insurance funds nhich nould keep its value.

Groups Covered. — The various systems may be divided into three classes. according to whether they apply in principle: (1) to all citizens; or (2) to all gainfully occupied persons and their dependents; or (3) to smaller and specified classes of people.

The first class, by the 1950s. comprised the systems of Great Britain. Iceland, Norway and Sweden. In some countries certain benefits, such as pensions and children's allowances. were universal whereas others, such as those granted on account of employment injury and unemployment, were reserved for employees. Sickness benefit in Great Britain was granted only to the gainfully occupied, but in some countries this benefit was available to any person of working age. Special provision was made for employees in agriculture in Bulgaria, Yugoslavia and France and for domestic servants in Bulgaria and Yugoslavia. Before World War II it was usual in many countries for social insurance schemes and especially pension schemes to exclude public employees, who were covered by special schemes.

The bringing of the self-employed within the scope of social insurance, adopted in Great Britain. was one of the most difficult matters which had to be considered; partly on account of the cost involved and also of the difficulty in enforcing payment of contributions. At first there were many prosecutions for nonpayment but the number steadily declined and the practical difficulties did not prove to be as great as had been expected.

Benefits Provided. — The majority of the systems at mid-century covered the loss or reduction of earnings caused by sickness, maternity, old age and death. Only a minority, however, provided benefits for the unemployed. For instance, the French system did not cover unemployment. The dominant concern of France had for several years been the increasingly rapid fall in the birth rate and the resulting serious threat to the future of the country and its population: hence the outstanding importance attached to family benefits in the French system.

When a new social security scheme was introduced in any country, there was a tendency to limit the coverage in the first stage. One factor underlying all the schemes was, however, the need to provide means to enable persons who have become ill to resume their employment as soon as possible, not only on humanitarian grounds but in order to meet the manpower situation. In France persons who had to give up their employment because of sickness were entitled to special medical benefit and sickness benefit for three years if they were considered likely to recover after prolonged sickness.

Old-age pensions were payable at different ages. This was probably because of environmental and possibly racial factors which determine the early or late onset of senescence, but the cost of the scheme was no doubt an important factor. One unusual feature in providing for payment of pensions mas the introduction in some countries of different retirement ages corresponding to the different degrees of arduousness of particular occupations. In most countries the pension was payable at the age of 65 for men and 60 for women.

Family Allowances. — The rapid extension of the provision of family allowances was a striking development. The first country to provide family allowances was New Zealand. but the principle was later extended to most European countries and commonwealth self-governing countries. In Great Britain the Family Allowances act. 1945, provided for payment to every family with two or more children of an allowance for each child, other than the elder or eldest, at the rate of 5*s*. a week, increased later to 8s. for the second child and 10*s*. for the third and younger children. These allowances were payable out of the national exchequer and did not depend upon insurance contributions. A person was treated as a child. for this purpose, if he was under the upper limit of the compulsory school age—I j—but if he remained at school after the school-leaving age. or was apprenticed, the allowance would continue up to the 18th birthday.

In Belgium family allowance was payable to employed and self-employed persons and to social-insurance beneficiaries with one or more children. In France it was payable to families (with two or more children) of gainful workers. widows, social-insurance beneficiaries, registered unemployed persons and persons incapable of gainful work. There the allowance, however, was not at a uniform rate. as was more general, but was fixed on a wage basis. In Ireland the allowance was payable only to families with three or more children. In Italy it was payable to families of employed persons and recipients of sickness or accident benefits with one or more dependents. The allowance varied by industry and for wage and salary workers. It was payable in the Netherlands to families of employed persons with one or more children. in Norway to families with two or more children and in Sweden to families with one or more children. In Portugal it was provided for families of employees in industry, commerce. the professions and government service with one or more children, the rate being fixed by individual funds to which employers and employees contributed. In Rumania it was payable to families of employees in industry and commerce with one or more children. In Spain it was provided for families of employed persons. small farmers and pensioners with two or more children and families of deceased workers with one or more children; and in Switzerland it was provided for families of employed persons with one or more children.

Administration and Finance of Social Insurance. — It is usual for each social insurance scheme to be administered by a government department under a minister or by a national institution which is self-governing subject to some governmental supervision. Local administration is usually entrusted to agencies of the central department, but in France it is undertaken by elected bodies. In the German Federal Republic social security insurance is administered and financed through statutory corporations whose administrative bodies are composed of representatives of insured persons and employers. In Finland and Sweden there is a unified scheme of administration of old-age and disablement pensions but other branches of social security are administered separately. In Sweden the national pensions board administers the pension scheme; the labour board. unemployment insurance; the national insurance office, employment injuries and health insurance.

In the Scandinavian countries much of the cost of providing benefits, especially old-age and disablement pensions, is met from national taxation but contributions meet a major proportion of the cost of health and unemployment insurance. The cost of benefits for employment injuries is met entirely by the employers. In Denmark and Sweden health insurance was started by the formation of health insurance societies which remained. as the scheme became more embracing. largely responsible for their administration. In Denmark old-age pensions were continuously financed entirely from national taxation.

Reciprocal Arrangements. — .+I feature of social security at mid-20th century was the making of reciprocal arrangements betn-een countries. The British act. for instance. empowered the making of arrangements with British Commonwealth countries and foreign countries for reciprocity in matters relating to benefits for unemployment. sickness. widowhood. orphanhood, retirement or old age. General reciprocal arrangements were made between Great Britain. Norway and Sweden. and between Great Britain and Australia and New Zealand in the British Commonwealth. Arrangements were also made between Great Britain and Ireland and between the five nations of the Brussels treaty powers (Belgium. France. Luxembourg, the Netherlands and Great Britain). Each of these countries. with some exceptions. agreed not to discriminate between its own citizens and those of the other countries concerned in the giving of social assistance or medical care. Each country also undertook not to repatriate a citizen of one of the other countries solely because he was in need of assistance which was likely to be long and costly. unless he was a recent arrival to the country. Provision was also made for any case where a national of any of the other countries concerned had been insured in three or more of the other countries, and for the preservation of acquired rights to benefit in the case of a change of residence. The arrangements with Norway and Sweden enabled British residents or tourists to make use of the health services. including hospital treatment. of those countries on the same terms as their own nationals. During the late 1950s general or limited reciprocal arrangements were also being negotiated between Great Britain and Denmark. Finland, Yugoslavia, the German Federal Republic and Austria.

III. SOCIAL INSURANCE IN GREAT BRITAIN AND THE COMMONWEALTH

The system of compulsory contributions for social insurance in Great Britain came into operation on July 5, 1948. as a result of the report of Sir William (later Lord) Beveridge. The statutes under which the various parts of the scheme were initiated were the National Insurance act. 1946. the National Health Service act, 1946. and the National Assistance act. 1948. The rates of contribution and benefits were altered by later acts. The cost was to be shared by the insured persons, the employers and the state. Every insured person was enabled to obtain any of the benefits by making a weekly contribution on a single card.

In general every person in Great Britain over school-leaving age and under pensionable age became insured in one of the following classes: (1) employed persons, *i.e.*, persons gainfully occupied in employment under a contract of service: (2) self-employed persons. *i.e.*, persons gainfully occupied hut not under contract of service; and (3) nonemployed persons. *i.e.*, those not gainfully occupied. Married women might choose whether or not to contribute under special conditions applicable to them.

Contributions. — The weekly rate of contribution paid by an adult employed man under the 1957 act was 9*s*. jd. and by an adult employed woman. 7*s*. 8*d*. This was reduced to 5*s*. 11*d*. in the case of a man and 4*s*. 10*d*. in the case of a woman earning remuneration at a weekly rate of 60*s*. or less. Boys and girls under the age of 18 contributed js. 3d. and 4*s*. 6*d*., respectively. In addition there was an employer's contribution of 8s. 1*d*. a week for a man and 6s. 7*d*. for a woman, increased to 11*s*. ;d. and 9s. jd., respectively, where the remuneration was 60*s*. a week or less. For boys and girls under the age of 18 the rates were 4s. 9*d*. and 3s. 10*d*., respectively. For self-employed persons. the rates for men and women were 11*s*. 6d. and 9s. 8*d*., respectively, and for boys and girls under the age of 18. 6s. ;d. and 5*s*. 9*d*., respectively. For nonemployed persons the rates were 9s. 1*d*. for men between the ages of 18 and 65; 7*s*. 3d. for women between the ages of 18 and 60; and for boys and girls between 16 and 18, 5*s*. 3*d*. and 4*s*. qd., respectively. For employed persons the employer was required to pay the whole contribution in the first instance but could deduct from wages the portion for which the employee was liable.

Benefits. — The rates of benefit were generally similar regardless of the need (unemployment, sickness, widowhood or old age). For an adult person (over the age of 18), other than a married woman, the weekly rate was 50*s*. with an allowance for an only child or the elder or eldest child of 15*s*., 7*s*. for each additional child and 30*s*. for an adult dependent. The benefits for children were in addition to the family allowance payable for other than the first child. A married woman over 18 received 34*s*. unless she was supporting an invalid husband or not residing with and unable to obtain any financial assistance from her husband, when she was paid the full 50*s*. rate. Boys and girls under 18 without dependents received 28s. 6d.

Unemployment Benefit. — To qualify for unemployment benefit, a person had to be available for class 1 employment and to have paid 26 contributions. The standard rate of benefit was payable during a benefit year if in the previous contribution year there had been paid or credited jo contributions. Unemployment benefit was payable for 180 days, plus up to 312 additional days calculated on the claimant's recent record of contributions and benefit. Xfter that he would not be entitled to further benefit until he had been back at work for 13 weeks.

Sickness Benefit. — To qualify for sickness benefit a person must have paid 26 class 1 or 2 contributions since entry into insurance. The standard rate of benefit was payable during a benefit year if in the previous contribution year there had been paid or credited 50 class 1 or 2 contributions. If between 26 and 50 contributions had been paid or credited, benefit was payable at a reduced rate. Certain disqualifications were laid down for receiving sickness benefit, such as if the person had become incapable of work through his own misconduct.

Maternity Benefits. — These were divided into: (1) maternity grant; (2) home confinement grant; and (3) maternity allowance. A maternity grant of £12 10*s*. was payable in respect of each baby born. Either the mother or her husband must have paid 26 contributions of any class before the date of confinement and must have had at least 26 contributions paid or credited in the last complete contribution year before the benefit year in which the confinement took place. A home confinement grant of £5, in addition to other benefit, was payable if the confinement did not take place in a hospital provided under the national health service scheme or in accommodation provided under the National Assistance act or in the course of transit thereto. This grant was intended to encourage women to be confined at home. The contribution conditions were the same as for maternity grant. A maternity allowance was payable to an employed or self-employed woman who gave up paid work for the period for which the allowance was granted. This was normally a period of 18 weeks beginning 11 weeks before the expected week of confinement. As in the case of other benefits the required contributions must have been paid or credited.

Widows' Benefits. — There were three kinds of widows' benefits, each being dependent upon the husband's contributions only: (1) widow's allowance; (2) widowed mother's allowance; (3) widow's pension. The widow's allowance of 70*s*. was payable for 13 weeks together with allowances for children (in addition to family allowance). The allowance was not payable if the widow was over 60 and her husband was entitled to a retirement pension. If the widow had a family which included a dependent child she would receive a widowed mother's allowance of jos. when she had finished drawing her widow's allowance, with an extra allowance for each child after the first. The allowance would be reduced in respect of earnings above 60*s*. in any week. Under certain circumstances, but not universally. a widow could obtain a widow's pension at the rate of 50*s*. a week when her other allowance ceased.

Guardians' Allowance.—Any person who had in his care a child who had lost both parents, one of whom must have been insured, was entitled to a guardian's allowance of 27*s*. 6d. a week.

Retirement *Pension.*—The expression "old-age pension," for which provision was made in previous statutes, was replaced by "retirement pension." This was paid to an insured man aged 65 or over or to an insured woman aged 60 or over who had retired from regular employment and satisfied certain prescribed conditions. The wife of a retirement pensioner even though she was not herself insured could qualify for a pension of her own at the age of 60, provided that she was retired. The standard weekly rate of retirement pension was 50*s*. or 30*s*. for a wife over 60 on her husband's insurance (increased to 50*s*. on his death). An increase of 30*s*. was payable to a retirement pensioner if he had an adult dependent; also 15*s*. for the eldest dependent child and 7*s*. each for younger children.

"Retirement" as understood under the act did not necessarily mean that the person had ceased to do any paid work. He could be treated as retired notwithstanding that he was engaged or intended to engage in a gainful occupation provided that such occupation was only occasional or inconsiderable in extent or otherwise not inconsistent with retirement. The amount a retirement pensioner could earn without reduction of his pension was limited. There were certain advantages if a person remained at work after pensionahle age. He could still obtain unemployment and sickness benefit within certain limits up to the age of 70 (65 for women) and could also earn a higher rate of pension. For every 2j contributions paid as an employed or self-employed person during the five years after reaching pension age, the retirement pension would be increased by 1s. 6*d*. a week. The rate of the wife's retirement pension would also be increased. At the age of 70 (65 for women) the full rate of retirement pension then earned would be paid though the pensioner might continue to work.

Death Grunt.—A death grant toward the cost of funeral expenses was payable on the death of an insured person, or on the death of the wife, widow, husband or child of the family of an insured person. This was £25 for an adult and smaller sums for persons under 18 years.

National Assistance.—The National Assistance act, *1948*, provided a unified state service of financial assistance according to need in place of various services provided previously by the state or local authorities. It was placed under the administration of the national assistance board, with offices throughout the country. It was the duty of the board to assist persons who were without resources or whose resources (including benefits receivable under the National Insurance acts) were insufficient to meet their requirements. The question of whether a person was in need of assistance and the nature and extent of any assistance to be given were decided by a local officer of the board in conformity with general regulations made by the minister of national insurance, but provision was made for consulting a local advisory committee in special cases. The board's officers themselves. however, used considerable discretion in applying the regulations. There was special provision for blind persons and persons who suffered a loss of income in order to undergo treatment for pulmonary tuberculosis. The cost of national assistance was met out of national taxation.

Noncontributory Old-Age Pensions.—Noncontributory old-age pensions, as distinct from contributory old-age pensions (or retirement pensions), were payable under the Old Age Pensions act, *1936*. They were a direct charge on the national exchequer and did not come out of the insurance fund. They applied to a diminishing number of old people who had not become entitled to retirement pensions by contributing under the national insurance acts, Ultimately this class of pensioner would disappear. Unlike retirement pensions. which were payable at 65, a noncontributory pension was not payable until the age of 70. Further, a noncontributory pension was not granted to every person who had attained that age, as eligibility was subject to a means test.

Workmen's Compensation.—Provision was made under the National Insurance (Industrial Injuries) act, *1946*, for the compulsory insurance of all persons engaged in insurable employment against personal injury caused by accidents, or the contraction of certain industrial diseases arising out of or in the course of such employment. The provisions of the act therefore replaced the former provision for the payment of workmen's compensation under the various workmen's compensation acts, the first of which was passed in 1897.

Health Services.—Various health services without direct payment were made available to the whole population under the National Health Service act. *1946*. These included: (1) hospital and specialist services; (2) certain domiciliary services provided by local health authorities; and (3) general medical, dental, pharmaceutical and ophthalmic services.

Under former schemes, free medical attention and medicines were available only to insured persons and not to members of their families. Cnder the later scheme, everyone became entitled to these services for himself and members of his family, if any, and had the free choice of a medical practitioner from whom treatment might be obtained. provided the medical practitioner had agreed to serve under the scheme. The doctor was paid a capitation fee for each person on his list, together with certain additional allowances. Medicine prescribed by the doctor could be obtained free from any pharmacist taking part in the service. Later a charge of 1*s*. was made for each prescription. Dental treatment, in respect of which a fixed charge was imposed later, was also available from dentists taking part in the service. Their remuneration was provided by scales of fees for various types of work. General responsibility for the national health service scheme was vested in the minister of health, who acted through regional hospital boards and hospital management committees; the domiciliary service was administered by local executive councils in different parts of the country.

National Insurance Administration and Finance.—The minister of national insurance, later designated the minister of pensions and national insurance, was made responsible for the administration of the scheme. His department worked through regional and local offices in close association with the local employment offices of the ministry of labour and national service. A national insurance advisory committee was established to assist the minister in discharging his iunctions under the act with the special task of considering any draft regulations before their submission to parliament. There were also local advisory committees throughout the country to assist local officers of the ministry. Contributions were paid by the purchase of special stamps at any post office; one of these stamps was to be affixed to the insured person's contribution card ior each week of employment but special arrangements could be made for stamping in bulk. When the national insurance scheme came into operation the invested assets of the former health, unemployment and pensions schemes, amounting to about £900,000,000, were taken over. Of this, £100,000,000 was credited to the national insurance fund (under the control of the minister) to meet the payment of insurance benefits and the cost of administration. Into this fund was to be paid the money received from the sale of insurance stamps. The remaining £800,000,000 of the old funds was used to constitute a reserve fund. The interest on the investment of this fund was to be paid into the main fund. In addition to bearing the cost of benefits under the national insurance scheme, contributions bad to be made from the fund toward the cost of the national health service. The balance in the national insurance fund at March 31, 1955, was £381,069,000; the reserve fund balance was £1,068,600,000.

British Commonwealth Systems.—At mid-20th century schemes of social security were operating in most commonwealth countries to a varying degree. In Australia there was no contributory insurance scheme, but the social security services were administered by the commonwealth department of social service and the cost was met by the exchequer. The rates of assistance apart from maternity and child allowances were based on a means test. In New Zealand the general social security benefits, apart from orphans' pensions and family benefit, were also subject to a means test, but legislation provided for the gradual elimination of age benefit subject to a means test by the substitution of superannuation benefit, available to persons aged 65 and over who satisfied certain residential qualifications. A person in receipt of any other benefit under the Social Security act, 1938, except family benefit, was not entitled to superannuation benefit. The rate for this benefit was fixed at £75 a year from Oct. 1, 1951, to rise by fj a year annually until the rate of pension under the means test was reached. In Gibraltar a comprehensive insurance scheme came into operation in 195j, while in Malta National Insurance and Assistance acts establishing a comprehensive scheme took effect in 1956. (*Sue* also SOCIAL SERVICE.)

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(JN. M.)

SOCIAL SERVICE. The term "social service" is defined broadly as the provisions made by governmental or voluntary efforts to meet income maintenance, medical care, housing and recreational needs and provisions for the care and protection of special groups which have become recognized as essential community responsibilities in industrial society. The term is somewhat differently used in the United States and Great Britain and the social services do not follow identical patterns of administration, finance and use of professional personnel. Yet the experience of one country influenced that of the other, so that by the 1950s there was far less difference in the design of social service within Great Britain and the United States than there had been prior to the 1930s, when significant changes took place in the United States.

While essentially the origin of social service is ancient, stemming from the tenets of the Judaeo-Christian teachings, the modern institution took shape with the impact of the industrial revolution upon family and community life, substituting as it did an industrial for an agrarian economy, urban living for rural living, and creating dependence upon the wage system as a means of livelihood. The effect of the industrial revolution was felt in Great Britain long before it reached the United States. This is an important factor in understanding the history of social service in the two countries.

Methods of Social Service.—The methods of social service, whether or not carried out by professionally trained personnel, characterize a formalized way of helping people to help themselves. Social service is based on the recognition of variations in individual capacities and variations in the social structure. The objective is to help the individual utilize his abilities for his own welfare and for that of the community. The helping process of social service is formalized and is made available both through community-sponsored agencies, governmental or nongovernmental, and through community institutions such as the courts and the schools which desire to function more fully in their service to individuals with particular problems or handicaps. The process is limited in use to those services or agencies for which there is a defined social goal, a stated social purpose and responsible sponsorship, all designed to promote the social welfare of individuals and groups in the community.

Three generally accepted methods are identified in social service. The first is social casework, which aims through understanding the individual in his total situation to help him make maximum use of the established community institutions. The second is social group work, which seeks through an understanding of the behaviour of individuals in a group setting to help them utilize their fullest capacities for their own welfare and for the welfare of the group as a whole. The third is community organization, which attempts to help groups of individuals or groups of agencies so to work together that their combined efforts will be conducive to the social welfare of the whole community. Community organization has thus a two-way emphasis—helping groups to examine and co-ordinate their efforts and helping them take definite steps of an educational or legislative nature that will accomplish changes in the community pattern of living. Social work research plays an important part in evaluation and program planning which are basic to the three methods described above.

Governmental (public) responsibility for people in need took form first in Great Britain with the enactment of the Elizabethan poor law ("old poor law") in 1601. Subsequently the American Colonies adopted the essential principles of this statute in providing for assistance to people who were in need. Xongovernmental (voluntary) responsibility reached its peak of development in Great Britain by the end of the 19th century, in the United States not until the end of the second decade of the 20th century. The principle of social insurance nas accepted in Great Britain in 1897 with passage of the first Workmen's Compensation act; and in the United States in 1908, when the first Workmen's Compensation act was passed covering federal civil employees. In both countries the philanthropic individualism of the 19th century was succeeded by a partnership of governmental and nongovernmental activities, in which governmental responsibility became an accepted instrument through which citizen responsibility for citizen welfare could be expressed. This development was paralleled by an increasing comprehension of the needs of all individuals in contemporary society and a growing awareness that social service should be available to all who need it and can use it. This was in contrast with concentration on the problems of a single segment of society associated with the late 19th century. As against a general belief that social maladjustment has its origin in the physical or emotional make-up of the individual, it became recognized as having both individual and environmental causation, with an interdependence between the two as the principal factor to be considered.

GREAT BRITAIN

In Great Britain, the term "social service" includes governmental and nongovernmental provisions in the field of social insurance, social assistance, medical care, housing, education and recreation as well as in the field of care and protection of special groups. The inclusion of education as a social service in Great Britain is significantly different from United States practice.

Social Insurance.—The key to the British social insurance system is found in the famous Beveridge plan outlined in *Report on Social Insurance and Allied Services*, prepared by Lord (then Sir William) Beveridge in 1942 at the request of the British government. This report identified as "five giants" in the path of social progress "want, disease, ignorance, squalour and idleness"; stated that social insurance should be considered an attack on want and that a comprehensive social security service should be achieved by co-operation of government along with efforts of private individuals. which -would "combat" these "five giants." In contrast to specific efforts directed at specific problems in which government had long been engaged and in nhich voluntary efforts had participated, Lord Beveridge stated the principle of comprehensive social security which would cope simultaneously with all five of the major problems he had identified. Subsequently the Education act of 1944, the Family Allowances act of 1945, the National Insurance act of 1946, the National Insurance (Industrial Injuries) act of 1946, the National Health Services act of 1946, the Children act of 1948, the National Assistance act of 1948 and other measures either amended existing statutes or established new provisions, all of which were designed to implement the principle of comprehensive social security.

Under the National Insurance act of 1946, a system of social insurance provided income maintenance benefits covering the "main eventualities" from birth to death. Employed persons, self-employed persons and persons not gainfully employed constituted the three groups into which population was divided for insurance purposes. "Eventualities" included unemployment, sickness, retirement, death, maternity, widowhood and surviving children of school age. The National Insurance (Industrial Injuries) act of 1946 provided benefits for the worker injured during employment and for surviving dependents in the event of accidental death of the worker. Under the Family Allowances act of 1945, allowances for each child beyond the first in every family were paid at the rate of five shillings per child per week. These provisions were administered by the ministry of national insurance, through local offices of the ministry, through employment exchanges and through the post offices. The National Insurance act and the National Insurance (Industrial Injuries) act provisions were financed on a tri-partite basis, with contributions from insured persons, employers and the government. The Family Allowances act provisions were financed by general taxation.

Social Assistance.—The terms "social assistance" and "public assistance" are used synonymously in Great Britain and describe, in general, provisions for income maintenance not a part of the National Insurance act and the National Insurance (Industrial Injuries) act, and auxiliary services which are specifically defined. such as domiciliary care for persons who need such care and for whom it is not otherwise available. This is a residual provision for those outside the scope of the acts, either because of the nature of their need or because of their inability to qualify for benefit.

The administration of social assistance remained in the hands of the local assistance authorities. empowered by the national assistance board to perform specific functions. These services were financed by local authorities, by grants from the national government for specific services and by equalization grants under the Local Government act of 1948 available to local political units whose general financial condition fell below that of the average in its particular group.

Health, Housing, Recreation. — The provisions of the National Health Services act covered medical services, hospital care and preventive or auxiliary health services. Medical services became available to everyone without respect to insured status, age or other circumstances. Medical practitioners under contract with local executive councils were made responsible for the provision of personal medical services. These councils were appointed by the local health authority, the minister of health and local medical, dental and pharmaceutical committees. Hospital care. similarly available, was planned and supervised through a systern of regional hospital boards appointed by the ministry of health. Administration of hospitals was placed in the hands of hospital management committees appointed and responsible to the hospital board. Preventive, auxiliary and related services in the health field became the responsibility of the local authorities. These included health centres and home nursing and substitute housekeeping services in homes where illness handicaps the homemaker.

The national health services were financed in part from contributions from the National Insurance act, from local authorities and from the national government. As indicated, they were placed under administration of the minister of health with professional guidance from the central health services council appointed by the minister after consultation with appropriate organizations.

In connection with the administration of "housing estates" by the local housing authorities, the social-service function of administration was conceived of as help to the tenants in establishing equitable rent. in utilizing most fully the facilities of the housing project and as help in referring tenants in need of social services to any one of the existing services available to them in the community.

While local educational authorities retained as their main function the provision of educational facilities for children under the compulsory school age of 15 years and for technical and commercial education for persons over compulsory school age, they also assumed responsibility for school medical care service through the national health service; for psychological services; for physically and mentally handicapped children; for nursery schools, school milk and lunch programs; and for obtaining recreational facilities for school children and young persons between the ages of 15 and 20 years. So far as public responsibility was concerned, recreation thus became the task of the local educational authority. To implement this function, the authority might make grants to voluntary organizations or establish provisions directly. At the same time national voluntary organizations in the field might also receive direct grants from the central government through the National Council on Social Service.

Children; Handicapped **Persons.**—Under the Children act of 1948 local political unit authorities through duly appointed children's committees became responsible for children under 17 years of age who were without parents or appropriate guardians or whose parents or guardians were unable to provide for them. Both temporary and long-time care of the child became the responsibility of the children's committee appointed by the local authority. Furthermore. the authorities might assume the power of guardianship subject to the approval of the court having jurisdiction in juvenile cases. For juvenile offenders, juvenile court hearing, probation, commitment to approved schools and commitment to a Borstal institution for young persons between 16 and 21 years of age were provided.

Services to the physically handicapped, other than financial assistance, were provided by the local authorities either directly or through voluntary agencies. These services included provision of sheltered workshops, suitable home work, and general welfare of the handicapped person. Those handicapped by industrial accident became the responsibility of the local authority of the ministry of labour, which administered the services of industrial rehabilitation and employment.

Provisions for the mentally ill and mentally handicapped became the initial responsibility of the local health authorities. Hospitalization and custodial care were assigned to the regional hospital board. When noninstitutional provision was made. the responsibility remained with the local authority. which might also make provision for aftercare as directed by the ministry of health to which over-all responsibility was assigned.

An especially interesting feature of the social service program of Great Britain uas the provision whereby citizens' advice bureaus or information centres were to be established either by the local authorities or by voluntary organizations which might be aided by the local authority.

Nongovernmental or Voluntary Social Services. — Voluntary efforts, many of which had pioneered in methods. continued to be encouraged and aided with little supervision except where specifically required by a statute In contrast with the situation in the United States. where administrative and financial separation between the governmental and nongovernmental agencies was sharply defined. there were provisions under the Education act, the National Health Services act, the National Assistance act and the Local Government act, whereby financial grants might be made to voluntary organizations in special fields. Examples were youth organizations, discharged prisoners' aid societies, aftercare associations, national old people's welfare committee, and information centres.

The National Council on Social Service became the principal instrument for making governmental grants to nongovernmental agencies. This co-ordinating and planning body, to which voluntary organizations were affiliated, worked in close co-operation with governmental agencies.

Local councils and rural community councils of social service were both affiliated with and independent of the Kational Council on Social Services. They were engaged in studying conditions, in discussions and in joint planning in order to make agencies serve more effectively. *(See* also PENSIONS; SOCIAL SECURITY.)

UNITED STATES

In the United States, the term "social service" is less broadly defined than in Great Britain. For example, education is not generally considered a social service, although there are special provisions established within the system of popular education that are distinctly social in character and in many instances are staffed by proiessional personnel from the social-service field.

Social Insurance.——Under the Social Security act of 1935, as amended in 1939 and in 1950, an income maintenance program known as old-age and survivors insurance included retirement benefits and survivor benefits for the dependent relatives of the insured person. The coverage of the first act (193j) was expanded by the amendment of 1950, bringing under insurance systems domestic workers, certain agricultural workers and self-employed and on an optional basis employees of nonprofit organizations and of state and local governments. This became a federally administered program financed by contributions from employers and employees. Benefits depended upon the length of covered employment and upon the record of wages paid during this period of employment. Under the act of 1937, railroad workers were covered under a separate program known as the railroad retirement system.

A second income maintenance program established by a social insurance principle was that of unemployment compensation. **A** pay-roll tax was levied on employers of eight or more persons in covered industries, and by the device of "tax offset," 90% of funds so accumuiated were being made available to the states with laws and procedures meeting certain minimum standards. The federal government paid the administrative costs incurred by the states. Once minimum standards were met, the states, in turn, acquired latitude, and in some instances enacted legislation requiring employees' participation and extending coverage to the small establishments and providing a higher benefit payment. The covered industries excluded domestic and agricultural employment, employees of nonprofit organizations and employees of state and local political units. Unemployment compensation was provided for railroad workers under the railroad unemployment insurance system.

A third income maintenance program was workmen's compensation or industrial accident compensation which, except as it affected federal employees and railroad workers, was the result of state legislation.

Public Assistance.—Under the Social Security act as amended in 1950, a federal and state partnership was established, enabling the states to provide public assistance for four categories of persons in need. Aid to dependent children, old-age assistance, aid to the blind and aid to the totally and permanently disabled comprised the four categories for which the states with approved programs could obtain federal reimbursement according to a matching basis specified in each category. The state might, in turn, bear the total share of the state cost or establish some combination of local and state financing. A residual category of individuals not belonging in any one of the four mentioned above was known as "general assistance," and for this program the state and local political units carried full financial responsibility.

Housing and Recreation.—Governmental participation in health and medical programs was much smaller at mid-20th century than in Great Britain. Through a network of federal, state and local provisions and with participation of the federal government through grants-in-aid to the states, a system of local public health units was being established. These local units and the supervising state health departments held the key position in the preventive health program. Medical care for individuals in specific diagnostic groups—such as tuberculosis, venereal diseases, certain other communicable diseases, mental illness and remedial care of crippled children—had been established as a governmental responsibility. Grants from the federal government for research in cancer, in heart, in the care of the mentally ill and in the training of personnel in the mental health field had also become available.

Under the provisions of the Hospital Survey and Construction act of 1946 and amendments of 1949, federal funds were made available to enable the states to make surveys of hospital needs looking toward a regional distribution of hospital and diagnostic centres; and funds were also made available for aid in hospital construction. Personal medical care, except for the diagnostic groups mentioned above, was limited to veterans, merchant seamen, Indians and to the group known as "the medically needy." Amendment to the Social Security act of 1950 permitted federal matching of funds for the medical care of public-assistance recipients and for the domiciliary care of these persons in public and private institutions. A few states had defined "medically needy" to include self-sustaining groups of persons with incomes insufficient to purchase adequate medical care. But such provisions were limited in extent and in income levels. Other than these provisions, personal medical care was still under private auspices, with considerable expansion of group hospital and medical care insurance plans either under community auspices or under labour-management agreements.

Under the Housing acts of 1937 and 1949, local housing authorities, established in accordance with state law, could receive long-term loans (40 years) from the federal government to cover 90% of the cost of low-cost public housing projects, available to low-income families. Slum clearance and redevelopment of properties and guarantees of long-term financing for the meeting of housing needs of middle-income families also became available.

The low-cost public and scattered private housing projects were recognized as a social welfare service. It was recognized also that families with low incomes, selected primarily because they had been living under substandard housing conditions, would include persons of different races, nationalities and religious faiths who could utilize community facilities to aid them in the various adjustments to living in close proximity. Community agencies, both public and private, were encouraged to make these available to the housing community, and the responsibility of housing management, other than the property maintenance and tenant selection. became that of informing and interpreting the facilities to the housing residents.

Although the U S. system of popular education had never been considered to be among the social services. there were nevertheless auxiliary services established in connection with the system which were properly so designated in that their function was to help children of compulsory school age make fuller use of the facilities of the schools. Preventive school health services. student counselling, school social work and psychological services—all had an emphasis on helping that properly designated these provisions as "social service."

Public recreation remained primarily the function of local political units as defined by state law, and it was divided between two local authorities—the board of education and the local governmental authority. Co-ordination of the two was sometimes effected by voluntary effort at the local level and sometimes aided by state legislation. providing certain benefits for a co-ordinated program. State recreational authorities, the first of which was established in 1945, became engaged in making available information and advice concerning local recreational developments. Recreational areas were developed within the state parks. especially those with resort possibilities, and attempts were made to make them available to voluntary agencies providing summer camps and recreational programs. A system of national parks (*q.v.*) was begun in 1872 as the responsibility of the federal government. Established in areas of great natural beauty or of historic significance, they became important recreational facilities for the entire population. Any co-ordination of these federal. state and local facilities. however, remained on a voluntary basis. Up to the 1950s, with some important exceptions, they had been regarded as recreational facilities and not as recreational programs in which professional leadership had its place. However, the use of these areas by nongovernmental agencies with professional leadership was generally encouraged.

Children and Handicapped Persons.—Services to children, except as they had been established and expanded in rural areas and in areas of special need through federal grants under the Social Security act, remained the responsibility of the local communities and the states. Care of dependent, neglected and delinquent children was still the responsibility of the child welfare authority or the juvenile court. Determination of custody in case of neglect or dependency is in the last analysis a judicial procedure, nhich may assign custody or guardianship to a governmental or nongovernmental agency as well as to an appropriate relative. Similarly. adoption is a judicial determination, but there remained variations within the states concerning the extent of state or local administrative responsibility for adoption studies and supervision of children placed in adoptive homes. Foster home care, temporary or long-time and institutional provision continued to follow different patterns in the various states. No phase of social service in the United States had so many variations in administration. In some. the use of voluntary agencies, nith or without grants of state or local funds, had become extensive. In others, governmental agencies, local and in a few instances state. were used.

The provision of care for the mentally ill and mentally handicapped remained a state responsibility. Preventive efforts were both local and state. as was aftercare responsibility; but, because of expense and type of problem, the principal provisions for care and treatment had long been regarded as belonging to the larger unit of government. Except for direct administration of Saint Elizabeths hospital. Washington. D.C., and U.S. Veterans administration hospitals. the federal government played no part in these programs other than through the National Mental Health act, enacted in 1945, which made funds available for research, training and the extension of community facilities for preventive care.

In the field of care for the physically handicapped, other than those injured through industrial accident, the federal government, through grants to the states under the Vocational Rehabilitation act of 1943 and through the crippled children services of the Social Security act of 1935, assumed a major though not exclusive responsibility for the corrective educational and vocational training needs of these groups. There was still a substantial participation, however, by governmental agencies and nongovernmental agencies at both the state and local levels.

Nongovernmental or Voluntary Social **Agencies.**—With the assumption by government of responsibility for meeting basic income maintenance needs and other social services in health, housing, recreation and in care and protection of special groups of persons — notably children — the function of nongovernmental social service in the United States became increasingly that of research, experimentation, demonstration, supplementation and maintenance of those services not yet recognized as proper for the governmental authority to institute. This change first became notable in the 1930s. Nongovernmental or private social services, however, continued to maintain important leadership in the total field.

In the field of family welfare, family-service associations emphasize counselling, voluntarily sought by those who wish this service, and certain auxiliary services, such as income supplementation or family life education directed toward the strengthening and development of the family. Considerable attention is given to the development of high standards of service, and to this end the Family Service Association of America became recognized as the standard-setting agency.

Child welfare agencies occupy an important place in the scheme of nongovernmental agencies in the United States. Child-caring institutions are for the most part under private auspices, and the importance of the sectarian institution should be especially noted here.

Noninstitutional agencies are engaged principally in foster-home placement and supervision, adoption study and supervision, protective care of neglected children in their own homes and provision of services for especially handicapped children, such as those with severe behaviour disorders or requiring unusual facilities for education and development.

In the field of medical care, nongovernmental agencies play an important part in the preventive field where public interpretation and public education are stressed. Examples are the National Tuberculosis association, American Cancer society, American Heart association, National Foundation for Infantile Paralysis, a few of which have state or local affiliates. Some of these efforts lead later to legislative provisions for services supported by taxation.

Voluntary hospitals and outpatient services play an important part in provision of hospital and personal medical care for the medically needy, in some instances supplementing the public provisions and in others carrying major responsibility, with or without government aid,

Auxiliary services include medical social casework and psychiatric social casework. Voluntary medical care insurance, such as Blue Cross and Blue Shield plans, provide limited hospital and medical care.

In mental health also, nongovernmental agencies carry important responsibilities for preventive programs, either in the educational area or in treatment of incipient disorders, through community or hospital-sponsored clinic services. Such organizations as the National Mental Health foundation, and local and state mental hygiene societies are examples of these educational efforts. One of the contributions of the voluntary agencies has been to stimulate agencies, such as schools and courts, to recognize the importance of mental-hygiene aspects of the service provided.

In youth programs, the voluntary associations dominate the field in the United States. The Y.M.C.A., Y.W.C.A., Y.M.H.A. and Y.W.H.A., Boy Scouts and Girl Scouts, Camp Fire Girls, girls' and boys' clubs and others have long-established traditions and are generally accepted. The 4-H club programs under agricultural extension service play an important role in rural areas.

Similarly social settlements and neighbourhood and community centres are recognized as the province of the nongovernmental agencies. Some tendency for government to assume responsibility for community centres was observable at mid-20th century, but this trend was not extensive. Both traditions and the conviction that nongovernmental auspices would serve citizen participants more effectively accounted for the continued leadership of the voluntary agencies in this field.

Social planning bodies such as councils of social agencies, federations of health and welfare and neighbourhood councils are nongovernmental in character. At the national level, examples are the National Social Welfare assembly and the American Public Welfare association. At the state level may be cited such organizations as the Pennsylvania Citizens Association for Health and Welfare and the New York State Charities Aid association. At the local level, social planning councils with autonomous agencies as constituent members exist either in connection with or independent of the central financing bodies. In this same connection, social-welfare forum bodies such as the National Conference of Social Work and the state conferences of social welfare; the National Catholic Welfare conference and the National Conference of Jewish Social Welfare perform an important function in discussion and education that affects social planning.

Government also plays a part in the discussion-forum type of social-welfare planning. The White House conferences held at the end of each decade, the National Health conference of 1938 and the National Conference of the Aging in 1950, are all examples of initiative taken by the federal government in organizing nation-wide conferences dealing with timely subjects. They had profound effect on trends both in the governmental and nongovernmental fields.

The social planning council may or may not be an integral part of the central financing body in the local community. The community fund or community chest is the accepted mechanism for raising voluntary funds for the financing of voluntary agencies. A national organization known as Community Chests and Councils of America, composed of and partly financed by local community chests, was giving leadership in the whole field at mid-century. Member agencies of the local chest are limited to those for which a single financial appeal is practicable, thus excluding agencies which may not be widely accepted.

PERSONNEL

In Great Britain, the recruitment of personnel to staff the governmental services at the national level is achieved by the method of open competitive examination to which individuals under 25 years of age and, under special exceptions, veterans are eligible. It is generally assumed that experience and in-service training will prepare personnel for promotion to more exacting responsibilities. Local authorities having power to appoint personnel are not governed by the general civil service act and have wide latitude in recruitment.

At both the national and local levels of recruitment, the place of the specialist in social service is a limited one. Depending on the nature of the service, there are specialists in housing management, in child welfare, in hospital social service and in psychiatric social casework. Where so designated, the social-service worker is asked to meet generally accepted professional qualifications in the particular field. These qualifications involve training in social science, for which 24 universities or university colleges were making provisions at mid-20th century, or demonstrated experience or some combination of the two.

In the voluntary field, social workers are employed in family casework agencies, in child-welfare agencies, in youth-service agencies as youth leaders, in agencies under religious auspices as moral welfare workers, and in neighbourhood work, community centres and settlements.

In the United States, with the exception of federally financed and administered social-service programs, the recruitment and assignment of personnel in the public social services is within the responsibility of the states and local political units. The services just indicated as exceptions are covered by regulations of the U.S. civil service commission, which permit the fixing of requirements for the selection of specialists in various fields.

These include specialists in the field of social work identified both by training and experience as requisite for the responsibilities to be performed.

Under the system of federal grants-in-aid to the states under the Social Security act, all state services in the field of public assistance, child welfare and unemployment compensation are obligated to use what is known as a merit system of selection. This is also true of the federally aided services in the field of health under the Public Health Services act. A merit system follows the general principle of civil service but is to be distinguished from it.

Except as they are guided by the general principle of merit selection, the states have latitude in fixing eligibility requirements. salary and tenure provisions. and there are substantial variations within the state systems concerning. for example. the extent to which special training is required. Local political units such as counties and municipalities establish their own systems of personnel selection. The extension of civil service and merit systems in the states was rapid after 1939. This was due in part to the transfer of large numbers of social workers from private nongovernmental agency employment to governmental agency employment. It was also due to the development and interest of schools of social work in preparation for the public services and to the active support of professional standards by such professional organizations as the National Association of Social Workers and similar organizations in special fields of psychiatric, medical social and group work.

In the field of nongovernmental social services, the standards of personnel selection are subject to the determination of individual boards of directors and sponsoring bodies. They are generally affected by standards recommended by national organizations of which the agencies may be local affiliates. In addition, the influence of the schools of social work and the influence of professional membership associations are important factors in establishing and maintaining personnel standards.

At mid-century, there was a serious disparity between demand and supply of trained personnel. This situation constituted the greatest single barrier to progress in the use of professionally-trained social workers in the nongovernmental agencies.

As social service becomes a significant field of professional activity in which both men and women are employed. the nature, length and educational level of preparation are increasingly important. In both countries. university sponsorship of programs of professional preparation and liberal arts studies as desirable preprofessional preparation are generally recognized. The program of professional study itself combines theory of the practice of social service methods. concurrent with or followed by field instruction within social agencies and knowledge of the history, structure and administration of social welfare programs. The schools of social service in the United States place greater emphasis on the theory of practice and on field instruction than do similar schools in Great Britain. Professional training for the field of social service in the 1950s, however. was moving toward a common base which recognized the process of "helping" as something which requires actual practice in the use of theory as essential for this purpose. *(See* also PENSIONS; **SOCIAL** SECURITY.)

OTHER COUNTRIES

Social service. social work, social welfare services and welfare work are variously defined by the other countries of the world. Through the United Nations current and authoritative information became available from member nations. Two surveys (*Methods of Social Welfare Administration* and *Training for Social Work, an International Survey*) issued by the United Nations Department of Social Affairs contributed greatly to the understanding of the various systems and comparisons and contrasts between them.

According to Mrs. Katherine Kendall (*Training for Social Work, an International Survey*), the 33 countries reporting social-service systems may be grouped as (1) those regarding social work as individual charity expressed in terms of almsgiving and voluntary services by individuals on behalf of the indigent; (2) those regarding social work as organized activity under governmental or nongovernmental auspices directed toward the solution of problems connected with economic dependency and (3) those regarding social work as professional service under governmental and nongovernmental auspices potentially available to every member of the community irrespective of his means, to assist him in achieving his full potentialities for productive and satisfying living.

These differences in definition are reflected in the characteristics of the systems. such as the relative importance of governmental and nongovernmental provisions, the place of tax-supported and voluntary or sectarian institutions, the use of the social insurance principle in comparison or contrast with the use of the social assistance principle in meeting economic and medical care needs of the population, and the roles of the central government and the states or regions and the local political units in the administration of the services. Political and social philosophies, the economic structure and development of the countries and the nature of social needs in large measure determined these characteristics. A country-by-country study is necessary to a full understanding of the individual systems.

A characteristic common to all, however, was the increasing use of the "social-security concept" during and following World War II.

Provision for old-age. invalidity, survivors insurance and pension (or assistance) programs were established in 33 countries by 1939. By 1949, the number had increased to 44. In general these systems were financed by contributions from employer and employees in covered industries and supplemented by governmental contributions. Benefits were dependent upon length of covered employment and extent of earnings. At mid-century. seven countries used the method of pension with a means test to meet the needs of these groups. Others employed some combination of insurance and assistance in their programs.

Medical care provisions as a part of social insurance systems were established in 36 countries by 1949. an increase from 24 in 1939. Medical care provisions not a part of the social insurance systems were established in other countries.

Workmen's compensation providing cash benefits and medical care for persons injured or disabled in employment had been extended by 1949 to 57 countries. To a limited extent only was disability caused by occupational disease included with these provisions. The trend in legislation had been to require that insurance to guarantee this compensation be carried and administered by a governmental agency.

Protection against a wage loss through unemployment was provided in 22 countries either through compulsory unemployment insurance, governmental subsidies of voluntary insurance programs. public works, government aid to the unemployed or through some combinations of two or more of these methods.

Family allowance systems provided regular cash benefits to families with one or more dependent children. These provisions were especially characteristic of continental European countries where substantial expansion of such programs characterized the period during and immediately following World War II.

Professional and technical training of personnel employed in the administration of social insurance and social welfare programs was also increasingly recognized.

See also references under "Social Service" in the Index volume.

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SOCIAL SETTLEMENTS are social welfare agencies established to provide a variety of services to people who live in given geographical neighbourhoods. These agencies may also be called settlement houses, community centres, neighbourhood houses, neighbourhood centres, neighbourhood associations or guilds. In Great Britain there are both residential settlements, where members of the professional staff live as well as work, and community centres founded by city and borough councils after World War II. Settlements. under a variety of names, are to be found in most countries of western Europe and in southeast Asia and Japan.

History. — The settlement movement began with the founding of Toynbee hall (*q.v.*) in London in 1884. Samuel A. Barnett (*q.v.*), then vicar of St. Jude's parish, invited a number of university students to join him and his wife in "settling" in a deprived area. The movement spread to the United States when Stanton Coit, nho was one of the early visitors to Toynbee hall, established Neighborhood guild, now University settlement, in the lower east side of New York city in 1886. In 1889 Jane Addams (*q.v.*), another Toynbee hall visitor, and Ellen Gates Starr bought a residence in the near west side of Chicago, Ill., and started Hull house. In the same year Jane E. Robbins and Jean Fine (Mrs. Charles B. Spahr) opened the College settlement in New York city. Two years later Robert A. Woods established Andover house. later called South End house, in Boston. Mass. The movement spread to other countries mainly through the influence of visitors from those countries to settlements in England or the Cnited States.

Purposes. — The purpose of a settlement is the development and improvement of a neighbourhood or a cluster of neighbourhoods. It differs from other social agencies in that it is concerned about neighbourhood life as a whole, not with providing selected social services. In a sense the neighbourhood is its client Settlements seek consciously to develop harmonious relationships among community groups of different cultural, economic, religious and social characteristics. While they may have sponsorship and support from a religious organization, their purpose is to serve all kinds of people who live in the neighbourhood regardless of race, class or creed.

Settlements seek to help people act together as an active and informed citizenry for the improvement of their living conditions and environment. Under the leadership of pioneer workers such as Lillian D. Wald (q v.) at the Henry Street settlement in New York city, Jane Addams and the many outstanding persons who served as residents and volunteer leaders (Joseph Moss and Sophonisba Breckinridge, to mention only two from Hull house, for example), social settlements helped win the enactment of laws providing for juvenile courts, mothers' pensions, workmen's compensation and the regulation of child labour; they promoted playgrounds and recreation centres. maternal, infant and child health clinics and services, adult education programs and took part in housing and other reforms.

Services. — The services of settlements and the names they adopt vary from country to country and within any given country. However. all are alike in that they are committed to bringing together people of all ages who live in the same geographical area for the purpose of following common interests and of improving neighbourhood life generally. The settlement's program of service and action is determined by the needs and interests of the people in a particular neighbourhood. It varies from one period of time to another in accordance with changing needs and conditions. One settlement serving two or more neighbourhoods, which differ in composition or condition, may offer different services to each. In general, services fall under three main categories: work with individuals and families; work with groups; and work with, or in behalf of, the neighbourhood as a whole.

Work with Individuals and Families. — Informal counseling and home visiting are done by almost every member of a settlement's staff. Where problems are such that specialized skill is needed, settlements have employed casenorkers. psychologists, psychiatrists, home economists and vocational counselors. In neighbourhoods lacking adequate health services, medical or dental clinics have been provided, while at the same time settlements have campaigned for the extension of public health services to meet neighbourhood needs. Nursery schools and day care for children have been provided for families needing them, because of employment of mothers. home conditions or other reasons.

Work with Groups. — There is a dual purpose in work with groups; *i.e.,* to enrich the social life and experience of the individual members and to provide opportunities for the group as a whole to contribute to an improved neighbourhood. Settlements serve two types of groups, namely membership groups sponsored by the agency and autonomous neighbourhood groups or organizations. Membership groups include friendship clubs, classes, athletic teams, interest or hobby groups.

Among their membership are people of all ages and of varied interests and abilities. To such groups the settlement provides a place to meet and a group leader, teacher or coach, whichever is appropriate. For younger groups it may also provide program materials and equipment. Older groups are encouraged to provide at least part of these essentials for themselves. Members join these groups for fun and satisfaction and often for personal and social development. The settlement's worker with the group seeks to develop feelings of neighbourliness, mutual respect and social responsibility. These groups use most of the space and staff-time of settlements.

Independent neighbourhood organizations and groups often seek and use certain services of the settlement. It may be only the use of a room for meetings. It may also be the counsel and guidance of a staff member for help on organizational or program problems. Settlements by request have helped to develop parent-teacher associations in neighbourhood schools. They have helped local churches to develop social and recreational programs for youth. They have provided guidance in the development of youth, recreational or welfare programs for labour unions, veterans', civic and fraternal organizations.

Work with the *Neighbourhood.*—Toynbee hall in Great Britain and some settlements in other countries have followed the tradition of having some professional staff members as well as university students and other volunteer workers live in the settlement's building in order that they might become in fact as well as in feeling a part of the neighbourhood. In all settlements, the staff workers, wherever they may live, are expected to become very familiar with neighbourhood people, conditions and problems. Moreover, they are expected to identify themselves with attempts to improve conditions and to solve problems. They work together with the people, with governmental officials and with citizens of the larger community to this end. Local individuals and groups are encouraged and helped to organize and to take appropriate action to secure enforcement of housing. safety and sanitation codes. Reliable information about proposed public improvements. such as highways, slum clearance and urban redevelopment. is made available to neighbourhood people and they are encouraged to express their concerns and their wishes to appropriate governmental agencies and officials.

Neighbourhood action may be directed toward legislation as well as to administrative decisions. Settlements seek to acquaint social welfare and other planning bodies with facts about living conditions and social needs in their neighbourhoods and as social agencies participate, through their representatives on community welfare councils or similar groups, in social planning for cities and metropolitan areas. This continuing concern of settlements has given the movement a reputation as an agent of social reform.

Administration. — The responsibility for operating each settlement is vested in a board of directors composed of citizens, some of whom live outside the neighbourhood but in the general metropolitan area, and some who live in the vicinity of the settlement. This board is the policy-making body and is responsible for securing and administering funds necessary to support the settlement program. It usually determines and carries out the program in partnership with the staff and with persons in the neighbourhood, whose opinions and help it seeks.

Workers with professional education in social work most frequently make up the administrative and supervisory staff. Workers trained in informal education: in nursing, in early childhood education, physical education and recreation also are employed extensively in settlements. In the United States most settlements secure financial support from community chests or united funds.

Some settlements, both in the United States and Great Britain, have substantial endowments, the interest from which furnishes considerable support. Funds are provided by governmental agencies to settlements in most countries. This is more common in European countries than in America. Local, national and international religious organizations support a considerable number of settlements. In countries other than those in North America, industrial corporations and private individuals often directly contribute to the support of settlements. Charitable trusts and foundations frequently support settlement programs, particularly new or demonstration projects.

The buildings used for settlement programs vary greatly. Some are large and well equipped. Many settlements have a modest central building but use rooms in buildings owned by housing authorities, public schools and churches for some of their activities. Some groups meet in private homes of members. Professional leadership, rather than meeting space, is seen as the primary contribution of the settlement. However, in a congested and deteriorating city neighbourhood, the settlement house often furnishes a hospitable and permanent common ground where diverse and transitory groups gain a feeling of security and of belonging which they cannot find elsewhere in such a neighbourhood.

The Settlement and the City.—Historically the social settlement was a method of solving certain problems inherent in urban living, particularly for the economically underprivileged. Crowded conditions, preoccupation with one's own urgent problems and the lack of concern of one's neighbours made difficult the maintenance of neighbourly feeling and responsibility characteristic of rural and village life. In the United States, before the adoption of the quota laws of 1921 and 1924, waves of immigrants successively crowding into transitional, depressed or slum areas faced additional problems of coping with strange customs and a strange language. The settlement attempted to restore under urban conditions some sense of belonging and of caring which seemed necessary in a humane society. The settlement movement was essentially an urban phenomenon.

The difficulty of finding financial support in smaller, less well organized (for purposes of social welfare) communities has tended to confine settlements to metropolitan areas nhere such support could be found. However, because of the concern of religious organizations particularly, some small agricultural and newer industrial communities have been helped to establish and maintain a community centre, similar to a settlement. Dispersion of industry outside of metropolitan areas has brought into being new towns which need this general-purpose type of community service. Communities of migratory agricultural labour, particularly where children are involved, have claimed the attention of religious organizations in the United States, with the result that a settlement type of nork has been established.

City, National and International Organizations.—In the larger cities of the United States and in some cities of Europe the settlements have formed voluntary city federations. In most instances, these federations have not employed any staff. but have provided opportunities for employed workers especially and for some board members, to discuss common problems. This discussion frequently has led to joint action on matters of legislation, publicity or specific service programs. The first such federation was formed in Chicago before the turn of the 20th century and the second in New Tork city shortly thereafter. In a fan smaller cities all of the settlements have combined to form one agency which operates several centres in different neighbourhoods of the city.

The founders of early settlements in the United States found it helpful to meet periodically to discuss common problems, especially conditions which seemed to require national co-operation and action of the federal government for their remedy. In 1911 they established the National Federation of Settlements, with Jane Addams as its first president. Robert Woods of Boston's South End house was the first executive secretary. on a volunteer basis. From 1929 on the federation employed a full-time executive secretary to facilitate the co-operation of the settlements on matters of national concern and to help improve standards of neighbourhood work throughout the country.

The British settlements established the British Association of Residential Settlements for the same purposes. Several European countries also have national organizations of settlements, most of them established after World War II.

The first international conference of settlement workers was held in London in 1922. This led to the organization in 1926 of the International Federation of Settlements. Except for a hiatus immediately before and during World War II, this federation has met every four years. After World War II its headquarters were at the French Association of Social Centres in Paris. In 1956 they were moved to the Dutch federation in Utrecht, Neth. The International federation is represented through observer status as a nongovernmental organization at the United Nations.

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SOCIAL WELFARE has been defined by a United Nations, expert group as "organized activity that aims toward a mutual adjustment of individuals and their social environment." There are very few activities of modern democratic governments or private nonprofit organizations, however, that would not fit this definition in its broadest sense. More specifically and for the purposes of this article. social welfare is considered as including the attempts made by governments and voluntary organizations to help families and individuals by maintaining incomes at an acceptable level, by providing medical care and public health services, by furthering adequate housing and community development, by providing services to facilitate social adjustment and by furnishing facilities for recreation. In addition, social welfare includes legislation and facilities designed to protect those who might be subject to exploitation and to care for those special groups considered to be the responsibility of the community. Although educational services are usually considered as social welfare provisions, they are excluded from the discussion that follows.

All nations have developed social welfare services as they have moved from agrarian to industrial economies. In preindustrial societies the family group cares for its own young, its own aged, its own sick and disabled; what food and shelter is available is distributed among all members: whatever social maladjustment occurs is dealt with by the family. Such a system of mutual responsibility becomes impossible under modern industrial organization which demands mobility and the congregation of a large proportion of the population in crowded urban centres. It has become necessary, therefore, for society to provide substitutes in the form of social services, subsistence, medical care and protection. In all countries these have been provided both by private associations and by the authority of the state.

EARLY DEVELOPMENTS

The early history of social welfare in most western nations is the history of the poor law (*q.v.*) and of the private charities and foundations nhich supplemented it. Until the latter half of the 19th century, therefore, most social welfare services carried only negative implications. They were to assuage abject poverty and suffering; they were to prevent epidemics of deadly disease; they were to protect the population against begging and thieving; they were to appease the lower classes and so prevent revolution and maintain order. Earlier improvement in social welfare services was deterred by two enduring concepts: first, that government should avoid to the greatest extent possible any interference with the economy or social relationships; second, that all was well with the economic and social organization and that any poverty or social maladjustment could be attributed to inherent inadequacies or moral infirmities of the individuals concerned.

These two concepts were emphasized during the 18th century Enlightenment and became most effective as the middle classes obtained political power. The demand for limited government, a reaction to the excesses of monarchies and mercantilism, was, of course, at the heart of the struggle for modern constitutional government. Social welfare services, except those provided by private benevolence, could not be developed as long as the function of government was thought to be limited to the protection of private property and the conduct of foreign affairs. Less theoretical concern about the propriety of governmental responsibility for social welfare services was expressed during the latter part of the 19th century and early 20th century, particularly in the United States. There the public services were usually manned by political appointees with no civil service tradition or security of tenure. Graft and other political chicanery was to be expected.

The second concept had its origins in Judaeo-Christian philosophy and was articulated in secular terms during the 18th century. Recognizing first the supreme importance of the individual, the philosophers of the Enlightenment saw the greatest fulfillment of the individual and therefore the greatest welfare of society in the operation of the free market. Since each individual, according to natural immutable laws, was bound to operate rationally in his own self-interest, any interference with the freedom of an individual to choose, for example, a path which leads to poverty instead of wealth would be in violation of natural law and inimical to the general welfare.

These ideas. which found ready acceptance among the middle classes, were buttressed by the theories of such men as Joseph Townsend, English clergyman, geologist and author of *A Dissertation on the Poor Laws* (1786), who considered the spectre of poverty and suffering necessary to entice men to work at menial occupations; T. R. Malthus who considered any aid given to the poor as encouraging them to increase their numbers and so to diminish the subsistence available to the rest of the population; and David Ricardo who saw in the "wage fund" the impossibility of improving the condition of the labouring classes. Also delaying improvement in social welfare was Protestantism in general and Puritanism in particular with its emphasis on hard work and frugality and its equating of worldly success with divine election. The acme of this trend in ideas was achieved by the Social Darwinists during the last half of the 19th century. Herbert Spencer, for example. believed that men who advocated social welfare measures were "blind to the fact that under the natural order of things society is constantly excreting its unhealthy. imbecile, slow, vacillating. faithless members." Suffering by some must be endured so that the welfare of the many may eventually be achieved.

Poor Law Reform (1834).—The poor law reform of 1834 in England was the most specific expression in legislation of such ideas concerning the nature of poverty and the proper role of the state in its relief. All relief to the able-bodied in their own homes was forbidden and all who wished to receive aid must move into the workhouse. This law established officially the principle of "less eligibility" which was to plague the development of social welfare in the United States and England for the next hundred years Since poverty was due to individual fault, since any encouragement to laziness or thriftlessness was a threat not only to the proper operation of the economic system but the very survival of the nation, all efforts should aim at making the application for and receipt of poor relief as odious and degrading as possible. In the United States during the early 19th century no such national statement could have been expected because of the limited powers and responsibilities of the federal government at that time. The Yates report of 1824 in New York state and the Quincy report of 1821 in Massachusetts, however, both recommended that all the poor be cared for in public almshouses, the latter stating "that of all the modes of providing for the poor, the most wasteful, the most expensive, and most injurious to their morals and destructive to their industrious habits is that of supply in their own families."

Voluntary Welfare. — The ideas of the Enlightenment, which were so congenial to the middle classes during the 19th century, also had the effect of encouraging voluntary social welfare. While the discipline of *laissez faire* economics and devotion to natural law impelled the commercial classes to permit suffering and allow poverty to go unrelieved by government, the humanitarian aspects of the Enlightenment emphasized the importance of good works and the benefits of charity to the giver. Benjamin Franklin, for example, was an insistent opponent of all forms of public relief yet was a well-known philanthropist whose time and money had been given to the creation of a large number of welfare organizations This humanitarianism also caused men of influence to be repelled at the condition of the working classes resulting from the free operation of economic forces. The paradoxical quality of their attitude toward social welfare is illustrated by the fact that in England the first substantial factory act, providing for the appointment of factory inspectors and requiring that employed children between the ages of 9 and 13 attend school for two hours each weekday, was passed during the year prior to the restrictive poor law reform of 1834.

Lavish expenditures for private charity were possible during the early period of industrialization because of the accumulations of great wealth in the hands of a few individuals. Many of the endowed hospitals. schools, universities and charitable foundations had their origins in the era of unrestricted capitalism in England, the United States and throughout western Europe. The unrestrained giving typical of the 19th century. however, was disturbing to the conscience of the middle-class liberal as it too could pauperize the recipients, discourage thrift. sacrifice and hard work and so interfere with the free operation of natural economic law. Their answer was "scientific philanthropy" which aimed at separating the "deserving" from the "undeserving" poor and assisting the former to self-support. In England and the United States this rationalization of benevolence was carried on by the Charity Organization societies.

The humanitarian impulses of liberalism also gradually led to a less rigid attitude toward the supposed evils of public poor relief. While the leaders of private charity were concentrating on saving the "deserving" poor from the evils of the workhouse or almshouse, the public authorities were attempting to make a similar distinction. Special provisions were made first for the mentally ill, then for dependent children. Relief in their own homes was permitted the aged and infirm. By the early 20th century in England and later in other countries special provisions were instituted for the able-bodied who were unemployed for reasons considered to be beyond the scope of personal fault By categorizing the poor on the basis of the supposed causes of their destitution, it was possible to relieve suffering without moral damage to the recipients of relief and without interfering with the free operation of the economic system.

Social Insurance. — Even more acceptable to the middle classes than categorization of the poor was social insurance. Here was a term and a concept borrowed from the commercial world Social insurance would place the relief of poverty on a "businesslike" basis. It would encourage thrift and provision for the future and would in no way pauperize the recipients of its benefits. Social insurance in most countries, therefore, developed during the early 20th century and has gradually been expanded to include most common risks and to cover most of the population. Poor relief on the other hand has never recovered from the slander of the 19th-century liberals and remains in most places a "residual category."

Credit for the development of modern social welfare services should not be given to the humanitarianism of the middle classes exclusively. The rise to political influence of the urban proletariat was perhaps more important. It was not possible to convince the labourers that an economic system which brought hardship and suffering to so many of their numbers was what nature intended or was divinely sanctioned. They had experienced or witnessed poverty which could not be attributed to moral infirmities but was the result of economic conditions beyond their control. The evil of government intervention was much less serious to them than the evils of free competition bridled only by monopoly. This relationship between the rise of organized labour to a position of political significance can be seen most clearly in the case of England There the acceleration in the enactment of labour and social welfare legislation coincided with the entrance of the trade unionists into parliament beginning in 1874.

On the continent of Europe the influence of socialism was probably more effective than either the labour movement per se or the humanitarianism of the liberals. In the United States the influence of organized labour was not crucial to the furtherance of social welfare measures until the period of the 1930s. The earlier advances there can be attributed to agitation by middle-class reformers and intellectuals.

In a sense it can be said that modern social welfare programs are the result of both the middle classes and the urban proletariat being willing to abandon their apocalyptic hopes and to attain their ends within the framework of constitutional democracy. The middle classes were the first to move from their original position. As the progress of industry led to larger accumulations of capital, men with small or middle-sized financial resources found it harder and harder to survive in competition with wealthy rivals. In practice it became apparent that the free market was an obstacle to all but a few. Although free competition continued to be considered the basis of society, genuinely competitive conditions called for positive action by the state. for tariff protection and antimonopolistic and other forms of remedial legislation.

By the 20th century most socialists also realized that they would be able to achieve their aims only by reforming the existing system through established institutions and they too turned to positive state action. The working-class movement had been able to accomplish much improvement in working and living conditions by strikes and other nonpolitical means but the only way to consolidate these gains was through legislation. Organized labour had also been able to protect its members to some extent from the risks of sickness, injury, old age and unemployment by collective bargaining and mutual benefit societies. but in order to provide wide coverage and adequate benefits it was necessary to turn to compulsory insurance which could be enforced by the taxing power of the state and subsidized from general revenues.

In the United States the movement from the poor laws to modern social welfare provision followed much the same pattern as in England and on the continent but at a much slower pace. This was probably because the nation was almost exclusively dominated by the middle classes during the 19th and early 20th centuries. Not only were there no groups comparable to the nobility and peasantry of Europe but, in addition, a politically conscious and influential labour movement did not appear until relatively late. Early reforms, therefore, were essentially the product of middle class activity and were concerned more with the regulation and control of business and with attempts to improve legislative and administrative processes than with the provision of social welfare services. Only with the impact of the economic depression of the 1930s and the rise to political influence of the labour movement during that period did public social welfare arrangements begin to equal those of Europe.

The change in attitude toward the poor and other unfortunates and toward the responsibility of the community which occurred in western nations generally between the early 19th century and World War I cannot, of course, be attributed solely to the disillusionment of the middle classes or the extensions of suffrage which brought the influence of the working classes to bear directly upon public policy. Other forces subtly altered the outlook of the public toward the social ills which beset those nations which were being industrialized at a rapid rate. For example, there was the fear of revolution threatened by socialists. communists and anarchists. Concern for the poor and for the plight of the working classes was encouraged by the papal encyclical *Rerum novarum* (1891) and by the Christian socialists; in the United States the Social Gospel movement encouraged Protestants to seek a solution to the social problems of the day (see LEO: Leo *XIII;* CHRISTIAN SOCIALISM). Improved means of communication and the spread of literacy brought to increasing numbers of people the facts of poverty and suffering and the remedies proposed by militant reformers. Recurrent business depressions began to dispel the idea that all was well with the economic and social system and that poverty could in many cases be attributed to individual fault.

Whatever the causes, the results of this change in attitude can be illustrated by the extent to which social insurance measures had been adopted by western industrialized nations prior to 1914. Laws providing compensation for industrial accidents were in force throughout practically all of Europe, in many of the British dominions and colonies and in about half of the United States. There were compulsory sickness insurance programs in Germany, Austria, Hungary, Great Britain and Norway and voluntary insurance was subsidized by government funds in most of the remaining European countries. Compulsory old-age insurance was operating in France and Germany. The first compulsory unemployment insurance system had been instituted in Great Britain and subsidized voluntary unemployment insurance coverage was available in many large European cities and nationally in Norway and Denmark.

In most countries the progress of social insurance continued after World War I. By 1930 practically the entire industrialized world had workmen's compensation in some form or another. Practically all of Europe had some form of social health insurance. Of the 27 countries in Europe. 23 had either old-age insurance or old-age pensions or both. By 1935, 19 European countries had nationwide unemployment insurance on either a compulsory or voluntary basis. Also in 1935 the United States adopted the Social Security act which provided a nationwide program of contributory old-age insurance, unemployment insurance, grants to the states for public assistance to the aged, the blind and dependent children, and for various health and child welfare services.

Other Developments. — Social welfare developments during the early 20th century were not, of course. limited to those in social insurance and public assistance. A few examples concerning the welfare of children will illustrate the range and nature of other improvements. As children were removed from the workhouses and almshouses there was resort first to free foster homes and private and public specialized institutions. Later, emphasis was placed on the value of boarding homes supervised by professionally staffed social agencies. The first juvenile court was established in Chicago in 1899 and the idea spread rapidly throughout the world. Great Britain and Canada adopted juvenile court laws in 1908, France and Belgium in 1912, Hungary in 1913. Austria and Argentina in 1919 and Germany and Brazil in 1923. Except for the Scandinavian countries, which adhered to the theory that children should not be tried in courts at all and gave responsibility for delinquent children to child welfare councils, the juvenile court system was gradually adopted throughout most of the world. Treatment of delinquent children was greatly improved by the development of probation services, and all nations gained from the experiences of the Borstal institutions for young offenders established in England in 1908 (see BORSTAL SYSTEM). The importance of family life to child development was emphasized by the first mother's pension act passed by the state of Illinois in 1911. (See also CHILD WELFARE.)

Perhaps the greatest advances in social welfare during this period were in the area of health and medical care. Medical research developed means to immunize whole populations against major epidemic diseases. Improved medical care and knowledge both decreased infant mortality and increased longevity. Advances in public health removed important obstacles to further urbanization and industrialization. Improved facilities for sewerage, water purification and food preservation diminished the dangers to health inherent in city living. The assumption of responsibility by the state for town and country planning. for standards of housing and for the provision of recreational facilities all contributed to the health and welfare of industrial communities. (See also PUBLIC HEALTH.)

A final example of the change in attitude toward social and economic conditions and individual maladjustment is the growth of the new profession of social work. particularly in the United

States and Great Britain. From the "scientific philanthropy" of the Charity Organization societies of the 19th century the knowledge and methods of social work developed to a point where university degrees were awarded for their mastery. By 1930 professional social workers were being called upon in increasing numbers to staff the public social services and to provide the leadership necessary to ensure that services provided would be of the greatest possible assistance to individuals for whom they were designed. See also SOCIAL SERVICE.

DEVELOPMENTS SINCE THE 1930S

The world-wide economic depression of the 1930s and World War II added new dimensions to the concept of social welfare and furthered its acceptance by all classes in the major industrialized democratic nations. The trend emerging during the 19th century had been from palliative and punitive measures to the provision of services and financial benefits which wouid compensate for the failings of the economic and social systems. Emphasis during the postwar period has been upon the responsibility of the community through voluntary and governmental action to correct such deficiencies.

The Atlantic Charter of 1941 proclaimed the intention of democratic nations to abolish poverty and establish freedom from want. It was realized by all countries that another prolonged depression might lead to the destruction of democracy and submersion of the free enterprise system. In addition, the industrial output and progress during the war that made possible a condition of full employment of all resources served as a challenge to all nations to maintain full employment after' the cessation of hostilities. If full employment could be maintained then freedom from want was a goal which could be realized, and each nation could establish a "national minimum" standard of living. Increases in productivity accompanying full employment would permit each individual to have a basic income which would supply his essential needs no matter what vicissitudes of life he experienced.

The ideas of full employment and of a national minimum both received detailed exposition in the Beveridge report published by the government of Great Britain in 1942. This report gained world-wide attention and was the inspiration for many of the social welfare developments during the postwar years. Among other matters the report emphasized the importance of family or children's allowances as it had been determined that about a quarter of all want in Great Britain was due to failure to relate income during earning to the size of family. The influence which this report had upon western nations is illustrated by the rapid increase in the number of family allowance plans following the publication of the report. Ireland and Canada established universal family allowance plans in 1944, making payments to all children of certain ages regardless of the income of their parents. New Zealand made its plan universal in effect during 1946, and Norway and Sweden instituted such programs in 1946 and 1947 respectively.

The Beveridge report was able to assume that full employment could be maintained not only because of the wartime record but also because of the "new economics" developed by John Maynard Keynes and his disciples throughout the world. Their theories rejected the classical economist's fear of government interference and instead emphasized the positive role which government must play in maintaining full employment and expanding production. They believed that there are many ways in which an economy can be helped by government toward full employment but they all must be aimed at encouraging consumption and investment and discouraging excess saving. Because of the emphasis on consumption, social welfare expenditures have come to be considered as instruments of fiscal policy as well as means for the relief of destitution and the improvement of social conditions. Their effectiveness from a fiscal point of view depends upon the extent to which they serve to redistribute income and maintain or increase consumption during periods of threatened economic recession.

It would be impossible to summarize all the social welfare developments since the 1930s as their complexity in any one country defies analysis. Progress has been made by all nations and this progress has been due to a great extent to increases in productivity and thus in national income. In order to establish freedom from want a nation must be producing sufficient goods and services to provide a basic minimum for all its inhabitants. For underdeveloped nations, therefore, the greatest contribution to over-all social welfare has been an increase in investment to increase productivity.

Some appreciation of the range in the proportion of total income devoted to social welfare services following World War II can be obtained from data published by the International Labour office in 1958. This report attempts a comparison of the total expenditures by various nations for compulsory social insurance, certain voluntary social insurance schemes, family allowances, special schemes for public employees, public health services, public assistance and benefits granted to war victims. The percentage of national income which was being expended for these services ten years after the war was for the United Kingdom 10.7%, for Canada 9.1% and for Australia 8.1%. In western Europe the percentage for the Federal Republic of Germany was 21.4%, for France 18.5%, for Italy 16.1%, for Sweden 11.1% and for Denmark 11.1%. The percentage for the United States was 6.6%. To account for these differences it would be necessary to study in detail the social, economic and political situations in each of the nations involved. Decisions regarding the appropriate level of social welfare expenditure are essentially political and made within the context of constitutional democracy in these countries. Crucial factors affecting such decisions are the total income available, the nation's concept of its national minimum and the relative influence of competing interest groups.

Some idea of the progress that has been made by the more wealthy nations can be obtained by examining in some detail the history and status of social welfare provisions in Great Britain and in the United States as representing the two major trends of governmental responsibility. In Great Britain, the trend has been toward the guarantee of a national minimum social security, with children's allowances, comprehensive health insurance, etc., available to all. In the United States, on the other hand, the trend has been toward the provision of public assistance for specified categories—dependent children, the needy aged, the needy blind and the needy disabled.

GREAT BRITAIN

Social welfare in Great Britain during the 19th century was characterized on the one hand by the brutal and repressive philosophy of the poor law reform of 1834 and on the other by a new reform movement by which the principle of governmental intervention in the interest of the well-being of the people was firmly established. As in most other western nations this progress toward modern social welfare was accomplished first by members of the middle and upper classes who were disturbed by the suffering occasioned by the free operation of the economy. They were joined during the latter part of the century by organized labour and socialists.

The movement began with a campaign against child labour. In 1802 Sir Robert Peel secured passage of a bill restricting the employment of pauper apprentices to 12 hours a day between 6 A.M. and 9 P.M. In 1819 Peel was joined by Robert Omen in bringing about the passage of a law forbidding the employment of all children under 9 years and restricting the work of children under 16 years to 12 hours between 5 A.M. and 5 P.M. Although this act applied to all children, it had limited usefulness as it applied only to the cotton industry and no effective means of enforcement were specified. Britain's coal fields also were the scene of important struggles concerning the regulation of working conditions, especially of women and children, and the development of trade unions (see COAL AND COAL MINING: *Mining and Miners*). The Factory act of 1833 both restricted child labour and provided for inspection. This protection granted children was the first of a long succession of laws designed to safeguard labour by providing better living and working conditions, by promoting health and sanitation, by developing housing and by encouraging education.

By 1847, for example, the working day for women and all persons under 18 years was limited to ten hours. A year later the first true sanitary measure, the Public Health act of 1848, was passed.

Labour's first attempt to gain influence in politics occurred during the decade which ended in 1848 when there were demonstrations and rioting aimed at achieving a people's charter which involved, among other matters, manhood suffrage. With the collapse of Chartism the workers turned from politics to the improvement of their economic status. In addition to bargaining for higher wages and better working conditions, they developed consumers' co-operatives, stemming from the teachings of Robert Owen. The beginnings of social insurance also were apparent as trade unionism emphasized mutual benefits through insurance against sickness, unemployment and old age. The improved position of labour resulting from these activities won respect and in 1867 suffrage was granted to urban workers and in 1874 the first trade unionist entered parliament.

The defeat of Chartism also brought the socialists to influence; of these the most important groups from the point of view of social welfare were the Christian Socialists and the Fabians. Christian Socialism was started in 1848 by J. M. Ludlow, Frederick Denison Maurice and Charles Kingsley and emphasized co-operative associations among the workers and education for the working classes. It did much to foster a sympathetic relationship between the church and the socialists and labour leaders. The Fabian society (*q.v.*) was founded in 1883, and among the nucleus which determined its policies were George Bernard Shaw, Sidney Webb, Sydney Olivier and Graham Wallas. The Fabians were concerned with immediate and practical reforms which they helped accomplish by issuing scores of publications, and by having individual members enter politics and public administration. The interests of the society were far-ranging and included women's suffrage, an eight-hour day, a minimum wage, housing, public education and poor relief. *(See* also SOCIALISM and SOCIALISM: PRINCIPLES AND OUTLOOK, the latter by G. B. Shaw.)

During the last quarter of the 19th century two other groups had at least indirect effect on England's progress in the field of social welfare. The first was the Charity Organization society founded in 1869 in London by Edward Denison and Octavia Hill and guided for 39 years by its general secretary Sir Charles S. Loch. Although the society espoused the principles of the reform of 1834 and opposed all forms of public relief, it did recognize that there were some deserving poor to whom assistance might be given if the purpose of the aid was to preserve the family, strengthen character and prevent poverty by helping people to be self-supporting. In addition, in the process of social investigation to separate the deserving from the undeserving, much knowledge was gained concerning the living conditions of the poor and their habits. The formal and informal reports of the visitors did much to convince the well-to-do that all poverty was not due to individual irresponsibility and that general social reform was needed.

The second group were social investigators which included parliamentary committees, royal commissions and individuals such as Edwin Chadwick, whose report on sanitary conditions to 1842 set forth facts which showed how environmental conditions contributed to ill-health and mortality. The most influential investigator was Charles Booth who undertook in 1886 his study reported in *Life and Labour of the People in London.* His investigation was detailed and scientific. He studied people by trades and by the districts in which they lived; he surveyed the conditions under which they worked, the size and quality of their homes. Also examined were hours of labour, rates of pay and the extent of unemployment and irregular employment. It was a study of all the people and he found that one-third of the population was on or about the line of poverty or below it. These findings were confirmed for a small city by Benjamin Seebohm Rowntree's study of York in 1900 where it was discovered that 28% of the total population of that city was in poverty.

The struggle between uncompromising individualism and the concept of government as a social force continued throughout the 19th century and into the 20th when an attempt to resolve it was made by the Royal Commission on the Poor Laws and Relief of Distress appointed in 1905. The important protagonists were represented on one side by representatives of the Poor Law division and the Charity Organization society, who constituted a majority, and on the other by representatives of the Fabian society and Socialist-Labour interests. As might have been expected, although there was some fundamental agreement among the commissioners, no single set of conclusions and recommendations was acceptable to all and majority and minority reports, therefore, were issued. Although the commission's responsibility was to concentrate on the poor law, its deliberations and two reports had implications for all of social welfare.

The two reports were in agreement in their rejection of the spirit of the poor law reform of 1834. Indicative of this was their insistence that the title public assistance be substituted for that of poor law or poor relief and that the emphasis in administration should be changed from deterrence to help, prevention and social provision. Both also agreed that there should be a national system of employment exchanges, unemployment and invalidity insurance and regularization of employment. The crucial difference between the two reports was in their ideas as to the future role of poor relief. The majority report saw the existing functions of the poor law carried out by public assistance committees appointed by the county borough councils with treatment and preferred assistance being provided by voluntary aid committees in each community. The minority report, led by Beatrice Webb, wished to do away with the poor law entirely and assemble its activities under existing agencies. These old poor law functions would be assigned to divisions in the county councils responsible for education, health, pensions and mental disease, with relief to the able-bodied to be administered by a ministry of labour to be created. Although the recommendations of the commission were not enacted into law immediately as was the case in 1834, they did signify a new attitude toward poverty and social welfare and were soon followed by a rapid extension of social insurance and public assistance outside the poor law and finally by the abolition of the poor law itself.

20th-Century Reform.—The general election of Jan. 1906 also provided evidence of a new attitude and was a revelation of the new forces that had been released by the 19th-century enfranchisement of the workers. The Liberal party received an enormous majority and labour itself had substantial representation. The leadership in parliament saw government as a means of social change and proceeded rapidly to enact national social welfare measures. The first invasion of the poor law came with the Provision of Meals act of 1906 whereby the local education authorities were empowered to supply meals to children unable to take full advantage of education by reason of lack of food. This was followed during 1907 by the Education (Administrative Provisions) act which provided for medical inspection and attention to the health and physical condition of public school children. In 1908 came the Old Age Pensions act which provided a flat weekly benefit to all those over 70 years whose income was below a certain amount and who, until 1919, were considered to be "deserving." Also in 1908 the Coal Mines Regulation act established the principle of the eight-hour day. In 1909 the Labour Exchanges act created a system of labour exchanges designed to attack unemployment by increasing the mobility of labour, and the Trade Boards act made a beginning at setting minimum wages.

The culmination of this period of social legislation came with the National Insurance act of 1911 which provided for compulsory health and unemployment insurance for certain industrial workers. Leadership in sponsoring this program was provided by Lloyd George. The intention of the government to adopt the principle of compulsory insurance was announced by Winston Churchill, and the details of the schemes were worked out by Sir Hubert Smith in collaboration with Sir William H. Beveridge. Both the health and unemployment plans were to be financed by contributions from employers, employees and the state, setting a precedent to be followed by future social insurance programs in Great Britain. Participation in the insurance was limited to manual labourers and to persons in other occupations receiving less than a prescribed amount of wages. Health insurance was administered through approved nonprofit groups organized by friendly societies (*q.v.*) or labour unions or as adjuncts of commercial insurance companies. Unemployment insurance was administered through a national system of employment exchanges. In 1925 the principle of insurance was extended to cover the eventualities of old age and death by the Widows', Orphans' and Old Age Contributory Pensions act of that year.

The social legislation beginning in 1906 made it possible for many more persons to avoid applying for poor relief when their earnings were interrupted but did nothing to alter the structure of the poor law itself. In 1918, however, some of the harshness was reduced by the removal of the disenfranchisement provisions. In 1919 responsibility for national supervision was placed in the newly created ministry of health, and in 1929 the local boards of guardians were abolished and their functions turned over to the county councils. By 1930 the tenets of 1834 had been discarded to the extent that aid was regularly being given to the able-bodied unemployed in his own home. This change in philosophy of poor law administration can be attributed, in part at least, to the failure of unemployment insurance to meet the need occasioned by the widespread unemployment which followed World War I and continued into the 1930s. Those forced to apply for relief as a result of the decrease in the number of jobs available could hardly be held personally responsible for their plight.

By 1931 the unemployment insurance plan had ceased to have any actuarial basis and the fund had long been insolvent. This situation had been caused by successive extensions of the period of benefits and the payment of "uncovenanted" benefits which assumed that contributions would follow when employment was obtained. The National Economy act of that year put the scheme back on an actuarial basis by increasing contributions and decreasing benefits, and a system of transitional benefits from national funds mas instituted for those no longer eligible. Need for these payments was determined by county public assistance committees who also administered poor relief. Although it was required that these allowances be in cash and that no work test be imposed, there was great dissatisfaction with the plan because of the great variation in amounts paid from county to county from national funds. A centralized national administration of puhlic assistance to the unemployed was finally established by the Unemployment act of 1934 which created the Unemployment Assistance board. Allowances set on a national basis were administered by national civil servants whose decisions were subject to review by local appeal tribunals. War-related responsibilities as well as supplementation of pensions and insurance benefits were assumed by the agency, which in 1940 became the Assistance board.

By the beginning of World War II in 1039 Britain had a fairly comprehensive public social welfare system. There were public medical services, a national health and unemployment insurance system. widows' and orphans' pensions, old-age pensions. public assistance and provision for the control and subsidization of housing and the supervision of town planning. These were supplemented by an extensive network of voluntary services. Wartime experience, however. emphasized that there were serious gaps and weaknesses in the existing system. The problems of evacuation. for example, showed that there were considerable inequalities between some of the medical services provided in the towns and in the country.

The aspirations of the people of Britain for a better and more economically secure life after the war were given official expression in 1942 in the famous Beveridge report on Social *Insurance and Allied Services.* It recommended the extension of social insurance so that a true national minimum and "cradle to the grave" social security would be available to all no matter what exigencies might occur. This interdepartmental report signed by Sir William H. Beveridge insisted, however, that this plan would be successful only if there was a system of children's allowances, if there were comprehensive health and rehabilitation services for all and if mass unemployment could be avoided.

With the end of World War II. Britain's public social welfare services were reorganized and enlarged to form such a comprehensive system. A series of acts forms the framework within which this system is still developing. The Family Allowances act. 1945, the National Insurance act, 1946. and the National Insurance (Industrial Injuries) act. 1946, were all based on the Beveridge report. The National Health Service act. 1946, established the machinery for operating the new health services. while the New Towns act 1946, and the Town and Country Planning act, 1947. created the conditions necessary for rebuilding the nation in a rational and orderly way. The National Assistance act of 1948 removed the last traces of the old poor law by providing that anyone in need should be assisted out of central government funds, while the Children act of 1948 provided for a more nearly equal chance in life for the child deprived of normal parental care.

With the poor law specifically repealed in 1948. the only qualification for public assistance is need according to standards provided in regulations which are subject to parliamentary approval and are revised from time to time according to cost of living trends. The amount of grant payable is determined by comparing any resources already available to the applicant with the figure at which his needs are assessed according to regulations. The figures are subject to addition for rent according to the amount paid and may be altered when particular circumstances so require. The provision of welfare services under the act, as distinct from financial aid, is the responsibility of the local authorities.

Child welfare services are also the responsibility of the local authorities and their cost is shared by the localities and the exchequer. By the act of 1948 it is the duty of the local authorities to receive into their care any child under the age of 17 who appears to them to have no parent or guardian. or who has been abandoned or whose parents are unable to provide for him temporarily or permanently. They must also accept children committed to them by the juvenile court or under the Matrimonial Proceedings act in exceptional cases resulting from divorce. Children in care are. if possible. boarded out with foster parents or rnay be placed in a children's home managed by a local authority or a voluntary organization. The children's officer of each locality is assisted by a staff of social workers who undertake inquiries, give help and advise in planning for the care and upbringing of individual children and supervise them in foster homes.

The development of comprehensive public social services in Great Britain has not deprived the voluntary agencies of a useful role in social welfare. They complement the statutory services and can often undertake work which is outside the scope of national and local agencies. Much of their work is now aided with public funds and in many branches of social service they act as agents of the public authorities. The larger societies concerned with children are Dr. Barnardo's Homes, the Church of England Children's society and the Catholic Child Welfare council. all members of the National Council of Associated Children's Homes. Valuable community service is still rendered by the 50 or so social settlements found in the poorer districts of the cities. In all large towns and many small ones there are Citizens' Advice bureaus. The Family Welfare association, which was founded in 1869 as the Charity Organization society, receives in its area offices in London applications for help from over 4,000 families and individuals a year. There are about 180 other welfare agencies which help families in difficulty or distress, while marriage guidance is given in over 100 centres, and the Family Planning association maintains about 200 clinics. Welfare services for the sick continue to be provided by the British Red Cross society, the Order of St. John, St. Andrew's Ambulance association and many others.

The United States

The history of social welfare in the United States cannot be traced in as orderly a fashion as that of Great Britain. In the United States social welfare functions have traditionally been considered as being exclusively within the sphere of the state governments with financial and administrative responsibility devolving to counties. townships and municipalities and until the 1930s there were only isolated instances of federal concern. The status of social welfare at any particular time. therefore, must be described in general terms since each state developed its provisions at a pace which reflected its needs, the status of its industrialization and the attitudes of politically dominant groups toward social welfare and particularly toward poor relief. Any consistency results from the fact that as each state enacted social welfare programs it benefited from the experience of those which preceded it. In addition, it is difficult to assess the influence of interest groups and changing economic and social philosophies. At both the state and federal levels dissatisfactions tend to be met by changes in policy by one or both major political parties rather than be expressed in a separate political movement. The influence of organized labour on social welfare, for example, is difficult to appraise. Prior to the 1930s it was the avowed policy of the American Federation of Labor to concentrate on collective bargaining and not to sponsor remedial social legislation. With the formation of the Committee for Industrial Organization (later called Congress of Industrial Organizations) and a change in leadership of the A.F. of L. the labour movement began to assume a positive political role and exerted a powerful influence on public policy, but always within the framework of the two-party system.

The early colonists had brought with them from England the methods of the poor law of the 17th century with its emphasis on local responsibility and administration. Because of the necessity for individual initiative and hard work in developing and expanding a new country. harsh attitudes toward those unable to support themselves were common and the settlement laws designed to protect localities from being burdened by paupers from some other place were stringently enforced *(see* POOR LAW: *United States)*. As in England at the time. persons who were dependent because of physical and mental disabilities were treated no differently than those unemployed because of some other factor, By the beginning of the 19th century the general attitude to ard the poor and toward public relief became even more punitive as the ideas of the Enlightenment had their effect and as legislation in the United States reflected experiences in England leading to the reform of 1834. Increasingly the almshouse was considered the most suitable and economical method of caring for those in need. Many states made county or township almshouse care mandatory.

The reforming and humanitarian zeal typical of the middle classes of this period uas concentrated on the abolition of slavery and the struggle for free public education Some attention. however, was paid to the problems of poverty. Robert M Hartley founded the New York Association for Improving the Condition of the Poor in 1841. This organization aimed at saving the "deserving" poor from the almshouse and emphasized moral aid rather than material relief. In 1853 Charles Loring Brace founded the New York Children's Aid society which was a pioneer agency in removing children from the almshouses and orphanages and placing them in foster homes. During this period beginnings were also made for separate provision for special classes of dependents under state government auspices. A school for the "deaf and dumb" was established in Connecticut in 1816 and another in Kentucky in 1822, both of which received some federal aid In 1841 Dorothea Lynde Dix began her crusade for the improvement of the treatment of the insane. She carried her cause personally to every state east of the Rocky mountains and in almost every instance her memorial to the state legislature was folloued by the erection of a state hospital or the improvement of an existing one Her memorial to the congress of the United States finally resulted in a bill being passed which would have granted public lands to the states for the care of the insane. The bill was vetoed by President Pierce on the basis that it would establish the principle of federal responsibility for "all the poor in all the states." This veto was used as a precedent for denying aid to the states for social welfare until the 1930s.

The period between the American Civil War and the opening of the 20th century was one of rapid industrialization characterized by business practices which were ruthless and predatory Although evidence of social deterioration such as the growth of slums and the poverty of immigrant and native workers did not go entirely unnoticed. all could be explained by the theories of *laissez faire* and Social Darninism. Some attempts at improving conditions, however, were made by three groups. First there were the state boards of charity and corrections. By 1867, 16 states had established such boards following Massachusetts' example of 1863. Their responsibilities were initially limited to inspection and supervision but later included the direct administration of prisons, reformatories, mental hospitals and other state welfare institutions. The second group was the Charity Organization societies which were found in 92 cities by 1877. Their philosophy and methods were similar to those of the London Charity Organization society, with emphasis on the individualized treatment of deserving applicants for aid and opposition to all forms of public relief. Their "scientific philanthropy" developed over the years into modern social work and its principal method, casework. The third group were the social settlements. The first settlement house was established in New York city in 1887. Perhaps the most important from the point of view of social welfare reform was Hull House founded in Chicago by Jane Addams in 1889. since the group assembled there were outspoken in their belief that government has a responsibility for the well-being of all the people.

While Great Britain was embarking on its great period of social legislation beginning in 1906, the United States was in the midst of the Populist revolt and the Progressive party movement. which began in the 1890s and continued until the nation's entrance into World War I. Primary emphasis during this period was on reform of state and local government and the control of business, but progress in social welfare was also made. After overcoming constitutional difficulties in 1908. for example, reformers began the process of achieving state laws on industrial accidents. occupational diseases, factory inspection and safety measures, regulation of child labour and special provisions to protect women in industry. Attempts to achieve a national child labour law were twice defeated by adverse supreme court decisions; not unti! 1938 were they successful. In 1909 Pres. Theodore Roosevelt called the first White House Conference on Children, which emphasized the importance of the family and the home. One result of the conference was the establishment in 1912 of the U.S. children's bureau. Among the most important of the new social welfare programs enacted during this period of economic, political and social reform were workmen's compensation, mothers' aid and pensions for the blind. The first established the principle of social insurance in the United States and the others achieved the first breakup of the poor laws.

In 1908 a federal Compensation act covering civil employees of the federal government provided a stimulus to the states to enact workmen's compensation laws. The first law to be held constitutional by the state courts was passed in 1911 and by 1920 workmen's compensation laws were in effect in 43 states. Alaska and Hawaii. The White House conference had encouraged concern for the welfare of children left orphaned or abandoned or taken from poverty-stricken parents. and so laid the groundwork for the development of mothers' aid legislation. The first state-wide mothers' pension lam was enacted in Illinois in 1911 and, by 1913. 17 states had followed its example. The needs of the blind also gained early recognition. The first special pensions for them were provided by Ohio in 1898 and by Illinois in 1903.

Other important social welfare developments during this period included the expansion of public parks and playgrounds and the establishment of voluntary recreational agencies; the growth of state and local public health departments and the improvement of public health services; the strengthening of child welfare services and the spread of the juvenile court idea; and the rise of philanthropic foundations devoted to social welfare such as those of Carnegie, Rockefeller and Russell Sage. Finally there was the development of Community Chests and Councils of America to co-ordinate the financing and activities of the many social welfare agencies by then found in all population centres.

The social reform movement which haited at the time of the United States' entrance into World War I did not resume following the Armistice until the economic depression of the 1930s. During this period of relative complacency, however. some advances were made. In 1920 the federal government offered grants-in-aid for the vocational rehabilitation of disabled persons. The following year funds were provided the states to help support maternal and child health services. All but three states were receiving grants under this program when it was discontinued in 1927 Further breakup of the poor law occurred when Montana and Nevada passed old-age assistance laws in 1923. By the end of 1929. 11 states had such provisions.

1930s to World War 11.—The depression of the 1930s found the social welfare provisions of the United States wholly inadequate to cope with the needs of the millions of unemployed men and women. Except for the few categories already mentioned, poor relief was almost entirely locally administered and locally financed. The rapid increase in relief loads during 1930 and 1931 placed an impossible burden on local, and particularly municipal. finances. The first shift in responsibility was to the states. New York was the first to establish a temporary relief administration and was followed by seven states prior to May 1932. In that month congress passed the Federal Emergency Relief and Construction act, marking the beginning of federal responsibility, which ofiered emergency loans to the states to help meet the costs of relief. Only six states did not take advantage of the offer.

Franklin D. Roosevelt's inauguration as president in March 1933 marked the beginning of a new era. On the basis of the country-wide support he received in 1932 and 1936 he was able to insist upon the enactment of a wide assortment of social welfare legislation. Important in this regard was the backing he received from the now politically articulate labour movement.

The first measure enacted to relieve the plight of the unemployed established the Civilian Conservation corps (March 1933 to July 1942). This program provided workcamp employment to over 3,000,000 young, unmarried men during the ten-year period. In May 1933 the Federal Emergency Relief administration was established and given authority to make grants to the states for both work relief and direct relief. The administration mas created for two years and all powers were to be exercised by the administrator. Harry L. Hopkins. This program lasted until the autumn of 1935 and expended a total of $3,000,000,000. The FERA exerted a lasting influence on the administration of public assistance, particularly through its requirement that public funds must be administered by public agencies and its encouragement of relief payments in cash rather than in kind. Between November 1933 and March 1934 the FERA was temporarily discontinued and replaced by the Federal Civil Works administration, which was a gigantic federal works agency offering to pay wages to 4,000.000 unemployed if state and local governments would put them to work. Other social welfare programs enacted by congress prior to 1935 were the Public Works administration (1933–42) which aimed at stimulating the economy with large-scale construction projects, the U.S. employment service (1933) and the Federal Surplus Commodities corporation (1933—later called Surplus Marketing administration), which purchased farm surpluses and distributed them to public assistance agencies.

When the FERX was discontinued it was replaced by the Works Progress administration (1935–42) which was designed to give work to all needy persons who could work and to return responsibility for the "unemployables" to the states. The National Youth administration (1935–42), which was first a part of the WPA and later an independent agency, provided part-time employment for needy school and university students and others, helped establish job training and counseling programs and encouraged the development of constructive leisure time activities for youth.

In June 1934. President Roosevelt set up a special cabinet committee on economic security. to make recommendations concerning a comprehensive program relating to old-age security and uncmployinent, sickness and health insurance. A report of the committee was transmitted to congress on Jan. 17, 1935. The resulting Social Security act which became law on Aug. 14, 1935, marked a new stage in the acceptance by the federal government of responsibility for the welfare of all citizens. It established a national contributory old-age retirement annuity system for workers in industry and commerce and laid the basis for a nationwide system of insurance to protect persons against the risks of short-term unemployment. In addition it provided for federal grants-in-aid to the states for old-age assistance, aid to the blind and aid to dependent children and for maternal and child health services. child welfare services services for crippled children and vocational rehabilitation.

Since 1935 most impoitant social welfare developments have been extensions or improvements of the Social Security act. Three later federal acts, however, must be mentioned. The Fair Labor Standards act of 1933 prescribes national standards for wages, hours. working conditions and child labour applicable to firms producing goods destined for interstate commerce. In 1946 congress passed the Employment act. which declares that it is the continuing policy and responsibility of the iederal government to promote maximum employment. production and purchasing power. The National Mental Health act (1946) is designed to provide a method for financing research and training programs and to assist the states in establishing community mental health centres.

Social Insurance.— By 1060 the limited old-age benefits of the Social Security act of 1935 had become the Old Age, Survivors and Disability Insurance program. In 1939 benefits were extended to certain dependents and survivors of eligible persons. in 19.56 to disabled individuals 50 years of age and over and in 1960 to all eligible disabled persons and their dependents. Coverage of the program had been successively extended until nine out of ten workers were included. Since 19.50 congress has regularly revised the benefit schedule to reflect changes in the cost of living.

Unemployment insurance, adopted by all states shortly after the passage of the Social Security act, underwent little change during the ensuing years and in some aspects regressed. Coverage remained as limited as in 1935 except: that in 1954 it was extended from employers of eight or more persons to employers of four or more. No standards as to amount and duration of benefits had been imposed by the federal governrnent and benefits stated as a percentage of average wages had generally decreased since the prograni was introduced.

Workmen's compensation had remained since its beginnings in the early 1900s a state-controlled program providing benefits and medical care to persons injured, and benefits to survivors of those deceased, in the course of employment. Because of the complete lack of centralized supervision and standard setting. there was a confusing array of coverage provisions, benefit levels and administrative arrangements.

Public Assistance.— Despite the extension of social insurance, about 4 persons out of every 100 in the population were dependent upon some form of public assistance during 1960. They were in need and either ineligible for benefits provided by other public programs or, if eligible, received insufficient amounts. This assistance was provided by the states and localities with the help of the federal government under the three categories of the Social Security act of 1935 and a fourth category, aid to the permanently and totally disabled, established in 1950. Those in need but not eligible for any of the federally aided programs depended upon general assistance or poor relief, which in most states was still locally administered and financed.

All 50 states had programs of old-age assistance which provided aid to persons over age 65 who were in need, aid to dependent children which assisted needy families with children who had lost support or care because of a parent's death, incapacity or absence from the home, and aid to the blind. All but seven states had legislation providing aid to the permanently and totally disabled. Financial participation by the federal government in the case of each one of these programs was computed as a percentage of the average grant paid by each state up to a specified maximum. Since 1958 this percentage has varied to some extent in accordance with differences in per capita income among the states.

Federally aided public assistance is superior to poor relief primarily because of the requirements state programs must fulfill in order to be eligible for grants-in-aid. ' These requirements are aimed at protecting the needy individual's right to public assistance if he is eligible according to standards set by the state. For example. assistance must be available in all subdivisions of the state. all persons must have an opportunity to apply for assistance and have their applications acted upon within a reasonable time, and an opportunity for a fair hearing before the state agency must be provided anyone whose claim is not acted upon within a reasonable time. The federal government also requires that assistance be given in the form of money or medical care. This provision has been interpreted as preventing any restriction on the recipient's use of the money payment. He may spend it as do others in the community and continue to live in his own home without interruption of family life. This aspect has been particularly emphasized since 1956 when congress declared that a major purpose of public assistance administration was to promote the well-being of the nation by encouraging the states to place greater emphasis on helping to strengthen family life and helping needy families and individuals attain the maximum economic and personal independence of which they are capable.

The federal government in its requirements sets no standards as to what constitutes a national minimum for health and decency. Each state. 'therefore. is responsible for determining who are needy people and how much they will receive under a given program. States differ both in their definition of need and the degree to which they decide to meet need as determined. One state may provide for some medical needs in its old-age assistance program. but not for its aid to dependent children program, while another state may make no provision whatsoever for medical care. In 1960 average payments per recipient for old-age assistance, for example, ranged from a low of less than $30 per month in Mississippi to more than $100 per month in Connecticut. States not only differ in the amounts of assistance they are able or willing to pay, but also in their definitions of what resources an applicant may retain and still be eligible. Policies vary greatly, therefore, with respect to the responsibility of relatives, the value of life insurance, cash reserves and the ownership of real property.

The federal government also permits the states to require a certain period of residence in the state before an individual can be eligible for aid. Such provisions, reminiscent of the settlement provisions of the old poor law, occurred in the legislation in alinost all of the states. For old-age assistance, however, less than half the states required as long a period as the Social Security act permits; *i.e.*, five of the last nine years. The common residence requirement for aid to dependent children was one year.

Those needy individuals and families who cannot qualify for one of the federally aided categories of public assistance must resort to general assistance. which is administered in most states on a local basis in much the same manner as the poor law of the 19th century. Such aid is usually given in cash but frequently in the form of orders for groceries, rent and other items. In most states it is provided only to unemployable persons. and nonresidents are aided only in emergencies with arrangements being made for their return to their state of residence as quickly as possible.

Medical Care. — The greatest gap in social welfare is in the area of medical care., While in Great Britain health services are freely available to all, not even state-supported health insurance is available in the United States. The movement for compulsory health insurance began during the depression period of the 1930s. and was almost successful during the years immediately following World War II. As of 1960. however, the only government supported care available to all persons was that provided to needy individuals and families eligible for public assistance. and onlv ten states provided relatively comprehensive medical care under such auspices. More liberal eligibility requirements for medical assistance to the aged were made possible under the Social Security act amendments of 1960 if the states wish to adopt such plans. Most protection against the costs of illness is provided by voluntary health and hospital insurance plans contracted for by individuals or by employers for their workers. According to the Health Foundation study in 1953, 60% of the families having hospital expenses had 80% or more of their expenses met through insurance. (See HEALTH INSURANCE.)

Social Welfare and Collective Bargaining. — One of the important reasons for the relatively slow development of public social welfare services, especially those dealing with medical care, has been the fact that organized labour has apparently been able to obtain many health and welfare benefits more easily through collective bargaining than through legislation. In 1958 the total cost of these "fringe benefits" was about 6% of all wages and salaries; 70% of all wage and salary workers were covered by life insurance, about 65% were covered for costs of hospital care and surgery, 46% for regular medical care and 11% for major medical expense. In addition, over 50% of all private industry employees were eligible for temporary disability payments, 40% for supplements to retirement benefits available under the Social Security act and 4% for supplements to unemployment insurance.

Voluntary Programs. — Private social welfare agencies continue to fulfill an important function despite the expansion of governmental programs. Their services are so numerous and so varied as to make summarization impossible. In a typical urban community will be found both sectarian and nonsectarian family service agencies, child welfare agencies, mental health clinics, home nursing services, medical out-patient clinics and a variety of recreation and group work agencies. Certain national agencies such as the American Red Cross and the National Traveler's Aid association also have branches in many localities. The financial support for these agencies is for the most part obtained by private donations although public subsidy of private child welfare agencies and mental health clinics is common. Fund raising for local agencies and local branches of some national agencies is usually accomplished through a federated appeal. In most communities the co-ordination of services is the responsibility of a council of social agencies or health and welfare council to which most public and private agencies belong.

INTERNATIONAL SOCIAL WELFARE

International social welfare programs have increased and expanded with the growing realization that the development of human resources is the real key to a better way of life for the peoples of all countries and that relieving poverty. ill-health and misery is an important part of the task of maintaining peace. The focus of such activity is in the United Nations where the Department of Economic and Social Affairs of the UN secretariat administers a world-wide program of research. technical assistance, community development and information. The principal organ of the United Nations in the social field is the Economic and Social council. Policy recommendations for this group are developed by the UN Social commission and carried out by the Bureau of Social Affairs and Advisory Welfare Services.

Other social welfare activities are carried on by specialized agencies which have been established by intergovernmental agreement and are co-ordinated by the UN Economic and Social council. The World Health organization (WHO) helps combat disease and epidemics throughout the world. The United Nations Educational. Scientific and Cultural organization (UNESCO) assists governments to eradicate illiteracy. The Food and Agriculture organization of the United Nations (FAO) seeks. among other things. to overcome chronic food shortages. The U S high commissioner for Refugees supervises the application of the international convention relating to the status of refugees. The oldest of the specialized agencies is the International Labour organization (ILO) which gives special attention to problems of income security and labour legislation. See also SOCIAL SECURITY; SOCIAL SERVICE: WORKMEN'S COMPENSATION.

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SOCIETY ISLANDS: *see* Pacific Islands.

SOCIETY OF JESUS: *see* Jesus, Society of.

SOCINUS, the latinized form of the Italian Sozini, Sozzini or Soccini, a name borne by two Italian evangelical rationalists of the 16th century, whose influence survived in Socinianism and subsequently in Unitarianism (*q.v.*).

1. Laelius Socinus (Lelio Francesco Maria Sozini) (1525–1562) was born at Siena on Jan. 29, 1525, and was educated as a jurist at Padua. He later told Philipp Llelanchthon that his desire to reach the *fontes juris* led him to biblical research. At Chiavenna in 1547 Laelius came under the influence of Camillo Renato. He traveled extensively as a student, questioning the reformers, and in 1547 matriculated at Basel. He was successively at Geneva. Basel, Zurich, Wittenberg, Prague, Vienna and Cracow (1549–51). Political events drew him back to Italy in June 1552. He was at Padua at the time of Michael Servetus' execution (Oct. 27. 1553), and then was in Basel (Jan. 1554), Geneva (April) and Zurich (May), which became thereafter his principal residence.

Of the reformers, Heinrich Bullinger was Laelius' closest and wisest friend. Laelius' theological difficulties turned on the resurrection of the body, predestination, the ground of salvation (on these points he corresponded with Calvin). the doctrinal basis of the original gospel, the nature of repentance and the sacraments. The fate of Servetus directed his mind to the problem of the Trinity. At Geneva (April 1554) he made incautious remarks concerning the doctrine; and Bullinger questioned him as to his faith, receiving from him an explicitly orthodox confession with, however, a frank reservation of the right of further inquiry.

In 1556. after the death of his father, who had disinherited him, Laelius was involved in pecuniary anxieties. He visited in 1558 the courts of Vienna and Cracow to obtain support for an appeal to the reigning duke at Florence for the recovery of his patrimony; but. fearing the Inquisition. he did not go beyond Venice. In Aug. 1559 Laelius returned to Zürich. where he died on May 14. 1562.

In addition to letters and his confession of faith. two more radical writings recently have been ascribed to him. His library and unpublished writings greatly influenced his nephew and heir.

2. Faustus Socinus (Fausto Paolo Sozzini) (1539–1604) was born in Siena on Dec. 5, 1539. the only son of Alessandro Sozzini, brother of Laelius. Orphaned young, Faustus had no regular education, being brought up at home with his sister and spending his youth in desultory reading. When his uncle Laelius was pursued by the Inquisition. Faustus considered it advisable to leave Italy for Lyons (1559–63). where he engaged in business. In 1562 he identified himself with the Italian congregation in Geneva, and at the death of Laelius went to Zurich in May 1562 to gather up his uncle's papers and settle his affairs. About this time Faustus composed his *Explicatio* of the Prologue of St. John (related to an earlier work of his uncle's), in which he wrote of Christ as divine by office rather than by nature. In a letter from Lyons, dated 1563. to an Italian, he announced a second principle of his theology, the natural mortality of the soul.

Toward the end of 1563 he returned to Italy, outwardly conforming to the Catholic Church. and for 12 years was in Florence in the service of Isabella de' Medici, daughter of the grand duke of Tuscany. He apparently studied law at this time. At the instance of "a great personage" he wrote (1570) his treatise *De auctoritate s. scripturae*. In 1571 he was in Rome. probably with his watroness. He left Italy suddenly at the end of 1574 and settled at Basel. There he began translating the Psalms into Italian verse. and. in dispute with Francesco Pucci, composed *De statu primi hominis ante lapsum,* arguing again for the natural mortality of man even before the Fall. His discussion with Jacques Couet, Protestant minister in Paris. on the doctrine of the atonement was issued in a treatise, *De Jesu Christo servatore,* finished July 12, 1578. and published in Poland in 1594. In it, as earlier in the *Explicatio,* he stressed Christ's humanity and passibility. The Word or will of God appeared in the form of flesh, a man. Christ's resurrection, rather than his death. is the action that enables his devout followers likewise to look forward to resurrection in spiritual bodies. After the resurrection, Christ ascended to take his place at the right hand of God, henceforth sharing in God's power. Thus Christ, though in nature purely human, as the adoptive Son is worthy of adoration, for to him God Almighty bestowed after the ascension the government of the world.

The Basel manuscript of *De Jesu Christo servatore* was read by Giorgio Blandrata (*q.v.*), court physician in Transylvania (*q.v.*). It was Blandrata's object to limit the judaizing innovations of the eloquent Unitarian bishop Francis Dávid (1510–79), which might jeopardize the religious settlement reached earlier under King John Sigismund. Socinus' full justification of the adoration and invocation of Christ within a forthright unitarian theology commended his treatise to Blandrata, who thereupon called Socinus to Kolozsvár to reason with Dávid. During a visit of four and a half months (1578–79) Socinus tried in vain to persuade Dávid to adopt his doctrine. Dávid instead from his pulpit exerted all his powers in denouncing the cultus of Christ, and his civil trial followed. Faustus cannot be accused of complicity with what he himself called the rage of Blandrata, but his references show that theological aversions froze up his native kindness.

The remainder of Socinus' life was spent in Poland. The main positions in his theological system had been worked out before he became involved in the struggles of the Unitarians of Transylvania and the Polish Brethren. He considered the Bible as a revelation of the way to eternal life through following the teachings and example of the man Jesus Christ. who, like all men. was mortal but who, by obedience unto death, had been vindicated by God in the resurrection and ascension. Socinus held that all who accepted the good news of biblical obedience and persevered in evangelical belief and behaviour to the end would be resurrected at Christ's second advent. Those who failed to live evangelically would remain in the dust. Socinus recognized two ordinances, the Lord's Supper and baptism, the latter reserved for converts from outside the Christian community, such as Jews and Muslims.

Excluded at first by his views on baptism from the antitrinitarian, anabaptist Minor Church centred in Raków, Socinus acquired by degrees a predominant influence in its synods. He converted the Arians of Little Poland from their avowal of Christ's preexistence. and most of the Lithuanian Unitarians under Simon Budny from their rejection of the invocation of Christ. Through correspondence with friends he continued to influence the policy in Transylvania. Against Budny and Jacob Palaeologus, and in line with the anabaptist Racovians, he insisted on the unlawfulness not only of war but also of the taking of human life in any circumstances, hence, his contention that magisterial office is unlawful for a christian.

A pacifist, he left Cracow to reside (1583–85) with a Polish noble, Christopher Morsztyn, whose daughter Elizabeth he married (1586). In Oct. 1590 the inquisition at Siena deprived him of his inheritance. He began, therefore, to publish in his own name, with the result that in 1598 a mob finally expelled him from Cracow. At the end of his life he was working on *Christianae religionis brevissima institutio,* which became the basis for the Racovian Catechism, a statement of Socinian principles published at Rakow in 1605. He died at Luslawice on March 4, 1604.

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SOCIOLOGY. Sociology is one of the several specialized social sciences. Its primary objective is to gain a knowledge of man and society insofar as it may be achieved through investigation of the elements, processes, antecedents and consequences of group living.

Sociology is differentiated from the other social sciences primarily by the basic fact with which it starts. the fundamental assumption which underlies its activities. and the problems with which it is concerned. The basic fact is the relative helplessness of the human infant at birth who is always born into, and depends for his survival upon, a social group. The fundamental assumption is that the conduct of the person—his ways of thinking and ways of acting—and the nature of the social orders—its structure. function and values—are to be understood as a product of group life. The problems with which sociology is concerned may be stated as a long list of specific items but, more appropriately, may be generalized into broad groupings oi subject matter such as those represented by social organization, social psychology, social change, social disorganization, human ecology and population. Each of these broad fields of sociology may be further divided into subfields, and all are concerned with problems of theory and method.

As a science, sociology. contrary to popular misconception justified in part by its early history, does not have as its objectives the determination or modification of social values, the proposal of reforms. the design or administration of welfare programs or the direct promotion of a better social order. These are important objectives to be sure. but they are the tasks of the social engineer such as the statesman, the administrator, the legislator, the educator, the social worker, the clergyman. the labour leader, the agitator and the propagandist. rather than that of the sociologist as such. As a scientist the sociologist is concerned only with the pursuit and funding of knowledge about man and society. In such knowledge which ideally comprises generalizations drawn from empirical and verified investigation. the sociologist strives to understand and to achieve prediction of human conduct and social phenomena. To the sociologist, values are among the data which he studies and not the end product of his labours.

HISTORY OF SOCIOLOGY

The word sociology was first used by August Comte (1798–1857) in 1837 in a series of lectures on which his famous work Positive Philosophy (6 vol., 1830–42) was based. His coining of this term, a hybrid of Latin and Greek still disliked by many users of the king's English! has led him to be regarded by a number of writers as the founder of sociology. Yet, his conception of sociology as an all inclusive general social science—a synthesis of all knowledge about "humanity" which he used in the sense of the universal society—and his promotion of "positivism" as the foundation for the mystical religion of humanity which he proclaimed in his later life, are widely divergent from contemporary conceptions and practices of sociology. Comte did make a great contribution to the social sciences in general in producing a synthesis of the social thought of the century which preceded him, beginning with the work of David Hume, in laying great stress on the application of the positive method to social phenomena—a method of observation, experimentation and comparison—and in his evaluation of the importance of studying laws of succession and association of phenomena rather than cause. It is more accurate to say that Comte in his classification of the sciences and his description of their development made a place for and heralded the approach of sociology, rather than that he founded it.

The history of sociology. in a loose sense, began centuries before Comte. but, like all history, has no clear-cut beginning. Historians of sociology, at least those who have published histories of sociology or of social thought. have variously begun their accounts with ancient civilizations (*e.g.,* Pitirim Sorokin, Joyce O. Hertzler or Emory S. Bogardus). with the Greeks (*e.g.,* Floyd N. House, Harry E. Barnes or James P. Lichtenberger) or with 19th-century thought (*e.g.,* P. Barth. Albion W. Small).

If the genesis of sociology is traced to folk, philosophical. political and legal thought about man and society, then sociology had its beginnings in the earliest records of human thought in the ancient civilizations of Egypt, Babylonia, Assyria, Persia, India and China. If sociology is rigidly defined as a specialized empirical social science, then it may be said that it certainly did not begin before the 20th century. It is much less important, however, to fix a precise date for the beginning of sociology as a science than it is to have an understanding of what it aims to do, of the problems with which it is concerned and of some of the main currents of thought which led to its emergence.

Social Thought Prior to the 19th Century.—The history of sociology, in the loose sense referred to above, is essentially the history of social thought through the ages—a heritage which sociology shares with all the sciences, natural and social. Although various aspects of social thought, from the earliest human records which can be traced back 5,000 to 6,000 years to the dawn of the 19th century, have special implications for the development of sociology, only the briefest mention can be made of them. Ancient literature and relics contain keen insights into interpersonal relations. group life, social control, social organization, social stratification, human nature, and social institutions, including the family, the state and property. But early social thought was essentially of a pre-scientific character, for it was largely of a common-sense nature, sporadic, traditional and unverified, and suffused with the interventionism of the supernatural.

Systematic social thought, at least in a form which has been reasonably well preserved, originated with the Greek philosophers. Beginning with about 600 B.C. a remarkable series of Greek thinkers became preoccupied first with the ,world of nature and then with the world of man. The Greek philosophers. and especially Plato and Xristotle, provided penetrating analyses of the relation of man to society, of social institutions and of social processes; contributed to important methodological developments; and originated basic elements of social theory which have remained in the focus of intellectual discussion ever since.

Despite the setting of the stage for the development of science by the Greeks. natural science did not develop until 2.000 years after Thales (c. 640–*c.* j46 B.c.) and social science until more than 2,000 years after Xristotle (384–322 B.c.).

By the 15th and 16th centuries: however. the combined influences of a number of events produced the revival of learning manifested in humanism and naturalism. and the way was clear for the resumption of critical social thought. By the end of the 17th century, natural science had forged a relatively secure place for itself, and thought about the social as well as the natural world had become largely secularized.

Nineteenth-Century Influences.—By 1800, many interrelated intellectual pathways led to the consideration of various aspects of man and society and a number of them contributed to the emergence of the science of sociology. The way had been paved for the application of scientific method to social phenomena by such men as G. B. Vico (1668–1744) and C. Montesquieu (1689–175j); quantitative methods had been applied to population phenomena by the "political arithmeticians" such as William Petty (1623–87) and John Graunt (1620–74); and important insights into central sociological problems had appeared in the writings of the "Scottish moralists," Francis Hutcheson (1694–1746) and Adam Ferguson (1723–1816).

Major influences on the development of sociology in the 19th century were exerted by scholars who dealt with substantive and methodological problems n·hich, at least implicitly, helped delineate a field and methods for the social sciences, in general, as well as for sociology in particular. These writers may be classified into groups, not mutually exclusive, organized around leading ideas. The ideas may be broadly grouped into three categories: first, those focusing on problems which set the stage for, or themselves became, central problems in sociology; second. those emanating from biology, which exerted an important influence on early sociology; and third, those concerned with methodology and techniques of research. In addition to these ideas, the emergence of sociology was also influenced by ideas and programs of social reform, which on the one hand stimulated interest in sociology and on the other confused its role as a science.

Ideas Related to Central Problems.—The writers contributing to this category of ideas may be classified into a number of groupings, also not mutually exclusive. These included the scholars who dealt with the nature of the historical process, the distinction between the state and society, the nature of culture, folk psychology, the analysis of self-consciousness, the influence of the physical environment, the role of "social forces" and "interests," the economic activity of man and the population problem.

The writers who inquired into the nature of the historical process sought to relate successive events and to generalize from the experience of history. They devoted considerable attention to the question of whether history could or should generalize as against reporting unique events. Important participants in this development included Immanuel Kant. J. G. Fichte. G. W. F. Hegel, Karl Marx, Wilhelm Dilthey and Wilhelm Windelband.

In early social thought the "social" was largely synonymous with the "political." Preoccupation with the state precluded attention to other aspects of society. The scholars who differentiated between the state and society helped to point up the need for the study of the nonpolitical aspects of the social order. Thus they made explicit in their affirmation or opposition the need and place for a new science. They included such men as Robert von Mohl (1799–1875), H. von Treitschke (1834–96) and Ludwig Stein (1859–1930).

Also made explicit during the 19th century was the idea of culture as a thing in itself. It was emphasized that culture, both in its material and nonmaterial aspects, could be studied historically and comparatively to illuminate the nature of man and society. Early culture historians and anthropologists included Friedrich Ratzel (1844–1904), Adolf Bastian (1826–~yoj), Alexander von Humboldt (1769–1859) and Lewis H. Morgan (1818–81). These men, and others, collected a mass of data on the cultures of diverse people, and their efforts to compare. analyze and explain similarities and differences helped stimulate the sciences of anthropology and sociology.

Another group of writers were expressly concerned with "folk psychology" and with the relation of folk psychology to the individual mind. Their analysis of folk psychology and the "collective mind" led them to explanations of human nature and of individual traits as arising from culture. These writers defined one of the central problems of sociology in its contemporary sense in highlighting the dependence of a person on the social group and describing personality as a subjective aspect of culture. They included such men as Johann F. Herbart (1776–1841), the Grimm brothers Jacob (1785–1863) and Wilhelm (1786–1859), Moritz Lazarus (1824–1903), H. Steinthal (1823–99) and Wilhelm Wundt (1832–1920).

Closely related to the study of folk psychology and the nature of the mind was the analysis of the growth of self-consciousness. The description of self-consciousness as a phenomenon dependent upon society and arising in social interaction continued to play a central role in mid-20th century social psychology. Contributors to this analysis included Von Humboldt, Georg Simmel (1858–1918) and James M. Baldwin (1861–1934).

Although ancient and early modern scholars were concerned with the influence of environment, various streams of thought during the 19th century led to more intensive investigation into the influence of geographic factors on social organization and human behaviour. Geographers and anthropo-geographers who investigated this problem varied in their conclusions from strict environmental determinism to more modern indications of the limiting influences of physical environment. These writers helped pave the way for the science of sociology in general, and more specifically for contemporary sociological interest in human ecology and regional studies. They included such men as Karl Ritter (1779–1859), H. T. Buckle (1821–62), P. G. F. LePlay (1806–82) and Vidal de la Blache (1845–1918).

Another central problem in early sociology originated in the writings of the scholars concerned with "social forces," "interests" and the social process. The notion of social forces appeared in the historical literature in efforts to explain events in terms of their underlying and antecedent factors. The notion. however, was also used more generally to explain basic human and group behaviour. Among the writers who sought explanations of behaviour in social forces and interests were: Buckle; Ludwig Gumplowicz (1838–1909), Gustav Ratzenhofer (1842–1904) and Gabriel Tarde (1843–1904).

The development of economics during the 19th century represented the emergence of perhaps the first of the social sciences to a position of respectability and general acceptance. The description of the economic man as a rational, calculating. hedonistic person stimulated interest in individual motivation and in the analysis of rational behaviour. The emphasis placed by economic writers on the division of labour led to investigation into its relation to the social structure and process. Especially noteworthy among the writers on economic matters were Adam Smith, David Ricardo, Jeremy Bentham and J. S. Mill. An important offshoot of classical economic thinking was that represented by critics of the new industrial order and of classical economics, manifest largely in the writings on socialism. In this literature the names of Karl Marx and Friedrich Engels were outstanding.

Closely tied in with, and contributing to, economic thinking were the discussions of "the population problem." Dramatized by Nalthus, whose "law of population growth" was originally presented as a refutation of Condorcet's and William Godwin's notions of perfectionism, consideration of the relation between population and means of subsistence occupied considerable attention in the world of practical affairs, as well as among scholars. Writers concerned with population and with the antecedents and consequences of population growth included, besides Malthus, Francis Place (1771–1854), Archibald Alison (1792–1867), Adolphe Quetelet (1796–1874), Karl Marx and Herbert Spencer.

Ideas from Biology. — Important developments in biology during the 19th century, climaxed by the theory of evolution, contributed both directly and indirectly to early thought in sociology. The influence of biology on sociological thinking may be considered under four groups of ideas; namely, the theory of evolution, the "organic analogy," the problem of "heredity versus environment" and the theories of racism.

One of the most dominant influences on 19th-century thinking, in general. was that exerted by the theory of evolution. Stimulated by Malthus' discussion of the "struggle for existence" and with the taxonomic labours of Linnaeus available, Alfred R. Wallace and Charles W. Darwin independently published their epic making contributions which made evolution the cornerstone of social as well as of biological thinking for decades. Evolutionism was quickly adopted by students of social phenomena as a basic explanatory principle applied to the social order, as well as to the biological. Among the writers who adopted social evolutionism were Walter Bagehot (1826–77), John Fiske (1842–1901), Gumplowicz, Ratzenhofer and Spencer.

In addition to providing the principle of evolution, biology also exerted an important influence in the development of sociology in the writings of the scholars who compared society with an organism. Impressed by the organic character of society, a number of writers described the social order in terms paralleling the biologist's description of an organism. The organic analogy. while subject to the limitations of all analogies. did perform the function of directing attention to the organic character of society and stimulated more intensive inquiry into the nature of the structure and function of the social order. It led special attention to consideration of those aspects of society that made the social whole more than a sum of all its parts. Among the writers to utilize the organic analogy were Comte. Spencer. Albert Schaffle (1831–1903), Paul von Lilienfeld (1829–1903), René Worms (1869–1926) and J. Novicow (1849–1912).

Influenced by the prominent place of variability in the theory of evolution, and on the basis of studies of individual differences, the attention of a number of scholars was devoted to the consideration of the relative roles of heredity and environment in human behaviour. Individual differences were recognized as attributable to both hereditary and environmental factors. Writers with a biological orientation tended to stress the greater importance of the former. Their work took the form of emphasizing the hereditary factor in two respects: first, as the basic factor in explaining individual differences in abilities and behaviour: and second, as the basic factor underlying social change. Especially prominent in the development of these ideas were Sir Francis Galton (1822–1911) and Karl Pearson (1857–1936).

A special variation' of the efforts to explain human behaviour in biological terms was found in the ideas of a number of writers on racial superiority and inferiority. On the whole, this literature, while often ornamented with the trappings of biological findings. was propagandistic in character and tended to play up the alleged superiority of the Aryan or Nordic race. They are mentioned here because they stimulated a widespread controversial literature which helped to focus attention on historical and cultural. as well as biological, factors in accounting for racial as well as individual differences. Among the writers who contributed to the literature of racism were Arthur de Gobineau (1816–82), G. V. de Lapouge (1854–1936) and Otto Ammon (1842–1916).

Ideas Relating to Methodology and Techniques.—The writers briefly treated above contributed to some of the central substantive problems of emergent sociology. Equally important were the writers who helped develop a methodology for sociology. These writers may be considered in three groups: first, those who contributed to general methodology; second, those who contributed to statistical techniques; and third, those who contributed to the "social survey."

Noteworthy, first of all, were the methodological contributions of a number of historians who, in grappling with the problems of method in history, made important contributions to social science in general. F. K. von Savigny (1; 79–1861) stressed the methodological implications of continuity in the historical process; K. F. Eichhorn (1781–1854) called attention to the complexity of social phenomena and the importance of the idea of multiple causation; B. G. Niebuhr (1776–1831) emphasized the necessity of being critical of sources and of the role of the investigator; and Leopold von Ranke (1795–1886) gave great impetus to the habit of documentation and annotation. Also of great importance were the methodological contributions of Comte. Dilthey and Windelband, who grappled with the general problems of social science methodology as contrasted with method in the natural sciences.

Simultaneously with the consideration of general problems of method there were important developments in the application of mathematics to the analysis of social data. Building particularly on previous work in probability theory, as well as in general mathematics, statistical techniques were evolved during the 19th century suitable for the treatment of social phenomena. Important contributors to these developments included P. S. Laplace (1749–1827), Adolphe Quetelet; Karl Frederick Gauss (1777–1855), Adrien Marie Legendre (1752–1833), Francis Galton and Karl Pearson.

Significant from the standpoint of method as well as for the substantive data it provided was the "social survey" as it developed during the 19th century. The social survey was essentially a fact-finding enterprise designed to illuminate social and economic evils in a specific area for purposes of ameliorative action. Although action oriented, the social survey provided basic data for research and stimulated widespread interest in the study of social. economic and political problems. Some of the more important social surveys were those conducted by LePlay; Sir Edwin Chadwick (1800–go) and Charles Booth (1840–1916). The latter's famous report, *Life and Labour of the People in London* (16 vol., 1889–1903), set a pattern for similar surveys in other countries.

Other 19th-Century Influences.—In addition to the developments outlined above. sociology was greatly influenced by the increasing attention during the 19th century to the social, economic and political problems arising from the accelerated pace of the industrial revolution and urbanization. These problems were dramatized by extreme manifestations of poverty, high mortality rates, urban slums. abuses of labour. political unrest and political corruption. Nineteenth-century critics of the industrial order, philanthropic and utopian efforts to deal with the more severe social and economic conditions, the literature on socialism and anarchism, and increasing awareness of and efforts to deal with the problems of a rapidly changing social order constituted an important part of the 19th-century climate in which sociology emerged as a distinctive field.

Pioneer Sociologists.— Sineteenth-century writers included a number of men who are generally regarded as the founding fathers of sociology. Early sociologists were not the product of any one nation. In France they included, in addition to Comte. Emile Durkheim (1858–1917), Lucien Lévy-Brühl (1857–1939). Gabriel Tarde and Gustave LeBon (1841–1931); in Germany. Ferdinand Tönnies (1855–1936), Georg Simmel (1858–1918) and Max Weber (1864–1920); in Austria. Ludwig Gumplowicz and Gustav Ratzenhofer; in Russia. J. Novicow and Maxim Kovalevsky (1851–1916); in Italy. Scipio Sighele (1868–1913) and Vilfredo Pareto (1848–1923); in England. Herbert Spencer (1820–1903), Leonard T. Hobhouse (1864–1929) and Patrick Geddes (1854–1932); and in the United States. Lester F. Ward (1841–1913), William Graham Sumner (1840–1910), Albion W. Small (1854–1926). Franklin H. Giddings (1855–1931), Edward A. Ross (1866–1951) and Charles Horton Cooley (1864–1929). Other countries also developed pioneer sociologists. but their works were, for the most part. untranslated and they did not enter into the mainstream of sociological development.

Of the pioneer sociologists, perhaps the most influential in terms of the impact of their work on other sociologists were Durkheim, Weber and Cooley. Durkheim provided a clear delimitation of the field of sociology as a science devoted to the study of "the social fact." Social facts. which included forms of behaviour. thought and feeling. could be studied, he emphasized, as things in themselves. The social fact was exterior to the individual. anterior to him and exercised a constraint upon his behaviour. It was to be studied as a collective representation and not in its individual manifestations. In his *The Rules of Sociological Method* (George E. G. Catlin. ed.), he described what he regarded as the field and the method for sociology. In other publications. notably *Suicide, a Study in Sociology* (1897, translated by John A. Spaulding and George Simpson), the *Division of Labor in Society* (1893, translated by George Simpson) and the *Elementary Forms of the Religious Life* (1912, translated by J. W. Swain). Durkheim provided examples not only of the application of his methods but also of notable pioneer empirical investigations.

Weber also delimited a field for sociology. To Weber, sociology was a science devoted to the interpretation and understanding of social behaviour so as to achieve its prediction. He defined "social behaviour" as behaviour carried out according to the intention of the acting individual in reference to the behaviour of others. Sociological analysis was to be devoted mainly to getting at the intentionality of social behaviour. This was to be achieved through gaining an "understanding" of social behaviour: intellectually, if the behaviour was rational. by recognizing the logic of the means-end relationship; by means of empathy, if the act was irrational, by projecting oneself into a situation and experiencing the emotional context involved. Weber made an important methodological contribution in his description and use of "ideal type" concepts as tools of analysis against which to observe and analyze real situations. He also recognized the utility of statistical methods, especially the fundamental notions of probability and association as tools of research. Weber's consideration of bureaucracy and social stratification contributed materially to sociological investigation of these subjects. Some of his more important publications available in English are *The Theory of Social and Economic Organization* (translated by A. M. Henderson and Talcott Parsons). *From Max Weber: Essays in Sociology* (translated by H. H. Gerth and C. Wright Mills) and *The Methodology of the Social Sciences* (translated by Edward A. Shils and Henry A. Finch).

Cooley, in his doctoral dissertation *The Theory of Transportation* (1894), contributed in an important way to interest in human ecology as a field of sociology. In this work he dealt with transportation and the general economic base as a substratum of social organization. His subsequent work resulted in major contributions to general sociology and social psychology. He began with a theory of human nature and the genesis of the self, as set forth in his *Human Nature and the Social Order* (1902). His study of personality led him to the study of social structures and forms as treated in his *Social Organization* (1909). He completed what may be regarded as a system of sociology in his analysis of collective life in *Social Process* (1918). Cooley's treatment of the "primary group." the '(looking-glass self," communication and the problem of society and the individual provided subsequent sociologists with an important part of their conceptual framework. His methodological contributions lay largely in his suggestive work in ecology on the one hand, and in his description of "sympathetic introspection" as a tool of research on the other.

Mention should also be made of Small as one of the important pioneer sociologists. particularly for his contribution to the development of sociology as an academic discipline and as a profession. On the substantive side, Small, although he changed his position in the course of his career, helped define the scope of sociology as a science; played an important part in introducing European. and especially German, sociological thinking into the United States; and laid great stress on the development of method as a prerequisite to the advance of sociology as an empirical science.

It is not possible. of course, even to summarize the work of all of the individual builders of sociology. Most of the founders of sociology had in common a penchant for system building and, no doubt under the influence of the brilliant and dramatic 19th-century scientific successes in other fields such as that represented by Darwin's theory of evolution, attempted to account for man and the social order in terms of broad, comprehensive and global principles. Most of the systems were characterized by universal explanatory schemes. such as "evolutionism," or by monistic explanations of human behaviour such as "imitation."

A number of the pioneer sociologists subscribed to the view that sociology was essentially a normative, meliorative discipline. They engaged in great. debates over nominalism and realism, as manifested in the discussions of the "atomistic" or "organic" conceptions of society or the distinction between the individual and social aspects of the group; over the relation of sociology to values; over the priority of the study of the form as opposed to the content of individual and group behaviour; over the role of the "biological," the "psychological" and the "sociologistic" factors or levels of explanation; over the materialistic and idealistic conceptions of the historical process; over the suitability of natural science methods for the study of social phenomena and especially the applicability of quantification or statistical techniques; over the conception of sociology as the general social science or one of the special social sciences.

In the works of the pioneers these and other issues, as they bore on the emergence of a science of society. were clarified; and if the problems were not resolved. their discussion was, on the whole, exhausted. so that points of departure were provided for subsequent students.

The common and essential characteristic of these early sociologists was the fact that they were. in the main. still social philosophers rather than scientists. Their basic methodology was still grounded in speculative thinking rather than empirical investigation. although to be sure there were some notable exceptions (*e.g.,* Durkheim's *Suicide,* 1897, and Sumner's *Folkways,* 1907). These pioneers of sociology were concerned more with discussions of what sociology should be, and should do. rather than with the doing of it. But they performed an important function in crystallizing and making explicit some of the basic issues, consideration of which was perhaps prerequisite to the emergence of sociology as an empirical science; in delimiting an area of investigation; in posing many of the specific problems of sociology; in framing a methodology and providing a number of research techniques: in contributing materially to the development of sociological concepts; and in providing important insights which influenced the course of subsequent developments in sociology.

Twentieth-Century Developments.— System building in sociology continued into the 20th century, and for the first two decades there was also a sustained ipterest in the broad general problems of the type indicated above. The distinctive rnarks of 20th-century sociology. however. lie in its delimitation as a separate social science; in the emphasis placed upon research as the primary task of sociology; in the emergent conception of theory as a prelude to. and product of. research rather than an exercise in armchair speculation; in the broadened participation of sociologists in empirical investigation; and in the increasing use of statistical and experimental or simulated experimental methods. Accompanying these developments was a great increase in the number of sociologists and in the widespread appearance of sociology in university and college curricula: especially in the United States, as a recognized academic discipline. In these developments, sociology, if it did not become a science in a rigorous sense, at least definitely moved in that direction. By the end of the first half of the century, the great bulk of sociological publications comprised reports of empirical research, and broad social speculation had definitely ceased to be a major preoccupation of sociologists, especially in the Cnited States.

The shift from speculative social thinking to empirical research was led and fostered by the generation of sociologists who followed the pioneers and who, for the most part, were their students and sometimes their disciples. The trend toward empirical investigation was most manifest in the United States: partly because of the availability of greater resources for research. Generous research grants by the large foundations (such as the Rockefeller foundation and the Carnegie Corporation of New Tork), expanding research appropriations by the federal government, especially for agricultural research at the outset, and increased expenditures by action agencies for "applied research" provided the means for the conduct of empirical investigations. Research activities were stimulated, also, through the development of professional organizations whose primary objective was the encouragement of such activity. The most important of these were the American Sociological society, founded in 1905, and the Social Science Research council: which was organized in 1923. Sociological research activity, however, was by no means confined to the United States.

In the United States the transition from social speculation to empiricism was spearheaded by such men as W. I. Thomas. Florian Znaniecki. Robert E. Park, E. W. Burgess, W. F. Ogburn. Ellsworth Faris, Richmond Mayo-Smith, R. M. MacIver, L. L. Bernard. F. S. Chapin and H. W. Odum. Not all of these men themselves pioneered in research activity, but they all showed an enthusiasm for, and interest in, research which they passed on to their students. Early 20th-century examples of empirical investigation included such works as Sumner's *Folkways* (1907), Paul U. Kellogg's *The Pittsburgh Survey* (1909–14), C. J. Galpin, *The Social Anatomy of An Agricultural Community* (1911) and W. I. Thomas and Florian Znaniecki, *The Polish Peasant in Europe and America* (1918–20). In addition works which, while themselves not empirical investigations, contributed inestimably to the increasing tempo of research activity included R. E. Park. *The City: Suggestions for the Study of Human Behavior in the Urban Environment* (1915), and R. E. Park and E. W. Burgess. *Introduction to the Science of Sociology* (1921). The former provided a framework for urban and ecological research. The latter brought together in a systematic fashion the insights and concepts of earlier writers set in a framework oriented to research. Pursuant to these publications. a series of monographs were published by young sociologists. trained at the University of Chicago, which constituted the first mass series of empirical investigation in sociology.

After about 1940, the relatively large volume of discrete research reports in sociology led some sociologists to feel that the pendulum had swung too far away from sociological theory. Pure fact finding was criticized as being as unproductive as pure speculation. In consequence, there was a discernible attempt on the part of sociologists to tie their investigations to relevant theory, and to direct their research activities toward the testing of explicitly stated verifiable hypotheses.

Sociology was slower to develop in Europe than in the U.S. during the 20th century, especially in its research manifestation. Up to World War II, in England a mere handful of men had claim to the designation of "sociologist." although a number of prominent scholars had contributed to the development of various aspects of sociology. The situation was similar on the continent. with the exception of France and Germany. Although an important literature was developed which contributed materially to sociological insight and theory, empirical research did not reach the stage or magnitude of development in either France or Germany that it achieved in the Cnited States. In France. sociological activity was closely interwoven with that of anthropology and, in large part, not clearly differentiated.

After World War II, however, there was evidence of increasing interest in sociology in Europe and in other parts of the world. The number of chairs in sociology at recognized universities grew considerably. An International Sociological association was established under the sponsorship of the United Nations Educational, Scientific and Cultural organization in 1950, and Louis Wirth (1897–1952), of the University of Chicago, was elected its first president. At the meeting of the association in 1953, at Liège, Belg., more than 300 sociologists were in attendance from 46 countries.

FIELDS OF SOCIOLOGY

There is no generally accepted classification of the fields within sociology. The classification used below. for purposes of convenience in summarization, is an arbitrary one. The fields listed are closely interrelated and not mutually exclusive. They serve to denote general areas of specialized interest for research and teaching purposes. Most of the references to research and publications are restricted to sociology in the United States. partly because most of the specific research reports in other languages have not been translated into English. and partly because greater emphasis has been placed on, and greater resources available for, empirical research in sociology in the U.S. than in other countries.

Social Organization. — Social organization as a field of sociology is concerned primarily with the study of the structural; functional and dynamic aspects of group living. It includes investigation of the community. the family, the social group, social institutions. race and ethnic relations, social stratification and social mobility. It is concerned also with the problem of social control as achieved through the study of the various forms of informal and formal controls ranging from the constraints upon behaviour exerted by the mores and folkways to that by the law and formal sanctions. Especially prominent after 1930 were studies in the community. the family and race and ethnic relations; and after 1940, studies of social stratification! industrial sociology, bureaucracy and the small group.

Sociological study of social organization is in a number of respects similar to the research activity of social anthropology. Prior to World War II, social anthropology confined its investigations primarily to primitive societies, but the general approach and literature of the two fields is at some points a common one. This was especially true in France, but was evident also in England and in the United States.

Social organization is closely related to the other fields of sociology and, in a fundamental sense, constitutes together with social psychology the central core of sociology. Its ramifications are as diverse as the social structures in society, and the study of individual aspects of social organization has given rise to a series of sociological specialisms, as rural sociology, urban sociology, the sociology of law, the sociology of religion, the sociology of education. the sociology of knowledge, political sociology, industrial sociology. the sociology of work and sociometry. The latter is a field of research in which social structure and interpersonal relationships are graphically and quantitatively represented.

Social Psychology. — Social psychology studies human nature and personality as influenced by group life on the one hand. and collective behaviour on the other. With diverse origins in biological and psychological as well as social thought, it is far from a unified field. It is a branch of both sociology and psychology. The psychological approach has, on the whole, differed from the sociological in its greater emphasis on the study of the individual, as against the group, and by its greater use of laboratory and experimental methods.

The problems generally studied by sociologists in this field include the nature of human nature as a product of group life; personality and its formation, social attitudes, public opinion and propaganda, communication; interpersonal relations; crowd and mass behaviour; and social movements.

The general literature of social psychology reflects the variety of schools of thought. Among the more prominent general approaches, some more of historical than contemporary interest, are: the biological approach. represented by the "instinct" school which dominated social psychological thinking in the early part of the 20th century; the collectivistic approach which emphasizes the influence of the social group and culture on the behaviour of the person; the behaviouristic approach which places emphasis on the objective observable activities of the human organism; the symbolic interactionist approach which may be viewed as a form of social behaviourism in which the social act is the basic unit of analysis ; the psychiatric approach which includes Freudian psychoanalysis, modifications of the Freudian approach. and other psychiatric approaches; the Gestalt approach which stresses the importance of "functional wholes" as the elements of study; the group dynamics approach, a form of Gestalt psychology which studies changes in group structure and function under varying conditions.

Of these. the distinctively sociological orientations are largely the "symbolic interactionist" and forms of the "collectivistic" approaches. Sociologists. however, have been influenced by the other orientations and have. in turn. exerted influence upon them.

World War II greatly stimulated sociological research in social psychology in the United States. especially within the military establishment. Major empirical investigations were conducted in which measurement techniques were applied to a number of social psychological problems. This work marked the increased collaboration of social psychologists from both the disciplines of sociology and psychology who, at a number of points and especially in the study of small groups. communication and attitudes, have been working on common problems.

Social Change and Social Disorganization. — Social disorganization studies the disruption of established social relations that interfere with, or prevent, the functioning of the social group and that demoralize the person. Social disorganization is discernible in the breakdown of forms of social control and in the deviate behaviour of persons. Social change is concerned with changes in culture and social relations — their nature, the processes and mechanisms involved, the factors which underlie them and their consequences. The study of social disorganization is closely related to the study of social organization. The study of social change forms the link between the two. Social disorganization may be regarded as one phase of a continuous process of social interaction in which an equilibrium is achieved which constitutes social organization. which is subjected to social change, which may produce social disorganization, which, in turn) may be a first step in social reorganization.

The study of social change requires investigation into the conditions and factors producing change — economic, technological, demographic, political. cultural or other — and the characteristics and results of change. Specific subjects of investigation include the study of invention, cultural diffusion, crises. acculturation and resistance to change. Social change studies also include the various elements of time series analysis as applied to social data — the analysis of cyclical, seasonal and other short-run changes, as well as of secular trend.

Studies of social disorganization may be considered under three closely interrelated categories, individual disorganization, family disorganization and community disorganization. The study of individual disorganization includes analyses of such behaviour as crime and delinquency. mental disorder, suicide, alcoholism and vice; and also such subjects as poverty, unemployment and child labour. Research in family disorganization involves study of family tensions. separation and divorce. Investigation of community disorganization covers such topics as political corruption, the breakdown of formal and informal social controls, mass unrest, mob behaviour and revolution.

Human Ecology. — Human ecology studies the spatial and temporal relations of population aggregates, human behaviour and social institutions — the distributive and temporal aspects of society. It is concerned with symbiotic as opposed to social relationships; with the physical and technological bases of group living. the social substructure, which usually exerts impersonal but important influences on the structure and functioning of the social order.

Human ecology in a sense is a subfield of the study of social organization and is also closely linked with elements of population study. It is closely related to the interests of human geographers who. like the sociologists. have borrowed the framework and concepts of plant and animal ecology and applied them to the study of man and society in relation to the environment. The interests of the geographer and the sociologist in human ecology have differed in that the former has been concerned primarily with the relation of man and his works to the environment. and the latter with the relations of human beings to each other as well as to the social order as affected by the environment.

Research in human ecology has been concerned with such problems as the general structure of urban and metropolitan areas and their processes of growth; the delineation of "natural areas" as opposed to political or administrative units; the spatial pattern of social phenomena such as delinquency, insanity, fertility, mortality, divorce, forms of family organization, churches. retail establishments: the distribution, and changes therein. of social and ethnic groups, and other population groupings within an urban area: the relation between place of residence and place of work; the correlation of spatial patterns of human behaviour and social institutions; and the factors. geographic, economic, technological, historical arid political, as well as social. which underlie spatial and temporal patterns. Although studies in human ecology have been concentrated primarily on urban areas, work has also been done on the spatial and temporal aspects of rural communities. especially by rural sociologists, and on "regionalism" on a national and world basis.

Population. — The field of population, broadly conceived. is concerned with the study of population numbers, composition, change and quality as they are influenced by. and as they influence, the social, economic and political orders. Population study is by no means restricted to sociologists but. rather, attracts the members of a number of both the natural and the social sciences. Demographers, as students of population are called, include biologists, geneticists. medical men. public health specialists, biometricians. actuaries, statisticians and economists, as well as sociologists.

Population study as an interest of social science was primarily a branch of economics from Malthus to about the first quarter of the 20th century. Later. however. although some attention was paid to population in both economic theory and research, active social study of population phenomena became more the province of the sociologist,

Sociological research interest in population has focused on such problems as population size and distribution; composition of population, including the social and economic as well as the personal characteristics of the population; population growth; components of population gron-th, including fertility, mortality and migration; family numbers. composition and growth; family formation and its components — marriage. divorce, separation, widowhood; differences in birth, death and migration rates among various population groupings and the factors associated with the differences; and the interrelations of demographic and social factors. From at least 1930, sociologists also became interested in the study of the structure and dynamics of the labour force as a major element of the total population. and in demographic aspects of special population groups such as youth and the aged.

The nature of population data, much of which comes from such official sources as censuses and vital registration systems, involved and permitted the utilization and development of statistical techniques, so that population study is one of the most quantified and rigorous fields of social science in general. as well as of sociology. Sociologists interested in population study frequently also pursue research in human ecology. which is closely related.

Sociological Theory and Method. — Sociological theory comprises the generalizations or principles of group life as applicable to personal behaviour or the social order. In the 19th and early 20th century literature. most of the content of sociology was "theory" in the sense of being social thought variously related to the world of reality and. in the main. arrived at without benefit of empirical study. From the beginning of the second quarter of the 20th century. theory came more and more to be regarded as primarily a frame for and a product of sociological research. Moreover. theory in this sense tended to disappear as a separate field of sociology and, appropriately. to be diffused throughout the discipline in close relation to the subject matter to which it relates. Another important change in contemporary sociological theory, as contrasted with earlier writings. was its more modest character. Contemporary theory tended to be of "middle range" rather than global. and more concerned with its relevance to research.

The development of sociological method generally followed two channels — qualitative and quantitative. The former involved the use of case material based on interviews, correspondence. diaries and life histories — sympathetic introspection and participant observation. The latter led to increased use of statistical techniques and of census and sampling survey data; the construction of tests and scales: simulation of, as well as attempts at, experimental methods; and model building. Some links between the qualitative and quantitative methods developed in the form of "content analysis" and methods of controlled observation and recording. Of special import were the developments to predict behaviour, especially as exemplified in the fields of parole prediction. and the prediction of success and failure in engagement and marriage.

APPLIED SOCIOLOGY

Sociology also had increasing application to the solution of practical problems, especially after the second decade of the 20th century. The findings of sociological research have been utilized, particularly in such fields as criminology, social work: education, race relations, planning, government administration. marketing, communication. propaganda, public opinion polling. social psychiatry. industrial relations, and marriage and family counselling. Most sociologists continued in teaching and research activities at universities and colleges.

A number of sociologists, however. utilized their training as professional personnel in fields such as those listed above as well as in the conduct of applied research activities for agencies in these and other fields.

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SOCIOLOGY, ANIMAL. The sociological study of organisms takes the group rather than the individual as the basic unit, and may fairly be called sociology in the broadest sense, defined as the science of organic communities. Sociology so considered includes communities of organisms with different levels of inclusiveness and of integration. Some of these may be described as follows: Biosociology deals with communities of plants and animals living together in nature: among the ecological communities that are the social units at this level of organization, the social bonds are weak and sociality is vague. The same is true in plant sociology. which is concerned with plant communities Animal sociology exists at this weaker level of sociality, but it also includes more closely knit groupings such as those of the social insects and, of course, of man. More appropriately defined, "animal sociology" deals with the social life of nonhuman animals, and "sociology" centres on the social life of man (see SOCIOLOGY).

Although biosociology and plant sociology are not closely related to human sociology, they have certain resemblances. Both deal with groups or communities of individuals and the mutual relations that bind them together rather than with the individual plant. or nonhuman animal, or man standing alone. Both are concerned with mutual dependence, with co-operation, with its opposite. dis-operation, and with competition.

The qualitative distinction between the sociology of man and that of other animals is not sharp, but since other animals lag far behind man in the development of abstract thought, in symbolic communication and in cultural institutions, there are very large quantitative differences. The distinctions are by no means absolute, however, and. in many relations, comparisons are continually being made between the social life of human and nonhuman animals. Indeed, the social life of animals is of interest to many only because of possible comparisons and, more especially, of contrasts with that of man. On the other hand, there are persons for whom the various patterns of behaviour of other animals are of prime importance in their own right. This animal-centred focus is often found among observers of the group life of animals; it is the dominant attitude among many bird watchers. Yet even the most extreme zoophiles are usually aware of some of the human aspects in the social behaviour of other animals.

All too often reports concerning animal sociology are given as though the animals observed were feathered or four-footed men. Such accounts are misleading. Man is the only animal we can know both objectively and subjectively. Except in the figurative sense, no person has ever been a worm. a fish, a snake-in-the-grass or even an ape. We have no inside information concerning the feelings or the outlook of such animals. The valid interpretation of all of their behaviour, social behaviour included, is difficult and often impossible except from the point of view of the outsider. This article attempts to be carefully objective. The story remains interesting even under such conditions.

The article is outlined as follows:

I. Aggregations of Animals
 1. Reasons for Aggregations
 2. Group Survival Values
 3. Modification of Behaviour
 4. Division of Labour
 5. Social Instinct
 6. Social Levels
II The Social Habit
 A Natural Co-operation *v.* Dis-operation
  1. Interactions
  2. Effects on Environment
  3. Co-operation and Dis-operation
  4. Competition
  5. Physiological Effects of Aggregations
 B. Group Modification of Structure and Behaviour
  1. Structure
   Polarity
   Aphid Wings
   Sex Determination
   Change of Sex
   Survival Value
  2. Behaviour
   Sex-Type Reactions in Protozoa
   Locust Phases
  3. Social Facilitation
  4. Co-operative Behaviour
III. Organization of Animal Groups
 A. Territory
  1. Types of Territorial Relations
  2. Biological Values
  3. Relation to Dominance-Subordinance Hierarchies
 B. Dominance-Subordinance
  1. Pecking Order
  2. Individual Differences
  3. Mammalian Dominance Orders
  4. Signs of Subordination
  5. Social Status and Sexual Behaviour
  6. Survival Values
 C. Leadership
 D. The Family
  1. Types of Mating Relationships
  2. Parent-Young Associations
 E. Extensions and Analogies
  1. The Organism and the Supra-Organism
  2. Subsocial and Social
  3. Conclusion

I. AGGREGATIONS OF ANIMALS

Animals and plants live in communities. Organisms in communities may live together because of common tolerances for the nonliving environment, or they may be unified by interactions between the organisms themselves. The latter form more closely knit units and are often called biocoenoses. Both biocoenoses and habitat-controlled assemblies are recognized as communities at the ecological level. Such matters are discussed in the article ECOLOGY, ANIMAL. The universality of this kind of community living is the important point here. Plant sociology is built almost entirely about the study of communities of plants, and animal ecology is much concerned with this relatively vague sort of sociality.

1. Reasons for Aggregations. — The ecological community is made up of several species living together. Animals do not spread themselves evenly throughout a community, rather they tend to collect in spaced or in contact aggregations of a few or of only one species. These so-called contagious distributions are the rule in nature. The simplest aggregations show very little integration; the more complex ones grade insensibly into closely knit insect or vertebrate social groups. Aggregations composed primarily of one species are more important in the development of society than are those of mixed composition.

The least social animal aggregations are represented by accidental collections. For example, animal drift lines occur along the margins of many bodies of water. They are particularly noticeable on the sandy beaches of the Great Lakes of North America, where they may extend for miles. In the animal drift along the shores of Lake Michigan may be found sizable collections of aquatic snails, small bivalves, crayfishes and even fishes, thrown up by the waves. Similar concentrations of insects are also deposited, with many of the individuals still alive; these have been carried out over the water by an offshore breeze, then caught in the water and tossed back on the land by currents and waves. So far as the animals are concerned, their aggregation is entirely accidental. They may remain aggregated through inability to move or simply as a result of inertia. Such aggregations are near the zero mark for sociality; the quality of inertia shown under these conditions has only slight social significance.

Animals aggregate under diverse conditions as a result of their own movements. Perhaps the simplest of a long, intricate series of aggregating behaviour results from so-called kineses (see ANIMAL BEHAVIOUR: Animal Behaviour Patterns), that is, from the unoriented reflex action of the whole animal. Thus animals that are stimulated by high light intensity slow down when they enter shaded areas. If many are moving about in a given locality, such photokinesis will cause them to aggregate in the shade somewhat as automobiles, moving freely along a highway. aggregate automatically when slowed down by entering a village or by any other agency that reduces their rate of movement.

Aggregations result from oriented reactions to light intensities, or to any other gradient of environmental forces, when an oriented response brings numbers of individuals into a restricted region. A positive reaction to odours, leading animals to a restricted source of food, gives a common example. The collected animals must have a certain amount of toleration for the presence of, often for contact with, other individuals if the aggregations are to form and particularly if they are to continue.

In contrast with the more or less automatic aggregation of animals in response to odours, light or shade, moisture, favourable niches and other environmental factors. there are the much more definitely social situations in which animals collect as a result of positive reaction to the presence of others like themselves. The aggregations of male midges dancing in the quiet atmosphere, or the formation of schools of fish or flocks of birds illustrate this widespread phenomenon.

2. Group Survival Values. — Group survival values often appear as a result of animals being congregated together. These can be found sometimes even in the accidental aggregations such as those of the drift line along Lake Michigan. Aquatic animals piled one upon another may retard drying to such an extent that the lower, most protected individuals may survive for some hours and so have an opportunity to escape should the waves arise or rains come and sweep them back into the water. Similarly, land insects may be shaded by the piled up mass and so escape death from drying or from heat and live to make their way across the sand to vegetation and greater safety. Aggregations also have disadvantages: surrounded animals may be smothered by their fellows, and the whole group forms a collection of foodstuff easily accessible to many predators. Some ecologists writing in anthropomorphic terms have called the drift line the "lunch counter of the beach" for mice, skunks and many other insect eaters.

Other types of aggregation also show group survival values, often to a high degree. Certain phases of these values are discussed below under the heading of natural co-operation. One common characteristic of these group effects is that as the animal aggregations become closely integrated there is a definite tendency for the group more and more to control a limited section of its own environment. Sometimes this control is gained by the death of those individuals that meet the full impact of the uncontrolled environment, to the distinct benefit of the remaining members of the group. The construction of nests, whether above or below ground, is a common method of securing partial environmental control. With the social insects (termites for example) the conditions within the nest often are quite distinct from those outside its walls. especially in reduced amplitude of fluctuation: they are much nearer to the termite optimum, particularly as regards humidity.

Groups with positive survival value, for some or all of the individuals present, serve a social function whether composed of protozoans, worms, insects or men or other vertebrates. The survival-value test of sociality must be based on real evidence, however, and even then it should be applied with caution. Aggregations are not necessarily beneficial for the aggregated animals, since overcrowded animals are often handicapped by long-continued close association with their fellows. Some of the relations between positive and negative survival values of the aggregating habit will be considered later in the present article.

3. Modification of **Behaviour.**—The effects produced by massed animals may not be of obvious or easily demonstrated survival value and yet give first-rate evidence of group influence. Group modifications of behaviour supply examples of this generalization. Each individual in a group of animals frequently shows decidedly different behaviour patterns from those given when the respective animals are isolated. When one animal behaves differently in the presence of its fellows from the way it would if alone, it is social to that extent regardless of survival values or other considerations. The behaviour of a group may be greatly modified by the presence of a single animal of an alien species; a migrating flock of birds often alters its behaviour decidedly in the sensed presence of a predatory ha k.

4. Division of Labour. — Aggregated social animals usually develop division of labour. In its earliest stages the division of labour may be quite informal — some animals are on the margin and others are protected within the group. It is as simple as that. Position may change from time to time without obvious reasons; the difference in function is temporary and, perhaps, accidental. Various complexities of division of labour are known, and lasting structural as well as behaviour differences illustrate the highest stage of its development. The castes of ants and termites give good examples.

The most common division of labour is that between the sexes This appears to some extent even among the Protozoa. In the simplest cases among higher animals, the fish. one sex produces eggs and the other sperm, both are shed into the surrounding water and that is the end of the matter so far as the parental generation is concerned. In other cases, of which common pigeons provide an example, both sexes are similar in size, appearance and to some degree behaviour; they differ in mating reactions as well as in primary sex functions. At the other extreme stand the many cases in which one sex is larger, showier, decidedly different in form or otherwise markedly differentiated from the other sex. The common domestic fowl, many other birds. most deer and other polygamous mammals such as the fur seal are examples. The concept of separate sexual castes fits the easily observed facts in such animals.

Another very common division of labour is that between continuing groups consisting of parents and their offspring. In its simplest and most widely distributed form, the division is between protector and those protected, or between food collectors that also eat and food consumers that do no collecting. In some instances, notably among certain termites, the developing nymphs act first as workers; later they become so-called soldiers or sexually mature reproductives.

Group modification of behaviour finds dramatic expression in the organization of social hierarchies, in territorial behaviour and leadership-followership relations. These are discussed at some length in a section below.

5. Social Instinct. — An instinct (*q.v.*) may be defined loosely as a rather complicated behaviour pattern transmitted from generation to generation by organic inheritance. Early naturalists thought highly of social instinct as a criterion of an animal society, and sometimes spoke of animal societies as organized at the instinctive level in contrast with human societies, which they regarded as being built at an intellectual level. A major difficulty arises, however, in demonstrating the existence of a social instinct as distinct from early learning. All too often the concept of instinct has been merely a convenient cover for ignorance. Although admittedly difficult to define with exactness, there is validity in the idea that animals aggregate as a result of inherited behaviour patterns and that the more complex animal societies develop among species with inherited patterns of sufficient complexity to be called instincts. Whether known as instincts, or appetites or drives, much of social behaviour appears to result from biologically inherited responses, modified in many instances by learned reactions.

The social appetite (to use a term more acceptable to many psychologists) can be compared profitably with the action of food-hunger or thirst. At relative peaks of intensity, the social appetite is usually feebler than the others. It is also more continuous in action and less dramatic. The peaks and depressions of its expression are smoothed out, hence it is less obvious. Sex-hunger is a special form of social appetite with many qualities obviously lacking in other phases of inherited drives toward sociability.

6. Social Levels. — The difficulties inherent in the further elaboration of any scheme of social levels among animals is evidence of the lack of natural divisions. The whole field of social interrelationships of organisms has a degree of unity untouched by any of its parts; some particular level of social appetite, group reaction, community integration, social value or exhibition of division of labour can be singled out only arbitrarily as forming the beginning of social life. Alfred Victor Espinas came to a similar conclusion in 1877 in *Les Sociétés animales,* which gave the modern orientation to comparative sociology. In effect, an early paragraph says:

No living plant or animal is solitary; animals especially are knit together by many ties. Even the most solitary of the sexual animals contract, ii only for a moment, an intimate union with another member of its species. Social life also exists among species in which the sexes are not distinct and separate. This is particularly obvious in colonial animals that remain physically attached to each other throughout life; the food eaten by one may be shared by many. Social liie is not an incident or an accident among animals; it is not the special privilege of some few that stand high in the evolutionary scale such as men, beavers, bees, and ants, but it is a normal, constant universal iact. The social relations may be summarized in the form of certain laws that are similar wherever they appear. The social facts indicate the existence of a homogeneous whole, well linked in all its parts, that iorms a natural domain with distinct unity.

Forty-six years later! William M. Wheeler! an American student of social insects, put the same set of ideas even more forcefully in almost the following words:

All living things are genetically related as members of one great family, one vast, living symplasm, which, though iragmented into individuals in space, is nevertheless absolutely continuous in time. In the great majority oi organic forms, each generation arises from the co-operation of two individuals Most animals and plants live in associations, herds, colonies or societies oi the same species and even the so-called solitary species are necessarily more or less co-operative members of groups or associations of different species. Living beings not only struggle and compctc with one another for food, mates and safety, but they also work together to insure to one another these same indispensable conditions for development and survival. (Adapted from *Social Life Among the Insects* by William Morton Wheeler, copyright, 1923, by Harcourt, Brace and Company, Inc.)

II. THE SOCIAL HABIT

Evidence indicates that the more specialized animal phyla are grouped into two main lines of evolution that sprang from a common general ancestor at or near the coelenterate level of organization. One branch passes through the forebears of the annelid worms and mollusks and culminates in the insects. The other line. after giving rise to echinoderms, evolved into ancestral chordates and culminates in modern vertebrates. Social insects thus are not near relatives of social vertebrates even in a zoological sense, and neither stands in the direct evolutionary line of the other. Whatever social traits they possess in common have either been separately evolved or trace back to the much more vague sociality of their unknown, common ancestral stock.

The relative numbers of different species of animals can also be given simply. If you will imagine that all the known animal species are represented by your own reach from the tip of the outstretched fingers of your right hand through to those of your left, the following approximate relations hold. the extreme end joint of the right middle finger represents all species of mammals; the second section of the finger stands for birds; reptiles and amphibians lumped together about fill the basal joint. The length of the palm represents the fishes. All the remainder of the entire outreach is taken over by invertebrate animals. The nonarthropod invertebrates account for the space from wrist to elbow of the right arm, and the arthropods make up all the rest, with the major part of this space needed to represent the insects. In all, there are more known species of animals than there are words defined in an unabridged English dictionary. Each of all these species, insects and noninsects, vertebrates and invertebrates, protozoans and nonprotozoans, has its own form of sociology. When sociology is restricted to the study of the relations between individuals of the same species. as it frequently is. the sociology of any species from all this multitude offers a wealth of problems. since no species is known that does not possess interindividual relations.

Social life reaches its apex with man (and the apes and monkeys), on the one hand. and with termites. wasps. bees and ants, on the other. In the main. the animal sociology below will centre on the social relations of the less definitely social animals. Treatment of insect societies may be found in the article SOCIAL INSECTS.

The vertebrates furnish notable examples of more-or-less social groups in each of the classes of that subphylum. There are schooling fishes and tadpoles. breeding assemblages of frogs, hibernating aggregations of snakes, hierarchies of grouped lizards, various stages of social organization and of communal living among flocks of birds and diverse social groupings among mammals. The latter include colonies of beavers, towns of prairie dogs. herds of hooved animals and hordes or families of various monkeys and apes.

The social habit has evolved among many kinds of arthropods. According to Wheeler (1923). social habits have arisen no fewer than 24 times in as many different groups of insects. Although the matter is by no means clear, it seems likely that the emergences of the social habit among vertebrates and insects do not come absolutely anew in each instance. Rather, it is an attractive hypothesis that they all develop from a common substratum of more vague presocial tendencies. Some of the evidence concerning the existence and nature of this more generalized forerunner of well-developed sociality will be presented and discussed in the following sections.

A. NATURAL CO-OPERATION *v.* DIS-OPERATION

The inclusive definition of sociality on which modern animal sociology is based assumes that integrations of two or more organisms into a supra-individualistic unity, on which natural selection can act, marks at least a beginning of social life. The most feeble units may be poorly integrated but still have demonstrable survival values. They may consist of small or large groups, and the survival value may or may not be obvious. The essential point is that all groupings of animals have some small amount of sociality whenever they are sufficiently integrated to behave as a group unit under natural selection. The aggregations may be natural or the existence of probable survival values may be tested when the organisms in question are placed together in experimental populations.

1. Interactions.— It may be helpful to consider some of the simpler conditions that are found in early stages of drop cultures of protozoans. First, take the situation in which one protozoan is washed free from bacteria and then placed alone in a drop of bacteriologically sterile medium. There is one living organism in a small environment that represents a habitat-animal complex reduced to simplest terms—an uncomplicated microcosm. The living animal modifies its nonliving environment, which at the same time affects the contained organism. The whole is an ecological action system.

If a second protozoan is introduced. the increases in complexity in the ecological system result principally from the direct or indirect effects of one animal interacting with the other. The interaction may be neutral, beneficial or harmful for either or both. (Actually complete neutrality is rarely found in any ecological action system.)

Any interaction between the two animals may have preliminary beneficial or harmful aspects regardless of end results; and. on the other hand, the final long-run effect may be helpful or harmful for the animals concerned regardless of the immediate or short-run effects. One animal may be benefited and the other harmed, but, in the end, it will be necessary to appraise the survival value for both organisms considered as representatives of their species.

Mating is one kind of interaction in which the habitat often plays a permissive, but beyond that, a passive role. This is an interindividual reaction in almost pure form, the results of which are normally beneficial to the race regardless of the immediate effect on the individuals themselves. Under several conditions the two protozoans may both be injured or killed as a result of mating.

2. Effects on Environment.— Besides the possibility of affecting each other, the animals modify their environment by living in it. In their reaction on the habitat. two protozoans may fix some toxic substance more efficiently or they may otherwise jointly condition their common medium more effectively than either can do acting alone. Many of the possibilities are considered in more detail and under more complex conditions in a succeeding section.

3. Co-operation and Dis-operation. — Interactions between organisms that prove to be helpful are evidence of the existence of co-operation, or at least of proto-co-operation, even in such a simple action system as that described above; opposing, harmful tendencies may be termed dis-operation. The two sets of processes are in fundamental opposition. With all lower forms of animal life. and often with higher ones, such co-operation or dis-operation is wholly nonconscious. The nonconscious character of the effects and of their underlying causation is especially evident in poorly integrated ecological systems in which man is not represented. This is a consideration that does not affect the fundamental nature of the resulting dis-operation or co-operation. It is essential to remember that. possible neutral effects aside, we are dealing with a system in which the survival values illustrate in simplest terms the basic social antithesis, that between beneficial (co-operative') and harmful (dis-operative) effects.

4. Competition. — Competition furnishes a special phase both of co-operation and of dis-operation. In general. competition occurs when there is a common demand for a limited supply. Among other situations this criterion applies to the competition of two males for the same mate. for a limited food supply or for limited space.

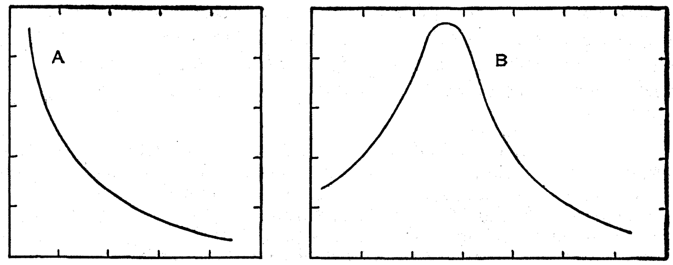
Competition frequently results in dis-operation, although the two are not synonymous. Two protozoans in a drop culture are in competition for a limited amount of food; the competition may result in the stunting or death of both or in one surviving at the expense of the other.

Co-operative competition also is known. A good example is furnished by the mass physiology of the sperm of sea urchins. In nature, these spermatozoa are shed into sea water where they may fertilize the eggs that have been similarly shed. In making sperm suspensions for experimental use, the male sea urchin is placed upside down in a clean dry watch glass. If sexually "ripe." the spermatozoa are shed through the aboral genital pores. Massed spermatozoa so collected live longer and retain their fertilizing power longer than sperm suspensions diluted with sea water. At least a part of the greater longevity of the crowded spermatozoa comes from the fact that the individual spermatozoa do not move when closely packed together. It seems reasonable to assume that the inactivity results from the lack of free space. Under natural conditions of dilution. if the available space is much restricted, the competition for it results in an inhibition of movement, a lowering of the rate of oxygen consumption, and is accompanied hy a decided increase in longevity. Competition here has distinctly beneficial results for all the competitors; it is co-operative as contrasted with being dis-operative.

The fact that, under certain conditions, competition for space results in a form of automatic co-operation as contrasted with automatic dis-operation is an important consideration for general sociology. The importance is greater since all the individuals present in the given illustration benefit from the competition. Under more usual conditions of competition. not all individuals benefit, and yet the end result may be favourable for the species under consideration: that is to say, the final outcome even of such competition is not necessarily dis-operative.

5. **Physiological** Effects of Aggregations. — Certain aspects of survival values and other physiological effects associated with aggregations of animals are summarized by the curves shown in fig. 1. Curve A shows results of biological processes in which the highest recorded value is given by the smallest possible population. A pig born as a litter of one normally grows faster than do members of larger litters, and this is a common relation for many animals.

In contrast, grouped animals often show increased efficiency that is sometimes reflected in longer survival, or they otherwise may grow better or live longer if neither too few nor too many animals are present; they have an optimal population density at some intermediate point of the possible range of numbers. This situation is summarized by fig. 1(B). As the population density increases, conditions become more favourable, or the rate of reaction is faster. or some comparable change occurs, until an optimal density is reached beyond which a further increase in density pro-



ADAPTED FROM ALLEE. "THE SOCIAL LIFE OF ANIMALS" (NORTON)

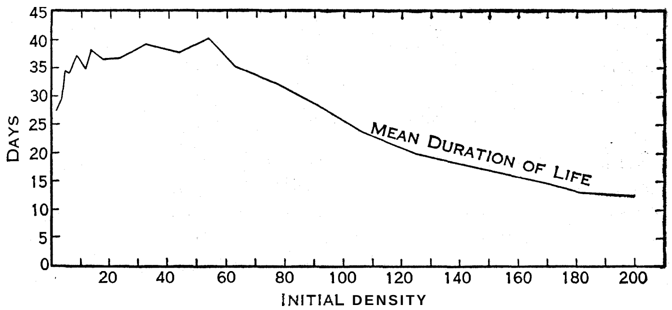
FIG. 1.—IN SOME PHASES OF POPULATION PHYSIOLOGY THE OPTIMUM POPULATION IS THE SMALLEST POSSIBLE (A); IN OTHERS, IT IS INTERMEDIATE IN SIZE (B)

duces a reversal of the observed trend.

Consideration of the two curves. A and B, and of the phenomena on which they are based, indicates that under most conditions overcrowding produces harmful results. This fact has long been known and can be verified easily. The existence of harmful results associated with undercrowding is a later and less well-known discovery. The biological results of undercrowding and of optimal population size imply the existence of natural co-operation just as the effects of overcrowding imply dis-operation.

B. Group Modification of Structure and Behaviour

The mass physiology of aggregated animals differs in various ways from the physiology of individuals. Illustrations include



FROM ALLEE, 'ANIMAL AGGREGATIONS' (U OF CHI. PRESS) AFTER PEARL

FIG. 2.—DROSOPHILA CULTURED IN I OZ. BOTTLES LIVE LONGER WITH FROM 35 TO 55 PRESENT PER BOTTLE THAN AT OTHER POPULATION DENSITIES

the acceleration of early development in certain aquatic eggs, the increased rate of asexual division in various protozoans and the decreased rate of mortality in populations of optimal density as contrasted with those more dense or more sparse (fig. 2).

Fundamental group effects are also known for size and structure and for behaviour. Even the determination of sex may be modified or controlled in several forms by the density of the interbreeding population.

1. Structure. — Crowding may affect the body size of animals. It is easy to demonstrate the stunting effect of overcrowding such as normally results from an inadequate food supply during the period of growth, or from the accumulation of excretions or of their decomposition products. Frequently an optimum population density. somewhat larger than the minimum, can be demonstrated at which larger animals are produced. *Drosophila*, for example, grow larger in small culture vials when from 8 to 16 are present than they do when fewer or more flies develop in the same volume.

Body form also may be directly controlled by population density. This is easily apparent among sessile animals which, like trees and many other plants. show decidedly different growth forms when crowded and when standing alone. The common barnacles and the ascidians of coastal marine waters grow much taller and more slender in the centre of a crowded group than they do when isolated. Even motile forms may be similarly affected; snails of the genus *Lymnaea* kept under crowded conditions for four successive generations became successively smaller and more slender until they were quite unlike the parent stock; the proportions of various body organs were also differentially altered.

Polarity.—The structural effects produced by crowding may be much more fundamental. Polarity is one of the basic structural properties of almost all organisms. In such marine plants as the algae *Fucus* and *Ascophyllum*, the polarity of the fertilized eggs can be experimentally controlled by a variety of environmental relationships, including the presence of other similar eggs in the vicinity.

The first cleavage of these eggs normally separates the developing zygote into two unequal cells, one of which gives rise to the apical part of the new plant; the other divides and redivides to form the rhizoid or holdfast section that anchors the alga to the substrate. The future axis was apparently undetermined at fertilization but has become fixed by the time of the first cleavage. When *Fucus* eggs are in a small group, as they often are in nature, the first cleavage plane divides the egg into an apical cell oriented away from the centre of the group and a rhizoidal cell that is pointed toward it.

Groups of two to four eggs show the phenomenon as well as masses of 50 to 100 do. Radiating designs of striking beauty are common in smaller aggregations. The rhizoids are directed toward the centre of the group regardless of the experimental arrangement and rearrangement of the eggs before germination. When large, compact masses of eggs are surrounded by others that are two egg diameters or less away from the periphery of the group, the latter develop their rhizoids toward the central mass. The eggs near the outer margin of a large group also show a similar orientation, while those in the very centre, surrounded by equal influences on all sides, tend to divide to form equal and similar cells at first cleavage.

Aphid Wings.—Aphids are the soft-bodied insects commonly known as plant lice. An aphid obtains its food by inserting its long, sucking mouth parts into a plant and sucking up the plant juices. The schematized life history runs as follows. sexual forms appear in the autumn and an overwintering, fertilized egg is formed that hatches out the following spring into a wingless female. This female, the so-called stem-mother. produces eggs that develop without fertilization—that is. by natural parthenogenesis (*q.v.*). Like the stem-mother, the new females are usually wingless and, in turn, soon give rise to young by parthenogenesis. The progeny settle near the mother and soon build up a densely crowded colony.

Winged females appear after a time and fly to new host plants where, still without sexual fertilization, each produces a new crop of wingless. parthenogenetic females. The induction of wings is distinct from the production of bisexual forms; in fact, most female aphids that require fertilization are wingless, although the males are usually winged.

The production of winged aphids by members of a wingless colony is often most opportune, corning as it frequently does when a given food plant is becoming overcrowded. Several environmental factors are known to affect the process. among them temperature, length of day and incipient starvation. The degree of crowding is also a potent factor for many species; sometimes it is the dominant influence. For such species, the more crowded the mothers the more winged forms develop among the offspring

The racial importance of such a control of wing production in aphids is easily seen. The power to emigrate thus attained by the progeny of a crowded colony facing a diminishing food supply brings survival values for the species. Here, more than in most instances among animals, man included. the dangers of overcrowding have been avoided by the evolution of adaptations that give an obvious illustration of the principle of unconscious, natural co-operation.

Sex Determination.—In certain widely distributed instances in the animal kingdom, the determination of the sex of the developing individual depends on association with another organism. The flagellate *Chlamydomonas,* a protozoan claimed by botanists to be one of the algae, shows much lability. It lacks the characteristic flagellum when grown in the dark in Knop-agar cultures. The flagella and resulting mobility develop if the cultures are placed in the light, or in darkness when weak solutions of certain sugars are added or when filtrates are introduced from cultures of actively swimming *Chlamydomonas*. In the last instance, swimming forms are induced by the addition of something given off by active cells.

The motility-producing compound, which has been isolated, is known to be the organic chemical crocin, a carotinoid derivative. It is effective even when only one part is present in 150,000,000,000 parts of water. Conditioning by related chemicals induces mutual attraction of the free-swimming gametes, which unite only if the water also contains the proper conditioning agent. The gametes of a hetervecious species are sex labile and may become all female or all male if treated by female-conditioned or by male-conditioned medium. In this plantlike animal, the sexes are not clearly differentiated, but there is a gradation of sexuality in which sex can be pushed toward maleness or toward femaleness by the presence of products of metabolism from previous or from current inhabitants of the culture water.

The large female of the worm Bonellia harbours small parasitic males within her uterus. The fertilized eggs are shed into the surrounding sea water. If the free-swimming young settle on the proboscis of a female Bonellia, they transform into minute males that become parasitic on the female worm. Those that do not come under female influence normally become functional females themselves. The sexually indifferent larva obtains some substance from the proboscis of the female that retards growth and produces a male. The external relations—usually the social relations, or lack of them—determine which of two alternative paths of development will be followed.

In several other well-studied cases, sex depends on population density. This situation has been worked out with care for certain nematode parasites of grasshoppers. If a few eggs are introduced into each of many grasshoppers, the resulting adult nematodes are females: if many eggs are given to each grasshopper, the nematodes are almost all males. The observed results cannot be ascribed to male-producing eggs having been killed off in one instance and female-producing ones in the other—a real transformation has been effected. The sex of the developing embryos must have been determined by the crowding of the nematode parasites within their hosts.

Change of Sex.—A variety of animals show consecutive sexuality. One and the same individual is first a male and later a female. With many, maleness is the juvenile, femaleness the more adult condition. This variety of sexual lability occurs in several invertebrate animals; among others, it is typical of some echinoderms, several mollusks, some annelid worms and certain crustaceans. In some cases the duration of the male phase depends on whether the animal has female associates.

Individuals of the Ophryotrocha, an annelid worm, in early maturity function for a while as males and then switch over and become females. The female phase may continue until the individual dies, or the male phase may be resumed. It depends in part on the surrounding conditions. When a few of the anterior segments of a functioning female are cut off, a tail regenerates on one piece, a head on the other, and both regenerated pieces become males. Later, if conditions are favourable, each becomes a whole female. A male may be continued as such for a long time by repeatedly removing the posterior segments. Many adverse conditions, including starvation, likewise cause females to revert to maleness or delay the fully developed male from becoming a female. The presence of waste products in the water pushes the reaction in the male direction.

When two females are placed together in a small dish in the laboratory—presumably something similar would occur under comparable conditions in nature—the more vigorous female may obtain a male mate by biting the other in two, by securing the major portion of a scanty food supply, or by being better able to resist the masculinizing effects of excreta-rich water. In time, the newly reverted male may become the more vigorous, develop into a female and cause the long-time female itself to become a male.

The sex of these worms is thus highly labile. The functional expression at any instant depends on a complex of factors that is not clearly understood. The complex includes the degree of conditioning of the medium. the presence or absence of other worms, and their degree of physiological dominance if present.

A similar case, with pertinent variations, is that of the boat-shell snails called Crepidula. Active sexual association with a female causes many males to remain members of that sex longer than they would if isolated. Among all species of *Crepidula* so far studied critically there are a few males that do not change sex; these are the so-called true males, as compared with the hermaphroditic males that constitute the majority of the population.

In the above instances, both sexes are normally present in the population. In one much-studied group, however, the species is carried for many generations by the female sex alone. This group is the cladocerans, or water fleas, primitive crustaceans of which *Daphnia* and *Moina* are examples. The sexual history of the cladocerans resembles that of aphids. Outbreaks of bisexuality occur usually as the pond becomes dry or as autumn sets in. The fertilized eggs are resistant and carry the species over a period of stress. They hatch into parthenogenetic females with the advent of better conditions and the race is made up for some generations of females only. Crowding the females of Moina is an effective method of inducing bisexuality. Crowding acts by decreasing the amount of available food, or by the overproduction of waste products, or perhaps by both of these combined with other unanalyzed factors. In any event, the close association of many parthenogenetic females results in the production of eggs with a prospective potency different from that of the eggs these same females would have produced if uncrowded.

Survival Value.—The adaptive value of a mechanism that produces when needed males, sexual females and the resulting resistant eggs is obvious. This frees all members of the race to be egg-producing members of the community when environmental conditions favour rapid expansion of the population. Each of the other instances cited can also be shown to have certain survival values.

As a result of the specialized method of sex determination that has been evolved in *Bonellia,* the potential loss of males is partially avoided. If the wandering, sexless larva reaches a suitable environment, it transforms into a female and is then able to direct the transformation of the next comer into a functional male. The survival value of the sex situation in *Crepidula* is similar; that in the nematode worms is more complicated and is associated with the necessity of avoiding overcrowding of the host species if the parasites are to persist.

2. Behaviour.—An animal shows social behaviour when its reactions differ in the presence of others from its normal solitary behaviour. The socially induced behaviour may or may not have survival value. A higher type of sociality is indicated when the behaviour of one animal is oriented with reference to another or to a group of other animals. A yet higher type of sociality is indicated by behaviour that differentiates between one individual and another. or between groups of animals.

As in many other aspects of sociology, it is interesting to apply the behaviour test to the Protozoa to find to what extent such evidences of social life can be found among animals without differentiated cells. Whatever sociality they show is a part of the life of a whole organism structurally limited to a single cell and represents sociality at the free-living cellular level. Protozoans reach primitive stages of the highest level of social behaviour, particularly in what has come to be known as the mating-type or sex-type reactions.

Sex-Type Reactions in Protozoa. — The full extent of the distribution of sex types among protozoans is unknown. Individual protozoans belonging to the same sex types do not conjugate with each other. They do conjugate readily with a member of the other sex type or types of their own variety; sometimes — though less readily — they conjugate with a sex type of a different variety. Often they will not conjugate across varietal lines.

An individual will bump into others of its own sex type and merely modify its course of swimming. If animals of a different mating type from within the same variety are introduced, individuals from the proper sex types will adhere, perhaps end to end. or in any other possible position, when they make contact with each other. They swim about clumsily and pick up others, each sticking to an individual belonging to the opposite sex type. A clump of some hundreds may collect thus in Paramecium bursaria. Later a reshuffling occurs; the clump breaks into conjugating pairs in which each animal is finally lined up parallel to its mate and with the oral surfaces adhering. The conjugation continues for 36 hours or more and involves the interchange of nuclear material. Then each breaks free and starts life as an ex-conjugant. All the asexual progeny of a given individual are said to belong to the same clone and. exceptions aside, continue to be members of the same sex type to which the parent ex-conjugant belonged. The clones show periods corresponding to youth, maturity and old age. They do not conjugate in early youth; the transition between youth and maturity is often marked by tentative conjugation; maturity is the period of normal conjugation; and in old age, the ex-conjugants usually die.

Other types of social behaviour of protozoans include the reaction pattern of some ciliates in which, after establishing contact. the members of a chance pair turn and swim side by side with their cilia touching though their bodies remain apart. This may be an example of exploratory behaviour related to the process of finding suitable mates, since in some species it is a regular preliminary to mating.

Lethal effects of one stock on another are known for P. *aurelia*. Such toxicity may be important in natural selection, for the producers of the toxic material would eliminate the members of a susceptible stock with which they were in close association. Such effects may well be an example of competition resulting in unconscious dis-operation for the susceptible stock.

Locust *Phases.*—Swarming locusts. or grasshoppers, are a widespread phenomenon, especially in or near the warm, semiarid regions of the world. Field observation indicates that in an exceptionally favourable season. the population density of grasshoppers in a given area increases notably. If the animals belong to species that lack swarming phases, no marked emigration occurs. and the numbers eventually fall when the environment becomes unfavourable. If the crowded population arises primarily from an increase in numbers of the solitary phase of a polymorphic species. then, when the nymphs become so abundant that individuals repeatedly come into close contact with one another, the latent tendency toward gregariousness is awakened and the development of a swarming phase has begun. The processes so started increase in intensity with continued crowding until swarming and emigration or other factors bring the population density below the critical level — that is, the level that awakens the drive toward close aggregation. The decrease in density may result from emigration, from changes in the physical conditions or from the increased activity of enemies (man included), or from some combination of these population-checking forces.

A growing mass of evidence' indicates the artificial crowding among polymorphic species tends to produce nymphs whose characteristics approach those of phase gregaria and that isolation brings trends toward phase solitaria. One striking characteristic of the crowded nymphs is their great increase in activity.

There is much that is not known about the underlying causal physiology of the behaviour of these locusts. Existing evidence indicates that mutual stimulation raises the rate of activity of the aggregated grasshopper nymphs. It is not known how the increased activity is related to the production of the distinctive black and orange or yellow coloration of the gregarious nymphs or how its absence results in forms lacking these colours. The important point contributed by these polyphasic grasshoppers to general sociology is the strong suggestion that, in these species, not only striking behaviour patterns but coloration and structural patterns as well are controlled by population density.

3. Social Facilitation. — In general, social facilitation reiers to any increment in frequency, intensity or complexity of the behaviour of one individual resulting from the presence of another. Social facilitation usually implies an increase in frequency, intensity or skill resulting from mutual action; it may also refer to an increased tendency to remain quiet. Social facilitation is involved in observational learning, although this is usually called imitation or contagious behaviour. The forerunners of social facilitation can be seen in many of the phenomena of mass physiology. Thus, grouped sea urchin (*Arbacia*) eggs are accelerated in their early cleavages, and grouped protozoans often undergo asexual divisions at a faster rate than would be shown if each were isolated Similar accelerations are known among bacteria, and the added activity of a number of bacteria working together, compared with the results when each works alone. is a measure of their communal action. Facilitation across species lines, called synergism, is also well known for bacteria.

Social facilitation in behaviour is shown by a variety of animals under diverse conditions. Rats fed in a group of five consume as much as 70% more food than is consumed when each eats alone. Hens may eat only half as much food when isolated as they eat when fed in small flocks. Hens showing no sign of hunger in the presence of food often begin to eat if they see another start to feed. Similar behaviour is known in children and has been demonstrated for many animals, including a number of species of fish.

The degree of social facilitation in the food-taking of fishes has been best studied by feeding the fishes known numbers of the common water flea *Daphnia.* Social facilitation does not occur if too many *Daphnia* are introduced, and a so-called confusion effect develops instead. In one instance, groups of goldfish ate more *Daphnia* than did four similar but isolated goldfish, until about 600 *Daphnia* were introduced at one time into the relatively small aquarium. The cloud of active small crustaceans darting in all directions seemed to confuse the fish and the rate of consumption fell off. When a similar number was introduced in small, successive lots, the fish again showed full group facilitation in food consumption.

The observations of fishes feeding on *Daphnia* give a good demonstration of both aspects of the confusion effect: the decreased consumption on the part of the predator and the added survival value that mere numbers furnish for the prey. This is another instance of the survival value of optimal numbers.

Caged rhesus monkeys eat oranges more readily than they eat bread. They eat more of both under controlled social conditions than they do when isolated, but the degree of social facilitation is much greater for bread. Chimpanzees are more likely to eat filter paper if they see a man eating similar stuff; this represents a kind of inter-species facilitation. Under some conditions, competition is a factor in social facilitation; for example, the presence of an imprisoned but clearly visible rat does not stimulate another to eat as does a free and active competitor. In other cases, the stimulus comes from seeing the activity of others without the presence of recognizable competition. Both factors enter into social facilitations in various learning situations with a variety of animals. The goldfish is not notably a schooling fish, and yet goldfish learn a simple aquarium maze more rapidly and with fewer errors if several are present together than they do when the same number of goldfish are trained in separate mazes. There is a tendency for the grouped goldfish to move together in a body and to be less disturbed by outside stimuli and so reduce their learning time. A trained leader mill accelerate learning even more.

Extra animals present in the learning situation may retard learning and so produce mutual interference in place of mutual acceleration. This has been found to be the case for a variety of animals. including cockroaches and shell parakeets. Both retardation and acceleration have been found in studying the effects of numbers on the rate of learning in children. The nature of the effect produced depends in part on the problem and, in part, on the personalities involved.

Social facilitation occurs among representatives of the highly social ants. Some species of *Camponotus* dig their nests in soil. They can dig when alone, but the rate of work varies with different individual ants apparently in correlation with deep-seated physiological differences. If marked ants are placed together in pairs, or in groups, they start digging sooner and work with more steadiness than they do when alone. The accelerating effect is greater for naturally slow individuals than it is for rapid workers: when ants intermediate in speed are used, they work faster in company with a rapid worker and are slowed down by the presence of one with slow working tendencies.

The presence of other animals of the same species frequently acts to reduce the activity of all present over that shown when each is alone. This social facilitation of relaxation has been carefully studied in the goldfish, in which activity was decreased from one-fourth to one-half in the presence of other similar fish. In this instance, sight of a single associated fish is sufficient to produce a decided quieting effect and even the presence of its own image reflected in a mirror reduces the activity of an isolated goldfish.

Some aspects of social facilitation approach what is called imitation in human behaviour. Often such behaviour is spoken of more objectively as contagious. Goldfish learn to swim a simple maze more readily if they have been placed so that they can see others learning. Song sparrows reared in the half-freedom furnished by an ornithologist's study were stimulated to contagious activity in a number of ways. When one sparrow ate, bathed or preened, the others were likely to do likewise; when one flew to the desk, another usually follo ed. Grouped chimpanzees that have some freedom of group movement show waves of activity that seem to be passed along by contagion. Social imitation as seen in man has its forerunners in the behaviour of other forms.

4. Co-operative **Behaviour.**—The literature of natural history contains many accounts of group co-operation of animals in nature. Often these anecdotes are more colourful than critical, but some are certainly trustworthy. Among the American pronghorns, if enough animals are present, an effective defensive group will be formed under pressure of attack by wolves or coyotes. Variants of group defensive action range from the "mobbing" of an attacker by a flock of birds, each individual of which is relatively weak, to the orderly retreat of a horde of baboons with the females and young in the places of least danger.

The group fishing of the double-crested cormorants gives an example of elaborate group co-operation. These birds may be seen fishing entirely alone and in small co-ordinated flocks of from 10 to 12 individuals. They also fish in giant flocks of as many as 2,000 birds. Fishing operations usually begin before the flock is fully formed. The basic pattern in the small flocks consists of a circular arrangement with all birds facing in the same direction. This pattern is changed when large flocks are formed; then, a long, narrow, well-packed line moves forward, fishing as it goes. Some of the cormorants swim at the surface. some swim at the same rate below the surface, and those left behind in the rapid advance take to the air and fly forward to catch up with the others. These large flocks pursue a given school of fish until the hunger of the birds is satiated or the school escapes. The small flocks swim at about two-thirds of the speed of the largest ones

Co-operative behaviour under laboratory conditions has been clearly demonstrated in mammals as far down the taxonomic scale as rats In the best experiments, pairs of rats were placed in an experimental situation that required the co-ordinated efforts of both animals if either was to obtain food and at the same time avoid an electric shock. Each rat was trained individually to feed when the region of the food was not electrified. When a shock was felt, the rat learned to go to a platform arranged so that the added weight of the rat cut off the electric current. When two rats, so trained as individuals, were placed together in this situation, they learned to take turns at the food dish and on the platform so that one cut off the current while the other ate. Pairs of rats even learned to co-operate in a more complicated situation in which the possibility of being shocked was present only 25% of the time. The co-operation disintegrated in the complete absence of the electric shock. Roughly similar evidence of co-operative food-getting has been recorded for cats even when the situation was complicated by one cat being socially dominant over the other.

Chimpanzees learn to execute still more complicated co-operative patterns. In a fairly complex situation, each of the selected chimpanzees learned by trial and error to operate four devices in a given sequence in order to obtain food from a mechanical vendor. Then pairs were caged close together and within easy sight of each other but separated by an open grille. Each chimpanzee could reach two of the four devices that must be operated. and each had a food vendor in its cage. If both operated the available devices rather steadily, food would be obtained now and then by a chance operation of the appropriate sequence. Co-operative behaviour was considered to have been given when one chimpanzee watched its partner's performance and pushed at the gadgets available to it at the proper time as indicated by the colour sequence. They often obtained food in a somewhat systematic fashion. The chimpanzees were also judged to show co-opelation when so-called solicitation was evident; at times the solicitation clearly indicated the location of the next device to be pushed. Meredith Crawford, who did these experiments, observed:

> The directive elements of the solicitation, that is. the bodily orientation of the partner, were clear and human-like. Perhaps it is significant that a soliciting animal never pointed but always used what seemed to be the more primitive method of pulling or pushing the partner. . . . It may be that an important transitional step in the development of language behaviour lies between the direct orientation of one animal by another through body manipulation and indirect orientation through pointing toward a distant object (Jour. Soc. Psychol., 13:278, 1941, Journal Press).

III. ORGANIZATION OF ANIMAL GROUPS

The most primitive of animal aggregations, sociologically speaking, show no discernible organization. Some of the highly integrated invertebrate groups--colonies of bees or ants, for example —have types of organization that can be perceived in part but about which real understanding of the fundamental relationships cannot be gained. The organizations of vertebrate groups are more obvious and more like our own. They are based on three general principles: (i) territory. (2) dominance-subordinance and (3) leadership, with. of course. the important complementary quality of followership.

These different. types of social organizations intergrade with each other to form complicated social patterns that fall into certain recognizable trends in the vertebrate groups beginning with fishes , There is some evidence of the operation of each oi the principles even among invertebrates. Thus hermit crabs display dominance based on size and force: crayfish show spaced aggregations in which a certain amount of territory about the individual is kept free of intruders, and some ants show leadership-followership relations. In the main, however, discussssion of group organization in this article is restricted to groups of fishes, reptiles, birds and mammals.

The study of organization requires the consideration of a set of phenomena that are not encountered in the analysis of the primitive. basic relations that make for survival of an organized aggregation or of group effects on behaviour. Defense of territory and the establishment and the maintenance of social dominance often call for hard fighting between the individuals of a contact pair. This aspect of intra-species struggle appears later in evolution than does primitive automatic co-operation. It is apparently made possible in part by the functioning of natural co-operation and of group-oriented behaviour which. together with gradients in the physical environment,, permit or condition the formation of aggregntions. It is only when animals are somewhat aggregated that organization becomes possible.

A. Territory

A territory, in the sense of comparative sociology, is a more or less restricted area that is actively defended against trespass by other individuals of the same species and sometimes against trespass by other species. Territorial behaviour is a complex phenomenon In full development, in its least complex form, this type of behaviour is based both on a positive reaction to a particular place and. within that area, on a negative reaction to other individuals of the same species, except for a mate or mates.

1. Types of Territorial Relations. — Information about the social aspects and implications of territorial organization is richer for birds than for any other animal group, and birds shon the following types of territorial relations. (1) mating, nesting and feeding ground for young: (2) mating and nesting but not feeding ground; (3) mating station only; (4) restricted to narrow surroundings of the nest: (*a*) solitary individual. (b) colonial birds; (5) winter territories; and (6) roosting territories This classification does not include all known instances of territorial behaviour among birds when territory is given the simplest, most inclusive definition of any defended area.

Blue geese (*Chen caerulescens*) were observed in' a bird sanctuary to defend the following territorial types: (1) family territory; (2) mated-female territory; (3) feeding territory; (4) nesting territory; (5j resting, or resting and sleeping, territory; and (6) moving territory. The last type was shown when a family of four kept a certain amount of nearby space clear from geese of their own and other species when they swam about as a family. These territories varied with time of day and with the season of the year. The defended area may be fixed and well-defined; the boundaries may vary or the whole territory may be established only transitorily.

Although the variations are great with different species, each of the types of territories possesses definite social implications. The territory may be taken up before or after mating. Some unmated males do not maintain permanent holdings: others do. Territories are often abandoned in winter. although some birds retain them even then. When one male has more than one mate, his holdings may be subdivided. The role of the female varies greatly in territorial behaviour; often she does not defend her mate's boundaries, though sometimes she does. Some flocks hold and defend definite areas, whereas others do not, and the flock territory may or mav not be subdivided.

Territories are often compressible depending on the population pressure in the given area and also on the ability of the male in territory defense. The defense of a given territory frequently entails active fights. With widely different species the combats may be formalized. Singing of birds and other sorts of defense short of direct use of force are well authenticated. Hordes of howling monkeys engage not in fighting but in howling encounters when they meet near their common boundary line.

When territoriality is well developed there is a reserve of unmated males and females that makes possible the prompt replacement of a lost mate in a functioning territory.

2. Biological Values. — Some of the general biological values associated with the territorial habit in birds are: (1) the unconscious organization of a local population into what may be regarded as a well-spaced aggregation: (2) promotion of monogamy, which is often important in rearing helpless young; (3) limitation of the breeding population and hence partially controlling population density; (4) provision of a relatively safe and defensible breeding place that often contains (5) insurance of an easily accessible, adequate food supply for adult and young birds during the rearing of the brood; (6) reduction in the rate of spread of diseases; and (7) reduction of fighting and thus conservation of energy. With suitable modifications, many of these values are to be found in the territorial behaviour of other kinds of animals, especially of fishes, lizards and mammals that defend restricted areas.

3. Relation to Dominance-Subordinance Hierarchies. — The territorial type of organization of populations is closely interrelated with the social hierarchies that often develop in smaller groups and that are based on dominance-subordinance relations. In fishes. for example, in a restricted amount of undivided space. certain species form a dominance hierarchy, whereas the same individuals in a larger aquarium. or in one that is partially subdivided, will establish defended territories. Usually, the lowest fish in the hierarchy is the last to obtain a territory and. if available niches are few. it may not establish one at all.

A territorial animal fights more fiercely within its own territory than when invading that of another animal. Sometimes, at least. the decrease in fighting power is related to relative distance from the territorial centres of the combatants. A bird that is socially subordinate in neutral. unclaimed territories tends strongly to become dominant in its home territory. Among various birds, especially pigeons. given individuals establish territories even in a sizable laboratory cage or small house. Records of fights under these conditions show now one of a pair and now the other winning, depending on the territory in which the combat takes place. Such relations furnish one transition from an organization based primarily on defended territories to social hierarchies of dominance and subordinance considered below.

There is no certainty as to whether territoriality preceded dominance hierarchies in evolution, or concerning the general sequence of these two forms of organization in social development. It is not even known that these social patterns are related in evolution; they are not necessarily so. even though they are often functionally interrelated. Young individuals of the green sunfish (*Lepomis cyanelltis)* in laboratory aquariums first form social hierarchies; later, with the approach of breeding, the males establish territories; similarly, with many animals, social hierarchies give way to territorial organization during the breeding season. On the other hand, certain ground squirrels of western North America, belonging to the genera *Eutamias* and *Citellus,* leave their individual territories and collect about food when this is locally abundant. The collected animals then form hierarchies that are revealed by definite chasing orders.

B. Dominance-Subordinance

There is little evidence among invertebrates concerning the existence of dominance-subordinance hierarchies resulting from contact relations between pairs of individuals. There is much evidence of the subordination of the individual to the whole social group such as occurs among the highly social insects. The causal relations whereby the entire group comes to dominate all the individuals composing it are only partially known.

In the higher fishes. social hierarchies based on individual dominance appear with many of their characteristics already in a high state of development. Final social status is typically determined after the first few contacts between two fishes and may harden soon into a fairly lasting despotic relationship in which the dominant member of the contact pair nips or drives or threatens the subordinate one without receiving nips or even threats in return. Such a social system is also known among the slow-moving turtles, as well as among the more active lizards. It is well developed in many birds and among mammals. Probably more is known about social dominance and subordinance in common chickens than in any other lower animal. The modern period in the study of social hierarchies was initiated by Thorleif Schjelderup-Ebbe in 1922.

1. Pecking Order. — The most fixed type of social hierarchies among birds is based on what has come to be called the peck-right. or pecking order. The higher ranking individuals are able to peck those of lower rank without being pecked in return. The relations within one flock of white leghorn hens are summarized in the table. The hen RG ired and green leg band) pecked all her subordinates except BR. Each hen of lower rank. except BR, was pecked by all those above her in the hierarchy and in turn pecked all those of lower rank. BY, the omega hen (lowest in the hierarchy), pecked none and was pecked by all.

A flock of hens may or may not be organized into a simple straight-line hierarchy. One of the commonest irregularities occurs when a hen with medium or even low social status has the peck-right over some individual that otherwise outranks her in general social position. In the flock shown in the table. RR. ranking fourth. was pecked by RW and YY and yet had the peck-right over RG, otherwise the alpha (highest ranking) bird of the flock. A commoner complication occurs when triangle situations arise in which A pecks B: B pecks C; and C pecks A. and then all three have the peck-right over those below them in the social scale and are pecked by all with higher social rank. Pecking triangles occur at all levels in the hierarchy of hens but they are more likely to be found in flocks of cocks than among hens. Sometimes, around a food bowl for example, the hens of a triangle will pass the peck around and around until something happens to break the combination.

The Social Order in a Flock of White Leghorn Hens

Individual	No, pecked	Individuals pecked								
RG	7	BY	RY	BG	RR	GG	...	YY	RW	...
RW	7	BY	RY	BG	RR	GG	BR	YY	...	...
YY	6	BY	RY	BG	RR	GG	BR	...	...	...
BR	6	BY	RY	BG	RR	GG	...	...	...	RG
GG	4	BY	RY	BG	RR	...	...	...	...	...
RR	3	BY	RY	BG	...	...	...	...	...	...
BG	2	BY	RY	...	...	...	...	...	...	...
RY	1	BY	...	...	...	...	...	...	...	...
BY	0	...	...	...	...	...	...	...	...	...

The organization in a flock of hens represents a type of social pattern in which dominance, once won, is relatively permanent. The same rank-order has been known to remain fixed for over a year. With pigeons, doves, canaries, shell parakeets and others, although the flock organization is no less real, the outcome of any given pair contact is less predictable. The social structure is based on a differential peck exchange in which dominance is indicated by the ratio of victories to defeats between the members of each contact pair. Such flocks are organized on what may be called peck dominance rather than on the more absolute peck-right relations existing among hens and certain other animals. The peck-dominance type of social order is related in part to territoriality in that animals tend to win contacts in or near their own territories and lose them in those of others. At least under laboratory conditions, peck dominance also occurs among some birds that have not established special territories.

Pecking organizations among birds are apparently based on the ability of birds to recognize and react to their flockmates as individuals. When territory enters as a factor, recognition of the individual's territory also becomes a part of the group reaction system. The space available for the flock often determines whether territory will or will not affect the system. When groups of canaries are caged in a small space, the social order becomes simple and definite; it is little complicated by territoriality. Given more space. individual territories tend to be established in which each bird becomes supreme in his own holding, regardless of how low his status may be elsewhere.

Early observations upon group organization in birds were limited to penned or caged flocks, in which individuals could be readily marked and observed. Later. such social order studies were extended to semiwild flocks and finally to several species of birds in nature.

With hens, under experimental conditions, individuals can remember and steadily give the same social reaction to each one of 25 or more individuals. Still larger flocks can be roughly divided by a human observer into upper. middle and lower thirds. Yet three weeks of absence from even a small flock will cause a hen to act and to be received as though she were a total stranger.

A hen can maintain social position in different flocks at the same time. Once her rank in four or five flocks has been established, she can be shifted back and forth in each flock every day or so and move fairly smoothly into her usual social position even though she has a different rank in each flock.

It must not be thought that hens. or animals in general, go about fighting their associates continually. There are hours together when no such social interactions can be seen. and watching for them becomes a tedious occupation. Hens. for example. spend much time in sunning. or dusting. or just sitting quietly: during such periods, even the omega hen of the flock. if she goes quietly about her own affairs with head held low, may escape blows from all her superiors If, however, she darts about actively. some one or another of her social superiors is likely to threaten or peck. and the pecks frequently are severe enough to draw blood.

2. Individual Differences. — Hens, and cocks too. behave differently toward their various associates. Some peck certain inferiors mildly and infrequently and give more and harder pecks to others than their position in the social order would lead the observer to expect A female despot may allow an inferior to pick food from her bill though others are pecked severely if they attempt to take a similar liberty An alpha cock may even allow an inferior to replace hiiii while mating but will react violently to a similar attempt by another associate There are many instances among these birds of what would be called favouritism and antagonism in human society.

High-ranking hens differ greatly in their reaction to socially inferior flockmates. Some are mild despots: others are severe, driving ones. Some allow inferiors to feed with them; others feed alone. Some inferiors feed quietly between pecks from those of higher social rank: others react strongly to being pecked and cease all attempts to feed for the time being. Often the omega hen feeds only after all others have left the food bowl and may not attempt to eat at all until hunger-driven to accept pecks in order to obtain food: she may even starve to death with only a social block between her and food. The range of individual reactions within a territorial or other social organization is very great.

3. Mammalian Dominance Orders. — Dominance orders are common also in mammalian groups, including mice, rats, hamsters, ground squirrels, cats, dogs. horses, cows, monkeys and apes. Each species presents its special set of variations from the general principle. Mice. since they stand relatively low in mammalian evolution, provide an interesting study. Little is known about their social organization in nature. Given hideaway niches, food in plenty and abundant space. the social picture would be different from that seen in laboratory cages.

Both males and females fight and, as usual, the males fight more frequently and harder. Small groups of male house mice caged together arrange themselves into various types of social orders. In one set of more than *4,900* observations, exclusive dominance of one male without resistance and without fighting among subordinate animals was found in *43%* of the cases. Sometimes there was resistance by one mouse, or a hierarchy of three ranks might be formed in a group composed of five mice. Often there was no fighting at all for several days. Once exclusive dominance in mice is established, it may persist unchanged for months, although the statistical expectancy of continued dominance for one individual in a long series of tests was found to approximate three weeks.

The temptation is great to summarize at length the details of social dominance in monkeys and apes. The reader should consult the books by S. Zuckerman (1932) on baboons and by Robert Yerkes *(1943)* on chimpanzees, cited in the bibliography, as well as the accounts by Clarence R. Carpenter of his observations of howling monkeys in Panamá (1934), of gibbons in Siam *(1940)* and of the semiwild rhesus monkeys on Santiago Island off Puerto Rico (1942).

Howling monkeys live in bisexual hordes with each group confined to a given territory. The usual adult sex ratio is three males to seven females. Complemental males roam through the tropical jungle between the groups and, if persistent, may gradually gain admission to some horde, or form the centre for a new one. The minimum observed size of these howler hordes was four, one male and three females. The largest numbered 35 animals of which *19* were adults — 5 males and *14* females. A co-operative group of adult males dominates and co-ordinates the howler clan.

Rhesus monkeys belong to the old world tropics. Those introduced on Santiago Island numbered about *350* in *1940.* After about two years on the island, they had organized themselves into five bisexual groups and two groups of males only. Typically the young male separates from his home group in early adolescence. joins a gang of other young males and lives with them until he is nearly adult; then he eases himself back into a bisexual horde and may gradually advance in social rank. On the average there are six females for each of the males in an adult group of these monkeys.

Dominance gradients exist in the unisexual groups of young males, and separate gradients are found for the males and the females in the bisexual hordes. The lowest-ranking male ordinarily outranks the female of highest rank. Females are characteristically subordinate to males in all the social groups of primates that Carpenter observed in nature with the exception of gibbons, whose adult males and females are co-dominant.

Groups of gibbons are smaller than those of howler or rhesus monkeys and may consist of only two individuals, a mature sex pair. They are essentially family groups in which headship rests equally on the two adults. Senile individuals may or may not be retained within the group. Gibbons of both sexes are very aggressive and now one, now the other dominates in such activities as feeding, play or sex behaviour.

Group life is normal for chimpanzees. Within the group, certainly in artificial segments arranged by man. dominance-subordinance relations form the chief means of social organization. Males usually dominate females, although regardless of sex the smaller, weaker, less enduring chimpanzee tends to be the subordinate member of a caged pair, particularly if these traits are combined with such psychobiological factors as sweeter temper, less courage and less social assertiveness.

One set of six female chimpanzees, observed in all possible pair combinations, showed a hierarchy of dominance in their success in competition for food. Mira and Nana showed a complete reversal of dominance during the period of observation. Nana, Cuba and Lita formed a social triangle somewhat like those existing among hens. Bentia and Lita were decidedly less dominant than the others. and members of the more dominant quartette associated with them more closely than with each other Often there is tension between aggressive animals with nearly the same social status.

These apes reacted socially with each other only 17% of the time they were together. Of this time, less than 1% was devoted to definitely aggressive action. (Groups of male mice similarly spend about the same amount of time in aggression.) Almost 63% of the social behaviour of apes consisted in grooming and about 33% of their interactions were devoted to play of one kind or another, not counting the approximately 3% spent in one form or another of sex behaviour.

4. Signs of Subordination. — Taking vertebrates in general, the most certain sign of dominance is the winning of a definite pair contact. Sometimes an individual gives ground because it has been temporarily out-fought or out-bluffed; it may return to the fray and win eventually. Defeat is often accompanied by easily observed signs of submission. A defeated fish often drops its challenging attitude of tense body and bristling fins; the whole length seems to hang limp in the water; the fish backs slowly from the victor and then turns and flees. Beaten lizards are known to give what is called the subordinate head nod, and the American "chameleon" *(Anolis),* with unconscious aspersion, has been described as turning a dirty yellow colour. Many animals, hens and mice among them, sometimes emit characteristic cries when defeated With hens, the face and head furnishings blanch, while those of the victor are literally flushed with victory. Defeated mice show submissive body postures.

Signs of social subordination also include the wary avoidance of superiors: moving quietly with head held low; hiding in obscure places or in protected corners; and accepting or even offering to assume the female position in pseudo-copulation. Yerkes was much impressed by many feminine aspects of the behaviour of socially inferior male apes.

5. Social Status and Sexual **Behaviour.**—Social status and sexual behaviour are closely interrelated. Although male animals usually dominate their associated females, this is not always true. and it can be demonstrated by a simple experiment that in some fishes, at least, social and sexual drives are distinct. Gradual cooling of the water around sword-tail fish (*Xiphophorus helleri*) causes them to lose their sexual appetite before the drive for social status disappears.

There is great variety in the relation between social rank and mating behaviour. The howling monkey hordes in the rain forests of Panamá, with their low dominance gradients, show no correlation between social dominance and the sexual possession of a receptive female. At the other extreme: in the half-wild rhesus monkey hordes on Santiago Island. the dominant male has exclusive possession of a single receptive female and, if more than one female is in sexual heat at the same time, the dominant male asserts his rights during the mid-period, when copulation is apparently most satisfactory.

When chimpanzees are paired in a cage, the male takes possession of limited or of unusually attractive food until the female comes to the sexually receptive stage in her regular cycle; then the dominant male gives way and the female gets first access to the food. The interplay of social forces here is complex and is affected by personality traits of both members of the sex pair. It is significant that when two females are caged together precedence of food also shifts from the socially dominant to the subordinate when the latter is sexually receptive. Yerkes *(1943)* reported many wiles by which a subordinate female chimpanzee may manage somewhat her dominant mate.

A socially dominant cock living with other males in a flock of hens may so suppress the subordinate cocks that the latter cease to mate with the hens. An essentially similar reaction has been reported for males of the sage grouse in Wyoming, in which so-called master cocks, comprising about 1[illegible] of all the males. make some 74% of the matings. and about 97% of the cocks make only 3% of the matings.

6. Survival Values.—Females standing high in the social hierarchies of flocks of hens, at least. under some conditions, are courted and mated less than are their lower-ranking subordinates. To the extent that this affects egg fertility. high social rank tends to lessen the long-term survival value for hens. This disadvantage is offset by some decided advantages. Briefly put, high social rank allows greater freedom of movement and certain essential priorities, notably as regards space, food and female mates. Low position in the social gradient carries restrictions that may be very severe and even fatal for the life of the individual. As indicated earlier, socially suppressed hens may starve within a few feet of food; and Arthur A. Allen observed that ruffed grouse, strongly subjugated by associates in a laboratory pen, may die for no known physical cause, though dominant grouse survive.

Dominance-subordinance organization among most vertebrate groups results from interindividual fights or threats. There is competition, often strong competition, for social status. The fighting may reach disruptive strength, as it does between males of the fighting fish, *Betta splendens;* but when the pair conflicts are not too severe they result in an organized group that has some rather definite survival values as a group in comparison with other aggregations in which organizational fighting is still in progress. Thus mating reactions are more normal in hierarchial groups when the organization is well established. and flocks of hens with an accepted peck-order produce more eggs, as a flock. than do similar lots of hens that are in the process of organization.

Competition at the individual level, in such instances. leads to the possibility of closer co-operation or to more effective competition between groups as units. Also, and obviously. co-operation between individuals produces similar results at the group level. Here again it is evident that, up to a certain degree. competition may be a form of co-operation or at least of proto-co-operation. When the interindividual conflicts become overintense, as in *Betta splendens,* competition is disruptive.

Conflicts and co-operation between small group units show similar relations with respect to larger, more inclusive group federations. If the intergroup struggles are not too severe, they yield more comprehensive organizations that have the increased power inherent in a generally accepted, smoothly working organization containing large numbers of individuals. The same effect may be produced by combining smaller co-operative units into a large whole, such as happens with many flocking birds.

C. Leadership

High-ranking members of a dominance hierarchy possess many social privileges that are not necessarily accompanied by social obligations. and alpha status in the social order is not necessarily correlated with leadership. The alpha hen in a foraging flock may or may not be at the apex in the line of advance; often she is not, and. in any event, the leading bird seems always more or less dependent on her followers.

In contrast. leadership may be closely associated with dominance as in the semiwild hordes of rhesus monkeys on Santiago Island, or it may exist without an obvious dominance order, This last relationship is approached in the Scottish herds of red deer that F. F. Darling (19373 watched, among which an old. experienced female—usually with a fawn of her own—is the leader of the herd. In pure development, leadership carries with it a variety of social obligations without corresponding social privileges.

Social organization based on leadership shows greater flexibility than does organization growing out of territoriality or from dominance-subordinance. Leadership can bring types of social efficiencies, in group protection for example, not provided by the other two organization types. The analysis of leadership is less complete than that of the others; much detail is known but generalization is difficult and the following treatment is in part tentative.

As with dominance and territoriality, individual leadership is better developed in groups of vertebrates than it is among invertebrates. Individual leaders are known among some species of ants in small artificial colonies: as in a Chinese species of *Camponotus;* and in nature as well, especially in *Eciton,* army ants of the American tropics. The raiding columns of these army ants show a shifting type of leadership with the ant or a small "pushing party" of ants at the apex advancing in a hesitant manner and then returning to a larger mass; as in hens, these ant pioneers are apparently much dependent on their followers.

With vertebrates, leadership is known among fish, lizards, birds and especially mammals. An experienced fish will lead inexperienced followers through a simple laboratory maze and so help them learn the shortest route much more rapidly than they can learn it when no experienced leader is present.

Leadership in flocks of birds presents many puzzling problems, of which the most basic deals with whether the front bird is really leading the flock or is merely the fastest flying or one of the least tired birds. In one well-authenticated instance, a mixed flock was composed of a dozen black-bellied plovers, two young dowitchers and a single golden plover. When the flock was flushed, the faster flying golden plover was soon ahead of all the rest. The dowitchers were slow and tended to fall behind, and when this happened the black-bellied plover wheeled. This affected both the apparent leader and the followers. The golden plover, finding itself alone, rose above the others, reoriented, and with a few rapid wing beats dived ahead again, apparently the leader of the whole flock. The slow-flying dowitchers caught up by taking the shorter course directly toward the circling flock. Soon they fell behind again and the whole series of reactions was repeated. There is almost as much reason for regarding the fast-flying golden plover as following along ahead of the flock as there is for thinking that the slow dowitchers were following behind it.

This whole set of phenomena illustrates pseudo-leadership. The essential orientation is furnished by the body of the flock and the stimulus for turning may originate on one of the flanks rather than being given by the leading individual. Pseudo-leadership is well known to exist in other animals.

In groups of gibbons leadership as well as dominance shifts back and forth between mates. Here. as often among mammals, high social status and leadership are closely correlated. A striking exception is shown in herds of red deer in the Scottish highlands. During the rutting season. stags enter the female herds and each rounds up as many hinds as possible. The stag dominates the hinds. If danger approaches, off goes the stag on his own, and the real leadership is seen to remain with the experienced female that usually leads the herd of hinds and their fawns.

Darling (1937) emphasized a striking difference between male and female-led herds. In the former, as illustrated by the roe deer of England, the group is small, held so by the aggressive intragroup behaviour of the dominant male and, to a smaller degree. of the female roe deer. In the female-led herds of red deer, in contrast. the group tends to be large and the young remain members of the home herd for a longer time.

From such data. the generalization has been reached that throughout the higher reaches of the animal kingdom males tend to be sufficiently aggressive so that they exert a disruptive social influence in contrast to the less aggressive females. Various devices have evolved that centre about this and other phases of the relations of the sexes. Many insects, such as aphids and the more social wasps, bees and ants! produce males in limited quantities and at limited times. The mammalian solution is different; in many gregarious mammals the males join the female herd only during the sexual rut and keep by themselves or gather in small male herds during the remainder of the year. Only among the termites have the males become as highly socialized as the females?and the evolutionary or physiological processes by which this came about are unknown.

D. The Family

Aggregations of both sexes, but of different species, form during the mating season, especially of species that mate at approximately the same time of year. Male frogs will attempt to clasp females of other species of frogs or toads, or, in fact, almost any moving object that they can grasp, even fishes. Coccinellid beetles of different species attempt copulation. Often there are unisexual aggregations of one sex or the other, or both, at or just before the breeding season.

1. Types of Mating Relationships.— Sexual congregations of the same species range down to conjugating aggregations of protozoans. Among higher animals the types of mating relationships include:

1. Polygyny, in which one male regularly mates with more than one female; the situation is fairly common among lizards, birds and mammals, the domestic cock and hens providing a well-known example.

2. Polyandry, in which several males breed interchangeably and successively with one female, is relatively rare in pure form; it occurs when several dwarf males are associated with each female, as in the barnacle *Alcippe* or the worm *Bonellia,* and is found in certain species of spiders in which each female consorts with two males.

3. Monogamy is fairly widespread among animals. It is found among beetles such as the wood-dwelling Passalidae, in which the adult sex pair remain together with their offspring. Seasonal monogamy seems common among many animals, having been reported for certain spiders, some reptiles and many birds and mammals. Longer duration of monogamous relations is also known, the common red fox furnishing an outstanding illustration. Among the apes in nature, gibbon families are based on monogamous mateship.

4. Sexual promiscuity is even more widespread, especially among relatively solitary animals. It occurs among many fishes where the sexes mingle at the spawning grounds. Certain lizards and gregarious bats have this sexual habit. Among mammals, the female muskrat accepts any male that may appear when she is in her short sexually receptive period.

5. The sex relations within a horde of howling monkeys present another variant. These animals form an almost closed group that contains more females than males. Sex relations are communal within the horde. Any female, on coming into heat, accepts the nearest male and, when he is satiated, moves on to another, with no sign of sexual jealousy in the part of either sex.

2. Parent-Young Associations.— The association together of young of the same brood, and still more, the association of offspring with either or both parents, is almost as potent a social force with nonhuman animals as are similar relations in man. Many variations occur. Primary aggregations exist in which the individuals are descended from a common father or a common mother. or from common parents. Such aggregations often remain near the place of hatching or birth and show all gradations between loose and quite firm integrations. The primary reason for the animals being together lies in their common origin, but their continuing aggregation often depends on the favourable character of the place or on the abundance of suitable food rather than on genetic factors. In other instances, social appetite appears to hold the group together.

Primary aggregations may arise as a result of asexual reproduction in Protozoa, of natural parthenogenesis in cladocerans or aphids, or from bisexual reproduction. *Lophyrus* caterpillars, which feed on pine needles, form a larval aggregation that arises in the beginning from the fact that the eggs are laid close together. The female moth departs after depositing her eggs and is not associated with her offspring. The common origin is not sufficient in itself to account for the young remaining together since many other kinds of caterpillars scatter as they become able to crawl about; other forms remain aggregated during early larval life and separate when partly grown; and still others remain together during their whole larval life, spinning a common silken nest and even pupating together, only to separate when adult.

Primary aggregations composed solely of young animals may be all of similar age and size, as in schools of young minnows; or they may consist of infertile workers and potentially sexual animals. as in a bee colony when the old queen has departed with her swarm. All may have one or both parents in common, as usually happens with the caterpillars just mentioned, or the offspring from different individual families may join, forming large groups of mixed parentage. This happens at times with young spiders and is commoner among juvenile fish.

It is much more usual for a mother to remain alone with her offspring than for the father to do so. Newly hatched leeches, tiny crayfishes or minute spiders, clinging to their respective mothers, help show how widely distributed this form of association is in nature. The aphid stem-mother and her brood, mole crickets (*Gryllotalpa*), earwigs (*Forficula*), colonies of ants or bees and red deer and many other mammals illustrate mother-offspring groupings. Each female may consort only with her own young, or two or more family groups may join as do some ants, seals and wild hogs.

In another smaller series of animals, well illustrated among certain fishes. the male guards the eggs after they are laid by itinerant females in the territory that he defends. Often he aerates them by fanning gently with his fins, meantime mounting guard over the developing eggs and newly hatched young. Males of the stickleback and of large- and small-mouthed black bass, among others, have this general habit. Males may establish still more intimate relations with eggs. The male midwife toad *(Alytes)* carries strings of eggs twisted about his legs, and a frog of the Chilean forests (*Rhinoderma darwini)* crams the fertilized eggs into his singing pouch, which becomes greatly enlarged during the breeding season. The eggs develop and transform in the paternal cavity and the young animals hop forth from their father's mouth as fully developed tiny frogs.

The variations from normal family patterns are numerous and sometimes important. Thus unmated wolves may be associated with a mated pair—the whole pack then hunts as a unit—and unmated bob-white quail of either sex adopt orphaned young. Such variations as these have great survival value.

The association of both parents with their offspring is by no means uncommon among insects and is the regular habit with many birds and mammals. Passalid beetles live with their young in the tunnels they make in rotting logs. *Necrophorus* beetles live similarly in decaying animal bodies. Both sexes of social wood roaches. the forerunners of termites, like termites themselves, live surrounded by their offspring. Song sparrows, robins, bluebirds and many others of the commonest birds have this habit. Foxes. wolves, roe deer and gibbons are among the mammals that react so.

It is not known what percentage of all the vast variety of known animal aggregations grow immediately from the family or from recognizable variations of family life. Many of them do. The higher forms of social development among insects arise from the association of parents with their offspring. as in termites, or from one or more females and their young, as in wasps, bees and ants. The family has also been very important in the development of social life of various vertebrates. Important as sex and the family are as integrating social factors, they do not form the sole outlet for the expression of the fundamental social appetites, nor are they the only foundation on which social structures have arisen. Even so, the most permanent societies appear to have developed when sexual and parental integrations have operated in addition to the more elemental aggregating tendencies.

Whatever the pathway taken, the social life of all animals rests in final analysis on the basic nonconscious drive toward natural co-operation that is co-incidental with all life and is especially developed among animals.

E. Extensions and Analogies

Great care must be exercised in forming judgments about the probable social behaviour in untested situations and especially about the inner social feelings of animals under any conditions.

It is unsafe to assume, without direct information, that one order of birds will show social patterns closely resembling those of some species belonging to a different order. It is still more hazardous to try to estimate the degree and kind of sociality across wider taxonomic gaps. For example, pending direct inquiry, it is unsafe to predict that individual-to-individual social hierarchies exist among sharks from the fact that such social rank-orders exist among many species of bony fishes.

Still greater caution must be exercised, again pending direct information on the precise point at issue. before making extrapolations between human sociality and the social life of other species. Men may and do disregard or compensate for inconveniences based on position in the social "peck-order," but we cannot judge therefrom that other animals do likewise. Despite the need for great restraint in such matters, stimulating cross comparisons can be made that help to integrate animal sociology into a unified whole despite the marked differences between the social relations of man and those of other animals.

1. The Organism and **the** Supra-Organism.— The analogy between the biological processes within the organism and the sociological processes within society long ago attracted attention. Thomas Hobbes' Leviathan and the jess cumbersome comparisons of Herbert Spencer in his discussion of the analogies between the organism and society are matters of historic interest only. but they did more or less vaguely foreshadow the modern realization, particularly by biologists. that similarities exist between individual organisms and organized social groups. Since even ecological communities, as well as more closely knit societies, behave as more or less integrated entities. they are often regarded by biologists as representing a set of emergent levels concisely designated as supra-organisms.

Even biologists do not stress the resemblances between societies and a closely co-ordinated organism such as an insect or a man. They do see pertinent resemblances between the social supra-organism and simpler invertebrates. Sponges. for example. often have one part of the individual colony working in direct opposition to another when the co-operation of both is needed for efficient operation of the whole. Starfish, in righting themselves, and even in walking across a smooth surface, often tear off some of their tube feet that were working in opposition to the movement of the whole.

Society, human society as well as an insect society based primarily on inherited behaviour patterns, shows many pertinent comparisons with these more poorly integrated organisms, and yet primitive organisms and primitive or advanced societies are somewhat integrated wholes.

Numerous social convergences exist between human and insect societies including the following:

Division of labour; social integration through signals, chemical agents, and activity gradients; social dominance; replication and duplication oi patterns; specialization of population units through classes or castes; ontogeny of social organization; phylogeny of social systems; divergence; convergence; recapitulation during ontogeny; degenerative evolution and vestigial characters; social variation and selection of social and familial units; and the dynamic maintenance of population equilibrium (Emerson, "Levels of Integration in Biological and Social Systems," *Biological Symposia,* vol viii, Jaques Cattell Press.)

Insects and mammals stand near the apex of their respective evolutionary branches of the animal kingdom. The similarities between the social life developed in each class are mainly matters of convergence and analogy. To the extent that the sociality of each develops from the co-operative tendencies of their common ancestors. their sociality is vaguely homologous. In many ways this is not a minor point. Even the sociality of man developed not alone from a distinctly human drive toward group co-operation but also grew out of the basic drives toward natural altruism that pervades all animal life.

2. Subsocial and Social.—For general and comparative sociology. the chief interest is not between extrapolations from the organismic to the supra-organismic level in organization--from the biological to the social. so to speak—but rather in the permissible extrapolations from the subsocizl to the truly social levels and in the opposite direction as well. Here again arises the problem as to where truly social life begins.

A part of the difficulty involved in answering this question may be avoided if it is recalled that rnany different levels of social organization exist and that these usually overlap. Among the groups that the biologist regards as somewhat more social than is implied by more vague ecological relationships the following may be recognized: (1) Those that show their social habit merely through the toleration of the close proximity of other similar animals in the same restricted space; these may exist without any positive mutual attraction and represent the toleration level of sociality. (2) Those groups that react more or less definitely as units—the group-integration level. (3) Those that show physiological division of labour. (4) Those that show morphologically distinct castes, each associated with some phase of the division of labour (the highest insect level). (5) Those that are organized to a large part by tradition and by symbolic communication and that frequently react to abstractions (the human level).

In presenting this abbreviated list of recognized social levels, there is no intention of assuming that the more complex types of social life evolved through the less complex ones. Such may or may not have been the course of social evolution. The insects do not stand in the direct line of man's ancestry. Their state of social development represents an insect evolution of sociality, not a stage toward that found in man.

Animals on the higher planes of sociality continue to show certain of the group attributes characteristic of the lower levels. Group survival values have been demonstrated throughout the whole series and apparently extend to the threshold of primitive life. Extrapolations forward from the lower to higher social levels can be made with more confidence than those in the opposite direction. It can be predicted, from studying the social survival values of primitive organisms, that, other conditions being equal, groups of more complex animals will have certain survival values as groups. It is much more hazardous to try to project highly developed human social traits, like social consciousness, back into the less complex social levels reached by other animals.

3. Conclusion.— For a final summarizing statement, it is necessary to turn back to evaluate two contrasting social forces discussed earlier in this article. The conclusion that emerges from cumulative studies on social biology is that co-operation and its opposite, dis-operation, both exist. There are egoistic and altruistic tendencies in nature, and both are important. The question arises insistently to which of these is the more fundamental and significant. Any such evaluation should be based on short-run and on long-run effects. Considering the evidence available, contrary to Herbert Spencer and the conclusions of social Darwinism, the co-operative forces are biologically and sociologically the more important and vital. The balance between the co-operative, group-centred tendencies and those that are dis-operative and egoistic is relatively close. Under many conditions, the co-operative forces lose. In the long run. however. the group-centred, more altruistic drives are the stronger.

If co-operation had not been the stronger force, the more complicated animals, whether arthropods or vertebrates, could not have evolved from simpler forms and the more complex social levels could not have arisen and persisted. Finally, so far as man is concerned, the weight of the-evidence from the sociology of other animals strongly indicates that. despite many appearances to the contrary. human altruistic drives are as firmly based on an animal ancestry as is man himself. As Espinas concluded years ago. social life is not an accident appearing sporadically among a few highly evolved animals. It is rather a normal and basically widespread phenomenon. Despite many well-known appearances to the contrary, human tendencies toward goodness on the personal community, national and international levels are as natural as is man's trend toward being intelligent.

Other articles on related subjects are ANIMAL BEHAVIOUR; PSYCHOLOGY. COMPARATIVE; SOCIAL INSECTS; COURTSHIP, ANIMAL; PLAY. ANIMAL.

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SOCKMAN, RALPH WASHINGTON (1889–), U.S. clergyman. whose "National Radio Pulpit" program became the longest continuing radio program in the United States, was born at Mt. Vernon. O., on Oct. 1, 1889. After receiving his A.B. degree from Ohio Wesleyan university (Delaware, O.) in 1911. he went to Columbia university in New York city for graduate study. While there he became active as a member of the Madison Avenue Methodist Episcopal church and served as intercollegiate secretary for the Young Men's Christian association until he received his M.A. degree in 1913.

He then began study at the Union Theological seminary and when he was graduated in 1916 was appointed associate minister of the Madison Avenue Methodist Episcopal church and became minister in 1917. His epigrammatic and vivid sermons were popular from the beginning as were published collections of them and other religious writings. One of the first U.S. clergymen to broadcast sermons, in 1936 he succeeded S. Parkes Cadman, who had founded the "National Radio Pulpit" program in 1928.

Sockman was president of the Federation of Churches from 1927 to 1929 and after 1928 was head of the World Peace commission of the Methodist Episcopal church. In 1950 he was appointed associate professor of practical theology at the Union Theological seminary. Among his books are *Suburbs of Christianity and Other Sermons* (1924); *Men of the Mysteries* (1927): *Movals of Tomorrow* (1931); and *The Higher Happiness* (1950).

SOCORRO, a city of west central New Mexico, U.S., the seat of Socorro county, on the west bank of the Rio Grande river, 75 mi. S. of Albuquerque.

Socorro is the centre of a livestock, grain raising and dairying region. Cattle, sheep, goats and horses are the principal stock; and there are orchards and truck farming. To the west and southwest are the Socorro and Magdalena mountains and the Dátil, Black and San Mateo ranges, in which silver, gold, galena, copper. lead and zinc have been mined.

The name Socorro was given to the site in 1628 by Friar Alonso de Benavides. who found a Franciscan mission had been established in 1598 by two friars left by Juan de Oñate. Under De Benavides' direction the restoration of this mission began and eventually it became the Church of San Miquel, one of the oldest churches on the North American continent.

Socorro was prominent in the events of the Spanish occupation. the Pueblo rebellion in 1680 and in the reconquest of Gen. Diego De Vargas. Having been a centre for the protection of the Piro against the hostile Apaches, it was abandoned after the rebellion and not resettled by descendants of the original Socorrans until 1817. It was made a Union garrison for Ft. Craig during the Civil War and was a centre for the storing and transport of supplies.

Silver was discovered nearby in 1867, and Socorro became the largest city in the New Mexico territory in the 1880s. Mining became intermittent except for zinc ores after the drop in the price of silver in the 1890s.

Socorro is the seat of the New Mexico Institute of Mining and Technology, established in 1889.

For comparative population figures *see* table in NEW MEXICO: *Population.*

SOCRATES (*c.* 470 B.C.–399 B.C.), the great Athenian philosopher. was put to death in 399 B.C. at the age of 70. His birth thus falls in or about 470, ten years after Salamis. His father, Sophroniscus, was a friend of the family of the "Just" Aristeides; the tale that he was a sculptor first appears in the 3rd century in Timon of Phlius and seems to be only a misinterpretation of a playful remark in Plato. His mother. Phaenarete, acted as a "midwife," but no inference as to social status can be founded on this.

The memoir writer Ion of Chios mentioned meeting him at Samos in the company of Archelaus, the Athenian successor of Anaxagoras, presumably during the military operations of 441–440.

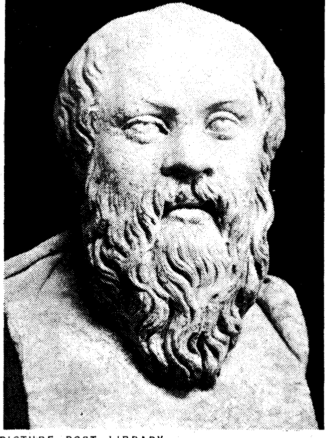
The connection between the two men is also asserted by Aristoxenus the Peripatetic and the doxographical tradition based on Theophrastus calls Socrates the "disciple" of Archelaus. Plato. Xenophon, Aeschines of Sphettus agree in depicting him as intimate with the leading figures of the Periclean circle (Xspasia, Xlcibiades. Xxiochus, Callias).

Xenophon (*Mem.* iv, 7) concurs with Plato in saying that he was well versed in geometry and astronomy. and this representation agrees with the narrative of Plato's *Phaedo* and the Aristophanic burlesque of the *Clouds.*

Socrates must already have been a conspicuous figure at Athens when Aristophanes and Ameipsias both made him the subject of their comedies in 423, and since the comedians made a special point of his neediness he had probably suffered recent losses. (The marked poverty of his old age is said in Plato's *Apology* to have been caused by his preoccupation with his mission to mankind.)

Socrates was married, apparently late in life. to Xanthippe, by whom he left three sons. one an infant. Xenophon speaks of her high temper; there is no evidence that she was a "shrew"; the sons. according to Aristotle. proved insignificant (*Rhetoric B.,* 1390, b. 31).

Socrates' record for prowess and endurance was distinguished. He served as a hoplite. perhaps at Samos (441–440), at Potidaea, where he saved the life of Alcibiades (432–430), Delium (424) and Amphipolis (?422 or ?437–436).



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SOCRATES (*c.* 470 B.C.–399 B.C.), FROM A BUST (SCULPTOR UNKNOWN)

In politics he took no part. knowing, as he told his judges. that office would mean compromise with his principles. Once at least,[1] in 406–405, he was a member of the council of 500, and at the trial of the victors of Arginusae. being one of the *prutaneis,* resisted. at first with the support of his colleagues, afterward alone, the unconstitutional condemnation of the generals by a collective verdict. He shon-ed the same courage two years later in the "Terror" of 404. The "thirty" wishing to implicate honourable men in their proceedings, instructed Socrates with four others to arrest Leon. one of their victims. Socrates disobeyed, and says, in Plato's *Apology,* that this might have cost him his life hut for the counterrevolution of the next year.

In 399. four years after the amnesty, he mas indicted for "impiety." The author of the proceeding was the influential Xnytus. one of the two chiefs of the restored democrats. but the

[1]This was not, of course, a "magistracy." Plato, *Gorgias* 474*a,* seems to refer to another earlier occasion.

nominal prosecutor was the obscure and insignificant Meletus. There were two counts in the accusation, "corruption of the young" and "neglect of the gods when the city worships and the practice of religious novelties."[1] Socrates, who treated the charge with contempt and made a "defence" which amounts to avowal and justification, was convicted, probably by 280 votes against 220. The prosecutors had asked for the penalty of death; it now rested with the accused to make a counter-proposition. A smaller, but substantial, penalty would have been accepted, but Socrates took the high line that he really merited the treatment of an eminent benefactor, maintenance at the public table. He only consented for form's sake to suggest the small fine of one *mina,* raised at the entreaty of his friends to 30.

This incensed the court and "death" was voted by an increased majority,[2] a result with which Socrates declared himself well content As a rule at Athens the condemned man "drank the hemlock" within 24 hours, but in the case of Socrates the fact that no execution could take place during the absence of the sacred ship sent yearly to Delos caused an unexpected delay of a month, during which Socrates remained in prison, receiving his friends and conversing with them in his usual manner daily An escape was planned by his friend Crito, but Socrates refused to hear of it, on the ground that the verdict, though contrary to fact, was that of a legitimate court. and must therefore be obeyed. The story of his last day has been perfectly told in the *Phaedo* of Plato, who, though not himself an eye-witness, was in close touch with many of those who were present.

Socrates wrote nothing; therefore our information about his personality and doctrine has to be sought chiefly in the dialogues of Plato and the *Memorabilia* of Xenophon. Both men were nearly 45 years younger than Socrates, and can therefore only speak from first-hand knowledge about the last ten or twelve years of his life. Xenophon's relations with him seem not to have been close, and he has even been suspected of deriving much of his material from Plato's dialogues. His admitted deficiencies in imagination and capacity for thinking do not make him the more faithful exponent of a philosophical genius.

To call him a "Boswell" does poor justice to the intellect of Boswell. (It must also be remembered that Boswell collected his material largely during Johnson's life, and with his knowledge and help) We need also to discount Xenophon's apologetic purpose. His most valuable statements are those which appear most at variance with his main thesis that the prosecutors of Socrates were mistaken from their own point of view. Plato's more vivid picture has been suspected on the ground that Plato used Socrates as a "mouthpiece" for speculations of his own. What this really means is that the so-called "Ideal Theory" expounded in the *Phaedo* is held to have been originated by Plato after the death of Socrates. There are serious reasons for denying this assumption though they have not yet convinced all scholars; in any case it is a *petitio principii* to employ it, without investigation, as an argument to discredit Plato's testimony. Xenophon's silence at most only proves that Socrates did not converse on such matters with him. In some important respects Plato's testimony is confirmed by the remains of Aeschines of Sphettus. The *Clouds* of Aristophanes yields valuable information about Socrates in his middle "forties," when allowance is made for its character as a burlesque. It should be compared carefully with the autobiographical statements put into the mouth of Socrates in the *Phaedo* (96*a*–100*a*). These are not "contemporary evidence," but they are clearly meant to express Plato's *bonn fide* belief about his master's intellectual history.

Personal Characteristics. — Though Socrates was a good fighting man, his outward appearance was grotesque. Stout and not tall, with prominent eyes, snub nose, broad nostrils and wide mouth, he seemed a very Silenus. But, as his friends knew, he was "all glorious within," "the most righteous man of the whole age" (Plato, *Ep.* vii. 326 *e*). His self-control and powers of endurance were exemplary; "he had so schooled himself to moderation that his scanty means satisfied all his wants."

But he was no self-tormenting ascetic; he "knew both how to want and how to abound," and could be the soul of the merriment at a gay party. He had no sympathy — this was a main point in the *Telauges* of Aeschines — with the slatternliness of his friend Antisthenes or the godly dirtiness affected by "Pythagorists" There was nothing of the complacent self-righteousness of the Pharisee, nor of the angry bitterness of the satirist, in his attitude towards the follies or even the crimes of his fellow men. It was his deep and life-long conviction that the improvement not only of himself, but of those with whom he might have to do, was a task laid upon him "by God," but the task was not to be executed with a scowling face and an upbraiding voice. Like St. Francis Xavier, he thoroughly understood how important it is to one who would win men's souls to be "good company." Conscious of his own infirmities, he felt a real and profound sympathy for those who had not learned to master their frailties and passions.

He was a true patriot, and his devotion to the city in which he had been born and bred was only made the more evident by his conviction that he could best prove it by setting his face resolutely against the attractions of specious and popular, but deadly, false theories of public and private morality. When the city brought him to trial and threatened him with death his sense of civic duty forbade him to withdraw into exile before the trial, or to accept the opportunity of escape during his unforeseen imprisonment. It was his very patriotism which made him an unsparing critic of the "democracy," which means, in Nietzsche's phrase, "one flock and no shepherd," and so led directly to the accusation which proved fatal to him.

Nothing was more marked in his character than an unusually keen sense of humour, an appreciation of the comic in human nature and conduct which protected him at once against sentimentality and against cynicism. This is what his opponents in Plato call his "irony," and treat as an irritating affectation. "Intellectually the acutest man of his age, he represents himself in all companies as the dullest person present. Morally the purest, he affects to be the slave of passion" (W. H. Thompson). No doubt. in part this irony was "calculated"; it "disarmed ridicule by anticipating it." But its true source is the spontaneous sense of "fun" which makes its possessor the enemy of all pretentiousness, moral or intellectual, in himself and in others. And it is certain that, though the purity of Socrates is beyond question, he really had an ardent and amorous temperament.[3]

Religion. — Socrates was clearly a man of deep piety with the temperament of a "mystic." Like other educated men of his age, he regarded mythology, with its foolish or immoral tales about gods, as a mere invention of the poets. But he found it easy to combine his own strong belief in God, the all-wise and all-good ruler of the world, with the view that in practice we could worship Gad in the way prescribed by "the usage of the city." God's existence is shown, he held, not only by the providential order of nature and the universality of the belief in Him, but by warnings and revelations given in dreams, signs, oracles. The soul of man partakes of the Divine; the concluding pages of Plato's *Apology* prove that Socrates had a strong belief in its immortality. (Xenophon for apologetic reasons is silent on the point, but has reproduced the argument in the dying speech of his Cyrus in the *Cyropnedia.* Aristophanes, too, makes Socrates combine the parts of "infidel" physicist and hierophant of a mysterious private faith, and in the *Birds* [1553, seq] represents him as presiding at a fraudulent *séance.*) He was regular. says Xenophon, in prayer and sacrifice, though he held that since only the gods know what is good for us, our prayer should simply be "give me what is good"; we must not dictate the form the blessing should take. It is clear from Plato that Socrates was deeply influenced by Pythagorean and Orphic religious ideas, though he regarded the ordinary Orphic mystery-monger with healthy contempt

[1] καινὰ δαιμόνια in the indictment means literally "novel practices in religion." not "novel deities" (though the second is insinuated).

[2] What offended the court was not the smallness of this sum—go *minae* was not a small sum in the economic circumstances of the time —but Socrates' description of himself as a distinguished public benefactor.

[3] Cf. Aeschines, *Alcibiades* Fr. 4 (Krauss), which confirms the representation of Plato on this point.

The evidence that Socrates had a markedly "mystical" temperament is abundant. Plato tells of his curious "rapts," in one of which he stood spellbound for 24 hours in the trenches before Potidaea, and there seems to be an allusion to this singularity in the *Clouds* (171 seq.).

The familiar "Divine sign" tells the same story. This, according to Plato, was a "voice" often heard by Socrates from childhood. It forbade him to do things; but never gave positive encouragement. (Xenophon, who makes more of the matter, says, less probably, that it did give positive directions.) Plato treats the "voice" very lightly; by his account, it merely gave prognostications of good or ill luck, and the occasions of its occurrence were often "very trivial." Thus it was neither an "intuitive conscience," nor a symptom of mental disorder, but an "interior audition," a "psychic phenomenon" of a kind now known to be not specially uncommon.

Mode of Life.—Socrates' whole time seemed to be spent "out of doors," in the streets, the market-place, and more particularly, the *gymnasia.* He cared little for the country and rarely passed the gates. Though he frequented by choice the society of lads of promise, he also talked treely to politicians, poets, artisans about their various callings, their notions of right and wrong, the familiar matters in which they might be expected to take an interest. The object of all this, he says in the Apology, was to test the famous Delphic oracle which had pronounced him the wisest of men. It is clear from the Apology that the oracle had made this declaration, no doubt because the Delphic authorities knew from the form of the question what answer was desired. The presupposition of the *Apology* is that this happened before Socrates had become conscious of his mission to his fellow men; even at that early date, it is implied, he had the highest of reputations in circles interested In wisdom.[1] Acutely sensible of his own ignorance, Socrates set himself to convict "the god" of falsehood.

But when experience showed that those who thought themselves wise were unable to give any coherent account of their wisdom, he had to admit that he was wiser than others, just because he alone was aware of his own ignorance. This account is plainly tinged with the usual "irony." Socrates did not take Apollo and his oracle very seriously. But that he was quite serious in believing himself charged with a mission, not from "Apollo," but from God, to preach to his fellow men the supreme importance of knowledge of what is for the soul's good is proved by his declaration that he is more than ready to face instant death rather than to neglect his commission. The poverty in which this mission had involved him. and the austerity of the rule of life it entailed were notorious.

Summer and winter, his coat was the same; he had neither shoes nor shirt. "A slave who was made to live so," the sophist Antiphon said, "would run away." This self-imposed life of hardships was the price of his spiritual independence. His message was variously received Some of those whose false pretentions were exposed by his trenchant criticizing regarded him with ill-will; many thought him an officious busybody. Among the younger men, many merely thought it good sport to see their elders silenced. Others (Xenophon says that this was the case with Alcibiades and Critias), deliberately attached themselves to him for a time "for private ends," believing that to learn the secret of so acute a reasoner uould he the best preparation for success in the law courts, the council and the assembly. Others sincerely hoped by associating with him to become good men and true, capable of doing their duty by house and household, by relations and friends, by city and fellow-citizens.

Finally, there was an inner circle who entered more deeply into his principles and transmitted them to the next generation. But these were not "disciples" united by a common doctrine. Socrates finally repudiated all claim to have "disciples." The bond of union was a common reverence for a great man's intellect and character. It was, in the main, this group who were collected round Socrates in the day of his death; many of them, *e.g.,* Eucleides from Megara, and the young Theban Pythagoreans, Cebes and Simmias, were foreigners from States which had been enemies of Athens in the Peloponnesian War.

[1]This is also proved by the attachment to him shown by Eleatics from Megara and young pupils of the Pythagoreans from Thebes and Philius These connections must have been founded before the Peloponnesian War

The Accusation and Its Causes.—The explanation of the attack made on Socrates is simple. He had been on terms of close friendship with the two men whose memories were most obnoxious to the democrats. Critias, the fiercest spirit among the extremists of the "Terror" of 404, and Alcibiades, whose self-will had done so much to bring about the downfall of the Athenian empire. The charge of "educating Alcibiades" was made prominent in the pamphlet written a few years after the trial by the "sophist," Polycrates, in justification of the verdict. More than half a century later, the orator Aeschines reminds his audience that Socrates had been put to death because he was believed to have educated Critias. In point of fact, it was absurd to make Socrates responsible for the ambitions of Alcibiades, and, as he reminded his judges, he had disobeyed an illegal order from Critias and his colleagues at the risk of his life. But it is natural that he should have had to suffer for the crimes of both men, the more that he was known to have been an unsparing critic of democracy, and of the famous democratic leaders. These suspicions would be made the more acute by the remembrance that Socrates had not, like the advanced democrats, withdrawn from Athens during the "Terror."

He was, in fact, suspected of using great abilities and gifts to pervert his younger associates from loyalty to the principles of democracy, and the convinced democrats who had recovered the city in 403 were unwilling, as Burnet has said, "to leave their work at the mercy of reaction." That they took no steps for four years is probably explained by the state of complete confusion and congestion into which the disorders of 404 had thrown the law courts. The motives of Anytus, an upright, unintelligent democrat, are thus quite explicable. From his point of view, Socrates would be at the best a "whig," and democrats who remembered the career of Theramenes could not be expected to make a fine distinction between the "whig" and the traitor.

The real grounds for the attack could not be disclosed in the indictment, since the amnesty which terminated the struggle of 404–403, and of which Anytus himself had been a main promoter, covered all offences committed before the archonship of Eucleides (403). Hence the charge had to be couched in the form of a vague accusation of "corruption of the young." Probably for the same reasons Anytus was ashamed to appear as the principal in the matter and put forward the obscure Meletus, who might venture on "indiscretions" more openly. If Meletus was the same person who also prosecuted Andocides in the same year on the same charge of 'impiety," and if, as is not unlikely, he is the real author of the speech Against *Andocides* ascribed to Lysias, he must have been a half-witted fanatic, and this may explain why the chdrge of irreligion was added. The real nature of this "irreligion" appears never to have been explained. Xenophon suggests that the allusion was to the "Divine sign" but this cannot be correct. It is clear from Plato's *Apology* that Meletus said nothing about the "sign" at the prosecution, and that Socrates is speaking with his "usual irony" when he pretends to guess that the mention of "religious novelties" in the indictment referred to it. In the *Apology,* Socrates says that the prosecution is, no doubt, relying on memorirs of Aristophanes' *Clouds,* where he had been made to talk "atheism" as part of the burlesque on men of science.

But there must have been more behind the charge, and it seems likely that Burnet is right in reminding us that the prosecution of Andocides revived the old scandal of the "profanation of the mysteries," which had thrown Athens into a ferment on the eve of the Sicilian expedition in 416–415. The two chief victims, Alcibiades and his uncle Axiochus, were both among the intimates of Socrates, and there is reason to think that others of his friends were affected. If this is what lay behind the charge, we can understand why its real meaning seems never to have been explained Owing to the terms of the amnesty, the matters in question were not really within the competency of the court Socrates himself. in the account of Plato, who was present at the trial, treats the whcle matter with contempt. His defence consists in narrating the facts of his past life, which proved that he was equally ready to defy the populace and the "thirty" in the cause of right and law, and in insisting on the reality of his mission from God and his determination to discharge it, even at the cost of life. The prosecutors had no desire for blood They counted on a voluntary withdrawal of the accused from the jurisdiction before trial; the death penalty was proposed to make such a withdrawal certain. Socrates himself forced the issue by refusing at any stage to do anything involving the least shade of compromise. The prosecution had raised the question whether he was a traitor or, as he held himself to be, an envoy from God; Socrates was determined that the judges should give a direct verdict on the issue without evasion. This is what makes him a martyr, but also what forbids us to call Anytus a murderer.

Doctrine and Method. — Socrates was a man of the Periclean age, and the Periclean age witnessed one of the periodical "bankruptcies of science." Cosmological speculation, which had been boldly pursued from the beginning of the 6th century seemed by the middle of the 5th to have led to a chaos of conflicting systems, each of which could establish only one point, that all its rivals were wrong. Parmenides of Elea had apparently cut away the ground from science by showing that the real world must be quite unlike anything which our senses reveal to us, and that, consequently, the method of cosmology, interpretation of the world by analogies from familiar sensible experiences, is inherently fallacious. His pupil Zeno seemed to have shown that even the postulates of mathematics are mutually contradictory.

Science, then, seems impossible, and this is why the ablest men of the generation before Socrates, such as Protagoras and Gorgias, turned away from the pursuit of it and tried to find a use for the intellect in professions which concern themselves, not with the discovery of truth, but with making a success of human life. "Probability is the very guide of life," and in practical matters "useful" points of view may be attainable, even if scientific certainty is beyond our reach. According to the narrative of the *Phaedo*, Socrates, as a young man, began with an experience typical of his age. He was enthusiastically interested in "natural science," and familiarized himself with the various current systems, being specially interested in the contrast between the old Milesian type of cosmology with its flat earth and the Italian type with its spherical earth. He was also interested in the mathematical puzzles raised by Zeno about "the unit" (*i.e.,* the problem of continuity). He discovered, to his distress, that though each authority was quite sure that the views of the others were wrong, none of them could give any proof that his own were right.

There was a complete lack of critical method. For a moment he hoped to find salvation in the doctrine of Anaxagoras that "mind" is the source of all cosmic order, since this seemed to mean that "everything is ordered as it is best that it should be," that the universe is a rational teleological system. But on reading the book of Xnaxagoras, he found that the philosopher made no effective use of his principle; the details of his scheme were as arbitrary as those of any other. After this disappointment, Socrates decided that he had "no head for physics" and must fall back on his own mother-wit. Accordingly he resolved henceforth to consider primarily not "facts" but λόγοι the "statements" or "propositions" we make about them. His method should be to start with whatever seemed the most satisfactory "hypothesis," or postulate, about a given subject, and to consider the consequences which follow from it. So far as these consequences prove to be true and consistent, the "hypothesis" may be regarded as provisionally confirmed; if they are false or mutually inconsistent it is discredited. But it must be a strict rule of method not to confuse enquiry into the consequences of the "hypothesis" with proof of its truth. If the question of its truth is raised, the issue can only be settled by deducing the initial "hypothesis" as a consequence from some more ultimate "hypothesis" which both parties to the dispute are content to accept. The method, still familiar to us as that of true science, is manifestly suggested by reflection on the "antinomies" of Zeno, whom Aristotle called the creator of "dialectic," and whom Plato, in the *Parmenides,* afterwards described as meeting Socrates in the youth of the latter. So far, Plato's story has every appearance of being historical. But it is still the fashion to hesitate to follow it any further. According to him, Socrates next proceeded to take it as his own fundamental "hypothesis" that every term (such as "good," "beautiful," "man") which has a single unequivocal denotation directly names a single self-same object of a kind inaccessible to sense-perception and apprehensible only by thought. Such an object Socrates calls an ἰδέα or εἶδος, Form. (The transliteration "Idea" is misleading, owing to the psychologizing of the sense of the word by Locke and his followers.) The sensible things of which we predicate beauty, goodness, humanity, have only a secondary and derivative reality. Strictly speaking, we must not say that they are this or that, but only that they *become* this or that for a time, in virtue of the temporary "presence" (παρουσία) to them of the corresponding Form, or, as it is also expressed, in virtue of their "participation" (μέθεξις) in the Form. A sensible thing, in fact, is simply a temporary complex of Forms.

In the *Parmenides* of Plato Socrates is made to expound this doctrine to the great philosophers Parmenides and Zeno as his solution of the standing puzzle of the one and the many. This is the doctrine of Forms (the "Ideal Theory") as it is stated in the *Phaedo* and *Republic.* Though it is quite different from the version of the doctrine ascribed by Aristotle to Plato, it has been usual in the 19th century to assume that it is an earlier form of that doctrine consciously devised by Plato after the death of Socrates. The chief argument for this view is based upon the observation of Aristotle that Socrates rightly "did not separate" the universal from the particular *(Met. M.,* 1078 *b30)* as, it is apparently implied, Plato did. It is, however, not clear that Aristotle means by this, what he never says expressly, that Socrates did not teach the doctrine ascribed to him in the *Phaedo.* He might equally mean that the doctrine of the *Phaedo* does not itself involve the kind of "separation" of the universal from the particular to which he objects in what he describes as the Platonic theory, and, since the *Phaedo* is one of the Platonic dialogues to which he most frequently alludes, it is strange that he should never have said that it misrepresents the historical Socrates on a capital point, if he really thought so.

On the other side, the doctrine is expressly said in the *Phaedo* to be a familiar one which Socrates "was always" repeating, and it is hard to believe that Plato could have made such a statement about a speculation of his own, especially as most of the personages of the *Phaedo* were certainly still alive long after the dialogue was written. It is hard to see what could be the point of such a mystification, and harder to understand how its author could have expected it to be successful. Of course, demonstration is out of the question in such a matter; we can only be guided by considerations of probability. If we think the probabilities against the view which credits Plato with deliberate mystification, we must be prepared to admit the possibility that he is also reproducing the thought of Socrates in the further development of the *Symposium* and *Republic,* where we hear of a supreme Form, that of Beauty, or Goad, the vision of which is the far-off goal of all intellectual contemplation. We may fairly suspect that the thought of Socrates is undergoing development in the mind of Plato, but it will be natural to regard the development as, in the main, unconscious, and to recognize that no complete separation of the Socratic and the Platonic in the result is possible.

It is certain that on the logical side the thought of Socrates proceeded "as if" the doctrine of Forms expounded in the *Phaedo* were its point of departure. Both Plato and Xenophon bear out the remark of Aristotle that Socrates may fairly be credited with two things, "inductive arguments" and "universal definitions" (*Met. M.,* 1078 *b27*). The "universal definition" is an attempt to formulate precisely the meaning of a universal significant predicate, *i.e.,* to apprehend what the *Phaedo* calls a Form, and it is from the practice of Socrates, who aimed at the clarification of thought about the meaning of moral predicates as the first indispensable step to the improvement of practice, that the theory of logical division and definition, as worked out in Plato's later dialogues and the logical treatises of Aristotle, has arisen.

The "inductive arguments" mean the characteristic attempts to arrive at such formulations by the consideration of simple and striking concrete illustrations familiar to us from both Xenophon and Plato, the perpetual arguments about "shoemakers and carpenters and fullers," which the fashionable speakers in Plato profess to think vulgar. Induction, on this view of it, is not regarded as a method of proof. Its function is that of suggestion; it puts the meaning of a proposed "definition" forcibly and clearly before the mind. The justification of the definition, then, has to be sought in a consideration of the satisfactoriness of the "consequences," which would follow from its adoption. Socrates himself sought for his "definitions" principally in the sphere in which he was most interested, that of conduct, private and public. As Aristotle says, he concerned himself with the "ethical," character and conduct, not with "nature" at large. This is what Cicero means by saying that he "brought down philosophy from heaven to earth."

Before him cosmology had been the chief topic of interest, after him, the central problem of philosophy was to formulate a rule of life. With him the "practical use of reason" comes by its rights. In this respect Socrates stamped on philosophy a character which it has never lost. The main outlines of his philosophy of conduct are fortunately quite certain, and could be discovered if we had no more material than the Platonic *Apology* and the *Memorabilia* of Xenophon. As the *Apology* tells us, the specific message from God which Socrates brought to his fellow men was that it is the great business of life to practice the "care" or "tendance" (ἐπιμέλεια, θεραπεία), of one's *soul*, to "make one's soul as good as possible," and not to ruin one's life, as most men do, by putting care for the body or for "possessions" before care for the "soul."

The thought which is here fundamental is that of the "soul" (ψυχή) as that which is most truly a man's self. In Greek literature, down to the end of the 5th century, we can trace two main senses of the word ψυχή. (1) It means "the breath of life" which a man parts with in dying. It is this which, in popular superstition, is left as a mere "ghost," or "shade," when the man "himself," his body, has perished. In earlier Ionian science this is identified with the "air" which a man inhales so long as he is alive. (2) In circles influenced by the Orphic religion the soul is thought of as something which has a destiny beyond the grave, but this, too, is something different from the self. It is a sort of stranger inhabiting the body, but having little to do with the conduct of normal life. It "sleeps while the body is active, but wakes when the body sleeps," and reveals itself chiefly in dream and trance. From the beginning of the 4th century we find ψυχή coming at last to mean what "soul" means to us, the normal waking personality, the seat of character and intelligence, "that," as Socrates says in Plato, "in virtue of which we are called wise or foolish, good or bad," and as this usage of the word first appears in writers whom we know to have been influenced by Socrates (Isocrates, Plato and Xenophon), we may fairly ascribe it to his influence. The thought now works out thus. The soul is the man (in the later Academic formulation a man is "a soul using a body").

Our happiness or well-being, then, depends directly on the goodness or badness of the soul. It is no happiness to possess health, or strength, or wealth, unless we know how to *use* these advantages rightly. If we use them wrongly, they will only be so many means to misery. The reason why hardly any one achieves happiness is not that men do not wish to be happy. No one ever wishes for anything but true good, that is, true happiness, but men miss their happiness, in spite of the universal wish for it, because they do not *know* what it is. They mistake for real good things which are not really good (*e.g.,* unlimited wealth or power). In this sense, "all wrong-doing is involuntary." The first and fundamental requisite for happiness, then, is that men should *know* true good and not confuse it with anything else. The good state of the soul is precisely that state in which it never makes the mistake of taking anything to be good when it is not really good. To "make one's soul as good as possible" thus means to attain the knowledge of good which will prevent us from *using* strength, health, wealth, opportunity, wrongly. If a man has this knowledge, he will always act on it, since to do otherwise would be to prefer known misery to known happiness, and this is impossible. "*All* the virtues are one thing," *knowledge* of good, and all "vice" is one thing, ignorance of true good.

"Popular" goodness—what passes current as virtue—is mostly illusory, because it is mainly a matter of habit, not of assured conviction about good. It breaks down under temptation; but if a man really knew that, *e.g.,* to commit a crime is worse than to suffer loss or pain, or death, no fear of these things would lead him to commit the crime. The professional "sophist," again, claims to be able to teach "goodness," but the claim is shown to be unfounded by the very fact that the sophist treats "goodness" as though it were a neutral "accomplishment" which can be conveyed by mere instructions. Now an accomplishment, or "art," can always be put to either of two uses, a good or a bad, as the physician, for instance, can use his professional knowledge to cure or to kill.

Knowledge of good is the one knowledge of which it is impossible to make an ill use; the possession of it is a guarantee that it will always be used aright. Thus Socrates becomes, as against the relativism of Protagoras, the founder of the doctrine of an absolute morality based on the conception of a felicity which is the good, not of Athenians or Spartans, or even of Greeks, but of man as man. It is not in virtue of our allegiance to a particular city, nor even of our place in a particular historical civilization, but in virtue of our universal humanity, that we have the task of "making the soul as good as possible," or, as Socrates also said, in language influenced by Pythagoreanism, "making it like God."

Politics, from this point of view, does not differ in principle from ethics. The business of the statesman also is the "tendance" of souls, though his task is to aim at making, not only his own soul, but the souls of all his fellow-citizens "as good as possible." The knowledge of good is also the "royal" science or science of governing, the foundation of all statesmanship. The radical vice of ancient democracy, according to Socrates, is that of not demanding evidence of any special knowledge in its leaders; it suffers the destinies of society to be in the hands of men without true insight. Partly this means that by not demanding intellectual qualifications for office, democracy surrenders the control of affairsinto the hands of men with no adequate expert knowledge. But this is only a minor part of Socrates' indictment. His main criticism is that though in some departments, at least, the democracy refuses to take the advice of any one but a qualified expert, on the question of the morality and justice of a proposed policy it treats any one citizen's opinion as of equal value with another's.

Even a Themistocles or a Pericles plainly had no knowledge of true statesmanship, as we see from the fact that they neither taught the principles of it to their sons, nor had them taught these principles by others, and if we look at the actual achievements of these men we can see that they were, so to say, good "body-servants" of the *Demos,* they gave it the things which tickled its taste, such as a navy and a commerce; they were no "physicians of the body politic," for they did not promote "righteousness and temperance," the spiritual health of the community. That is, they measured national greatness by wealth and empire, not by character. According to Plato, Socrates maintained that he himself, who abstained all through from active politics, was the one Athenian of the time who deserved the name of statesman. He deserved it because he understood, as the men of action did not, that national, like individual felicity, depends on the knowledge of good which inevitably leads, where it is possessed, to the action which makes the soul "as good as possible."

The well-known Platonic *Republic* may fairly be said to be, on its political side, a picture of the life of a society in which the whole system of social and economic life is based on this Socratic conviction that "politics" is the application to the community at large of the principle that knowledge of the absolutely good is the necessary and sufficient condition of well-being. How far any of the special regulations of Plato's *Utopia* embody actual convictions of Socrates is more than we can say, though it is significant that the *Aspasia* of Aeschines represented Socrates as maintaining one of Plato's "paradoxes," the capacity of women for war and politics.

The Socratics.—The thought of Socrates has, in the main, been made fruitful for subsequent ages by being taken up and continued in the life-work of Plato. A more temporary influence was exercised by certain other members of the group of Socratic men whom it has become customary to speak of as the "minor" Socratics. The most important of them are Antisthenes of Athens and Eucleides of Megara, with whom the Cynics and Megarians of the 4th and early 3rd centuries are historically connected. With them it is usual also to mention Aristippus of Cyrene, often still spoken of as somehow connected with the Cyrenaic school of the early 3rd century.

It is probable, however, that the current accounts exaggerate the closeness of the connection between these men and the later schools. Aristippus of Cyrene figures in Xenophon's *Memorabilia* simply as a luxurious and refined man of the world who makes it his rule of life to extract personal enjoyment from existence, sitting loose to all attachments which might interfere with his ease and not allowing himself to take root anywhere. The later anecdotes about him bear out this representation. There is no good evidence that he had a philosophy or originated a school. Aristotle ascribes no doctrine to him and never mentions a "Cyrenaic" school of Hedonists, though he could hardly have avoided doing so in his discussions of Hedonism in the *Nicomachean Ethics* if he had known of one. Plutarch expressly describes the Cyrenaics as contemporaries of Epicurus, and all the names of members of the school known to us belong to the time of the successors of Alexander the Great. The one point of doctrine common to them appears to have been that they rejected the notion of a good more permanent than the pleasure of the moment. The supposed connection of Aristippus with them seems to be based on a confusion with his grandson of the same name, who, according to Eusebius, reduced his grandfather's practice to theory.

Eucleides of Megara was a friend both of Socrates and of Plato, who temporarily took refuge with him after the death of Socrates, and, at a later date, dedicated the *Theaetetus* to him. All we know of his teaching is that he held to the Monism of Parmenides, maintaining that nothing is real except "the One," which is also called "wisdom" *φρόνησις*, "intellect" (*νοῦς*) and "God" (*D.L.*, ii. 106). The mention of "wisdom" as a synonym for "the One" seems to reveal the influence of Socrates. Most of our notices of Megarians deal with men of a later time, Eubulides, a contemporary of Aristotle, Diodorus Cronus and Stilpo. These men were pugnacious formal logicians famous for their rejection of the notion of "possibility" which is so fundamental in the Aristotelian philosophy. According to them, nothing is possible except the actual. Aristotle resented the criticism so keenly that "sophist" in his terminology appears to be regularly equivalent to "Megarian logician." It is not clear how these *ἐριστικοί* are connected with the Monism of Eucleides. There are reasons for supposing the puzzling antinomies of Plato's *Parmenides* to be a parody of Megarian logic, and it is a view which has been widely accepted in recent times that they are also meant in Plato's *Sophistes* by the "friends of Forms" who are there contrasted with the materialists and said to maintain that reality consists of a multitude of "incorporal Forms" which can only be apprehended by thought. This identification is, however, uncertain (and, in the present writer's opinion, mistaken).

Antisthenes was a friend of Socrates of long standing, with a marked individuality of his own, and a voluminous writer much admired for his style. He does not appear to have been a "disciple," though he was personally attached to Socrates, and particularly admired his strength of will and mastery of his passions. In philosophy he is chiefly known for two things, his denial of the possibility of making judgments in which the predicate and subject terms are non-identical, and his insistence in ethics on the simplification of life by the reduction of our wants to an indispensable minimum. In virtue of the latter he was commonly regarded as the founder of Cynicism and it is certain that he personally influenced the famous Diogenes and that the later Cynics were in the habit of regarding him as a model man. But it is not clear either that the Cynics of the 4th century were a "sect" or "school" in any real sense of the words, or that the nickname "dog" was ever given to anyone before Diogenes. It was believed in later antiquity that there was a personal feud between Antisthenes and Plato, and it seems certain that one of the works of Antisthenes, called *Sathon*, was a virulent personal attack on Plato. But the ingenuity spent in the 19th century on discovering polemical allusions to Antisthenes in Plato's dialogues seems to have been mostly wasted. According to Plato, the logical paradox that "contradiction is impossible" was maintained by numerous persons in the days of Socrates. Hence it seems unreasonable to detect special allusions to Antisthenes in the frequent references to this paradox in the dialogues.

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See also Sophists; Plato; Ethics, History of. **(A. E. Ta.)**

SOCRATES, the name of a famous 5th-century church historian. The *Ἐκκλησιαστικὴ ἱστορία* of Socrates, still extant in seven books, embracing the period from 306 to 439, was written in 439, or within a few years thereafter. He was born about 380 and brought up at Constantinople. He was a "scholasticus" or advocate. His work is dedicated to one Theodorus, who had urged him to write such a history. He had no thorough preparation for the task, and for the period down to the death of Constantius (361) was practically dependent on Rufinus. After his work was finished he became a student of Athanasius's writings and came to see how untrustworthy his guide had been. He accordingly rewrote his first two books (see H.E. ii. 1) certainly before 450 and probably before 444 (*see* Geppert, p. 8), and it is only this revision that has reached us. The chief sources from which he drew were: (1) the *Church History,* the *Life of Constantine* and certain theological works of Eusebius: (2) the *Church History* of Rufinus; (3) certain works of Athanasius; (4) the no longer extant *Συναγωγὴ τῶν συνοδικῶν* of the Macedonian and semi-Arian Sabinus—a collection of acts of councils with commentaries, brought down to the reign of Theodosius I. (this was a main source); (5) the *Constantinopolitan Chronicle;* (6) possibly a collection of imperial biographies; (7) lists of bishops; (8) collections of letters by members of the Arian and orthodox parties.

The theological position of Socrates, so far as he can be said to have had one, is at once disclosed in his unlimited admiration for Origen. All the enemies of the great Alexandrian he regards merely as empty and vain obscurantists; for the orthodoxy of his hero he appeals to Athanasius. Closely connected with his high regard for Origen are his appreciation of science generally and the moderation of his judgment on all dogmatic questions. According to him, *Ἑλληνικὴ παιδεία* is quite indispensable within the Church; many Greek philosophers were not far from the knowledge of God, as is proved by their triumphant arguments against atheists and gainsayers of divine providence. The apostles did not set themselves against the study of Greek literature and science; Paul had even made a thorough study of them himself. The Scriptures, it is true, contain all that appertains to faith and life, but give no clue to the art of confuting gainsayers. Greek science, therefore, must not be banished from the Church, and the tendency within the Church so to deal with it is wrong. This point of view was the common one of the majority of educated Christians at that period, and is not to be regarded as exceptionally liberal. The same holds true of the position of Socrates in regard to dogmatic questions.

EDITIONS AND LITERATURE.—Socrates' *History* has been edited by Stephanus (Paris, 1544; Geneva, 1612), Valesius (Paris, 1659 *sqq.*), Reading (Cambridge, 1720), Hussey (Oxford, 1853, reissued by Bright, 1878). It is also to be found in volume lxvii. of Migne's *Patrologia*, and there is an Oxford school edition (1844) after Reading. An English translation, revised by Zenos, is published in the Nicene and post Nicene Fathers, 2nd series, vol. ii.

See Harnack, "*Socrates u. Sozomen*" in Herzog-Hauck's *Realencykl.*, and ed., where bibliographical references will be found.

SODA. Under this somewhat loose title are included a number of substances of great industrial importance; viz., sodium carbonate, sodium bicarbonate, sodium hydrate or caustic soda, sodium sesquicarbonate or trona and sodium carbonate crystals or washing soda. The bulk of soda compounds is manufactured but there exist in various parts of the world, notably in Canada, the United States and east Africa. natural deposits of trona in the form of salt lakes. Washing soda. which is sodium carbonate combined with a proportion of water to form crystals, is a familiar substance as also is sodium bicarbonate in medical preparations. The remainder of the group provide raw material for other industries and are not commonly met elsewhere. See ALKALI; ALKALI MANUFACTURE. (A. E. H.)

SODA FOUNTAIN, a term used to designate the equipment from which carbonated water, flavoured and sweetened, is drawn and dispensed. An apparatus to serve soda water in a glass or tumbler instead of from a bottle came with the development of carbonating machinery. English and French manufacturers in the period from 1800 to 1825 devised improved equipment for making what was called soda water. One improvement was a strongly built metal tank, cylindrical in form and holding several gallons of water, in which carbonic gas entered.

This cylinder, as it was called in England, or fountain, as it was known in the United States, was mounted on a frame and was rocked back and forth to increase the saturation of the water by the gas. The cylinder was placed under the counter in the shop. and the soda water was drawn through a pipe which had a draft arm above the counter.

Various changes and improvements in the fountain were made by U.S. manufacturers. About 1855 the marble soda fountain was introduced, the apparatus being a marble box with an ice chest to cool the coil of pipe and a metal container for the sirups, which were drawn from a row of faucets. These early soda fountains changed from time to time as improvements were made. At first carbon dioxide was obtained by the interaction of an acid and a carbonate; then the gas was prepared from various sources—from natural gas, collected from brewers' fermenting vats, and from burning coke. The last-named source thereafter supplied most of the carbonic gas, which comes in liquid form in steel cylinders for carbonating beverages.

Other improvements mere mainly in perfecting the carbonating machinery, in mechanical or electric refrigeration, in extending the service of the soda fountain and in simplifying the working of the equipment so that the process or system is more or less automatic.

Modern soda fountains are built in a variety of forms, are thoroughly insulated and sealed to keep out air and heat and are divided into mzny sections and compartments. A fountain unit is commonly equipped with a cooling chamber for soda and ice water, compartments for chipped ice, cabinets for holding bulk ice cream in cans and for packaged ice cream, sirup jars with pumps, crushed fruit jars, dry cold storage compartments for fresh fruits, milk or bottled goods and open sections with drainboard and sink. (L. J. V.; X.)

SODALITE, a member of the group of rock-forming minerals comprising the isomorphous species sodalite, haiiynite, noselite and lazurite. Sodalite (so named because it contains soda) occurs as well-formed, colourless crystals in the ejected limestone blocks of Monte Somma, Vesuvius. In the nepheline-syenite of Dungannon. in Ontario, bright sky-blue material has been quarried for use as an ornamental stone. Haüynite, or haüyne (named after R. J. Haiiy) occurs as bright blue crystals and grains in the lavas of Vesuvius, Rome. the Eifel, etc. Noselite, or nosean. is found as grayish crystals in the sanidine bombs of the Eifel. Lazurite is an important constituent, together with some haiiynite and sodalite, of lapis lazuli (*q.v.*).

The chemical composition of the members of the group is as follows:

Sodalite	$Na_8(AlSiO_4)_6Cl$
Haiiynite	$(Na,Ca)_8(AlSiO_4)_6(SO_4)$
Noselite	$Na_8(AlSiO_4)_6(SO_4)$
Lazurite	$Na_8(AlSiO_4)_6S$

Crystals usually have the form of the rhombic dodecahedron and are often twinned with interpenetration on an octahedral plane. They are white, or often blue in colour. and have a vitreous lustre. The hardness is 5 and the specific gravity 2.2–2.4.

These minerals are characteristic constituents of igneous rocks rich in soda and they also occur in metamorphic limestones. (L. J. S.; CL. F.)

SODALITY OF OUR LADY, THE, a religious society which grew out of the middle ages. The founder, John Leunis, a Flemish Jesuit scholastic, established the first Sodality of Our Lady at the Roman college in 1563.

The purposes, essentially, were embodied in the first rule of the sodality:

"The Sodality of Our Lady is a religious body . . . which aims at fostering in its members an ardent devotion, reverence, and filial love towards the Blessed Virgin Mary. Through this devotion and with the protection of so good a mother, it seeks to make the faithful gathered together under her name good Catholics, sincerely bent on sanctifying themselves, each in his state of life, and zealous, as far as their condition in life permits, to save and sanctify their neighbour and to defend the Church of Jesus Christ against the attacks of the wicked."

The Sodality of Our Lady was approved by Pope Gregory XIII and later by other popes who granted indulgences for particular spiritual and good temporal works. Sodalities are erected by the bishop of each diocese and affiliation with the mother sodality in Rome is made, with his sanction, by the father general of the Society of Jesus, to whom the popes have given the right to communicate the privileges and indulgences of the primary sodality.

From Rome the sodality spread to Belgium, France, Bavaria, other parts of Italy, to Sicily and to England. In 1574 the first sodality in the Americas was established at the Colegio Maximo in Mexico City.

Limited at first to men, the sodality was later made accessible to women and girls by Pope Benedict XIV in 1751. In 194j the sodality existed in every part of the world. In 1940, when the last complete computation was made (before World War 11), there were 67.117 sodalities, established for men and women and children, of all classes and ranks. In the United States there were (1945) 13,502 sodalities.

The national secretariate for the United States was in St. Louis, Mo. The officialorgan. The Queen's *Work*, was published, as well as three other periodicals. and special program services for parish groups, college, high school and schools of nursing sodalities. and elementary sodalities. (D. J. W.)

SODA WATER: see SOFT DRINKS.

SODDY, FREDERICK (1877–1956), British scientist, Nobel laureate in chemistry. 1921, who predicted the existence of isotopes and named them, was born at Eastbourne, Sussex, on Sept. 2, 1877, and was educated at Eastbourne college, the University college of Wales, Aberystwyth, and Merton college, Oxford.

From 1900 to 1902 Soddy was demonstrator of chemistry at McGill university. Montreal: Que., where he worked with Sir Ernest Rutherford. Afterward he worked under Sir William Ramsay at University college, London, becoming in 1904 lecturer at the University of Glasgow. In 1914 he became professor of chemistry at Aberdeen university and next (1919–36) was Lee's professor of chemistry at Oxford.

With Sir Rutherford. Soddy developed the disintegration theory of the radioactive elements.

As a result of his study of the disintegration series of the radio elements Soddy concluded (1912) that certain elements should exist in two or more forms which may have diiferent atomic weights but are indistinguishable and inseparable chemically; these forms he called "isotopes." He was elected a fellow of the Royal society in 1910.

Soddy's numerous scientific publications, chiefly on radioactivity, include *Radioactivity* (1904); *The Interpretation of Radium* (1909; rev. ed., 1920); *Chemistry of the Radioactive Elements* (1912–14); *Matter and Energy* (1912); *Science and Life* (1920); *The Interpretation of the Atom* (1932); *The Story of Atomic Energy* (1949); and *Atomic Transmutation* (1953). He was awarded the Albert medal in 1955. He died on Sept. 22, 1956, at Brighton.

SODEN, HERMANN, FREIHERR VON (1852–1914), German biblical scholar, author of a new theory of textual history of the New Testament. was born in Cincinnati, O., Aug. 16, 1852, and was educated at the University of Tiibingen. He was minister of Dresden-Striesen in 1881 and in 1887 became minister of the Jerusalem church in Berlin. In 1889 Soden became *Privatdocerit* in the University of Berlin. and four pears later was appointed extraordinary professor of divinity. He died in Berlin on Jan. 15, 1914.

Soden's most important book is *Die Schriften des neuen Testaments, in ihrer altesten erreichbaren Textgestalt hergestellt auf Grund ihrer Testgeschichte* (1902–10).

Soden introduced, besides a new notation of manuscripts, a new theory of textual history. He thought that in the 4th century there were in existence three recensions of the text, which he distinguished as *K*, *H* and *I*. After establishing the texts. he reconstructed a hypothetical text *I-H-K*, which he believed to have been their ancestor. He then tried to show that this text was known to all writers of the 3rd and 2nd centuries, but had naturally to account for the fact that the quotations of these writers and the text of the early versions often diverge from it. The explanation that he offered was that the Diatessaron of Tatian was widely used and corrupted all extant texts: so that the Old Syriac, the Old Latin. the quotations of Irenaeus. Clement. Tertullian and others may be regarded as various combinations of the Tatianic text and *I-H-K*. Finally, he tried to show that the Tatianic text is itself in the main merely a corrupt form of *I-H-K* altered in order to suit the necessities of Tatian's plan.

Indispensable though they are to the specialist in textual criticism of the New Testament, Soden's notations for the various manuscripts or groups ,of manuscripts were so elaborate, and his classifications of readings were so recondite, that they never gained general currency even among biblical scholars.

(K. LE.; X.)

SODERBLOM, NATHAN (1866–1931), Swedish Lutheran archbishop, a champion of church unity and world peace, and Nobel laureate. was born on Jan. 15, 1866. at Trono, in Hälsingland. At the University of Uppsala he took degrees in classical and oriental languages and in theology. Influenced by Albrecht Ritschl's writings, he approached the problems of the faith with an open mind and a new enthusiasm for the original teaching of Luther. Ordained in 1893, after seven years as chaplain to the Swedish legation in Paris he was appointed professor of theology at Uppsala (1901), where he had an invigorating effect on the students and church life. From 1912–14 he also held a professorship at Leipzig. In 1914 he was appointed archbishop of Uppsala and primate of Sweden. Visits to the United States and other countries aroused an interest in Christian unity which bore fruit in the first World Conference on Life and Work in Stockholm in 1925 which Soderblom organized. The series of these conferences united with the conferences on Faith and Order to form the World Council of Churches (*see* REUNION, CHURCH). For this work Soderblom was awarded the Nobel peace prize in 1930. He died at Uppsala on July 12, 1931.

In theology Soderblom made an original contribution in the field of comparative religion and early published a study of Persian religion *La Vie future d'après le Mazdéisme* (1900). Of greater importance was his study which emphasized that the fundamental conception of religion was not the idea of God but the conception of ' the holy." (*Gudstrons uppkomst*, 1914: German trans., *Das Werden des Gottesglaubens*). He delivered the Gifford lectures at Edinburgh in 1931 (*The Living God: Basal Forms of Personal Religion*, 1933). Studies on Luther appeared in a collection, *Humor och melankoli och andra Lutherstudier* (1919). As an early pioneer of the ecumenical movement Soderblom wrote *Christian Fellowship* (1923). A saintly man, a scholar and a great ecclesiastical statesman, he had a remarkable personal influence on those who knew him.

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SÖDERHAMN, a seaport of Sweden, in the *lan* (county) of Gävleborg, on an inlet of the Gulf of Bothnia, near the mouth of the Ljasne river, 183 mi. N. by W. of Stockholm by rail. Pop. (1960) 12,951.

Vessels drawing 15 ft. have access to Branthäll. The harbour is usually icebound for about four months in winter.

SÖDERMAN, AUGUST JOHAN (1832–1876), Swedish composer, was born in Stockholm on July 17, 1832. He entered the Leipzig conservatory in 1857 and remained there two years, studying with Ernest Richter and Moritz Hauptmann (*q.v.*). In 1860 he became chorus master of the Royal Opera at the Stora theatre in Stockholm. Two years later he was appointed second conductor there and held that position until his death in Stockholm on Feb. 10, 1876.

Soderman's first operetta, *The Devil's First Rudiments of Learning*, was composed at an early age and first performed in Stockholm in 1856. After that time, he completed about 60 compositions including ballads, operettas and songs, as well as sacred and incidental music. It is for his vocal music that Söderman is best known. especially the quartet "A Peasant's Wedding" from his operetta *The Wedding at Ulfåsa*, and the "Bröllopsmarsch" for four female voices. But his beautiful and original mass forsoloists, chorus and orchestra is considered his finest work.

Like Schumann, he set poems and ballads to music, principally those of Carl Bellman (*q.v.*).

SÖDERMANLAND, a *lan* (county) in central Sweden, south of Lake Malar, extends about 75 mi. east to west and 64 mi. north to south. Pop. (1960) 227.615. Area 2.645 sq.mi. The relief is broken by geological faulting, but the ground nowhere rises above about 400 ft. There are ancient towns, such as Eskilstuna, with engineering industries. The county gains importance from the Sodertalje ship canal to the east of it; this bypasses Stockholm in linking Lake Malar with the Baltic. Although not a rich district, it gains through being crossed by trunk railways and roads.

Nykoping. the county town, lost iron-ore shipment traffic to Oxelösund, which is less icebound. (A. C. O'D.)

SÖDERTÄLJE, a town of Sweden, in the *län* (county) of Stockholm, 23 mi. W.S.W. of Stockholm by rail. Pop. (1960) 33,014.

Sodertalje is on a bay of Lake Malar, there connected with the Baltic by the Sodertalje canal, $1\frac{1}{4}$ mi, in length, with a minimum depth of ten feet. This is on the route followed by the Gota canal steamers between Stockholm and Goteborg; it was opened in 1819, though a canal was begun there in the 15th century at the instigation of Engelbrecht. The town contains a church, believed to date from *c.* 1100.

SODIUM (symbol Na; atomic number 11, atomic weight 22.991), a chemical element belonging to the group of alkali metals. The electronic structure of the sodium atom is: $1s^2$, $2s^2$, $2p^6$, $3s^1$, having in common with the atoms of the other elements of periodic group I a single electron in the outermost energy level.

Only one stable and naturally occurring isotope, mass number 23, is known. but radioactive isotopes with mass numbers 21. 22, 24 and 25 have been prepared. On account of its intense chemical activity sodium is never found free in nature but in the form of compounds it is widely distributed; its various combinations comprise about 2.75% of the lithosphere. Sodium chloride or common salt is exceedingly abundant and widespread, being the chief salt present in sea water besides occurring throughout the world in extensive deposits which probably owe their existence to the evaporation of prehistoric seas. Sodium chloride comprises about 80% of the dissolved matter ($3\frac{1}{2}$%) in sea water, and the great preponderance of sodium salts over potassium salts in the sea is due to the fact that land plants assimilate large amounts of the latter as essential food and at the same time require in most cases only negligible amounts of sodium salts. A common salt mine at Wieliczka in Poland, said to be 500 mi. long, 20 mi nide and 1,200 ft. thick, has been worked continuously for 600 years. while other deposits are found at Stassfurt in Saxony; Cardona and Castile in Spain; California, New York and Michigan in the U.S.; and at Nantwich and Droitwich in England. The names of the last two places indicate the antiquity of the salt industry since "wich" is a Saxon suffix indicating a place where common salt was mined.

Sodium carbonates are also widely dispersed in nature, forming constituents of manv mineral waters, and occurring as principal saline components in natron or trona lakes, as efflorescences in Lower Egypt, Iran and China and as urao in Mexico, Colombia and Venezuela. The solid crusts found at the bottom of the salt lakes of the Araxes plain in Armenia contain about 16% of carbonate and 80% of sulphate. In Colombia there occurs a double salt. $Na_2CO_3.CaCO_3.5H_2O$, known as gaylussite. In Wyoming, California and Nevada enormous deposits of carbonates, mixed in some cases with sulphate and with chloride, occur. Vast areas of the steppes in Hungary contain sodium carbonate in the soil.

Natural sulphate occurs in an anhydrous condition as thenardite, Na_2SO_4, at Tarapaca, Chile, and in the rock-salt deposits at Espartinas near Aranjuez, Spain. Hydrated sulphates occur at several localities in certain provinces of Spain, and at Mühlingen in Aargau, and copious deposits of glauberite, the double sulphate of sodium and calcium, are found in the salt mines of Villarrubia in Spain, at Stassfurt and in the province of Tarapaca. Chile, etc. A native nitrate of sodium is obtained in great abundance in the district of Atacama and in Tarapaca, and was formerly imported into Europe in enormous quantities as cubic nitre for the preparation of saltpetre. Cryolite, a fluoride of aluminum and sodium, is extensively mined in Greenland and elsewhere for industrial purposes. These form the principal natural sources of sodium compounds — the chloride as rock salt and in sea water being of such predominating importance as to outweigh all the others. But it is questionable whether, taken altogether, the mass of sodium they represent is as much as that disseminated throughout the rocky crust in the form of sodium felspar (*i.e.*, as silicate of sodium) and in other sodium-containing rocks.

Although many sodium compounds have been known from very remote times, the element was not isolated until 1807, when Sir H. Davy obtained it by electrolyzing fused caustic soda (sodium hydroxide). This method was followed by that proposed by Joseph Gay-Lussac and Louis Thénard, who decomposed molten caustic soda with red-hot iron; and this in turn was succeeded by H. Brunner's process of igniting sodium carbonate with charcoal. In spite of many attempts, however, the metal could not be cheaply produced until electrolytic methods were perfected, and that patented by Hamilton Y. Castner in 1890 formed the basis of subsequent successful methods. Castner's process is based on the same principle as that by which Davy first isolated metallic sodium; *viz.*, the electrolysis of fused caustic soda (melting point 320° C.). The apparatus consists of an iron cylinder heated by gas rings below, with a narrower cylinder beneath, through which passes upward a stout iron cathode rod cemented in place by caustic soda solidified in the narrower vessel. Nickel anodes are suspended around the cathode, and between the two is a cylinder of nickel gauze at the bottom. with a sheet iron continuation above, the latter being provided with a movable cover. During electrolysis, oxygen is evolved at the anode and escapes from the outer vessel, while the sodium deposited in globules on the cathode floats upward into the iron cylinder, within which it accumulates and from which it may be removed at intervals by means of a perforated iron ladle. The fused salt, but not the metal. is able to pass freely through the perforations. The sodium is then cast into moulds.

Considerable sodium is also prepared by the Downs process in which fused sodium chloride is electrolyzed to yield chlorine as well as the metal. The high melting point of the sodium chloride (775° C.), nhich is inconveniently near the boiling point of the sodium (892° C.), is lowered to about 600° C. by the addition of sodium carbonate.

Properties. — Sodium is a silvery white, lustrous metal which tarnishes instantly in air because of the formation of a film of the oxide or the hydroxide. Since the outer or valence electrons are loosely held and readily move from one atom to another under the influence of an applied electric potential, the metal has a high electrical conductivity ranking fourth to silver, copper and gold. The single outer electron does not permit the firm binding of a sodium atom to all its neighbouring atoms; as a result the solid metal is soft and has a low melting point. Other physical properties are as follows:

Density, 20° C.	0.97 g. per cubic centimetre
Melting point	97.5° C.
Boiling point	892° C.
Ionization potential in the gas phase	5.12 v.
Normal oxidation-reduction potential	2.714 v.
Atomic radius	1.57×10^{-8} cm.
Ionic radius in crystals	0.95×10^{-8} cm.

Sodium is one of the most electropositive elements; it readily loses by transfer one electron per atom and thus functions as a powerful reducing agent. It is excelled in this respect only by the alkali metals below it in periodic group I; viz., potassium, rubidium and caesium. In the ordinary chemical reactions of the metal the sodium ion with an oxidation state of +1 is formed: $Na \rightarrow Na^+ + e$. Because of its great reactivity, the metal must be kept either in a vacuum or under an inert liquid such as water-free kerosene or benzene. It combines directly with the halogens and with phosphorus, taking fire when heated with these elements. It combines vigorously with oxygen, burning in air with a brilliant yellow flame and forming a mixture of the normal oxide (Na_2O) and the peroxide (Na_2O_2). The vigour of its combination with oxygen is such that it reacts with most oxides, liberating the element previously combined with the oxygen. Sodium reacts less energetically with water. however, than does potassium. but more so than does lithium, and if kept in one spot on the water surface, the temperature may go high enough to ignite the evolved hydrogen. With mercury, sodium reacts vigorously to form an alloy, or amalgam, which is a solid if the sodium content is 2% or more. An unusual property of sodium and the other alkali metals is their solubility in dry liquid ammonia to form conducting solutions. The metal atom loses its electron to an ammonia molecule, forming the metal ion and the ammoniated electron which imparts a blue colour to the solution.

Metallic sodium is used in the manufacture of sodium peroxide, sodium cyanide and sodamide, all of which are of technical importance. It is extensively used as a reagent in organic chemistry, and its alloy with potassium (liquid at ordinary temperatures) is employed in high-temperature thermometers. (See THERMOMETRY.) Its alloy with lead is used in the manufacture of lead tetraethyl, the essential constituent of antiknock gasoline, a fuel especially adapted to internal-combustion engines of the high compression type. Sodium, like the rest of the members of the alkali group, possesses to a marked degree the photoelectric effect (emission of electrons when exposed to light) and hence is used extensively in the manufacture of photoelectric cells on which television, telegraphic transmission of pictures and other similar devices depend. On account of its relatively high specific heat and high heat conductivity sodium found considerable application during World War II and after as a heat transfer medium by conducting heat from the heads through the hollow stems of valves in rotary engines used for aviation.

Compounds. — In its chemical combinations sodium is usually univalent; its salts are generally soluble in water, the least soluble being the pyroantimonate, $Na_2H_2Sb_2O_7$, and the magnesium uranyl acetate, $NaMg(UO_2)_3(C_2H_3O_2)_9.6H_2O$.

Sodium hydride, NaH, is a crystalline substance obtained directly from sodium and hydrogen at about 360" C. It burns when heated in dry air, and ignites in moist air; it is decomposed by water, giving caustic soda and hydrogen. Dry carbon dioxide is decomposed by it, free carbon being produced; moist carbon dioxide, on the other hand, gives sodium formate. Like lithium hydride, sodium hydride evolves hydrogen at the anode when subjected to electrolysis. This bchaviour shows that hydrogen can form a negatively charged ion, whereas normally it forms a positive ion. Sodium hydride has all the reducing properties of sodium accentuated by the effect of the hydrogen.

The normal oxides of the alkali metals are difficult to prepare, the difficulty of the preparation increasing nith the atomic weight of the metals. When sodium is burned in air or oxygen it is difficult to obtain the normal oxide free of the peroxide even when a limited supply of air or oxygen is used. Normal sodium oxide is best made by heating sodium azide with sodium nitrite:

$$3NaN_3 + NaNO_2 = 2Na_2O + 5N_2.$$

Sodium peroxide (Na_2O_2) is formed when the metal is heated in air or in oxygen. Commercially it is manufactured by passing an excess of dry air over metallic sodium contained in boxes of aluminum, maintaining a temperature of about 300° C. Sodium peroxide is not easily decomposed by heat and is stable in dry air; however, in moist air or when acted upon by water, it readily decomposes with the evolution of oxygen and the formation of sodium hydroxide. It is a powerful oxidizing agent under some conditions and a powerful reducing agent under others, depending on the nature of the substance with which it is reacting and the acidity of basicity of the solution. It is used for the decomposition of some minerals, especially silicates. In carrying out a sodium peroxide fusion, care should be taken that the temperature does not go too high. The oxidation usually takes place at a rather low temperature and the reaction may be reversed if the temperature is too high. Sodium peroxide oxidizes lead salts to sodium plumbate and uranium salts to peruranate. Sodium peroxide combines with carbon monoxide forming sodium carbonate:

$$Na_2O_2 + CO = Na_2CO_3,$$

and it reacts with carbon dioxide which is absorbed with the liberation of oxygen:

$$2Na_2O_2 + 2CO_2 = 2Na_2CO_3 + O_2.$$

The principle of the last reaction found practicable application especially during World War II and thereafter for the revivification of air in confined combat space such as aboard submarines and also aboard aeroplanes at extremely high altitudes.

Generally speaking, sodium salts closely resemble the corresponding potassium salts. and their methods of preparation are usually the same. For sodium salts not mentioned below reference should be made to articles wherein the appropriate acid is treated, unless otherwise indicated.

Sodium sulphide, Na_2S, obtained by saturating a caustic soda solution with hydrogen sulphide and adding an equivalent of alkali, is employed in the manufacture of soluble soda glass. Sodium sulphite, Na_2SO_3, which is employed as an antichlor, is prepared (with $7H_2O$) by saturating a solution of sodium carbonate with sulphur dioxide, adding another equivalent of carbonate and crystallizing. The anhydrous salt may be prepared by heating a saturated solution of the hydrated salt. The acid sulphite, $NaHSO_3$, or probably $Na_2S_2O_5$ (*i.e.*, pyrosulphite) when solid, obtained by saturating a cold solution of the carbonate with sulphur dioxide and precipitating by alcohol, is employed for sterilizing beer casks. Sodium sulphate, Na_2SO_4, known in the hydrated condition (with $10H_2O$) as Glauber's salt, is used as a cathartic and in the manufacture of cheap glass and wood pulp. For many years sodium was not known to form an alum (*q.v.*), but if a supersaturated solution of sodium and aluminum sulphates is allowed to crystallize below 20° C.. the alum $Na_2SO_4.Al_2(SO_4)_3.24H_2O$ is obtained, higher temperatures giving monoclinic crystals. The acid sulphate, $NaHSO_4$, also known as bisulphate of soda, is obtained as large asymmetric prisms by crystallizing a solution of equivalent quantities of the normal sulphate and sulphuric acid above 50° C.

The manufacture of sodium carbonate, commonly called soda, is treated under ALKALI MANUFACTURE. The anhydrous salt is a colourless powder or porous mass, having an alkaline taste and reaction. It melts at 852° C. On solution in water, heat is evolved and hydrates formed. Common washing soda or soda crystals is the decahydrate, $Na_2CO_3\ 10H_2O$, which appears as large clear monoclinic crystals. On exposure, it loses water and gives the monohydrate, $Na_2CO_3.H_2O$, a white powder sold as "crystal carbonate"; this substance, which is also formed on heating the decahydrate to 34° C., crystallizes in the rhombic system. Both these hydrates occur in the mineral kingdom, the former as natron and the latter as thermonatrite. The heptahydrate, $Na_2CO_3.7H_2O$, is obtained by crystallizing a warm saturated solution in a vacuum; it appears to be dimorphous. The acid carbonate or bicarbonate of soda, $NaHCO_3$, is produced in the ammonia-soda process for alkali manufacture.

Another acid carbonate, $Na_2CO_3.NaHCO_3.2H_2O$, is the mineral trona or urao. We may here notice the percarbonates, obtained by acting was gaseous or solid carbon dioxide on Na_2O_2 or $NaHO_2$ at low temperatures.

For sodium nitrite *see* NITROGEN; for sodium nitrate *see* NITRIC ACID AND NITRATES; for the cyanide *see* PRUSSIC ACID; and for the borate *see* **BORAX.**

Of the sodium silicates the most important is the mixture known as soluble soda glass formed by calcining a mixture of white sand, soda ash and charcoal. or by dissolving silica in hot caustic soda under pressure. It is a colourless transparent glass mass, which dissolves in boiling water to form a thick liquid. It is employed in certain printing processes, as a cement for artificial stone and for mending glass, porcelain, etc., and also for making the so-called silicated soaps. *(See* SOAP.) Sodium silicates containing excess of silica in solution are useful adhesives.

Sodium is most distinctly recognized by the yellow coloration which volatile salts impart to a Bunsen flame, or, better, by its emission spectrum which has a line (double), the Fraunhofer D line, in the yellow (the wave lengths are 5896 and 5890). It is gravimetrically determined as the magnesium uranyl acetate, *(see* above) or as the chloride after separation from other cations in an ion exchange column. instrumental methods such as spectrophotometry and polarography are also employed.

MEDICINE

Pharmacology. — The metal sodium is not used in medicine, but many of its salts are employed. Besides *liquor sodii ethylatis* the following salts and preparations are used in the British Pharmacopoeia. (1) *Sodii carbonis,* known as washing soda which on heating yields *sodii carbonis exsiccatus; sodii bicarbonas,* from which is made *trochiscus sodii bicarbonatis.* (2) *Sodii phosphas.* From sodium phosphate are made *sodii phosphas efiervescens* and *sodii hypophosphis.* *(See* PHOSPHOROUS). (3) *Sodii sulphas* (Glauber's salt), with its subpreparation *sodii sulphas effervescens.* (4) *Soda tartarata* (Rochelle salt), a tartrate of sodium and potassium, from which is made *pulvis sodae tavtaratae effervescens,* known as Seidlitz powder. (5) *Sodii citvo-tartras effervescens,* a mixture of sugar, sodium bicarbonate, citric and tartaric acids. (6) *Sodii chloridum,* common salt. (7) *Sodii sulphis.*

For *sodii bromidum* and *salicylatum* see BROMINE and SALICYLIC ACID respectively. *Sapo durus* (hard soap) is a compound of sodium with olive oil, and *sapo animalis* (curd soap) is chiefly sodium stearate.

Poisoning by caustic soda is rare; the symptoms and treatment are the same as described under POTASSIUM. The salts of sodium resemble potassium in their action on the alimentary tract, but they are much more slowly absorbed, and much less diffusible; therefore considerable amounts may reach the small intestine and there act as saline purgatives. They are slowly absorbed into the blood, and are a natural constituent of the blood plasma, which derives them from the food. Sodium is excreted by all the mucous surfaces and by the liver and kidneys. On the latter they act as diuretics. but less powerfully than potassisum. increasing the flow of water and the output of urea and rendering the urine less acid.

Therapeutics: External Use.—The *liquor* sodii *ethylatis* is a powerful caustic and is used to destroy small naevi and warts. A lotion of sodium bicarbonate is useful to allay itching. Solutions of sodium sulphite are used as mild antiparasitics. Internal *Use.*—Sodium chloride is occasionally used in warm water as an emetic, and injections of it into the rectum as a treatment for thread worms. A 0.9% solution forms what is termed normal saline solution, which is frequently injected into the tissues in cases of collapse. haemorrhage and diarrhoea. It forms a valuable treatment in diabetic coma and eclampsia. acting by diluting the toxins in the blood. From this has developed the intramuscular injection of diluted sea water in the treatment of gastroenteritis. anaemia and various skin affections. Sodium chloride is an important constituent of the waters of Homburg, Wiesbaden. Nauheim and Kissingen. Sodium bicarbonate is one of our most useful gastric sedatives and antacids, relieving pain in hyperchloridia. It is the constituent of most stomachic mixtures. Effervescent soda water is a mild gastric sedative. Sodium phosphate and sulphate are cholagogue purgatives and are used in the treatment of gallstones. The sulphate is the chief constituent of Marienbad and Carlsbad waters. Large doses of these salts are used to remove fluid in dropsy. Soda tartarate is purgative and diuretic, as is the citro-tartarate. These purgative sodium salts are most useful in the treatment of chronic constipation. and of the constipation associated with gout and hepatic dyspepsia. They should be dissolved in warm water and taken in the morning, fasting. In visceral gout and chronic catarrhal conditions of the stomach a course of alkaline waters is distinctly beneficial. Sodium salts have not the deuressant effect so marked in those of potassium.

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SODOMA (GIOVANNI ANTONIO DE' BAZZI) (1477–1549). Italian painter. the only representative of the High Renaissance in Siena, was born at Vercelli, in Lombardy, in 1477. His first master was Martino Spanzotto. from whom he acquired the strong colouring and other distinctive marks of the Lombard school. Sodoma was taken to Siena in 1501 by some agents of the Spannocchi family. and as the bulk of his professional life was passed in that Tuscan city he counts as a member of the Sienese school, although he is not related to it in point of style. He does not seem to have been a student in Siena, apart from some attention he gave to the sculptures of Jacopo della Quercia. With Pinturicchio he was one of the first to establish there the matured style of the 16th century. His earliest works of repute are a series of 31 paintings, executed from 1505 to 1508, in the Benedictine monastery of Monte Oliveto. on the road from Siena to Rome. illustrating the life of St. Benedict. in continuation of the series begun by Luca Signorelli in 1498 As a result of these he was invited to Rome by the celebrated Sienese merchant hgostino Chigi and was employed by Pope Julius II in the Camera della Segnatura in the Vatican. He executed two great compositions and various ornaments and grotesques. The latter are still extant but the larger works did not satisfy the pope, who engaged Raphael to substitute his "Justice," "Poetry" and "Theology." In the Villa Farnesina Sodoma painted some frescoes: "Alexander in the Tent of Darius" and the "Nuptials of the Conqueror With Roxana" (by some considered his masterpiece), probably painted about 1514. He afterward returned to Siena and in 1539 went to Pisa and Lucca in quest of work. From Lucca he returned to Siena, not long before his death. which took place on Feb. 14. 1549. He had squandered his property and is said (rather dubiously) to have died in penury in the great hospital of Siena.

It is uncertain whether Sodoma was a pupil of Leonardo da Vinci, though Giovanni Morelli (in his Italian *Pictures in German* Galleries) speaks of his having "only ripened into an artist during the two years (1498–1500) he spent at Milan with Leonardo"; some critics see in Sodoma's "Madonna" in the Brera at Milan (if it is really by him) the direct influence of this master. His most celebrated works are in Siena. In S. Domenico, in the chapel of St. Catherine of Siena, are two frescoes showing Catherine in ecstasy and fainting as she is about to receive the Eucharist from an angel—a beautiful and pathetic treatment. In the oratory of S. Bernardino scenes from the history of the Madonna—the "Visitation" (1518) and the "Assumption"' (1532)—are noteworthy. In the Academy are the "Deposition From the Cross" and "Christ Scourged"; by many critics one or other of these paintings is regarded as Sodoma's masterpiece. In the choir of the cathedral at Pisa is the "Sacrifice of Abraham" and in the Uffizi gallery of Florence a "St. Sebastian." Works by Sodoma also may be seen in many other public galleries of Europe and the Cnited States; there are several in the National Gallery of Art, Washington, D.C.

SODOM AND GOMORRAH, two of the five "cities of the plain" in the Dead sea region. the others being Admah, Zeboim and Zoar (Bela) (Gen. xiii, xiv, xix). They were destroyed by a rain of "fire and brimstone." Various identifications of these cities with modern sites have been suggested. based mainly on similarity of names. Jebel Usdum. for instance, the salt hill at the southwest corner of the Dead sea. has radically the same name as Sodom. which, indeed, may have been situated in its neighbourhood.

The element of history in the narrative of the "cities of the plain" is as difficult to assess as the sites are to determine. A scientific explanation of the catastrophe is not excluded. (See DEAD SEA.)

See "Report of the Joint Expedition of the *Xenia Seminary* and *the American School of Oriental Research* at Jerusalem *to seek for the* cities *of the Plain" in Bibliotheca Sacra* (1924). (E. Ro.)

SODOMY: see HOMOSEXUALITY.

SODOR AND MAN, the Manx bishopric reconstituted about 1134 by the Manx king Olaf I as the diocese of Sudhreyjar (Latin *Sodorenses*), the "southern isles" of the Norwegian dominions in Britain comprising Man and the Hebrides. The diocese remained in the Norwegian ecclesiastical province of Nidaros (Trondheim) from 1154 until the 15th century. Following the treaty of Perth in 1266, Man was separated from the Hebrides but. though Scottish bishops have been appointed for the Isles, since 1422 the Manx bishop still bears the title "Sodor and Man." The 13th-century cathedral of the diocese. dedicated to St. German, now in ruins, stands on St. Patrick's isle in Peel bay.

Bishopscourt, the episcopal residence since the middle ages, lies about 8 mi. to the northeast.

The diocese (in the province of York) still retains its ancient convocation. vicar-general and canon law. Further, its bishop has the same right as the archbishop of Canterbury to issue "special" marriage licences.

Since the Isle of Man has its own parliamentary system, and its bishop has a seat in the council of Tynwald, he is not entitled to speak or vote in the house of lords, but in the island he is a baron by right of his bishopric. (E. H. S.)

SOENDA ISLANDS: see SUNDA ISLANDS AND STRAIT.

SOEST, a town in the Land of North Rhine-Westphalia. Germany. 33 mi. E. of Dortmund. on the Cologne-Elberfeld-Berlin Ry. Pop. (1959 est.) 33,291. Mentioned in documents as early as the 9th century, Soest was one of the largest and most important Hanseatic towns in the middle ages. It was one of the chief emporiums on the early trading route between Westphalia and lower Saxony. Its code of municipal laws (Schran; *jus susatense),* dating from 1144 to 1165, was one of the earliest and best. and served as a model even to Liibeck. On the fall of Henry the Lion, Soest passed with the rest of Angria to Cologne. In the 15th century the strife between the townsmen and the archbishops broke out in open war, and in 1444 the fortifications of the town withstood a long siege. Papal intervention ended the strife, and Soest was permitted to remain under the protection of the dukes of Cleves.

Of its churches the most striking are St. Peter's, the Wiesenkirche. a gem of Gothic architecture, Maria zur Hohe, with beautiful mural frescoes, and the Roman Catholic cathedral. The town hall (1701) contains valuable archives; the gymnasium at Soest was founded in 1534, through the instrumentality of Melanchthon.

Ironworking, manufacture of soap, sugar, marmalade, machinery, lamps, cigars, bricks and tiles, linen spinning and brewing, together with market gardening in the neighbourhood and trade in timber and grain are the leading industries.

SOFFIONI (SUFFIONI), a name applied in Italy to certain volcanic vents which emit jets of steam, generally associated with hydrogen sulfide and carbon dioxide, sometimes also with a little ammonia and marsh gas.

The soffioni are usually arranged in groups and are best represented in the Maremma of Tuscany, where they contain a small proportion of boric acid (*q.v.*), for which they were for many years the chief commercial source. See FUMAROLE.

SOFIA, capital of Bulgaria, in an upland plain, about 1,700 ft. above sea level, between the western Balkans on the north and the Vitosha massif on the south. Two small tributaries of the river Isker, the Vladaya and the Perlovets, flow through the city.

History.—Serdica (from Serdi, the name given by the Romans to the inhabitants of the plain) was founded by the emperor Trajan. It became a Roman provincial town of considerable importance in the 3rd and 4th centuries A.D. Burned by the Huns in 441 Serdica was rebuilt later. Its name was converted into Sredets by the Slavonic newcomers who associated it with *sreda* (middle) and this form subsequently became the Byzantine Triaditsa. The town was taken by the Bulgars under Krum in 809 and. after Trnovo. became the second largest city of mediaeval Bulgaria. It successfully resisted the attacks of the emperor Basil II in 987 but between 1018 and 1186 it was under Byzantine rule, serving as a frontier fortress. It flourished again when Bulgaria recovered its independence. but in 1386 was captured by the Turks. In 1443 it was for a brief time occupied by the Poles under King Wladyslaw III and the Hungarians under John Hunyadi. Under Turkish rule the city was for nearly four centuries the residence of the *beylerbey* or governor general of the whole Balkan peninsula except Bosnia and Morea. During this period the population was mainly Turkish. Sofia was occupied by Russian troops in 1829 and 1878; by the British. French and Italian in 1918; and by the Russians again on Sept. 9. 1944.

Architecture and Growth of the Modern City.—The name of Sofia. which came into use in the 14th century. is derived from the Church of St. Sofia built by the Byzantines in the 11th century, now in ruins. The oldest building in Sofia is the round chapel of St. George. originally a Roman bath. Of the principal mosques built by the Turks. the large mosque, with nine metal cupolas, has become the National museum; the Black mosque has been transformed into an Orthodox church; the Banya-Bashi mosque is still used by Moslem worshippers. The old Orthodox cathedral of Sveta Nedelya (formerly Sveti Kral), in which the remains of the Serbian king Stefan Crosh II are preserved. was wrecked by the Communists on April 16. 1925, hut was later rebuilt. The new cathedral of St. Alexander Nevsky was built as a memorial to the Russians fallen in 1877–78. The royal palace, occupying the site of the Turkish *konak,* was built,by Prince Alexander in 1880–82 and enlarged by King Ferdinand.

When the constituent assembly sitting at Trnovo chose Sofia in 1879 as the capital of the restored Bulgaria, its population was only 20,858. It grew rapidly after the Balkan Wars of 1912–13 and World War I because of the influx of refugees from Macedonia. amounting to 154,025 in 1920. In 1947 it was 434.888, in 1956, 644.727 and estimated at 766,400 in 1560. Sofia forms the centre of a railway system radiating to Istanbul (300 mi.), Eurgas, Varna. Ruse (and Bucharest). Vidin, Belgrade (206 mi.). Kyustendil and Petrich. The station and railway yards were heavily bombed by the Allies in 1943 and 1944. After World War II a plan for the city's reconstruction and development was introduced. The Sofia university was considerably enlarged and many new public buildings and dwelling blocks were erected. The new Vasil Levski stadium can hold 45,000 spectators.

SOFTBALL is one of the most popular participant sports in the United States. Though there are conflicting claims of invention and origin, it is generally agreed that softball, closely akin to baseball. developed from a game called "indoor baseball" which was first played in the gymnasium of the Farragut Boat club in Chicago. Ill., in 1887. The game was introduced to the playgrounds and parks of Chicago and Minneapolis and later promoted by other public playground leaders throughout the country as a desirable outdoor game to be played in small public playgrounds. It became known in the United States by various names such as kitten ball, mush ball, diamond ball. indoor-outdoor and playground ball. Since there were wide variances in playing rules. size and type of playing equipment, and lack of uniformity as to dimensions of the playing field, a need developed to secure a uniform code of rules. In certain states. particularly Minnesota, Wisconsin, Florida and Colorado, the game rapidly progressed; playing rules were made more uniform and improved equipment was developed by manufacturers.

At the National Recreation congress in Springfield, Ill., in 1923, a rules committee was appointed by Joseph Lee, a United States pioneer in recreation. That year marks the start of the development of softball as it is known today. The Lee committee was later enlarged to form the International Joint Rules Committee of Softball. which came to include representatives of a number of organizations which promote and sponsor softball. The committee was formed to gain general acceptance of and to publish and circulate a standard set of rules; to study the game in order to recommend changes in rules that would benefit the largest number of players; and to co-operate with manufacturers of sporting goods to secure standard and satisfactory equipment.

The Amateur Softball Association of America must be credited for much of the successful growth of softball. Organized in 1932, it came to be the recognized governing agency for promotion and control of organized national competition. It became a member of the Amateur Athletic union, the U.S. Olympic commission, the National Recreation association, and the International Softball federation. Through its metropolitan, state and regional organization. it assumed responsibility for directing thousands of teams in competition, culminating in world championship tournaments for men and women, which have been held without interruption from 1933.

The International Softball federation acts as a clearing centre for the softball organizations of more than 20 countries, including Australia. Japan, Argentina, England and Canada.

Basically, the fundamentals of softball are the same as those of baseball (*q.v.*). Batting and fielding strategy are similar, but since the game is played on a much smaller area the action is much faster. It seldom requires more than an hour to complete seven innings for an official game.

A distinctive technique in softball is the underhand pitching. Special skills were soon developed in this art and pitchers developed baffling windups, followed by a release and throw of the ball that travels with a speed comparable to that of the overhand regulation baseball.

The regulation playing field for softball should have a clear, unobstructed area within a radius of 200 feet from home plate between the foul lines. It includes a diamond-shaped area with 60-ft. base lines. The pitching distance for men is 46 ft. and for women 38 ft. Bats must be round; not more than 34 in. long and not more than $2\frac{1}{8}$ in. in diameter at the largest part. The official softball is a smooth-seam ball. not less than $11\frac{7}{8}$ in. nor more than $12\frac{1}{8}$ in. in circumference. weighing between 6 and $6\frac{3}{4}$ ounces.

In summary. the rules for softball differ from those of baseball in the following respects:

(1) Softball base lines are 60 ft. long whereas baseball base lines are 90 tt.
(2) Softball pitching distance is 46 ft compared with baseball's 60 ft. 6 in.
(3) The official softball is heavier and larger than a baseball
(4) The official softball bat is shorter and lighter than a baseball bat.
(5) Softball games consist of seven innings whereas baseball games are nine innings.
(6) The chiei difference in the pitching rules is that in softball the ball is delivered by an underhand motion to the batter with a follow-through of the hand and wrist past a straight line of the body

before releasing the ball. The pitcher must pause for one second at the conclusion of his windup before delivering the ball.

(7) Base stealing is permitted in both games, but in softball the runner must keep contact with the base until the pitcher releases the ball on delivery to the batter.

Principal reasons for the great popularity of softball are that the game is played with speed, that it can be played at relatively low cost for equipment and uniforms, and that it can and is played by children and young and old men and women; and it has great appeal to spectators. Because of the smaller playing area, softball fans are continually thrilled by hard drives, bare-handed stops and fast throws. Close decisions are the rule on most plays. It gained wide acceptance, moreover, as an outstanding girls' and women's team sport; hundreds of women's softball teams are members of leagues which compete for honours in a world's championship tournament for women.

Softball demonstrated also its value as an informal recreational activity for industrial and business, church and school groups, at picnics and outings, and on the neighborhood vacant lots and playgrounds.

The widespread interest in softball in the United States was indicated by a broad geographic distribution of world championship teams after the formation of the Amateur Softball Association of America. In the 1960s it was estimated that in the U.S. alone softball was played by more than 20,000,000 participants annually. It was recognized as one of the five leading spectator sports with a probable yearly attendance of 125,000,000.

(A. T. N.)

SOFT DRINKS, or nonalcoholic beverages, may be divided into two classes: carbonated beverages (sometimes called aerated waters) and still beverages (those without carbonation). With the exception of club soda or sparkling water, carbonated drinks contain sugar and edible acids, as well as artificial flavours or natural flavours derived from fruits, nuts, roots, herbs or other plant sources. Still beverages generally contain natural or artificial fruit flavours.

History. — Carbonated beverages and waters developed from European attempts to imitate the popular and naturally effervescent waters of famous springs, with primary interest in their reputed therapeutic values. The effervescent feature of the waters was recognized early as most important. Jan Baptista van Helmont (1577–1644) first used the term "gas" in his reference to !he carbon dioxide content. Gabriel Venel referred to "aerated water." confusing the gas with ordinary air. Joseph Black named the gaseous constituent "fixed air."

Numerous reports of such experiments and investigations were included in the *Transactions* of the Royal Society of London in the late 1700s, including the studies of Stephen Hales. Joseph Black. David Macbride, William Brownrigg, Henry Cavendish, Thomas Lane, Joseph Priestley and others. Duplication of the waters of Bad Pyrmont. a spa in Germany near the city of Hameln, was one of the major objectives, probably because of the popularity of the spa and also because of the relatively simple nature of the mineral content of the waters there.

Priestley, who obtained "fixed air" for his experiments from a brewery near his house, published *Directions for Impregnating Water with Fixed Air* in 1772. For his reports concerning "fixed air" and the mixture of waters with it, but with special emphasis on the medicinal values shown by him to exist in artificially carbonated water (but since found to be illusory), he was awarded the Copley medal by the Royal Society of London in the following year.

Meanwhile, other European scientists were active in the field. Studies by Torbern Bergman, a Swedish chemist. were published in the reports of the Swedish Royal Academy of Science in 1775. Carl Wilhelm Scheele of Sweden was similarly engaged. Antoine Lavoisier. in France, identified the "fixed air" of Priestley as a combination of carbon and oxygen which he called *gas acide carbonique*. John Mervin Nooth, in England, developed special apparatus for the preparation of small quantities of the effervescent waters. His report appeared in the 1775 *Transactions* of the Royal society.

Improvements in the Nooth device were made by Jean Hyacinthe de Magellan in 1777, and in 1781–83 the English chemist Thomas Henry described apparatus for the production of carbonated waters on a commercial scale. Many others followed, and factories and bottling plants were opened in Geneva, Switz., Paris. London, Dublin. Ire., Dresden, Ger., and several other European cities during the period 1789–1821.

U.S. investigators also were interested in carbonated water and its health values. As early as the summer of 1807, in New Haven. Conn., Benjamin Silliman of Yale college began producing bottled soda water on a commercial scale, and he opened a public establishment for dispensing it. In Philadelphia! artificially carbonated waters were bottled and sold commercially by Joseph Hawkins, with machinery of his own invention. The firm was known as Shaw and Hawkins. Hawkins was issued a U.S. patent for preparation of imitation mineral waters in 1809, the first of record in this field.

The addition of flavourings to soda water to form the effervescent type of soft drink or carbonated beverage which became so widespread in America began early. Its exact origin is obscure, however. In 1768 Richard Bewley, in England, had introduced a form of soda water which he described as "mephitic julep," to be taken "with a draft of lemonade." He had followed a similar suggestion of Macbride concerning the medical efficacy of a mixture of fresh lime juice and alkaline salts taken as an effervescent drink.

Production Methods. — The basic ingredients in soft drinks are water, carbon dioxide, sugar, flavouring and, sometimes, artificial colouring.

Water, although most often taken from a safe municipal water supply. usually is given further processing to ensure uniformity of the finished product, because the amount of impurities in the municipal supply may vary from time to time. In some bottling plants the water-treatment equipment may consist simply of a sand filter to remove minute solid matter and an activated-carbon purifier to remove colour, chlorine and other tastes or odours. In most plants, however, water is treated by a process known as superchlorination and coagulation. In this process the water is exposed for two hours to a high concentration of chlorine as well as to a flocculant that removes such organisms as planktons (minute plants and animals); it is then passed through a sand filter and activated-carbon purifier.

Carbon dioxide gas gives the beverage its sparkle and tangy taste. and prevents spoilage. While it has not been proved that carbonation offers a direct medical benefit. carbonated beverages are used to alleviate post-operative nausea when no other food can be tolerated, as well as to ensure adequate liquid intake.

Carbon dioxide is supplied to the soft drink manufacturer in either liquid or solid ("dry ice") form, maintained under high pressure in heavy steel containers. As the pressure is released, the material changes into the gaseous form, in which it can be dissolved in water in quantities that vary with temperature and pressure. The amount of gas the water will absorb increases as the pressure is increased and as the temperature is decreased. Carbonation (of either the water or the finished beverage mixture) is effected by chilling the liquid and cascading it in thin layers over a series of plates in an enclosure containing carbon dioxide gas under pressure.

Flavouring sirups are made from sugar that is delivered from the refiner either in granulated form or as a 67% or 76% solution known as liquid sugar. The sugar is dissolved or diluted with processed water, and the desired flavouring substances are added. The resulting mixture is made more palatable by the addition of edible acids, principally citric acid, and its colour may be heightened by the addition of caramel (burnt sugar) or certified food colouring materials.

Two methods of producing the finished beverage are in use: either the sirup may be mixed with carbonated water prior to bottling or a precise amount of sirup may be measured into each bottle, after which the bottle is filled with carbonated water. In either case. the sugar content—51%–60% in the sirup—is reduced to 8%–13% in the finished beverage. The blending of sirups, mixing with carbonated water and filling of containers is carried out almost entirely by automatic machinery.

Most soft-drink producers use bottles of the returnable type. which reduce packaging costs, although some .are using nonreturnable. "one-trip" bottles and metal cans. Before filling. returnable containers are thoroughly flushed with hot solutions of caustic soda or other alkalies for a minimum of five minutes, and then rinsed with potable water.

The production of still beverages involves ingredients and techniques similar to those used for carbonated beverages. However. since they lack the protection against spoilage afforded by carbonation, still beverages usually are pasteurized. either in bulk or by continuous flash pasteurization prior to filling or in the bottle.

Some still beverages are sold in concentrated. frozen form. and these do not require pasteurization; however. they must be kept frozen until used. Since they are not under pressure, still beverages may be packaged not only in bottles and cans but also in cardboard cartons.

See also GINGER ALE. (JN. J. R.; H. E. K.)

SOFT FURNISHINGS: *see* INTERIOR DECORATION.

SOFT HAIL, precipitation of white, opaque or translucent. round or conical, snowlike grains 2–5 mm. in diameter. Soft hail is equivalent to the German *graupel*, a word often quoted in English meteorological literature, and to the *snow pellets* of U.S. terminology. From 1929 the International Meteorological Code has distinguished several slightly different forms of soft hail, giving soft hail a more restricted definition than theretofore. These are: small hail and soft hail.

Soft hail is a crisp compressible variety that bounces when it hits the ground, and falls steadily as a preliminary to ordinary snow. Small hail is soft hail that has become slightly rimed or glazed by passing through clouds, or by falling with rain, so that it is hard and does not bounce, and falls in showers, sometimes alternating with rain. Both types occur only at temperatures near the freezing point. Neither is a familiar occurrence outside of the western coasts of countries in higher latitudes: Norway, Chile. Iceland. British Columbia, Alaska. *See* HAIL. (R. G. SE.)

SOGA, the name of one of the great families of Japanese history, the first to usurp power and thus initiators of the tradition of dual government in Japan. In addition. Soga Iname was primarily responsible for introducing Buddhism into Japan, the first Buddhist temple in that country being in his home. Although descended from a collateral branch of the imperial family. the Soga's history is obscure until Iname became minister in A.D. 536. His son Umako also became minister. and. beginning with the death of the emperor Bidatsu in A.D. 585, executed a series of maneuvers that culminated in the enthronement of his niece as empress Suiko in 592. Between that year and 643 the Soga held undisputed power in Japan and could claim three emperors and one empress as their creations. In 645 Soga Iruka and Soga Yemishi were assassinated by the Fujiwara family who were to succeed them as regents, and with these murders Soga power ended. *See* also JAPAN : *History:* The *Clan Period.*

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SOGA (BASOGA, WASOGA), an east African people of the Interlacustrine Bantu group who inhabit the area east of the Nile between Lakes Victoria and Kyoga. Although sharing a common basic culture. the Soga were divided among several small states: Bugabula, Bulamogi, Busiki. Luuka, Kigulu, Bukoli, Bugweri, Butembe, Bunya and Bunyuli. In economy. technoloav and religion they resembled the Ganda (*q.v.*). In each state there were several dozen patrilineal clans! one of which held the rulership. The northern states were often tributary to the Nyoro, while the Ganda dominated the south.

Since 1894 the Soga have formed an administrative district of the Uganda protectorate and have shared a common local government. In the 1960s they numbered about 600,000. See also BANTU (INTERLACUSTRINE). (L. A. FS.)

SOGDIANA, a province of the Achaemenian empire (O. Pers. *Sughuda*), corresponding to the modern districts of Samarkand and Bukhara; it lay north of Bactriana between the Oxus and the Iaxartes, and embraced the fertile valley of the Zerafshan (anc. Polytimetus). Under the Greeks Sogdiana was united in. one satrapy with Bactria. and subsequently it formed part of the Bactrian Greek kingdom till the Scythians (*see* SCYTHIA) occupied it in the middle of the 2nd century B.C. The valley of the Zerafshan about Samarkand retained even in the middle ages the name of the Soghd of Samarkand.

SOGNE FJORD, an inlet of the west coast of Norway, penetrating 109 mi. eastward into the mainland. It is the longest fjord in Norway. and the deepest, approaching 700 fathoms in some parts. Sognefest at its entrance is 50 mi. by water from Bergen, in 61° 5' N. For the first 50 mi. the flanking mountains are unbroken by any considerable branch, but beyond this point several deep. narrow inlets penetrate the Jostedalsbre and Jotunfjeld to the north. and the Hardangerfjeld to the south. being walled in at their heads by snow-clad mountains. The chief fjords are Fjaerlands. Sogndals and Lyster fjords to the north. Aardals fjord to the east. Laerdals and Aurlands fjords to the south. Branching from the last is the Naero fjord, with a precipitous valley of great beauty (Naerödalen) at its head.

SOHO, a district in the City of Westminster, London. Eng., bounded by Oxford street (N.), Charing Cross road (E.), Coventry street (S.) and Regent street (W.); Piccadilly circus is at the southwestern corner. A plan of 1585 shows the area as fields which in 1643 just came within the fortifications of London hurriedly put up against the royalists; a fort stood near the northern end of the present R'ardour street. Gregory King surveyed the area for building and in 1681 built King's, later Soho, square; the district soon becoming fashionable. Foreign tradesmen. especially French Huguenots, finding few opportunities in the City, settled in Soho. In 1700 there were about a dozen French churches near and in Soho, but by the early 20th century the French had been displaced by, among others, the Italians whose quarter was originally in Clerkenwell. Soho has many famous names linked n-ith it, including G. J. Casanova. William Blake, who was born in Broad (now Broadwick) street, and Karl Marx; William Hazlitt lies buried in St. Anne's church gardens not far from the bankrupt Theodore. king of Corsica. Soho, no longer a community. is known chiefly for its continental restaurants and food shops; Berwick market is within its bounds, and clothing firms. film companies and publishers. especially of music. are established. The name (*So* ho in ratebooks of 1632) is an old hunting cry.

SOIGNIES (Flemish *Zinnik*), a town of the province of Hainaut, Belgium, with important limestone (Carboniferous) quarries in the neighbourhood. Pop. (1955 est.) 10,843.

The forest of Soignies once extended over south Brabant up to the walls of Brussels and was part of the *Silva Carbonaria* of antiquity. Napoleon ordered 22,000 oaks to be cut down in it to build the Boulogne flotilla for the invasion of England. King William I of the Netherlands continued the process. A portion of the forest in the neighbourhood of Waterloo was assigned in 1815 to the duke of Wellington.

SOIL is the product of two processes: the decomposition of rock and the decay of plant and animal life. Volcanic action and the disintegration and decomposition of large masses of solid rock have left a blanket of unconsolidated mineral material over most of the surface of the earth. This collection of mineral particles is called the regolith. It is always mixed with varying amounts of organic materials that have been added by the partial decomposition of organisms having lived in or on the regolith. The few inches of productive topsoil on which agriculture depends required thousands of years for their development.

The formation, properties and scientific cultivation of the soil are of interest to farmers, soil scientists: geologists, mineralogists, engineers and other specialists. These aspects of soil study are discussed here under the following headings:

I. Soil Development
II. Soil Classification
  1. Development of Soil Science
  2. Systems of Classification
  3. Soil Survey

III. Physical Nature and Properties of Soils
   1 Component Parts of Soils
   2. Structure and Its Practical Significance
   3. Porosity and the Weight of Soils
   4. Soil Moisture and Its Relation to Plants
   5. Soil Air and the Need for Aeration
   6. Soil Temperature: Its Importance and Control
   7. Soil Colour and Its Significance
   8. Soil Tilth and Tillage
IV. Chemical Properties of Soils
   1. Mineral Constituents
   2. Secondary or Clay Minerals
   3. Base or Cation Exchange
   4. Soil Reaction and Acidity
   5. Anion Exchange
   6. Alkali and Saline Soils
   7 Organic Matter
   8. Plant Nutrient Supplying Ability
   9 Soil Variations With Climatic Environment
V. Soil Microbiology
   1. Decomposition of Organic Matter
   2. Solution of Minerals
   3. Nitrogen-Fixing Bacteria
   4. Nitrogen Mineralization
   5. Xmmonification
   6. Nitrification
   7. Algae
   8. Actinomycetes
   9. Fungi
VI. Soil Productivity
   1. Soil Management
   2 Soil Treatment as an Investment

Additional information will be found under SOIL EROSION AKD CONSERVATION; SOIL FAUNA; SOIL TESTIKG AND ANALYSIS; LAND RECLAMATION; IRRIGATIOK; ROTATION OF CROPS; FERTILIZERS AND MANURES: LIMING.

I. SOIL DEVELOPMENT

The surface of the regolith seldom remains in the place where it was first formed; during its millions of years of existence it has been moved from place to place by wind. flowing water or advancing glaciers. Soil is any part of the regolith that has been in one place for a sufficient length of time and has been acted upon by natural physical, chemical and biotic forces of sufficient intensity to develop detectable surface and subsurface layers called soil horizons. Soil-horizon differentiation in the regolith involves the accumulation of organic materials in the shallower horizons and the movement of dissolved mineral materials from certain horizons into neighbouring horizons (*see* fig. 1).

The regolith was formed by the physical weathering or disintegration of massive rocks and minerals and by the chemical weathering or decomposition of some of the minerals in the parent rock. Rocks disintegrate or fracture into smaller and smaller particles due to alternate expansion and contraction resulting from heating and cooling, freezing and thawing, wetting and drying. Chemical weathering of rocks results from reactions of component minerals with oxygen and water and with carbonic, nitric and sulfuric acids of atmospheric and biological origin.

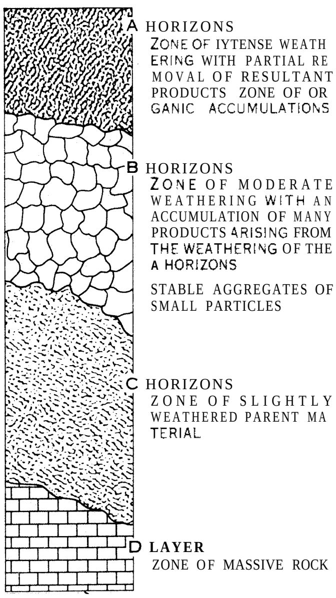
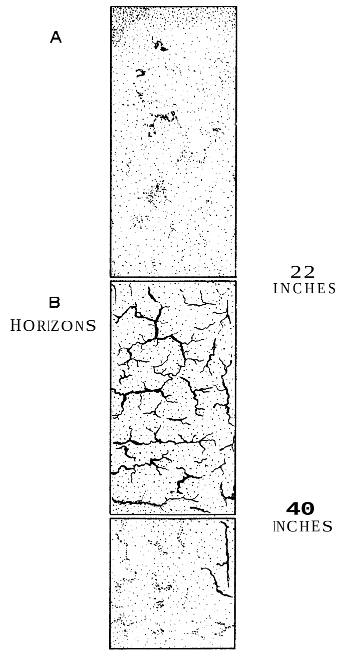


FIG 1.—SCHEMATIC REPRESENTATION OF WEATHERING IN THE REGOLITH OF THE EARTH'S CRUST AND SUBSEQUENT SOIL-PROFILE DEVELOPMENT

Soils develop from the regolith by a continuation of physical, chemical and biotic actions and reactions similar to those that originally formed the regolith and by a differentiation of the weathered regolithic material into a profile of horizons. For regolithic material to be classed as a soil. its surface must be differentiated from deeper material into from one to four possible master horizons designated from the surface downward as **A.** B and C horizons and D layer. Master horizons are usually several inches thick (*see* fig. 2, 3 and 4). If minor differentiations occur within the master horizons, the subhorizons are designated by appropriate subscripts such as A,, B_4, C,, etc.

Horizons become differentiated during soil development in the regolith because conditions vary with depth. In humid regions physical .and chemical reactivity and biotic activity are much more intense in the surface than in subsurface materials. Dispersed and dissolved products are moved from the surface horizons to the subsurface horizons or they are leached completely from the developing soil profiles. In desert regions chemical and biotic soil-forming processes are much less intense than in humid regions, and the zone of greatest chemical and biotic activity is usually within one of the subsurface rather than surface horizons. There is seldom enough water in desert soils to move products of weathering from one-horizon to a lower one. As a result of the above processes each horizon of a soil profile differs from the one above or below by one or more characteristics. such as colour, chemical composition, arrangement of individual particles or size distribution of constituent particles.



ILLINOIS AGRICULTURAL EXPERIMENT STATION
FIG 2.—A

The A horizons are the horizons of the surface layers of soil profiles. They contain more organic matter than the other horizons except in certain desert soils in which the production, preservation and accumulation of organic matter may be favoured somewhat more by conditions found lower down in the B horizons. The A horizons are the most weathered and leached of the various horizons. In the soils of the cold humid temperate regions. weathering and leaching have left residues in the A horizons which are high in silica and low in iron and aluminium oxides and other sesquioxides (*see* also *The Chemical Properties of Soils* below). The opposite is true of the soils of the humid tropics in which soil-forming processes have left residues in the A horizons which are high in the sesquioxides and low in silica (*see* also LATERITE).

The B horizons of the soils of the cold humid temperate regions may accumulate all or only part of the sesquioxides removed from the corresponding A horizons. In cases where only part of the sesquioxides has been deposited in the B horizons the remainder has been removed from the soil by drainage waters. Intermediate climates between the cold humid temperate regions and the humid tropical regions produce soils with A and B horizons having intermediate silica or sesquioxide residues and accumulations.

The humid temperate climates are conducive to-the formation in the A and B horizons of a group of very finely divided hydrated iron and aluminum sili-

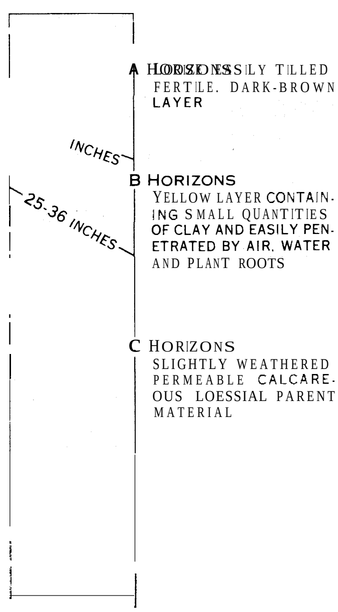


FIG 7 —TYPICAL FEATURES OF PROFILES OF SOIL WITH HIGH PRODUCTIVE CAPACITIES cates called clay minerals. The B horizons of soils occurring in these climatic regions have been enriched by clay minerals carried down by percolating nater from the A horizons.

The C horizons oi soils represent the types of material from which the A and B horizons were formed. These materials are called the parent materials of the soils of nhich they are a part and their characters are determined by the rocks from which they were originally iormed by weathering processes.

The D layers are beneath the soils and are not a part of the soil profiles. They are strata having properties much difierent from the overlying C horizons. They are strata which, by virtue of their properties and shallow position, exert a significant influence on the properties of the soils above.

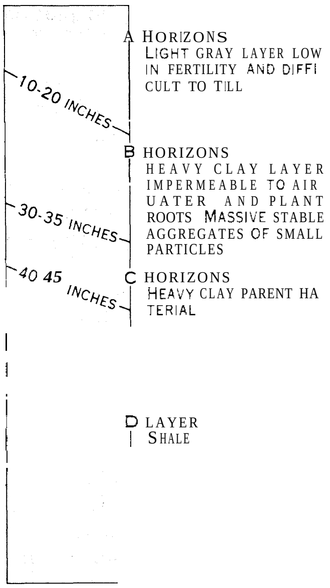


FIG. 4—TYPICAL FEATURES OF PROFILES OF SOIL WITH LOW PRODUCTIVE CAPACITIES

Some of the master horizons may be missing irom soil profiles. The A horizons may have been removed from come soils by erosion. Other soils may be too young and too feebly developed to shon B horizons In still other soils C horizons may be absent because the original regolith was so shallow that it became completely occupied by the A and B horizons. In opposite cases where the regolith is extremely deep. D layers usually are not recognized because they do not influence the properties of the overlying soils.

Soils may also develop from thick layers of organic materials found in the bottoms of naturally or artificially drained swamps or lakes occurring in regions with cold temperate climates. These organic materials accumulated. before drainage, from dead water plants and other organisms. These organisms were only slightly decomposed due to relatively low temperatures and a lack of oxygen at the bottom of the swamps and lakes. After the organic sediments become exposed to air by drainage, they differentiate into horizons and develop into organic soils. The A horizons are first formed by partial oxidation of the organic compounds and slightly mineralized fractions are left as residues. As organic soils become older they become more and more mineralized to greater and greater depths.

The factors that influence the rate and kind of soil development include: the nature of parent material, climate, biological activity, topography or drainage and the age of the developing soil profile. These factors, through combinations of many intensities, provide many environments and many possible variations in rate and kind of soil development. This can be illustrated by studies made on soils developed from regolithic materials deposited approximately 2,000, 10,000 and 200.000 years ago, respectively. The 2,000-year-old deposits are Indian mounds and the other two are continental glacial deposits, all occurring in humid temperate regions. The 2.000-year-old deposits show little if any soil-profile development; the intermediate regolithic materials have developed weak soil profiles; and the 200.000-year-old deposits have developed well-defined soil profiles. In contrast to this slow development in the temperate climates. in the tropics it is possible to find 50-year-old deposits of regolithic materials that have developed perceptible soil horizons.

Variations in age, parent material and environment have been responsible for the development of many kinds of soils on the earth's surface with many different physical. chemical and biological properties and with wide ranges in productive capacities. These soil characteristics have been influential in determining the kind of native vegetation best able to survive in various parts of the world. They are also influential in determining the methods man must adopt in using and managing soils for crop production.

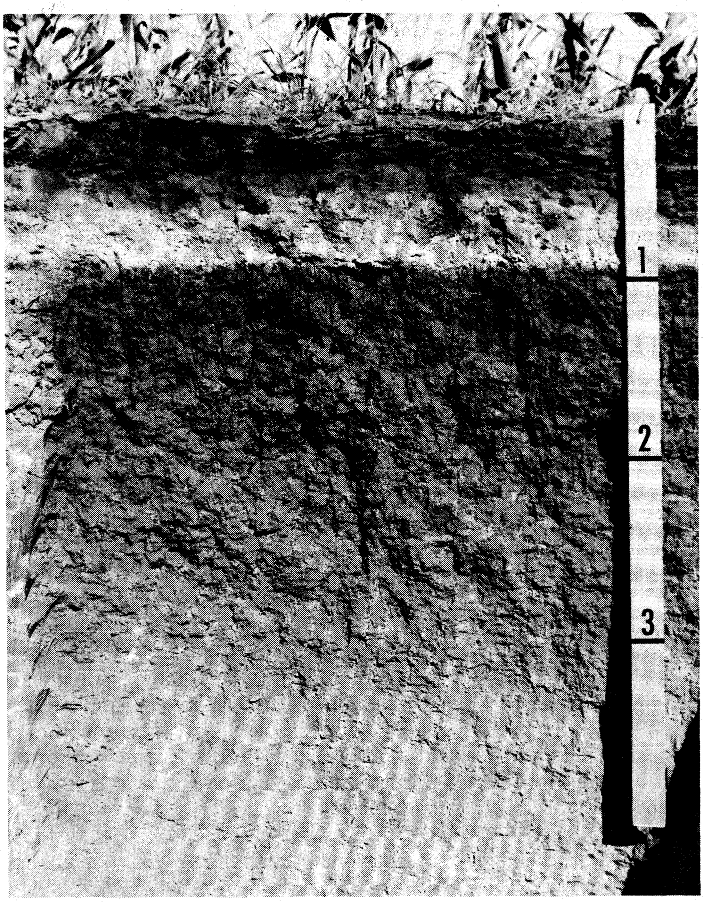
For more detailed discussion of the geologic processes involved in soil development ser GEOCHEMISTRY; GEOLOGY: *Physical Geology*; HYDROLOGY; SEDIMENTARY ROCKS. (J. E. GG.)

II. SOIL CLASSIFICATION

Although soil covers the land as an almost continuous blanket, it differs greatly in character and in useiulness to man from region to region, from farm to farm. and even within single fields. Soil scientists. engineers, geologists, farmers and others have named and classified difierent kinds of soil, each group according to its special knowledge and interest.

The early attempts to classify soil were based on its products rather than on its intrinsic properties, because men in ancient times were interested in the fruits of the soil, not in the soil itself. Even educated people of the 18th and 19th centuries associated the soil with the lowly position held by those who tilled it. and few found it worthy of study as a natural object. The infant study of geology was a reputable subject for scientists of those times, however, and European geologists were the first to make serious attempts to classify soil. To the geologists. however, the soil was merely a kind of disintegrated rock, and they classified it accordingly. This was the principal concept expressed in soil classification throughout most of Europe and the United States and Canada from about 1850 to 1920. Terms like granite soils, transported soils and residual soils came from classifications by geologists.

1. Development of Soil Science.—While soil classification was dominated by geologic concepts throughout most of Europe, a group of Russian scientists led by V. V. Dokuchaiev began to study the soil itself, not as decomposed rock but as a natural substance warranting special attention. They found that different kinds of soil had distinctive layers or horizons. and that the kind and arrangement of these horizons at a given place were determined by climate, vegetation, topography and age as well as geo-



BY COURTESY OF SOIL CONSERVATION SERVICE OF THE U.S. DEPARTMENT OF AGRICULTURE
FIG. 5—A VERTICAL SECTION THROUGH A CLAY-PAN SOIL SHOWING THE LAYERS DEVELOPED DURING SOIL FORMATION. (THE SCALE IS IN FEET)

logic material. Using this concept of dynamic soil formation, Dokuchaiev proposed the first classification of soil as an independent natural body in 1886.

The language barrier between Russia and the rest of the world prevented dissemination of the Russian concept of soil for many years. *The Great Soil Groups of the World and Their Development* (1908) by Konstantin Dimitrievich Glinka (*q.v.*) of the Leningrad Agricultural institute was translated into German in 1914 and, 13 years later, in 1927, into English. This work revolutionized soil classification throughout the world when it finally became known. Under its influence, European soil scientists emphasized concepts of soil development in their classification systems. The system of A. A. J. de Sigmond, published in 1933, was based largely on selected chemical properties acquired during soil formation. That of W. L. Kubiena, published in 1950 as *Diagnostics and Systematics of the Soils of Europe,* depended mainly on theories of the changes that occur in soils with time under different conditions. Most of those best known dealt with the major genetic kinds of soil of large areas and little with the details of soil properties important within farmers' fields.

In the United States, as in Europe, the concepts of geology dominated soil classification until the Russian work became known. From 1860 to 1900, E. W. Hilgard developed a concept of soil similar to that of Russian scientists and published an accurate picture of soil properties. correlated with types of vegetation, later to become major bases of soil classification. Few understood Hilgard's concepts, however, and much of his knowledge went unnoticed.

The first major lasting contribution to soil classification in the United States came through the establishment of the soil survey in 1899. This work involved making maps on which areas of the different kinds of soils of farmers' fields were shown for predicting crop adaptation, productivity and land values. Different kinds of soils, called soil series, were named after places where they were first found, such as Norfolk and Hagerstown. Each series was divided on the basis of texture into units called soil types, which became the basic units of soil classification for practical application to the problems of fields and farms. Thus while the genetic kinds of soil of extensive regions were being classified as great soil groups in Russia, in the United States the soils of small areas important to the individual farmer were being classified as soil types and series.

2. Systems of Classification. — After the German edition of Glinka's work was published in 1914, C. F. Marbut, chief of the division of soil survey of the United States, who translated the work into English. combined the Russian concept of great soil groups with the U.S. concept of soil types and series into a single system of classification useful for describing and naming soils of both extensive areas and individual fields. Marbut's system was presented to the First International Congress of Soil Science in 1927 and received world-wide recognition.

Knowledge about soils increased rapidly after 1930, and many schemes for classifying soils were proposed in different countries. In spite of modification of Marbut's system in 1938 and again in 1949, the soil survey staff of the United States department of agriculture under the leadership of C. E. Kellogg concluded that a completely new system was required to incorporate new knowledge and to eliminate the confusion of names and poorly defined classes that had developed. In 1952 the soil survey staff began the first of six trial systems, each of which was circulated among leading soil scientists throughout the world for trial under their conditions and was revised to accommodate their findings. Linguists developed a terminology based on Latin and Greek and translatable directly into related languages. The sixth revision was a system based on measurable soil properties rather than on theories of soil formation, although characteristics used to distinguish different kinds of soils reflected major concepts of soil development. Soil series of the United States were classified in the svstem. presented at the Sixth International Congress of Soil Science in 1960.

In addition to the taxonomic classification of soil, mapping units of soil surveys were grouped in many ways to show such interpretations as crop adaptation, single properties, productivity, erosion hazard and need for fertilizer or lime. The land capability system of the United States soil conservation service. designed as a guide for planning use and management of farmers' soils, was one of the best known of many such interpretive groupings. Comparable but less-known groupings were developed for such special purposes as irrigation, drainage and land appraisal.

The units of classification and mapping of detailed soil surveys have also been interpreted for engineering uses. In addition, engineers developed independent systems of classifying soil material according to texture and other properties important in engineering construction. Some confusion of names resulted because the engineering soil classifications deal mainly with soil as a material for construction, while those of soil scientists deal with it as a substance formed by natural processes.

For detailed information about criteria and systems of soil classification, see *Soil Science,* vol. 67, pp. 77–191 (1949) and U.S. Department of Agriculture, "Soil Survey Manual," *Handbook* No. 18 (1951).

(M. G. C.)

3. Soil Survey. — The purpose of a soil survey is to provide an inventory of the soil resources of a given area, usually a county or its equivalent. First, the soils of the area must be classified. This is done by making a field study of the properties of surface and subsoil layers at numerous locations. Typical soil samples are sent to the laboratory for physical and chemical examination. Next, a map is prepared on which is shown the locations of the different soil groups recognized in the soil classification. Finally, a written report to accompany the soil map is prepared, giving general information about the area, descriptions of the soils and suggestions concerning their use and management. Soil surveys are made by experienced soil scientists who are often assisted by one or more junior scientists. Since 1935, most soil maps have been made with the aid of aerial photographs.

In the United States, soil surveys were begun in 1899 by M. Whitney of the department of agriculture. Maps and reports are usually prepared in co-operation with the state agricultural experiment stations, although other agencies such as the department of interior and state department of agriculture sometimes sponsor soil surveys. In Canada the soil survey is associated with the Experimental Farms service and the universities.

Soil maps based on soil texture (sands, clays, loams. etc.) were included in the agricultural surveys of Great Britain in the early 19th century, and on the same basis the soils have been marked on the Drift maps of the geological survey. More accurate methods based on chemical and mechanical analysis were used in the surveys made in the 1890s and early 1900s by C. M. Luxmore and T. B. Wood, and also by A. D. Hall and E. J. Russell, who based their survey of southeast England (1911) on the geological origin of the soils. A more widely applicable basis is the mode of formation of the soil studied in the U.S.S.R., the pioneer being V. V. Dokuchaiev (1883). A soil map of Europe on this basis was published in 1937 on behalf of the International Society of Soil Science, the co-ordinator being H. Stremme of Danzig. In Great Britain the soil survey was established in 1939 under the direction of G. W. Robinson at Bangor, Carnarvonshire; in 1943 it was transferred to Rothamsted, Hertfordshire.

In Australia J. A. Prescott at the Waite institute made the first soil map in 1931; much detail has since been added. In Africa attention is concentrated on agriculturally important areas, and the intervening spaces are filled in by aerial, ecological and reconnaissance surveys. G. Milne made the first east African survey in 1936.

Much has been done in west Africa by British workers and by the French and Belgians in their territories.

See U.S. Department of Agriculture, "Soil Survey Manual," *Agricultural Handbook 18* (1951), "Soil," 1957 *Yearbook of Agriculture* (1957); G. R. Clarke, *The Study of the Soil in the Field* (1957).

(Er. W.; E. J. R.)

III. PHYSICAL NATURE AND PROPERTIES OF SOILS

The soil, in its relation to plants, provides a medium for root development and supplies nutrients for plant growth. To a considerable extent, the ability of soils to perform these functions is dependent upon their physical character and condition, which have much to do in determining moisture, air and temperature relationships. Hence, the physical make-up of soils. together with their resultant properties, exert a controlling influence on chemical reactions and biological processes.

1. Component Parts of Soils.—Soils are composed of solid, liquid and gaseous components. Materials in a solid state, soil minerals and organic matter, constitute the soil proper; the liquid and gaseous components, namely water and air, in the interstices between the solid materials, fluctuate continually, and frequently with conditions independent of the soil. The organic fraction varies widely, but seldom exceeds five per cent by weight. except in soils formed largely from plant remains. Organic soils, however, are of secondary importance to mineral soils.

The mineral constituents are extremely variable in size, shape and chemical composition. The size of particles is one of the most significant characteristics. Water absorption. air movement, rate of solution and ease of tillage are but a few of the numerous things affected by particle size. By mechanical analysis, which separates the particles into size groups known as separates, a quantitative statement of soil texture, illustrated in Table I, can be obtained. Results of a mechanical analysis do not include either organic matter or particles larger than two millimetres.

Each separate is characterized by definite physical properties, due chiefly to the size of the particles composing it. As the particles become smaller, their total surface area, hence their effectiveness in transmitting properties to soils, increases greatly. Particles less than 0.001 mm. in size, especially those making up the colloidal or gluelike portion of the clay, possess active internal as well as external surface, and therefore are much more reactive than the other clay and larger particles. Because of their cohesive nature, clay colloids play an important role in the arrangement of particles.

Table I.—Quantitative Statement of Texture by Mechanical Analysis

Name of separate	Diameter limits (mm.)	Amount present (per cent)
Very coarse sand	2.0 –1.0	2.3
Coarse sand	1.0 –0.5	6.7
Medium sand	0.5 –0.25	8.2
Fine sand	0.25–0.10	9.4
Very fine sand	0.10–0.05	12.5
Silt	0.05–0.002	44.8
Clay	Below 0.002	16.1

Every soil is a mixture of separates, hence the physical properties exhibited are determined by the proportions of separates present. A group of soils having the same range in particle size and physical properties based on texture constitute a soil class. Soils in which the properties of no one separate predominate belong in one class. This class, known as loam, contains more than 35% total silt and clay with less than 50% and 27% of silt and clay, respectively; the permissible amount of sand would be too low to exert a dominant influence on the physical properties exhibited. When the silt content exceeds 50% in a mixture with less than 27% of clay, the properties of silt predominate and the soil is classed as a silt loam. The transition from loam to silt loam, or between other soil classes, is not abrupt but gradual. Variation in properties of soils within a class is indicated by descriptive terms as light, friable and sandy; or heavy, plastic and clayey.

For practical purposes, soils of the common classes can be grouped as follows: coarse textured soils, the sands and sandy loams; medium textured, the loams and silt loams; fine textured, the clay loams and clays.

Even though mineral particles are the very foundation of soils, they always contain some organic matter; its accumulation is an integral part of soil development. Humus, the partially decayed organic matter accumulated in soils. is a dark-coloured, structureless material highly colloidal in nature. Unlike colloidal clay, the organic or humus colloids are not very cohesive and plastic; in general they tend to make sandy soils more cohesive and clayey soils less plastic. The efficacy of organic matter in changing soil properties depends on the amount present and the textural make-up of the soil. Thus, in determining soil class, it is necessary to take cognizance of the influence of organic matter in modifying physical properties associated with the mineral particles.

2. Structure and Its Practical Significance.—Structure deals with the arrangement of soil particles which occur as individuals, as groups or aggregates or as a mixture of the two. In coarse-textured soils, the particles exist and function largely as independent units, but in fine-textured soils different-sized particles are bound together with colloidal materials. The aggregate produced may be either a dense, continuous mass, exemplified by a clod, or an open. porous cluster typified by a granule. With greater pore space and effective surface, the granule represents the more desirable structure. These aggregates also vary in size, shape and stability. A composite of the single grain and aggregate structures occurs in medium-textured soils. These are neither too open and friable, nor too compact and plastic; their physical condition is generally favourable for plant growth and easily maintained.

Structural differences result from variations in the kind and amount of colloidal material present. In the absence of soil colloids, the single-grain arrangements predominate, while aggregate formations are never well developed. These colloidal materials, including various clay minerals, oxides and hydrates of iron and aluminum, together with soil humus, are the products of different chemical and biological processes involved in soil development. Factors and conditions influencing soil development naturally would affect not only the formation of colloids, but also their distribution and behaviour in soils. As a result, marked differences in the natural structure of soils have been developed. Structural differences of virgin soils, also of the undisturbed substrata in cultivated soils. are of great value in any scientific study and classification of soils; too, they are of practical significance because of their relation to drainage, aeration, root development, moisture retention and soil erosion.

When farmed, many soils soon lose much of their original aggregate structure. This change occurs primarily in the surface layer due to more rapid organic matter depletion, together with excessive and often improper handling. But, unlike texture, structure can be and frequently is changed; in fact, the main purpose of most tillage operations is to improve structure. Any control over many of the properties of a soil is possible only if its physical condition can be modified.

3. Porosity and the Weight of Soils.—Porosity means total pore space, the soil volume not occupied with solid materials, varying from 35% to 50% in dry soils. As texture becomes finer, the size of individual pore spaces decreases but total pore space increases. Any change in structure, or organic matter, also affects the size of pores and porosity. Both are reduced by compaction, often desirable in sandy soils. Porosity is increased in fine-textured soils by proper tillage and organic matter because of their influence in developing a granular structure in silty and clayey soils.

When compared on an equal volume basis, mineral soils when dry weigh more than water; organic soils, however, weigh less. The numerical ratio between the weights of equal volumes of dry soil and water represents the volume weight, or bulk density, of the soil. This fluctuates chiefly with differences in porosity, but is influenced also by the specific gravity, or particle density, of the various constituents in different soils.

Specific gravity is also a comparison of the weights of equal volumes of dry soil and water, but differs from volume weight since the equal water volume is determined by displacement and represents soil volume without pore space. Specific gravity is practically a constant for most mineral soils, with values of 2.65 to 2.70. Dark-coloured soils often are lighter due to more organic matter; organic soils have specific gravity values from 1.5 to 2.0, varying with their mineral content. In comparison with volume weight, specific gravity of soils is relatively less important. Volume weight usually ranges from 1.0 to 1.5 for fine-textured soils, and from 1.2 to 1.7 for coarse-textured soils. Changes in physical condition of the surface layer of soils under cultivation cause wide variation in volume weight. In all soils it naturally tends to increase with the deeper layers, especially the subsoil.

When the volume weight is known, the weight of dry soil per cubic foot, or per acre foot, or of any fractional part, can be computed readily. The average weight of dry soil per acre $6\frac{1}{2}$ or 7 in. deep, often called the "plowed section," is commonly given as 2,000,000 lb. Sandy soils are somewhat heavier, while organic soils weigh only about 1,000,000 lb. per acre 7 in. deep. These weight figures, either the averages or those computed directly from the volume weight, are useful in calculating the amount of soil water, the supply of organic matter or the quantities of plant-food elements present.

4. Soil Moisture and Its Relation to Plants. — Soil moisture, as here discussed, is exclusive of the water in chemical combinations occurring in certain soil minerals and organic compounds. The relative position of moisture with reference to the soil particles means that it is attracted unequally by the particles and acted upon by different forces. In consequence, soil moisture shows marked differences in its movement and availability to plants.

When air dry, a soil usually contains only hygroscopic moisture; that is, moisture which adheres to soil surfaces in very thin films, moves by diffusion and is unavailable to plants. Colloidal materials are chiefly responsible for hygroscopic capacity. Hence, it is never great in sandy soils, which are usually deficient in organic matter and have a low clay content.

Moisture, in excess of hygroscopic capacity, is retained in soil against gravity through the combined forces of adhesion. cohesion and surface tension. This moisture represents the capillary form. It exists as films around and wedges between particles; moves as a film due to surface tension; and is available to plants. The innermost portion of capillary moisture. however, is held so tenaciously as to preclude true film movement, or its use by plants. Thus the soil contains both hygroscopic and inner capillary moisture when permanent wilting of plants growing on that soil occurs.

Gravitational water, known also as free, excess or surplus water, is extremely variable: but is, in general, regarded as the difference between precipitation and a soil's capacity to absorb and hold water. Its presence in soils. contingent upon adequate drainage and a water supply in excess of capillary capacity, causes a deficiency of soil air and free oxygen, resulting in conditions which are inimical for seed germination, root development and other desirable soil processes. Ordinarily, gravitational water is more important as a reservoir to replenish useful capillary moisture than as a direct source of water to plants.

The ability of soils to hold capillary water is determined by their porosity and adsorptive power. As the particles become smaller, or the organic content higher, or the structure more granular, the capillary capacity increases due chiefly to the influence of clay or humus colloids. and/or more effective surface exposed. The moisture content of soils, at any particular time, represents the balance between additions and removals of water. Natural precipitation. the main source of soil water, is supplemented in certain areas by irrigation, and at times by water brought up from deeper soil layers by capillarity; however, this process is generally too slow to be of real significance in supplying the water needs of plants. Removals of water from soils result through evaporation at or near the soil surface, transpiration from plant surfaces, percolation downward due to influence of gravity and surface runoff. Loss by runoff decreases the potential supply of soil water.

Since water is often the chief limiting factor, even in humid regions, for crop production, every effort should be made' to increase and conserve the supply of available soil water. Cultural and tillage practices that increase water absorption reduce surface runoff; moreover: these same tillage practices control weeds, thus eliminating useless transpiration. Evaporation losses may be reduced through the use of windbreaks and mulches which may consist of either a protective cover of straw, paper or boards, or a layer of dry soil. The soil mulch, however, is effective in saving water only when the water table is within capillary reach of the surface; but under this condition, drainage to remove the excess water usually is more urgent than mulching 'to conserve water.

Of the soil water absorbed by plant roots, only a small fraction is retained by the plant; an enormous quantity is removed from it by transpiration. This varies widely with different plants and climatic conditions, and is controlled indirectly by securing efficient use of the water transpired. Control on many soils, therefore, may mean the use of fertilizers to meet some nutrient deficiency, or it may mean other practices such as drainage, liming or proper tillage to improve productivity. Thus the transpiration per unit of dry matter produced is decreased. (See also IRRIGATION.)

5. Soil Air and the Need for Aeration. — The pores in soils are occupied by air or water or both, the proportion of air to water decreasing rapidly as the particles become smaller. Differences in texture, structure and organic matter affecting porosity of soils also influence their capacity to hold water. Any increase in soil water decreases the amount of soil air. Thus, in poorly drained soils, and to a lesser extent in fine-textured soils having a compact rather than a loose condition, a deficiency of air exists.

Soil air, like the atmospheric air, consists of a mixture of gases, but it contains considerably more carbon dioxide and slightly less oxygen than does atmospheric air. With the gradual, but continual, depletion of oxygen and accumulation of carbon dioxide due to chemical and biological activities in soils, the need for soil ventilation becomes more urgent.

Aeration, the process by which stagnant soil air is replaced with fresh air, occurs naturally as a result of changes in temperature, variations in barometric pressure, movement of soil water or other processes. In practice, however, one of the chief controls over aeration is exerted by regulating soil-moisture conditions, particularly through drainage. Tillage may be used either to lessen or promote aeration since sandy soils, usually too well aerated, need to be compacted, whereas clayey soils, frequently too compact and often crusted over, should be stirred to facilitate aeration.

6. Soil Temperature: Its Importance and Control. — Seed germination, plant growth, and, in fact, all soil reactions proceed through a wide range in temperature but each has an optimum range where it is carried on most efficiently. Successful crop production is no less dependent upon proper soil temperature than upon suitable atmospheric temperatures.

Direct solar radiation is the chief source of heat to soils. Differences in texture, structure and organic matter that determine the moisture capacity of soils influence their ability to absorb and transmit heat. Dry soils, due to air in pores, have higher resistance to heat transfer than moist soils. Water is a better heat conductor than air, hence as soil air is replaced by water as the contact between particles, conductivity is increased; additional water. however, would retard the rate.

Heat generally moves from the surface downward as atmospheric temperature increases and from lower soil layers upward as it decreases. Changes in soil temperature lag considerably behind and are much less variable than those for atmospheric temperatures. Daily fluctuations in soil temperature are much greater in summer than in winter.

Differences in temperature of soils for the same degree of latitude are caused by variations in colour. moisture content, vegetative cover and direction of exposure. The relation of colour to heat absorption is well known; but darker colours in soils are due chiefly to organic matter, which increases the amount of soil water. Only when the surface becomes dry, would the dark-coloured soil likely be warmer than the light-coloured soil.

Dry soil has a low specific heat, only one-fifth that of water. The greater amount of heat needed to raise the temperature of water causes soil temperature to decrease as soil water increases. Thus. wet soils are cold and slow to warm up in the spring.

A bare, uncropped soil heats more rapidly, attaining a higher temperature in summer than a similar soil protected by vegetation. The vegetation acts as an insulator, reducing both absorption of heat and loss through radiation. When protected by vegetation, leaves or snow, heat is retained better and the soil remains warmer during the winter. In the northern hemisphere soils with southern exposure. receiving more heat per unit area, have higher temperatures than those with northern exposure, provided other conditions are similar.

Control of soil temperature is a matter of soil-moisture control. Excess water must be removed. if possible, by drainage. This will reduce evaporation, thereby conserving heat, and lower specific heat thus decreasing the amount of heat necessary to raise the soil temperature.

7. Soil **Colour** and Its Significance. — Colour provides information as to the conditions of and forces active in soil development, and represents an invaluable aid in soil classification. Since different colours are indicative of variations in conditions which influence productivity. colour is used as an important indicator of the agricultural value of soils. This use, however, necessitates that colour throughout the entire vertical section of soil be observed and interpreted in terms of soil properties affecting crop production.

Soil colours are of three main sources: decomposed organic matter. certain iron compounds and other soil minerals such as quartz, kaolin and mica. Soils low in organic matter with iron absent or unoxidized are coloured by soil minerais. Their colours are often dulled or concealed by organic matter or iron compounds, or both. Much of the humus. the most stable portion of the soil organic matter, is a dark-brown or black'residue coating the mineral soil particles. Under conditions of poor drainage and limited aeration, the reduced forms of iron together with anaerobic decay of organic matter favour the development of gray and drab coloration in soils.

Without good drainage and aeration, the iron could not be oxidized, nor the hydrated iron oxides produced to give the red and yellow colours. Red- and yellow-coloured soils are invariably low in organic matter; but when these colours, due mainly to hematite and limonite, are mixed with black from humus various shades of brown result.

With few exceptions. soil colour involves mixtures and is concerned with tints and shades rather than pure colours, so that ordinary colour charts are of little or no value in determining colour in soils. For this purpose standard soil colour charts, specifically made to include the colour range encountered in soils, are generally used.

8. Soil Tilth and Tillage. — The physical condition of the soil when considered in its relation to plant growth is known as tilth; its development must necessarily consider the requirements of the crop to be grown. Soil tilth, therefore, is more inclusive than structure, although the arrangement of the individual or aggregate structure particles is the fundamental basis of tilth in soils. While the textural make-up of soils cannot be changed practically, it is feasible to modify, through tillage practices, the structural condition of the surface layer.

Tillage, including any operation that stirs, inverts, fines, aggregates or firms the soil, is used not only to prepare a satisfactory seedbed but also to maintain optimum growth conditions throughout the season. While plowing is generally regarded as the basic tillage practice, many soils, especially those of coarse and medium texture, often can be prepared adequately by use of a disk harrow. Frequently much of the desirable aggregate structure in the finer-textured soils is destroyed by plowing too much, or when too wet. It is imperative to avoid all tillage practices on heavy, plastic soils when wet; otherwise the soil runs together and upon drying is in a cloddy condition, which may persist for several seasons. Volume changes which accompany moisture variations due to alternate wetting and drying break down the clods and tend to encourage the formation of granules; this effect is usually more pronounced in the presence of organic matter since it counterbalances the deleterious effect of an excessive amount of clay colloids on structure. The general lack of colloidal materials in coarse-textured soils prevents puddling, or even desirable aggregation, hence the possibilities of structural modifications are limited.

Cultivation, the intertillage given a crop, is used primarily to destroy weeds. This practice also modifies structure of the soil to the depth cultivated, thus affecting aeration, water absorption and evaporation. Conservation of moisture due to the formation of a mulch is of secondary importance to that due to the control of weeds. Furthermore, when cropped, the top portion of the surface soil is more valuable as a feeding zone for plant roots than as a soil mulch.

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IV. CHEMICAL PROPERTIES OF SOILS

The upper portion of the earth's solid crust, to a depth of a few miles. was estimated by F. W. Clarke to consist, to the extent of about 98 3%. of eight chemical elements. They are, in order of decreasing abundance, oxygen. silicon, aluminum, iron, calcium, magnesium, potassium and sodium. The first four comprising, respectively, 47%, 27%, 8% and 5% of the earth's crust are acidic or weakly basic in character. The last four, totaling 11.3%, are strong bases. The do-odd other elements are contained in the remaining 1.7% (see also GEOCHEMISTRY: Abundance and ***Origin*** of *Elements*).

These elements do not occur free, for the most part, but to some extent as simple compounds, such as oxides and carbonates, and to a much greater extent as complex alumino-silicates and ferro- (iron) silicates of the four strong bases mentioned. These silicates, which compose the bulk of the rocks of the earth's surface, occur in a great number of variations as to colour, crystalline form and chemical composition.

In the weathering of rocks containing these primary or unaltered silicates, hydrolysis plays a dominant role. In hydrolysis, or decomposition by union with water, the strong bases mentioned above are split off as soluble compounds, such as hydroxides, carbonates and bicarbonates. These, in a humid climate. are carried downward and out of the soil by percolating water, unless stopped by other chemical reactions which change them to less soluble forms. The insoluble residue from this weathering of the primary silicates is modified into secondary silicates of aluminum and iron which contain lesser amounts or in some cases none of the strongly basic elements, calcium, magnesium, potassium and sodium. These secondary silicates are the clay minerals of soils, the principal component of the clay portion.

In addition to the silicate clay minerals, there occur in the clay size-range simpler compounds, the hydrated oxides of silicon, aluminum and iron, which have split off from the primary minerals in the course of weathering. Along with these changes, organic matter accumulates from partial decomposition of plant and animal materials, so that the chemical components of the soil may be grouped in a general way into organic substances and inorganic or mineral substances.

In the following discussion, the chemical characteristics of the surface soils of the humid and semihumid temperate regions will be considered. These are the regions which contain most of the earth's cropped land and which support most of the world's human population. **A** brief discussion will then follow, indicating variations in surface soil character in some other climatic regions.

1. Mineral Constituents. — The mineral constituents of soils may be grouped on a basis of size of particles. Sand and coarser particles, together with the coarser part of the next finer grade, silt. are essentially primary minerals. The silt size is between 2 and 50 microns (μ) in diameter. (A micron is $\frac{1}{1,000}$ mm. or $\frac{}{,00}$ in.) Primary minerals are defined as those which have undergone no appreciable weathering change. In soils, they include the complex silicates previously described, and simple compounds, chiefly oxides, of which the most abundant is quartz or silicon dioxide, SiO_2. Calcium carbonate and dolomite, which occur mainly as limestones, are frequently present.

The primary minerals generally amount to 70% or more of the soil mass. Most of them are resistant to weathering, undergoing profound chemical change only through geologic periods of time, and consequently may be considered as contributing little to the dynamics of soil chemistry.

2. Secondary or Clay Minerals — Below the silt size-range is the clay fraction, ranging in size from two microns down. In 1937 in the Gnited States the division point between silt and clay was changed from five microns to two, partly in order to conform with European practice and also because the latter point more nearly separates colloidal material from that which does not possess colloidal properties.

The clay portion for the most part is composed of the complex aluminum and iron silicates derived from the weathering of primary silicate minerals. They are known as clay minerals or secondary minerals. These minerals, particularly below the one-micron size-range, exhibit colloidal properties to a high degree. That is, their internal surface or sum of the surfaces of the individual particles is very great, commonly amounting to several acres in a single cubic foot of soil. Soluble, chemically active substances accumulate at the surfaces of these particles from the surrounding moisture, and the result is a great intensification of chemical processes because of the large internal surface. This is one important chemical property of soils.

Exhaustive research on the colloidal clay minerals, most of it done since 1920, revealed much about their chemical and physical nature. Chemical investigations, X-ray studies and determination of the optical properties, when applied to the clay minerals, especially after separation into different size groups, as 1 to $\frac{1}{10}$ μ, $\frac{1}{10}$ to $\frac{1}{20}$ μ and so on, have shown that they possess several properties in common. Research by W. P. Kelley. S. B. Hendricks, C. D. Marshall, R. H. Bray and R. E. Grim in the United States and by workers in other countries showed that they are definitely crystalline, the crystals being platelike or broad and thin in form. This form is a result of their laminated structure, consisting of a series of atom layers each with a characteristic pattern and repeated in a definite order. There are many species of clay minerals. They may be grouped, however, into three main families: each of which is characteristic of the climatic region in which it was developed.

3. Base or Cation Exchange. — Residing chiefly in the clay minerals is the soil property known as ion exchange. Ions are atoms or atom clusters which bear an electric charge. Those with a positive charge are cations, and the negatively charged ones are anions. Those with opposite charges tend to unite with each other, forming chemical compounds known as salts. When a salt dissolves in water a portion separates into the constituent ions. The sum of the positive ion charges always equals the sum of the negative charges. Positive hydrogen (H) ions will unite with negative hydroxyl (OH) ions to form water, which is neutral. The acidic property of solutions is due to hydrogen ions and the alkaline property is caused by hydroxyl ions. Cation exchange. or base exchange, has been known since the work of Thomas Way in England about 1850, but the mechanism of the reaction and its importance in soil fertility were recognized much later. Colloidal clay particles are negatively charged. Their negative charges probably result from the weathering loss of bases. As a result they attract and hold cations, either metallic ones such as calcium. or, in their deficiency, hydrogen. The presence of hydrogen ions is the cause of acidity. The adsorbed ions are not removed by water and are, as a consequence, protected in the soil against excessive loss in drainage waters through leaching. This fact is of great importance in the practical maintenance of soil fertility because large quantities of basic plant nutrient ions are thus preserved in the soil against loss in drainage water. The bases, however, are easily and instantaneously replaced from the clay by other basic ions, so that one can saturate a soil with a given base, like calcium, by leaching it with a soluble, neutral calcium salt solution, which of course contains calcium cations. The bases are not held with equal tenacity. The retention by the clay minerals of those commonly found in soils decreases in the following order: calcium > magnesium > potassium > sodium. Their relative abundance in the soil in the exchangeable form is usually in the same order.

The capacity of different clay colloids and of the soil itself to adsorb and hold cations is a definite quantitative value, usually expressed as milligram equivalents (m.e.) per 100 grams of sample. The base-exchange capacity of clay colloids ranges from about 20 m.e. to more than 200 m.e., and in soils the range is usually between 2 or 3 and 40 m.e.

4. Soil Reaction and Acidity. — Inasmuch as acid hydrogen cations, as well as metallic or basic cations, can be adsorbed by the clay minerals, it follows that a hydrogen-saturated soil is acid. Its degree of acidity depends mainly on the ratio of exchangeable hydrogen ions to basic ions held on the clay surfaces. Soils in humid regions gradually become more acid whether under native or cultivated conditions because calcium and other cations are gradually replaced from the colloids and removed from the soil by leaching. The replacing ion is chiefly hydrogen of carbonic acid and other acids from decomposing soil organic matter. The application of limestone or of slaked lime to acid soils reverses the process just described by replacement of exchangeable hydrogen from the clay by calcium.

The intensity of soil acidity is expressed by the term pH followed by a numeral. The pH value is the negative logarithm of the hydrogen-ion concentration in gram atoms per litre. Thus in a solution of pH 5 the H-ion concentration is 10^{-5} normal; *i.e.,* the solution contains .00001 gram ion of active hydrogen per 1,000 g. of water. Neutrality is pH 7, since at neutrality both the $(OH-)$ and the (H^+) ion concentrations are 10^{-7} normal. The pH value of soils varies with the degree of saturation of the exchange capacity with bases, in contradistinction to hydrogen. Thus the base saturation of neutral soils (pH 7) varies around 75%, the remaining 25% being hydrogen. Virgin soils, *i.e.,* those that have never been cultivated, in humid temperate regions range from about pH 4.8 (strongly acid) to slightly alkaline, approximately 8.3, the latter value representing equilibrium with solid calcium carbonate. In some arid soils higher pH values are encountered, the high alkalinity being due to soluble carbonates of the alkali metals, sodium and potassium.

Soil reaction is important agriculturally because crop plants, as well as others, vary widely in their requirements and tolerances in this respect. Alfalfa and many clovers require essentially neutral soils, having a minimum pH of 6.2 to 6.5. Cranberries, at the other extreme, require very high acidities, represented by pH values around 4.

5. Anion Exchange. — This property of soil colloids is not as well understood as cation exchange. In the latter case the adsorbed cations are not a part of the essential structure of the clay mineral crystal, but are attached at the surfaces. Consequently base exchange does not alter the colloid crystal itself. As a result of investigation by S. R. Dickman and R. H. Bray, J. S. Burd and H. F. Murphy and others, it was postulated that anions are adsorbed by displacing hydroxyl (OH–) ions from the crystal lattice, thus altering the latter. In the soil colloids characteristic of the temperate humid regions, OH– ions are distributed somewhat sparsely in the 'deeper positions in the crystals. They are thus exposed only at the broken edges of the platelike particles, at which points anion exchange may occur. Investigations by Bray indicated that phosphate anions so adsorbed are readily taken up by plant roots that make contact with them. A chemical soil test for phosphate availability, by Bray, depends on the replacement of phosphate by fluoride ions.

Anion-exchange capacity of soils and clays is not as quantitatively definite a value as is the base-exchange capacity. On the other hand, the quantity of anion adsorbed is a function of the concentration of the ion in solution in contact with the clay. The equilibrium between adsorbed ion and that in solution at different concentrations follows definite trends, which in most cases can be fitted to H. Freundlich's adsorption equations (see ADSORPTION). In another respect anion and cation exchange differ sharply. The range in tenacity with which the various cations are retained on the clay particles is fairly narrow, while the range among the common anions is extremely wide. Some, in fact, are not adsorbed at all, while others, notably fluoride and phosphate, form relatively stable combinations with the colloid particle.

Clay minerals or colloids of the kaolinite type, found in humid tropical regions of intense weathering, possess an entire surface lattice layer of OH groups. These clays adsorb large quantities of phosphate ions, which displace the entire OH layer. Burd and Murphy found a low degree of plant availability for such phosphate. (See also CLAY AND CLAY MINERALS.) (E. E. DeT.)

6. Alkali **and** Saline Soils.—The term alkali has been rather loosely applied to all soils containing sufficient amounts of soluble salts to cause injury to plant life. When correctly used, the term alkali soils refers only to those soils that have a high pH value (high alkalinity) caused by sodium ions absorbed by the clay particles and to those that sometimes have considerable amounts of the alkaline salt. sodium carbonate. Reaction between water and the sodium-saturated clay liberates sodium and hydroxyl ions into the solution, making it alkaline. These soils were formerly called black alkali in the U.S.

Saline soils are those that contain less absorbed or exchangeable sodium and that are high in nonalkaline salts such as sodium chloride and sodium sulfate, or those that contain enough salts such as sodium chloride t~ maintain flocculation and repress hydrolysis of the clay portion of the soil which is itself the insoluble salt of a strong base and a weak acid. The term white alkali frequently has been used for these soils. Alkali and saline soils are widely distributed in the drier areas of the world. On soils where salts may be a problem a great deal of foodstuff is produced. In regions of low rainfall, salts accumulate where drainage is poor, their origin being caused by insufficiency of percolating moisture to wash out and carry away in the drainage the soluble salts present in the parent soil material or those that are formed by its weathering. They are frequently formed in localized areas by seepage water from higher elevations. Soil-forming materials reclaimed from the sea, as on the coast of the Netherlands, are also saline. The salts that most frequently predominate are the carbonates, chlorides and sulfates of sodium, magnesium and calcium, or mixtures of two or more of these salts.

The tolerance of the various species and varieties of plants to soluble salts in soils is very different. Among the more tolerant agricultural plants are sugar beets, garden beets, milo, Bermuda grass, Rhodes grass, alfalfa, cotton, tomatoes and barley. The less tolerant ones include beans, field peas, red clover, vetch, oats and peaches. It has been found that the presence of high concentrations of salts in the soil solution (the liquid portion of the soil in which the plant roots obtain nutrients) limits the intake of aater by plant roots. Yields are reduced approximately in proportion to the osmotic pressure of the nutrient solution. Although definite limits cannot be set for the amount of soluble salts required to reduce the yield of plants, less than 0.2% of salts in a soil is usually not harmful to salt-tolerant crops; in an alkali soil, lower percentages are harmful because of more toxic effects of the ions present. Relatively large amounts of salts may be added to the soil in irrigation water. In order to maintain the "salt balance" as much salt must be removed in drainage water from the soil as is introduced in the irrigation water. Many irrigation projects have failed because of salinization caused by lack of proper drainage facilities or failure to use enough water to move excess salts down and out of the soil profile. Others have failed because of the high percentage of sodium in the irrigation water.

The chemical reactions by which a normal soil, the exchange complex of which (essentially the fine or clay fraction) is saturated with calcium and magnesium ions, is converted to an alkaline soil are as follows: Ca-saturated soil + $2NaCl \rightarrow$ Na-saturated soil + $CaCl_2$. When the sodium-saturated soil is leached by water, little happens to it until the excess of soluble salts is removed. Further leaching brings about the reaction that is involved in the formation of the alkali soils of columnar structure called solonetz (see also RUSSIA: Soils and Their Influence: Chestnut and Brown Soils). This reaction is Na-saturated soil + H_2O — H soil + $NaOH$. Then, in the presence of carbon dioxide of the soil air, the salt sodium carbonate is formed—$2NaOH + CO_2 + H_2O = Na_2CO_3 + 2H_2O$. Alkali soils are sticky, impervious to water and unfavourable for agriculture. At the high pH values of alkali soils, dissolved organic matter coats the soil grains and gives a black colour. The reclamation of alkali soils is the reverse of the above processes. A soluble calcium salt such as gypsum is applied to the soil — 2Na-saturated soil + $CaSO_4$ = Ca-saturated soil + Na_2SO_4. The sodium salt is then removed in the drainage aater. Sulfur may be used in place of gypsum if the soil contains calcium carbonate. By biological action sulfur is converted to sulfuric acid, which reacts with the calcium carbonate to give gypsum. Good drainage is necessary to remove end products so that the reactions can proceed. Sodium-saturated colloids, in the absence of flocculating salts, "run together" or "freeze up." Sodium-saturated colloids in the presence of excess sodium salts may not be high in pH and are flocculated. (See also DRAINAGE OF LAND; IRRIGATION; LAND RECLAMATION.) (L. T. X.)

7. Organic **Matter.**—Soil organic matter has been the subject of a great deal of chemical research, but in spite of these efforts comparatively little is known about its chemical nature. Fresh plant material decomposes very rapidly under favourable soil conditions, but as the process continues it is increasingly retarded until a residue which is resistant to decomposition gradually accumulates, forming the fairly permanent stock of soil organic matter. Few of the chemical compounds in soil organic matter are known, although much research has been done. Oswald Schreiner identified 30-odd compounds from a very small portion of the total organic matter. Attacks begun by A. G. Norman and others, using various solvents, yielded increasingly encouraging results in the classification of chemically related groups of soil organic compounds,

Plants. in their growth, incorporate nitrogen. phosphorus, sulfur and other essential elements into their organic tissue, and these elements become a part of the soil organic matter if the plant residues return to the soil. As a result, from 30% to 60% of the total phosphorus of the surface soil, all of it originally inorganic in the parent material, is now found to occur in organic forms. Most of the sulfur and almost all of the nitrogen in soils are also contained in the organic matter. Potassium, on the other hand, remains soluble until adsorbed by the clay colloids, and its percentage in the organic portion is low. These accumulations of organic forms are an important factor in the nutrition of growing plants. Most of the changes which occur in soil organic matter are biochemical in nature and are discussed under *Soil Microbiology*,

8. Plant Nutrient Supplying **Ability.**—Plants require for growth and reproduction the elements carbon, oxygen, hydrogen, nitrogen, phosphorus, potassium. calcium and magnesium in variable but fairly large amounts. In addition, iron, manganese, boron, zinc and copper are required in very small amounts and are, therefore, designated as trace, or minor, elements.

With the exception of carbon, hydrogen, oxygen and part of the nitrogen, the plant-nutrient materials are absorbed through the root system in the form of simple ions. This does not mean that adequate amounts of these ions are normally present in the free soil solution. The exchangeable form of the basic elements is the principal immediate source from which the nutrients in the soil solution are renewed as they are taken up by plants. The exchangeable form also supplies plants directly by attachment of root hair to colloid particles, forming an interface at which exchange can occur. An analogous situation can be conceived as a possibility in uptake of adsorbed anions by plants. This conception of nutrient absorption by plants should be considered as fairly well-supported hypothesis rather than as established fact. It places the soil solution in a position of less importance in soils from a plant-nutrition point of view than formerly.

The clay minerals contain basic elements, *i.e.*, potassium and magnesium, in their internal structure, in addition to those in the exchange form. Illite is such a clay mineral rich in potassium. These forms are the reserve from which the more available exchange forms are renewed in the soil, and their abundance is a measure of the durability of chemical fertility. An analogous situation may exist with regard to phosphates.

The organic matter is an important source for plants of the nonmetallic nutrient elements. nitrogen. phosphorus and sulfur. They are released to plant-available forms accompanying organic matter decomposition. Chemical soil tests for the plant-available forms extract and measure the adsorbed (exchangeable) bases and anions as well as the water-soluble nutrients, and they also dissolve the less soluble forms which contribute significantly, though to a less degree, to plant growth. Specifically the objective of soil testing is the measure of the amounts of exchangeable potassium, calcium and magnesium, the amounts of adsorbed and also easily acid-soluble phosphates and the amounts of the ammonia and nitrate forms of nitrogen. Close correlations between these forms and plant response to added nutrients have been established by chemical soil tests and fertilizer experiments.

The trace elements previously listed received increasing attention after the early 1930s because of wider recognition of their effects on crop growth. Failure of earlier recognition may be due in part to failure to notice plant symptoms of trace-element deficiency or to diagnose them accurately. It may also be true that soils are only beginning to fail in supplying the small quantities needed by crops. Of the five elements listed, boron is the most generally deficient in the United States. (See also FERTILIZERS AND MANURES.)

9. Soil Variations With Climatic Environment.— Very young soils reflect the character of the parent material, but as weathering and its effects proceed soils tend increasingly to show the effects of the climatic environment while the resemblance to the parent material grows gradually weaker or disappears.

With decreasing rainfall outside the humid temperate areas of the earth, chemical weathering becomes less intense and the colloidal clay tends to be coarse. retaining more of its basic ions, including magnesium and potassium, at the expense of the base-exchange capacity, which is low. The soluble bases released by weathering are not leached from the soil and the soil reaction consequently becomes more and more alkaline. Chemical fertility is high but lack of moisture may limit crop yields (see also Alkali and Saline Soils above).

As one passes to subtropical and tropical regions of high temperature and high rainfall with intensified weathering and leaching, the silicate minerals are more completely decomposed, bases and silica are leached away and the resulting soils, known as laterite (*q.v.*), contain high concentrations of iron and aluminum. They are low in exchange capacity, low in present and potential fertility and, since bacterial activity is high throughout the year, organic matter is so rapidly destroyed that its content is low in spite of its rapid production by vigorous growth of vegetation.

In the cool to cold humid zones, forest vegetation, mainly coniferous, combines with the climatic conditions to produce the typical podsol soil group. From the chemical point of view it is found that the decaying needles of the forest floor produce a highly acid leaching solution which not only removes the basic ions excessively, but also dissolves iron and leaches it downward. where, with some of the aluminum and dissolved organic matter, it is redeposited in a tight layer some two to three feet below the surface. The soil layer immediately above this deposition is bleached white and ashy. The surface strata are high in silica content in contrast to the high iron and aluminum in the laterites. Like the latter, however, they are leached of their plant nutrients, are low in initial productivity and capable of being brought only to medium productivity by good management. See also EUROPE: *The* Study of Soils; TROPICAL AGRICULTURE.

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V. SOIL MICROBIOLOGY

Contrary to the opinion of many persons. the soil is not a dead, inert material. Actually. it is full of life, for a thimbleful of soil contains billions of living microorganisms. The organic matter already present in the soil, as well as that constantly being added by higher plants, animals and microorganisms serves as a direct source of carbon and energy for the heterotrophic soil organisms; that is, microorganisms that derive their carbon and energy from organic materials. Indirectly, organic matter serves as food material for autotrophic bacteria — organisms that obtain their carbon supply from the carbon dioxide in the soil air and their energy from the oxidation of simple chemical substances.

Bacteria. fungi, actinomycetes (a filamentous form, including *Streptomyces*), algae and protozoa—which have received the most attention from soil microbiologists — have a marked effect upon the productivity of soils. In general. highly productive soils contain an abundance of microorganisms. whereas less productive soils support a small population. While these facts do not prove that soils are productive because of their high microorganic population. or vice versa, there is much experimental evidence to show that microorganisms contribute to the productivity of soils through their varied activities.

1. Decomposition of Organic Matter. — One of the functions of soil microorganisms is the decomposition of organic matter added to the soil through the use of green manures — crops grown for soil-improvement purposes — animal manures, crop residues such as roots and stubble, and microorganisms. The sugars, siarches, cellulose and similar compounds in these organic materials serve as a source of energy for bacteria, fungi and actinomycetes. and largely disappear into the soil air in the form of carbon dioxide. Other compounds more resistant to decay remain in the soil longer and are important contributors to the humus in the soil. Bacteria, fungi and actinomycetes need nitrogen for their growth during the process of decomposition. Where the organic materials are low in nitrogen. microorganisms use the ammonium and nitrate nitrogen in the soil. Consequently. they may compete with grain crops for useful nitrogen where low-nitrogen organic materials are plowed under, resulting in a lower immediate yield than would be obtained in the absence of added organic material. Nitrate nitrogen is often lost in drainage water because of its high solubility. Such losses may be decreased by the use of low-nitrogen organic material on land having a high nitrate-supplying power during extended periods when no crops are grown.

Both farmers and city people, when preparing artificial manure, have taken advantage of the ability of microorganisms to decompose organic substances. In this process. leaves, lawn clippings, garden refuse and similar organic materials are mixed with ammonium sulfate or nitrate, superphosphate and crushed limestone. Microorganisms use the nitrogen in their growth processes; the limestone prevents the accumulation of acids; and the phosphate reinforces the manure. This process of making artificial manure is called composting. (See also FERTILIZERS AND MANURES.)

2. Solution of Minerals. — During the process of decomposition of organic materials. large amounts of carbon dioxide are produced. When dissolved in soil moisture, carbonic acid is formed and this weak acid may account for some solution of soil minerals. Some bacteria and fungi produce organic acids capable of dissolving minerals. Other microorganisms producing mineral acids are effective. to some extent at least. in releasing some of the nutrient elements from relatively insoluble soil minerals.

3. Nitrogen-Fixing Bacteria. — In the air above every acre of land there are about 69,000,000 lb, of elemental nitrogen. Curiously enough. most crop plants may be starving in this sea of nitrogen. Only when the nitrogen in the air is combined with other elements is it possible for crops to use this nitrogen in their growth processes. Similarly. most microorganisms need nitrogen that has been changed into either organic or inorganic combinations.

Some bacteria are able to use the elemental form of nitrogen that exists in the air. Thus. they can grow in the absence of combined nitrogen and, at the same time. produce nitrogenous substances which may be used later by crop plants.

The legume-nodule bacteria (rhizobia) are examples of organisms that can use air nitrogen. They grow in association with leguminous crops and are responsible for the nodules or tubercles which are associated with most leguminous or pod-bearing crops, such as peas and beans.

Role *of Legumes*.—The nodule bacteria furnish nitrogen compounds for the leguminous plant, and the leguminous plant furnishes energy material for the bacteria. Such a relationship, in which dissimilar organisms live together for their mutual benefit, is known as symbiosis.

Because leguminous plants are able to use air nitrogen indirectly, they will grow well, if nodulated, on soils that do not contain enough useful nitrogen for maximum growth of a nonleguminous crop, such as corn. A plentiful supply of nutrient elements other than nitrogen is necessary, however.

The amount of nitrogen nodulated leguniinous crops obtain from the air depends upon several soil conditions. Under favourable conditions, it is estimated that from 50 to 150 lb. of nitrogen per acre may be derived from the air. The amount of useful nitrogen in the soil, the kind of crops and the fertility of the soil (the relative amount of plant nutrients which are present) are factors affecting the amount of nitrogen that can be obtained from the soil.

The nodule bacteria vary also with respect to the amount of nitrogen they can take from the air. Some bacteria are highly efficient; other species have little capacity to obtain nitrogen from the air. Still others actually may be unable to secure air nitrogen and thus may be parasitic.

The supply of nitrogen in the soil may be replenished by growing nodulated leguminous crops if all or a part of the leguminous crops is returned to the soil. Obviously, the way the crop is handled determines the extent to which nitrogen-replenishment occurs.

No one kind of nodule bacteria will find a home on all leguminous crops. Of the approximately 10,000 species, only a relatively small number of leguminous crops and their nodule bacteria have been studied. These include about 20 kinds (strains) of nodule bacteria, recognized by their ability to produce nodules on different leguminous plants. There are some leguminous plants on which nodules never have been found.

Inoculation.—Because the success or failure of a crop may depend, in part, on the presence of nodule bacteria, farmers practise inoculation—the process of adding suitable nodule bacteria to the seed or soil—in order to be sure the leguminous crop will be nodulated. Where the leguminous crop is native to the area, inoculation is practised as a means of cheap insurance. Inoculation is very important for leguminous crops which are new to a locality.

Reliable commercial inoculants are sold by many seed stores. The information printed on the container gives the name of the crop or crops for which the inoculant should be used, as well as directions for its use. The cost per bushel of seed is comparatively low.

Other Bacteria.—In addition to the rhizobia, there are bacteria living independently in the soil; *i.e.*, they are free living and are capable of using air nitrogen in their growth processes. These bacteria are said to be nonsymbiotic. Some of the nonsymbiotic bacteria are aerobic, requiring free oxygen, while others are anaerobic, or able to live in the absence of free oxygen.

The Azotobacter are the most important among the aerobic nonsymbiotic nitrogen-fixing bacteria—those able to convert nitrogen from the air into nitrogen compounds. They are present in small numbers, rarely more than a few thousand in a spoonful of soil. However, the Azotobacter are found in most soils which are neither distinctly acid nor highly alkaline. Their importance in soil fertility is in doubt. Under highly favourable laboratory conditions. they fix appreciable amounts of nitrogen, but the evidence in natural soils is largely circumstantial. It has been estimated that the Azotobacter may fix from 15 to 40 lb. of nitrogen per acre per year.

Nitrogen fixation by free-living nitrogen-fixing bacteria may occur in poorly drained soils because several different microorganisms may live under anaerobic conditions and fix appreciable amounts of nitrogen. (See also NITROGEN, FIXATIOS OF.)

4. Nitrogen Mineralization.—Organic matter is the storehouse of nitrogen in the soil. The nitrogen fixed by both symbiotic and nonsymbiotic bacteria is present in the form of organic compounds such as proteins and proteinlike substances. Before this nitrogen can be utilized by growing crops. it must be converted into inorganic forms. Some of the processes by whichorganic nitrogen is changed into inorganic forms are carried on by several kinds of microorganisms, but the final steps in the formation of nitrate nitrogen, the form most readily used by higher plants, are the result of the activity of highly specific organisms.

5. **Ammonification.**—Ammonification is the process by which ammonium is formed in soils from nitrogenous organic compounds. It results from the action of microorganisms. The majority of the soil bacteria, many fungi and the actinomycetes decompose protein materials, utilizing the carbon for energy purposes and liberating ammonium produced in excess of the small quantities needed for growth of the microorganisms. Where large quantities of highly nitrogenous green manure crops are ploned under, correspondingly large amounts of ammonium are released. However, the ammonium that accumulates in most soils is transient, because it is utilized quickly by other microorganisms. Because of this quick utilization. it is not possible to measure directly the production of ammonium in soils, but accumulation at any specific time can be determined.

6. Nitrification.—Nitrification is the process of converting ammonium nitrogen to nitrate. When ammonium is oxidized, it is first changed to nitrite which, in turn. becomes nitrate upon further oxidation. Unlike ammonification, which is accomplished by numerous kinds of bacteria. fungi and actinomycetes under both aerobic and anaerobic conditions, the change from ammonium to nitrite is achieved by the specialized bacterium, *Nitrosomonas*. Another specialized bacterium changes the nitrite into nitrate. Both of these bacteria are strictly autotrophic and aerobic. Their activity in the soil is restricted by acid conditions; consequently, they are most active in well-drained soils where acidity has been corrected by a liming program.

Nitrification varies directly with the temperature and moisture of the soil within certain well-defined limits. In a cold, wet spring, little nitrate is formed and the leaves of higher plants often are yellowish in colour. indicating a lack of nitrogen. As the temperature rises and the soil reaches an optimum moisture content, nitrification increases and the leaves of the plants become darker green, indicating a supply of useful nitrogen. Higher plants growing in low areas in fields are more apt to show nitrogen starvation in the early spring because of water and temperature relationships.

In any good soil-management program, the aim of the farmer is to make sure that conditions are favourable for nitrification at the time of year when nitrogen is used most heavily by the growing crop. Because nitrate nitrogen is subject to leaching, the removal of substances in water solution, it is undesirable to have nitrate accumulate when crops are not growing on the land. For example. ammonium is not leachable, but under favourable temperature conditions it is changed by nitrification into nitrate, which is leachable. Therefore, when farmers wish to plow under nitrogen fertilizers in the autumn, it is desirable to wait until the soil temperature is about 50° F. or lower, to minimize the conversion of nonleachable ammonium into leachable nitrate.

7. Algae.—Soil algae occur in relatively small numbers in soils when compared with bacteria. Their numbers are in hundreds of thousands per gram of soil rather than in billions, as is the case with the bacteria. The algae contain chlorophyll—the green colouring matter in higher plants—and range in colour through greens, blue-greens, browns and reds. The volume of individual cells is roughly 3 times that of bacteria and 3 that of protozoa. Typical water forms of algae are much larger.

The blue-green algae are able to fix nitrogen and may be agents contributing to the maintenance of crop yields on low-producing soils. Because algae are capable of getting their carbon from the carbon dioxide of the air and fixing their own nitrogen, they are credited with the formation of organic matter on volcanic ash and on burned-over areas.

8. **Actinomycetes.**—Actinomycetes are somewhat intermediate in size and shape between bacteria and fungi. In some respects they resemble both. They occur in smaller numbers than the bacteria. but are larger in size and frequently surpass the bacteria in weight per given unit. One of their main functions is the decomposition of organic materials The characteristic odour of newly plowed soil is attributed to the activity of these organisms. Most actinomycetes are aerobic in nature and, like the fungi, are more abundant in dry than in wet soils. A few are parasitic on some plants and animals.

9. Fungi.—Fungi exist in soils in many different forms. Some may be seen only with a microscope, whereas others grow on the surface of the soil and have characteristic, visible shapes. Mush-

rooms are familiar examples.

The numbers and kinds of fungi present in soils depend upon moisture: temperature, the kind and amount of organic matter present and the acid condition of the soil. Many fungi are active under conditions of acidity and temperature that many bacteria cannot tolerate. For this reason, certain groups, particularly the heat-tolerant organisms. are important in the decomposition of grain straw and strawy manure. Others are involved in the decomposition of nitrogenous organic materials with the liberation of ammonia.

Some fungi are capable of living in association with higher plants. particularly trees. They enter the roots of these trees, forming an association called mycorhiza (*q.v.*). They appear to benefit the host plant by increasing the capacity of the roots to absorb nutrients.

Microorganisms in general, but particularly fungi, are important agents in maintaining in soils a granular structure called aggregation. The threadlike network that they form tends to hold soil particles together in crumbs—a condition favourable for the absorption of water and for the exchange of air between the soil and the atmosphere.

Neither the enumeration of the kinds nor a description of the characteristics and activities of individual groups gives a complete picture of the importance of microorganisms in the soil. Except under very unusual and highly unfavourable conditions, there is a continuous cycle of changes. Complex substances are broken down into simpler materials by some microorganisms, while the simple materials are combined to form more complex substances by other organisms. At any given time the status of the microbial population and its products are a result of the interaction of many group: of microorganisms. For instance. one-half of the phosphorus may be present in the organic fraction of the soil and the other half in the inorganic form. Microorganisms decompose a part of the soil's organic matter and change the phosphorus to an inorganic form that is useful for higher plants. At the same time, other microorganisms use the inorganic phosphorus as food and incorporate it in their bodies as organic phosphorus. This organic phosphorus is not available for the growth of higher plants until it is changed again into the inorganic form. Thus, in assessing the activity of the soil microorganisms, a series of checks and balances must be considered.

See also SOIL FAUNA.

See Francis E. Clark, "Living Organisms in the Soil," in U.S. Department of Agriculture, "Soil," *1957 Yearbook of Agriculture (1957)*; S. A. Waksman, *Soil Microbiology* (1952). (O. H. S.)

VI. SOIL PRODUCTIVITY

Soil productivity is the capacity of a soil, in its natural climatic environment, to produce a specified plant or sequence of plants under a specified system of management. In their natural state, soils differ widely in productivity because of differences in their ages and in the materials from which they are formed. Most silt loam soils. for example, are naturally more productive than sandy soils, and mature soils are more productive than soils that are either young, geologically speaking! or very old. The productivity of a soil is also partly determined by the way it has been managed in cultivation. In discussing soil productivity, it is appropriate to do so in terms of its relation to management.

1. Soil Management.—Management can be defined as the combination of tillage, cropping and soil-treatment practices used to produce a crop. The three practices compete with and complement each other. Desirable combinations of the three tend to eliminate the unfavourable effects on the soil of crop production, to reduce the adverse effects of climatic, insect and disease hazards, and to push crop yields toward their potential. Under continuing poor management (poor tillage, undesirable sequence or choice of crops andlittle or no soil treatment) the productivity tends to be lower and to vary widely. Under complete and balanced management, on the other hand, a soil can maintain or even improve its productivity: and consequently grow crops more economically. Good management increases the efficiency of the soil in meeting crop requirements and protects the soil from the deteriorating influences of crop removals, and from drainage and erosion.

In practical agriculture there is a tendency to underuse and neglect cropping and soil-treatment practices. which leads to soil exhaustion. greater susceptibility to hazards and declining productivity and lower economy of production. How cropping systems and soil treatments can affect soil productivity is shown in Table II; the corn yields shown there are from a plot of naturally productive dark-coloured silt loam soil, the differences resulting from the differences in management.

TABLE II.—*Effects of Cropping System and Soil Treatment on Soil Productivity*

(Data from University of Illinois Morrow Plots; original corn yields 50 bu. per acre)

Cropping systems	Acre yields of corn			
	No treatment		Treatment*	
	1904–57 (bu.)	1946–57 (bu.)	1904–57 (bu.)	1946–57 (bu.)
Corn every year	25	24	49	
Corn and oats, alternate years	35	36	73	
Corn, oats, and clover, one every three years	52	68	77	108

*Manure, limestone, and phosphate; legume green-manure crop included in corn-oats rotation.

Treatment practices (applying plant-food nutrients. liming materials and animal manures and plowing under green-manure crops) are used to restore constituents that are deficient in the soil. The amount to apply depends upon the needs of the crop for soil-derived nutrient elements and the ability of the soil to fill these needs. Background information for planning these practices is obtained from chemical analyses of crop plants and from various tests for soil deficiencies. Chemical analyses of crop plants show that species differ widely in their requirements for nutrient elements and that the requirements for the different vegetative portions of a plant differ widely.

The data in Table III, giving the approximate quantities of five elements removed from the soil in moderate yields, show these relationships for some of the more commonly gronn field crops. The legumes. such as alfalfa and soybeans. differ somewhat from the nonlegumes in that they can obtain from one-half to two-thirds of the nitrogen they need from the air if they are grown in association nith the proper nitrogen-fixing organisms.

Various tests for soil deficiencies can be used to indicate whether a particular soil can supply the requirements of crop plants. These include: (1) comparing crop yields and production practices for similar soils in the same community; (2) studying information that can be obtained from agricultural experiment stations; (3) natching crops during the groning season for symptoms revealing inadequate supplies of nutrient elements; (4) using chemical soil tests to detect deficiencies in available nutrients;

TABLE III.—*Nutrient Elements in Field Crops*

Crop	Acre yields (cwt.)	Pounds in acre yields				
		Nitrogen (N)	Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)
Corn—grain	28	50	8	10	1	4
—stover	30	25	4	32	1	4
Wheat—grain	15	33	6	6	1	2
—straw	25	14	2	20	5	2
Soybeans—grain	15	84	10	29	3	4
—straw	33	60	6	42	43	23
Potatoes	90	31	13	45	2	3
Cotton—lint	5	1	*	2	*	..
—seed	10	38	6	10	2	..
—stalks	20	28	3	16	11	..
Alfalfa hay	60	158	14	103	117	24
Timothy hay	40	44	6	52	11	6

*Trace

and (5) using plant tissue tests to learn whether the plant is obtaining sufficient nutrients at various stages of growth.

In humid regions, low nutrient-supplying powers can usually be improved by returning deficient constituents to the soil. The constituents most likely to be deficient and the materials most commonly used to restore them are as follows:

Organic Matter.—Many cropping systems bring about the destruction and loss of soil organic matter. Crop yields tend to decline in proportion to the reductions taking place. The unfavourable effects of these losses can be offset by the regular return of fresh supplies. In field crop husbandry, this is done with animal manure, legume and nonlegume green manures and crop residues.

Nitrogen.—Organic matter is the source of soil-supplied nitrogen. In some regions, as in the North American corn belt, the soil resources, the climatic condition, and the type of farming followed make it possible to provide a high level of nitrogen supply, with animal manures and the residues of legume and nonlegume crops used in association with each other. It is often necessary to supplement the farm resources of nitrogen with commercial supplies Even in the corn belt supplementary nitrogen is often needed. particularly if crop sequences are used that emphasize nonlegume crops and if little or no manure is returned to the soil. In some regions or under some conditions, it may be necessary to rely almost entirely on commercial nitrogen. Providing adequate supplies of nitrogen is a major problem in crop production.

Lime.—Lime affects soil productivity by modifying soil properties and supplying the nutrient elements. calcium and magnesium. Deficiencies are revealed by the development of soil acidity, to which most legume crops are especially sensitive. The proper use of lime as pulverized limestone, chalk, marl, or hydrated or burned lime occupies a place of first importance on many soils.

Phosphates.—Phosphorus is supplied from both mineral and organic soil constituents. Deficiencies may be reduced or temporarily eliminated on some soils by utilizing subsoil supplies with deep-rooted legumes. Effective correction, however, is dependent on the use of phosphatic fertilizers such as superphosphate, basic slag and rock phosphate. The economy of these carriers, which vary in chemical properties and behaviour, depends upon costs, soil conditions and the type of farming followed. The need for phosphatic fertilizers is widespread.

Potash.—Crops acquire potassium from various potash minerals. Some soils are not abundantly supplied with these minerals. Other soils are well supplied with some of the less available forms, but are unable to provide some crops with sufficient quantities of potassium for good yields. Deficiencies in potassium-supplying power can be reduced by returning crop residues and animal manure to the soil, but effective correction is usually dependent upon the use of potash fertilizers such as muriate of potash.

Minor Elements.—In addition to the nutrient elements supplied in the above mentioned materials, crops also depend upon the soil for small quantities of manganese, sulfur, zinc, copper, boron, iron and perhaps other elements. Deficiencies may be corrected by the direct application of suitable carriers or by the use of fertilizers containing the elements needed.

In correcting the nutrient-supplying deficiencies of soils, two general systems of practices have arisen. (1) the use of treatment materials in such ways as to improve the capacity of the soil for producing crops; and (2) the use of treatment materials in such ways, forms and rates as will favour the immediate response of specific crops in particular soil environments. The first system is directed toward the soil and involves a very careful planning of the cropping system and the incorporation, when needed, of liberal quantities of crop residues, animal manures. lime, phosphates and potash into the soil. The second system is directed toward the crop and involves the use of readily available nutrients, singly or in mixtures to provide sufficient quantities of nitrogen, phosphorus and potassium for effective growth and yield.

In the United States, the interest in this system has led to the large-scale manufacture of fertilizer mixtures in the form of grades for specific conditions. Either system is effective when properly used, but the most favourable long-time economy in crop production is more likely to be attained when the essential features of both systems are properly combined.

2. Soil Treatment as an Investment.—On most soils the use of some soil-treatment system will increase the yields of crops more than enough to cover the additional costs of the treatment. As would be expected, poorer soils benefit more from soil treatment than do soils that are naturally highly productive. Soil treatment does not entirely close the gap between soils of different productivity, but it reduces the amount of variation.

TABLE IV.—*Acres of Soils of Different Quality, With and Without Soil Treatment, Required lo Produce the Same Total Yield as 100 Acres of Untreated* Group *I Soils**

Soil Groups†	Management Practices		
	Tillage and cropping only (ac.)	Tillage, cropping and treatment (ac.)	Reduction for treatment (ac.)
I	100	75	25
II	107	85	22
III	123	86	37
IV	138	90	48
V	171	103	68
VI	174	102	72
VII	380	167	213
VIII	500	137	363
IX	648	156	492
X	884	136	748

*Based on average corn-equivalent yields of all crops grown on 21 Illinois soil experiment fields over time periods averaging 45 years, ending in 1956.

†The soil groups are listed in declining order of natural productivity, with Group I the most productive, and Group X, the least.

The results of applying treatments to soils of different productivity are shown in Table IV, where the benefits are indicated as reductions in acreages needed to produce the same amounts of crops. These reductions emphasize the importance of management systems that increase productivity, for if the same production can result from less acreage, land is released that can be used to produce more crops or converted to other economic or social uses.

See FERTILIZERS AND MANURES; ROTATION OF CROPS; *see* also Index references under "Soil" in the Index volume.

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(F. C. BR.)

SOIL ANALYSIS: see SOIL TESTING AND ANALYSIS.

SOIL EROSION AND CONSERVATION. This articie deals with the agricultural aspects of soil erosion and nith the development of conservation programs and conservation methods to protect farms and promote food production. For the mechanics of erosion see GEOLOGY. See also BREAKWATER; IRRIGATION; LAND RECLAMATION; RIVER AND RIVER ENGINEERING; WIND EROSION AND DEPOSITION.

SOIL EROSION

Soil erosion is usually described as the carrying away of soil by either wind or water. The Grand canyon, the fiords of Norway or the sink-holes and caves of the Carso region of Italy and the Dinaric Alps are all examples of normal or geologic erosion. a slow process that occurs under natural conditions. Over long periods of time, usually thousands of years, it makes definite changes in the earth's surface. There is little man can do to change this process or the end result.

The erosion dealt with under this heading is less spectacular but much more vital to the welfare of mankind. It is the carrying away by mind or water of the soil from farms and ranches so necessary for the raising of food, fibre and other agricultural products. Erosion of this type has been greatly speeded up by man's mismanagement of land, even to the point of destroying it for practical agricultural use within one generation.

Factors Affecting Erosion.—Chief among factors affecting water erosion is the amount of cover given the soil. Erosion is slow wherever soil is covered by trees or grass. At Zanesville. O., on comparable watersheds, woodland lost almost no soil during a nine-year period and pasture land very little. but cropland lost an inch of soil.

Closely allied to the matter of cover is the amount and intensity of the rainfall and its distribution during the season. Often a few hard rains which come at a time when crop cover is light will cause most of the soil loss. At La Crosse, Wis., four storms a year during 1940 to 1943 caused 95% of the total soil loss and 84% of the runoff from cornland.

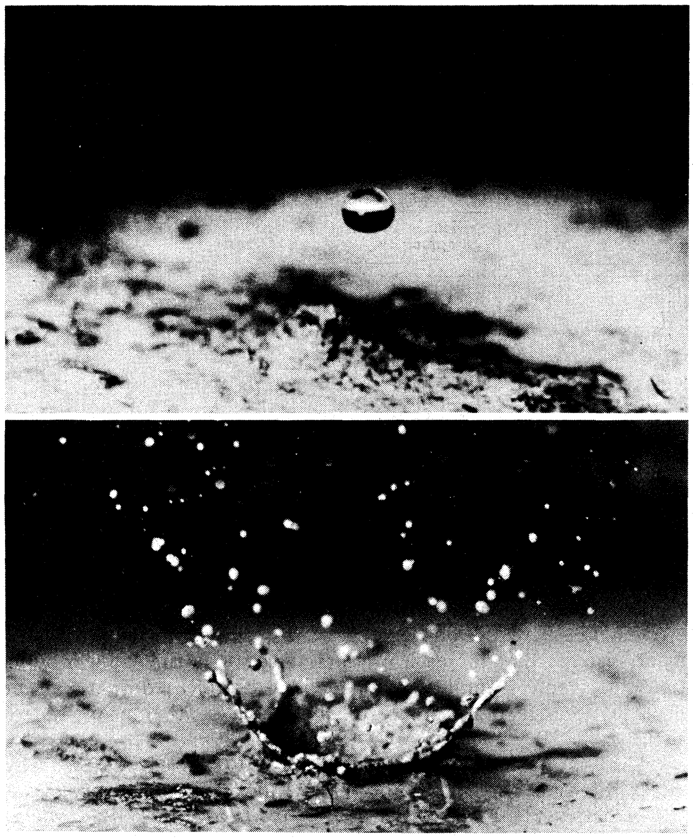

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FIG. 1.—A SINGLE DROP OF RAIN (TOP) AND THE AMOUNT OF SOIL IT CAN DISPLACE (BOTTOM)

Slope is another determining factor. The longer the slope the more soil and water are lost when cultivated. If the length of slope is doubled the soil loss is usually increased about 1.5 times. Similarly, steepness of slope affects the speed of runoff water and consequent soil loss. If the slope per cent is doubled the amount of loss is increased 2.5 times.

The nature of the soil affects the amount and seriousness of soil loss. The topsoil is generally the most valuable part of the soil profile because it contains more available plant food and organic matter. The surface soil can usually absorb water much faster than the subsoil. As the surface layer becomes thinner less water soaks into the soil and more runs off the surface, thus increasing the rate of soil loss. Losses from deep, open soils are less in amount and less serious than from shallow soils. The hazard increases for slowly permeable soils and those with tight, nearly impermeable subsoils.

The cropping system, kind and amount of tillage and conservation measures used all influence the amount of erosion. Heavy cropping of a soil causes the organic matter to decompose rapidly. Tillage hastens the process. Reduction of organic matter causes a change in the structure of the soil. The granular condition or clumping of the soil particles into more or less regular patterns is largely lost. The soil particles lose their tendency to stick together and are less able to resist the action of wind and water.

The main cause of wind erosion is lack of vegetative cover. This may be due to drought and high temperatures which reduce growth of vegetation; to tillage. and gro ing of cultivated crops which afford insufficient cover; and, in the case of pastures and ranges, to overgrazing. When soil is relatively bare, alternate freezing and thawing or wetting and drying loosens the surface soil and breaks down soil aggregates to granules that can easily be picked up by wind. The most critical seasons are late winter and early spring, when the wind usually blows strongest, the land is clothed with the least vegetation and the soil is most susceptible to movement. Wind erosion is particularly serious in arid and semi-arid regions.

Progressive Erosion Damage.— Soil erosion may be so gradual that serious damage is done before the land occupant is aware of what is happening. Each time a hard rain hits bare land soil is torn loose and snept away. Each raindrop hits the bare earth like a tiny bomb, sending the wet soil in every direction. Not only is soil torn loose to be washed down the slope but available plant food is dissolved and carried away.

Soil damage occurs in successive stages. At first the principal loss is by sheet erosion; that is, each time it rains the runoff water will remove a thin layer of surface soil. As the surface soil becomes thinner small rills (miniature gullies) appear. On cropland these rills are erased by the next cultivation and the field looks much as before. After most of the surface soil is gone gullies may become the principal problem. In gully erosion, channels are cut by water that has concentrated in the natural drainage ways or draws in a field. These channels may vary from a few inches to many feet in depth and up to many rods in width. As a result of gullying soil is lost, tile lines are washed out and fields are divided into two or more parts. Gully erosion is the most familiar type of erosion, doing serious injury to farm land. In the most advanced stages gullies may render land unfit for practical use for cultivated crops or even pasture. Reclamation of badly eroded land is expensive in any case, and full restoration is usually impossible except by natural processes of soil formation which require long periods of time. Sheet erosion, however, is actually more common and more serious than gully erosion because it takes place so gradually that the damage is not recognized.

Soil damage by wind erosion is serious and extensive. Farmers in affected areas suffer crop damage or complete loss of crops. Serious as this may be, the greatest loss is that of the fine soil fractions (silt. clay and organic matter). The wind exerts a sorting action on some soils much like a sieve. The finer particles, which contain the major part of the plant food elements, are gradually sorted out and carried away. Left behind is the coarser portion, which is less fertile and is often more erodible than the original soil.

Water and wind erosion result in much additional damage. Productive lowland soils often are covered uith sand, gravel, stones and low-fertility subsoil washed from slopes above. Water-borne silt fills stream channels, drainage ditches and reservoirs, thus interfering with drainage and shortening the usefulness of lakes built for flood control, water supply and recreation. Winds often cover productive land nith infertile sand and bury railways, highmays, fences, hedges, shelter belts and even farm buildings.

Erosion as a World-Wide Problem.— Surveys made in different countries have shown that erosion has damaged or ruined for practical use hundreds of millions of acres of once-productive land all over the world. Induced erosion continues to be a major problem in every agricultural region in the world except in northwestern Europe. In Great Britain and other countries of northwest

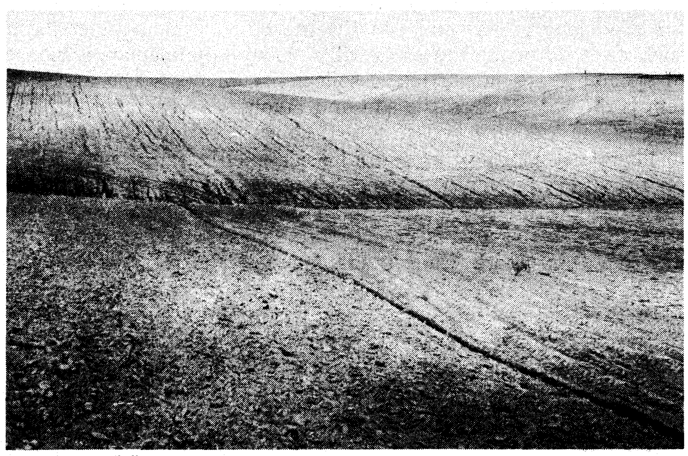

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FIG. 2.— SEVERE SHEET AND RILL EROSION

This field, plowed and disked in preparation for corn, lost an estimated inch of soil during spring rains. The light-coloured spots on the slopes indicate where the dark topsoil is gone and the light subsoil is showing through

Europe, well-distributed rainfall, lack of torrential rains and centuries of careful husbandry have preserved soil fertility remarkably well During World War II, increase in the misuse of land changed this situation, however, and serious erosion in parts of the uplands of England, Scotland and Wales was the result of up-and-down hill farming of potatoes and other row crops.

W. F. PURNELL

FIG. 3 — GULLYEROSION PRODUCED BY THE CONCENTRATION OF WATER IN THE NATURAL DRAINAGE WAYS OF A FIELD

The erosion problem appears to be common throughout the world. This conclusion is borne out by the Food and Agriculture Organization of the United Nations (FAO) in a bulletin, *Soil Conservation, an International Study* (1948). After reviewing conditions in the United States and citing examples of serious and widespread erosion in China such as. "The Yellow River is the muddiest great river in the world." the report continues: "But these are only examples—the problems of soil conservation are world wide. They are particularly acute in India, where, as in China. there is tremendous pressure of population on natural resources even more meager; in the Mediterranean region of Europe and the Near East, where centuries of human occupation and the nature of the climate and land forms have favored rapid soil erosion; in Latin America, where many countries with dense populations have rapidly eroding lands; and in South Africa and Australia, where conditions and problems and the history of occupation are similar to those of parts of the United States of America."

In the United States surveys show that erosion has severely damaged about 280,000,000 ac. of crop and grazing land. Another 775,000,000 ac. of crop, grazing and forest land have eroded to some extent It was estimated. in the latter half of the 20th century, that there were left in the farms and ranches of the country about 460,000,000 ac. of land suitable for cultivated crops. This included, besides land already in crops. about 95,000,000 ac. that needed clearing. draining. irrigating or other improvements to make them suitable for cultivation. All but about 100,000,000 ac. were subject to erosion if not protected.

CONSERVATION

Conservation and Productivity. — In its simplest sense, soil conservation means the saving or preserving of the soil. This would be a relatively easy problem were it not that while saving the soil it is necessary to use it. Man must depend on it for most of his food and fibre. The idea of "saving" recognizes the need to keep soil productive for future years; "using" recognizes the necessity of getting production from the soil now.

In addition to protecting and improving the land, soil conservation yields many side benefits. It helps lower the cost of farm production. This, in turn. increases farmers' profits and helps lower the cost of food and clothing to city dwellers. Soil conservation helps check drought damage in dry seasons and reduces flood crests in small and large streams in wet times. It reduces siltation of streams, reservoirs and harbours, thus helping to insure a cleaner water supply for cities and towns, improve navigation and provide a better habitat for fish and other forms of wildlife. It also provides a cleaner and more beautiful countryside.

The Conservation Movement. — Soil depletion and erosion began to take their toll early in the history of the American colonies. Most of the early colonists came from areas where rains fall gently. Therefore they were not prepared to handle soil in the North American climate, where rain often falls with great intensity. They cut down the forests along the eastern coast, built their homes and planted corn and other crops in the cleared fields. More and more land was plowed to produce food for the increasing population and for production of tobacco and grain that could be traded abroad for needed commodities.

Then a few farmers in the older sections noticed a change in the soil. At first it had been dark, in some places almost black, but it gradually became lighter in colour. When a heavy rain came, the loose soil mixed with the water and the muddy mixture flowed down the hills. carrying with it the richest portion of the soil—topsoil.

Destruction of soil by gullies and floods was noted by writers even before the Revolutionary War. By 1775 rivers that once ran clear were described as being black with mud. Early Massachusetts records indicate that most of the land near the coast was abandoned at least once before 1800.

Some of the leading men of that day were deeply concerned. Patrick Henry is credited with saying, "He is the greatest patriot who fills the most gullies." George Washington, who was an industrious farmer, was continually striving to conserve his land and check erosion. In his final message to Congress in 1796, he urged the creation of a board of agriculture, but it was not until Lincoln's administration in 1862 that the United States department of agriculture was created. Thomas Jefferson was constantly looking for ways to improve the productivity of his soil. While Jefferson was president his son-in-law~,Thomas Mann Randolph, introduced a system of horizontal plowing on his land that was the forerunner of contouring. The results delighted Jefferson. But people generally were not concerned about soil damage since there was so much virgin land. During the following century they moved west, clearing the forest for cropland, plowing the grasslands of the middle west and much of the Great Plains, and on to the Pacific coast.

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FIG. 4.—ERODED FARM LAND

Left unchecked, the combination of rain, runoff water and wind quickly renders land unfit for cultivation or even pasture

Conservation sentiment was built up slowly. Early in the 20th century Pres. Theodore Roosevelt called the first conference of governors to consider conservation of natural resources. Interest thus aroused led to the purchase of the first national forests and the establishment of the U.S. forest service.

Interest in soil conservation lagged during World War I and the agricultural depression of the 1920s. A soil surveyor in the bureau of soils, H. H. Bennett, was, during all this period, persistently calling attention to the serious erosion he had found in his survey work and trying to arouse! interest in a corrective program. The movement took a big step forward in 1929 when congress approved the establishment of soil conservation experiment stations to (1) measure the rates of soil and water loss; (2) determine the extent and location of damage by erosion; and (3) develop methods for controlling erosion. Soon there were 10 stations in operation gathering the information needed for an attack on the erosion problem.

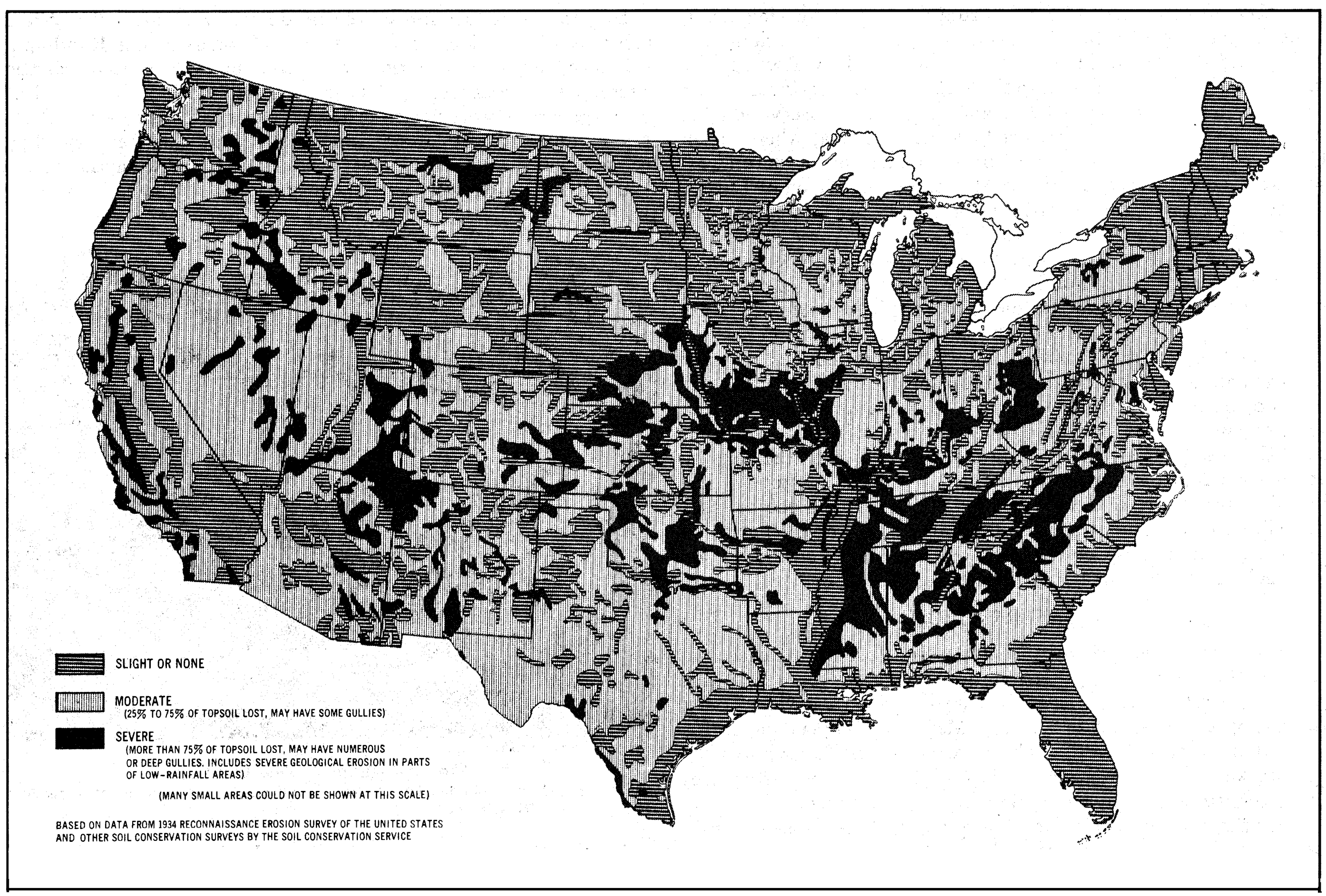
In 1933 the soil erosion service was set up in the department of the interior as one of the emergency agencies to help the country out of the economic depression of the early 1930s. Bennett was made chief of the first erosion control agency ever established by an important nation. In 1935, on the heels of the worst dust storm the U.S. had ever seen—dust from the Great Plains reached Washington, D.C.. and drifted far out to sea—congress passed public law 46, the first soil conservation act in the history of the United States or any other nation. The law established the soil conservation service in the department of agriculture. replacing the soil erosion service. The new agency was charged with carrying out, in co-operation with farmers, a program demonstrating good land use and erosion control. To facilitate the program, labour from the civilian conservation corps (CCC) was made available. The work was carried out first on farms in project areas covering representative watersheds throughout the country. Later it was extended to farmer co-operators in CCC camp areas in each state. But all this was demonstration of limited scope. There was need for farmers and government to work together to apply the lessons to all farm and grazing lands.

State and Local Programs.— Early in 1937 Pres. Franklin D. Roosevelt wrote to the governors of the states pointing out the need for state legislation to enable farmers to take necessary co-operative action in furthering the soil conservation program. With the letter a as a proposed standard state soil conservation districts act that provided for the organization by farmers of soil conservation districts as governmental subdivisions of the state to carry on projects for erosion control.

The suggestion was well received. Arkansas became the first state to have a soil conservation law on its books. In Aug. 1937 the Brown creek soil conservation district in North Carolina was organized and opened its doors as the first in the United States. By 1948 all states and territories had passed soil conservation district laws. More than 2,800 districts have been formed to include the major part of the land in farms and ranches throughout the United States and its territories.

After the coming of the soil conservation district the U.S. soil conservation service shifted its program to do most of its work in co-operation with these districts. The service assigns to each district one or more technicians to help farmers plan and apply conservation programs on their farms.' The assistance includes: (1) a detailed soil survey of the farm or ranch; (2) a conservation plan drawn up by the farmer and technician working together; (3) application of practices called for in the plan; and (4) maintenance of the established practices. Any farmer may participate by agreeing with the district directors to conserve and use his land properly.

Many conservation practices can be applied by the farmer without assistance. But drainage, terraces, strip cropping, farm ponds, diversions, land smoothing, gully control structures and the like require more technical skill than the farmer ordinarily has. The technical knowledge is supplied by technicians who work with the soil conservation district.



SOIL CONSERVATION SERVICE, U.S. DEPARTMENT OF AGRICULTURE

FIG. 5.—MAP SHOWING SOIL EROSION CONDITIONS IN THE UNITED STATES

The program of the soil conservation service has stressed work on a watershed basis. Early project areas were based on watersheds and the boundaries of many soil conservation districts are those of a watershed. In 1944 the service was authorized to apply special treatment for flood control on 11 watersheds in 12 states. In 1953 work was authorized and started on a pilot-watershed program covering 60 small watersheds in 34 states. In 1954 the service was designated as the U.S. department of agriculture representative agency to co-operate with local organizations in small watersheds throughout the nation in work aimed at upstream watershed conservation and flood control. Response to this program was widespread in all states. In all of these watershed efforts the work is carried on in co-operation with local landowners.

Results following high intensity. flood producing storms in several well-developed watersheds in different parts of the country have been most encouraging. Upstream retarding dams used along with recommended soil and water conservation measures on the watershed lands have greatly reduced flooding, erosion and siltation.

In 1956 a Great Plains Conservation program was authorized by congress to help farmers and ranchers of the region develop long-term plans for their land, including soil and water conservation measures and the land-use adjustments needed to achieve a more stable agriculture. It provided technical aid and cost-sharing assistance over a contracted period of years to farmers and ranchers in designated counties for applying measures as part of an approved plan. The soil conservation service is co-operating with local, county, state and regional agencies and organizations to promote this program.

Methods of Conservation. — Appropriate use of the land depends upon land contour, type of soil and climate. Land may be level, slightly or steeply sloping or even mountainous. Soil may be sandy or clayey, fertile or almost barren. Climate also varies. Therefore the farmer or rancher has a real problem in deciding how best to use his land, for there may be several kinds in his holdings. There are many examples of land that has been ruined or badly damaged because it was put to a use for which it was not fitted. To help a farmer or rancher with this problem, soil conservationists make a careful survey of the entire farm and put each area into one of eight broad classes of land-capability according to kind of soil, slope and degree of erosion. Each class is shown by a different colour or Roman numeral on the map of the holding. A farmer can refer to the map and quickly see whether a field can be safely cultivated or whether it should best be used for grazing, forestry or wildlife.

TABLE I. — Conservation Practices Applied in U.S. Soil Conservation Districts

Conservation practice	Total applied as of July 1, 1956	Remaining to be applied (preliminary est.)
Conservation crop rotations (ac.)	54,255,000	181,000,000
Contour farming (ac.)	32,736,000	110,000,000
Cover cropping (ac.)	19,438,000	60,000,000
Strip cropping (ac.)	13,815,000	56,500,000
Seeding ranges and pastures (ac.)	28,384,000	101,000,000
Tree planting on farm laud (ac.)	3,883,000	24,000,000
Farm areas improved for wildlife (ac.)	3,665,000	12,400,000
Drainage of farm land (ac.)	17,585,000	66,000,000
Land leveling for irrigation (ac.)	4,493,000	15,000,000
Conservation of water use for irrigation (ac.)	7,470,000	17,000,000
Terracing of farm land (mi.)	1,045,000	4,670,000
Water diversion ridges and channels (mi.)	58,500	402,000
Pond construction (no.)	748,617	1,500,000

Source: U.S. Conservation Service

An important point in land management is to treat each acre according to its needs. After the best use for land is determined the next problem is to treat each acre in such a may that it will produce as much as possible without injury from erosion. As stated above, good vegetative cover is the first defence against soil loss and runoff. Therefore, proper treatment of all classes of land will provide adequate cover.

For forest and woodland this involves protection from fire, managed cutting, and replanting if needed. For ranges and pastures approved practices include avoidance of overgrazing, resting to encourage growth of better pasture plants, renovating, fertilizing and reseeding. The program varies widely from the pastures of the humid eastern and southern United States to the semiarid ranges of the west and southwest.

Cropland is used more intensively than other land on the farm. More fertility is removed and cultivation encourages the breakdown of the organic matter which helps a soil resist erosion. The soil, when left bare, is open to the beating action of raindrops. This is especially true of row crops. such as corn, soybeans, cotton and potatoes, which are cultivated for weed control. Special care must therefore be taken to maintain and improve fertility, add new organic matter and protect the soil from erosion.

In the cropping system row crops are usually used in succession or rotation with small grains such as wheat, oats, barley or rye, and meadow crops — legumes or grasses or mixtures of the two. As protection against erosion, meadow crops are most effective, row crops the least and the small grains in between. How often each of the three classes of crops should be used in the rotation depends on the capability class of the land and the erosion-control practices employed.

TABLE 11. —Soil Loss From Crops in Various Rotations

Crops	Percentage of R-O-H
Row crop, spring grain, hay (R-O-H)	100
Continuous row crop (R)	422
Row crop, spring grain, catch crop (R-Ox)	242
Row crop, row crop, spring grain, hay, hay (R-R-O-H-H)	125
Row crop, winter grain hay (R-W-H)	86
Row crop spring grain' hay hay (R-O-H-H)	65
Row crop' spring grain' hay' hay, hay (R-O-H-H-H)	52
Winter grain, spring grain, hay, hay (W-O-H-H)	27

Results at experiment stations have shown the relative amounts of soil loss from different crops in various rotations. These are shown below in comparison with a standard three-year rotation of row crop (R), spring grain (O) and hay (H)—that is, R-O-H has the index number of 100. Added to some of the rotations are winter grain (W) and spring grain with a catch crop of legume for green manure (Ox).

Relative values of individual crops in different sequences also have been found.

Other Erosion Control Practices. — Even though good land use, a suitable crop rotation and soil treatment are used, some additional measures are often needed on sloping fields and where wind erosion is a problem.

Grass waterways rank first in prevention of erosion and the control of runoff water from cultivated land. They are usually located in the natural drainage ways, but they may be constructed along field boundaries in some cases. Waterways are best made dished or saucer-shaped and rather shallow to keep water from concentrating to any great depth. Width should be sufficient to carry heavy rains without overflowing. A dense vegetative cover is required to keep the water from cutting a gully through the centre. Grasses that make a dense sod are preferred for this purnose.

Where a waterway discharges into an open ditch or stream at a lower level, some sort of structure is needed to keep the overfall from cutting a gully back into the waterway. These structures usually are constructed of concrete or masonry. Earth dams often are built across a large drainage way to prevent gullying and to form a pond for water supply, wildlife and recreation.

Contour tillage is one of the simpler practices that reduce soil losses about 50% from those occurring with up-and-down hill cultivation. In contouring, all furrows and rons follow around the slope and are level from end to end. Since they encircle the slope they are usually curved. The ridges left by farm machinery in preparing the soil and cultivating the crop act as small dams, holding back the water and giving it time to soak into the ground. Contour guide lines may easily be laid out by the use of a simple level fitted with sights. Contouring is most effective on gentle slopes not more than 300 ft. long.

On longer slopes, contour strip-cropping has proved very effective. Instead of the entire slopes being planted in one crop, as in simple contouring, strips of row crops are planted between strips of close-growing crops such as small grains or meadow. If the contour ridges in the cultivated crop are overtopped in a hard storm, the close-growing strip below will slow down the water and catch much of the soil it carries. Strip-cropping has been found to reduce soil losses about 75%.

Terraces are widely used, especially on long slopes, and give the most effective control if they are properly laid out and constructed and are given good care. A terrace is a low, flat ridge of earth built across the slope, with a channel for runoff water just above the ridge. Usually terraces are built on a slight grade so that the water caught in the channel moves slowly toward the terrace outlet. Where several terraces are used on a long slope they have the effect of breaking it up into a series of short slopes that lose less soil than one long one. Before graded terraces are built, suitable outlets should be prepared to receive the water discharged from the terraces. These waterways must be well sodded to avoid gullying. In areas where soils are able to take in water readily and rainfall is relatively low, level terraces may be used. These terraces merely impound the excess water until it can have time to soak into the soil.

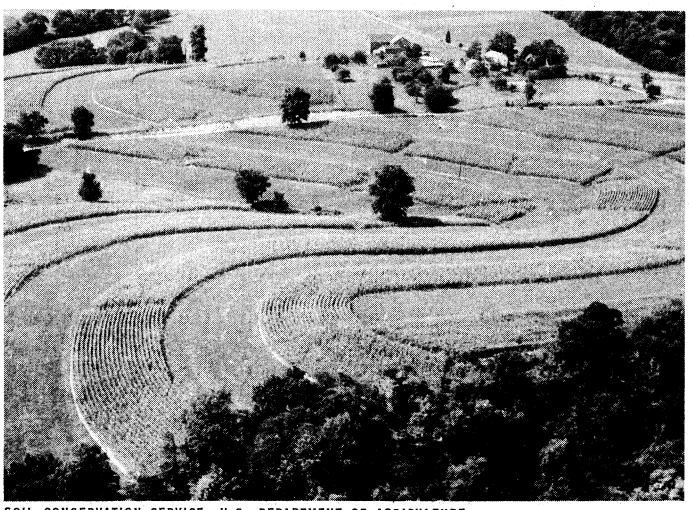


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FIG. 6. — CONTOUR STRIP-CROPPING

Strips of close-growing grass-ieoume meadow planted between strips of corn, a row crop

Diversion terraces, or diversions, are built in the same way as field terraces, but they are somewhat larger. They are often used to protect hillside fields from water falling on land above them, or to take water aaay from a gully and thus assist in controlling it. The practices already discussed are the major ones used in the control of erosion by water. Additional practices are in use but space does not permit their discussion.

Wind erosion control requires a somewhat different technique, which involves the following practices:

1. Protecting the soil surface with cover, usually vegetation. Tillage methods, called mulch tillage or stubble mulching, in which crop residues are kept on or in the surface of the soil, have proved effective.

2. Keeping the surface of the soil rough to slow down the wind and trap drifting soil.

3. Managing the soil so as to produce soil aggregates large enough to resist wind action.

4. Using barriers, such as crop strips, ridges or shelter belts to trap the drifting soil and keep it from spreading.

See also DRY FARMING.

World-Wide Conservation. — By the second half of the 20th century, conservation had gained support throughout the world. The conservation movement in the United States was widely studied and the programs of many nations were patterned after it. The United States sent many technicians abroad to study erosion problems and suggest courses of action. An extensive training program for technicians from various lands was established'and several hundred specialists from about 90 nations, colonies and protectorates were given training. More than 20 countries in North and South America, the Mediterranean region. Asia, Australasia and Africa had established organized conservation programs and about 30 other nations were applying conservation measures. Most of the programs were patterned after the one that had been developed in the United States and several included the soil conservation district as a part of their programs.

See also SOIL; FORESTS AND FORESTRY.

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SOIL FAUNA. Many members of the animal kingdom are present in both cultivated and uncultivated soils. Some of the animals are found within the soil for their entire life cycle, occasionally coming to the surface for short periods, while others spend only some definite portion of their life span in this subterranean environment. The animal population of the soil consequently consists of both permanent and transient inhabitants.

The soil fauna is composed of a variety of animals ranging from microscopic protozoa to vertebrates such as moles and ground squirrels. The major group of significance, however, is the invertebrate population. The simplest forms of underground animal life are the single-celled protozoa; this group, although part of the fauna, is discussed elsewhere with other soil microorganisms (see SOIL: Soil *Microbiology*).

The group of invertebrates discussed here includes a variety of distinct types. some ubiquitous, others occurring only infrequently and in small numbers. The major animals include the flatworms, the nematodes. certain mollusks — especially the slugs and snails — the earthworms, wood lice, millipedes, centipedes, a variety of arachnids and a broad spectrum of insects. In addition, a few vertebrate species make their homes in the soil.

On the basis of their feeding habits, the soil residents may be divided into categories, depending upon whether they feed on decaying organic matter (saprophagous), on living plants (phytophagous), on other animals (predaceous) or upon animal excretory products (coprophagous). Those that attack cultivated plants are a great menace to agriculture; but others play a positive role by aerating the soil and in many other ways.

The abundance of invertebrates in soil is determined in large part by the supply of available nutrients and by certain physical characteristics of the environment. For their optimum development, good aeration and drainage are necessary. Moisture conditions are significant, and the fauna tends to be present in smaller numbers when moisture is inadequate. Temperature is another important environmental influence, with little animal activity occurring at low temperatures. The addition of organic materials increases the population of animals, and each of the major groups is more abundant in manured than in unmanured soil.

The number of invertebrates in soil varies widely according to the environment, but in fertile, well-aerated soils the population ranges from several million to several hundred million per acre exclusive of the protozoa. Most abundant are insects. nematodes (roundworms or eelworms), earthworms and millipedes. Although there are vast numbers of smaller animals, these are so small that they make up only a fraction of the total weight of the fauna. The larger invertebrates, such as the earthworms and the myriapods (millipedes, centipedes, etc.), therefore, make up the bulk of the total weight. sometimes up to 90%. The fauna contributes as much as several hundred pounds of animal tissue per acre.

The nematodes are nonsegmented worms, commonly from 0.5 to 2.0 mm. long but occasionally up to 10 mm. in length. They are endowed with the capacity for active movement when in a liquid film. Many different types maintain a subterranean habitat, and the number of species is immense (see also NEMATODA). Some are saprophytic, using organic materials and even microorganisms as food; others prey upon members of the soil fauna including other nematodes. while a very important group can attack and parasitize growing plants. Some of the plant parasites prey upon one or a few plants, but others seem to be nonselective.

Mollusks such as snails and slugs spend part of their life in soil, and many mollusks will leave only infrequently. They prefer a moist environment and are common in shady areas at the soil surface as well as under rocks and surface debris. Although they will sometimes attack plants. they tend to utilize decaying materials. The mollusks are never abundant but may be present in numbers up to about 50,000 per ac.

Since the classical studies of Darwin, soil scientists have appreciated the significance of the earthworm (*q.v.*). These segmented norms spend their entire life cycle in the soil, emerging only occasionally. They are unfavourably affected by desiccation, low temperatures and poor drainage, and they are generally absent when the soil reaction is highly acid. They show a distinct preference for well-aerated and well-drained localities. An available supply of organic matter is important, and the earthworm population is highest in soils receiving barnyard manure and in pasture and forest soils. Earthworms can feed upon organic litter but have certain distinct preferences in their nutritional habits. When present, animal manures are used. Not only is the number greater in organically rich soils, but the worms themselves are larger. Under optimum conditions, their numbers range up to several million per acre with a large bulk of the entire animal weight as earthworm tissue—up to a hundred or more pounds per acre. As they burrow, the worms excavate channels that increase aeration, improve drainage, loosen the soil structure and provide paths for plant roots. The casts left by the earthworms tend to promote soil crumb aggregation as well. Darwin estimated that earthworms bring about 20 tons of material per acre to the surface each year—an amount sufficient to cover a field to a depth of one-fifth inch.

There are three major arachnid representatives: mites. spiders and ticks. The arachnids are usually free-living in nature, although some can be parasites on plants or higher animals. Their burrowing habits probably improve the structure, aeration and water movement in the soil.

Only two myriapods are encountered in appreciable numbers, the millipedes and the centipedes. Of the two, the millipedes are the more numerous, and soils rich in earthworms usually support the gronth of many myriapods. with the population in each acre extending into the millions. Certain myriapods can utilize organic matter and living plants for their growth. while others are predaceous. This group requires adequate moisture in the soil.

Many genera and species of insects are present, either in the adult form or in the larval or pupal stage, and these are frequently the most abundant of the invertebrate animals in the soil. Among the more common insects are ants, springtails, termites, and beetle and fly larvae. Insects may feed upon subterranean portions of plants or may live saprophytically, while certain species lead a predatory existence. The plant parasites of this group pose a serious threat to agriculture.

Certain vertebrates burrow underground and spend part of their lives under the surface. Prairie, forest and desert have their characteristic, burrowing species. Among the mammals are the moles, ground squirrels. mice, hares. shrews, woodchucks, badgers and gophers; among the reptiles are snakes, lizards and some turtles. The rodents in particular can be quite active in their movements through the soil.

The soil fauna has a great significance in soil structure and fertility and in plant pathology. The invertebrates are capable of causing a number of injuries to plants as well as being parasitic. There is evidence that the fauna may play an appreciable role in promoting the decay of organic matter, particularly in forest areas, although its significance is secondary to that of the microflora. As the animals burrow through the soil, they leave behind openings that improve aeration and drainage, although they may damage a cultivated field or wreak havoc on a well-tended lawn.

The fauna also can move a considerable quantity of plant residues as well as large numbers of microorganisms for considerable distances. The animal population serves to mix surface plant debris and forest litter with the underlying soil and also to move soil upward and leave it in the form of mound. In all respects, the soil fauna provides an interesting area of study for the soil scientist. the zoologist and the plant pathologist.

See D. K M Kevan (ed), *Soil Zoology* (1955). (M. AR.)

SOIL MECHANICS is the branch of engineering science dealing with the behaviour of soil when subjected to stresses or to the action of percolating water. The subject furnishes a rational basis for foundation engineering and earth-dam design and provides new tools for geological investigation.

Soil is a natural aggregate of mineral grains, with or without organic constituents, that can be separated by gentle mechanical means such as agitation in water. It may consist of the products of rock decomposition found essentially in their original position after weathering, or of materials transported and deposited by glaciers, streams or wind. Soil differs from most structural materials in that it consists of three phases: solid mineral matter, water, and air or other gas. Many soils comprise two-phase systems, of mineral matter and water, and are then said to be saturated.

Principle of Effective Stress.—Although soils constitute possibly the oldest construction materials known to man, the arts of foundation and earth-dam engineering remained essentially empirical until about the third decade of the 20th century. largely because the implications of the interaction between the soil grains and water had not been correctly evaluated. In 1923 Karl Terzaghi published the first clear statement of the principle of effective stress, a concept that proved to be the key to an understanding of the engineering behaviour of soils. According to this principle, the intensity of stress p acting normal to any section through a mass of soil is equal to the sum of two parts. the intergranular or effective stress p' which is transmitted from grain to grain at points of contact, and the neutral or pore stress u which is transmitted through the water in the pore space; that is,

$$p = p' + u \quad (1)$$

Moreover. the engineering behaviour of the mass of soil is exclusively a function of the intergranular stress and is unaffected by the neutral stress.

The significance of the principle of effective stress is illustrated in connection with the strength of saturated cohesionless granular materials such as sand or gravel. As early as 1773, C. A. Coulomb expressed the resistance s possessed by such a material against failure by sliding as

$$s = p \tan \phi \quad (2)$$

where p was the pressure per unit area normal to the section along which sliding took place and ϕ the angle of repose of the material. The quantity ϕ, now more precisely designated as the angle of internal friction, is a soil property depending somewhat on the kind and shape of the mineral grains and primarily on the looseness or denseness of the arrangement of the grains. It may range between about 30° and **44".** Since slopes subjected to percolating water often proved less stable than those on dry sand, it was commonly assumed that the values of ϕ for wet sand were 6° or more smaller than those for dry sand. Yet, direct shear tests by Terzaghi indicated essentially identical values in either state. The discrepancy was resolved by replacing p by p' in equation (2), whence

$$s = p' \tan \phi = (p - u) \tan \phi \quad (3)$$

In this form. Coulomb's equation is valid.

Curiously enough, Coulomb himself made no measurements to determine ϕ and assumed a value of 45° in his application of equation (2). Indeed, until the principle of effective stress was understood, meaningful tests of the physical properties of soils could not be performed.

Seepage Pressure.—If water flows through a deposit of sand, the viscous drag tends to move the grains in the direction of the flow and produces a force, known as a seepage pressure, between the grains. The seepage pressure is an intergranular stress. If upward flowing water produces a seepage pressure just equal and opposite to the submerged weight of the sand above a given horizontal section, the intergranular pressure becomes zero and, according to equation (3), the strength of the sand becomes zero. The sand is said to be in a "quick" condition and is incapable of supporting a load on its surface.

Where flowing water emerges from a cohesionless deposit the seepage pressure has a component directed outward and away from the surface and tends to dislodge and remove some of the smaller particles. If the process continues, a tunnel-shaped cavity or "pipe" may develop. The formation of such pipes beneath or within dams has led to several catastrophic failures. It may be prevented by blanketing the surface where the seepage emerges with coarser materials that permit escape of the water but prevent erosion of the fines. If the seepage pressure has a great enough upward component, it may be necessary to add weight to the top of the filter to counterbalance the upward forces.

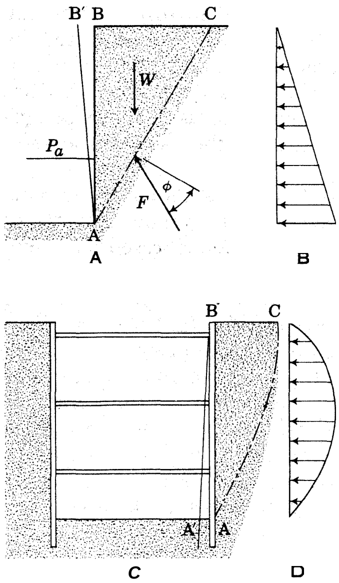

FIG. I.— SHEARING RESISTANCE
(A) Forces assumed by Coulomb in calculating earth pressure against retaining wall; (B) distribution of pressure against wall; (C) braced cut; (D) distribution of earth pressure against sheeting

Shearing Resistance.— The shearing resistance of soil is a primary factor in several problems of engineering importance. It governs the pressure against retaining- walls, bulkheads and the timbering of braced cuts. It also determines the bearing capacity of footings and piles and the stability of slopes, embankments and dams.

One of the first problems to receive attention in soil mechanics was the calculation of the pressure of earth against retaining walls. Coulomb solved the problem by considering the equilibrium of a triangular wedge of earth behind the wall (fig. 1[A]). He assumed the surface of sliding AC to be plane. The resultant force F on the surface of sliding was assigned the inclination ϕ to the normal to the surface, implying fully developed shearing resistance along AC. By allowing the inclination of AC to vary; Coulomb found the plane on which slip was most likely to occur, and the corresponding value of earth pressure $P_{a'}$ designated as the active earth pressure. He assumed this pressure to act horizontally at the lower third point of the wall.

Coulomb's theory proved, with slight modifications, to be satisfactory for ordinary retaining walls and is widely used today. However, it failed to account for the pressures that practical men observed against the bracing of open cuts. Experience indicated that the load in the upper braces was substantially greater than that given by the theory, whereas the bracing at the bottom was very lightly loaded.

Theorists generally ignored these observations. and practical men generally discounted the theories. The state of contradiction was not clarified until in 1920 Terzaghi recognized the great importance of the manner in which the support may yield. In connection with a retaining wall, the supporting surface AB yields into the position AB' and permits an uniform degree of lateral expansion in the entire sliding wedge XBC; the resulting lateral pressure increases linearly with depth (fig. 1[B]). On the other hand, in a braced cut, lateral expansion of the upper part of the wedge is restricted as soon as the uppermost brace is set; the deformation of the sheeting is likely to resemble BA′ in fig. 1(C). The large expansion at the bottom of the wedge is associated with a reduction of pressure at the bottom of the cut and an increase at higher levels. The corresponding pressure distribution is roughly parabolic (fig. 1[D]). Moreover, the surface of sliding is no longer plane but is curved. The general wedge theory of earth pressure (Terzaghi; 1939) took account of these factors and provided the means for calculating the loads in temporary bracing systems. The theory was confirmed by full-scale measurements on the bracing of the Berlin subway. Subsequently, it nas found applicable to clay soils and confirmed by numerous full-scale field measurements. including a series on the Chicago subway.

Slope Stability.— Closely related to problems in earth pressure are those dealing with the stability of slopes. Before about 1920 it was assumed that every soil possessed an angle of repose and that slopes would be stable if established at angles slightly smaller than the appropriate angles of repose tabulated in various handbooks. Occasional catastrophic slides, particularly in clay soils, indicated from time to time the inadequacy of the procedure. In particular, a series of slides on the Snedish state railways near the beginning of the 20th century, culminating in one with a loss of 41 lives. led to the appointment of a Royal Swedish Geotechnical commission to study the degree of safety of existing slopes and to suggest remedial and precautionary measures. The report of the commission, published in 1922, contained the most complete analysis of landslides up to that time. It made the first extensive use of what is now called the Swedish method of stability analysis. The method is based on the empirical observation that the surface on which a slide occurs is almost always an approximately circular arc. The principle of the method is shown in fig. 2. The mass ABC tends to rotate about O under the influence of the weight W_1. The rotation is resisted by the moment of W_2 and by the moment of the shearing resistances s acting along the circular arc AC. The value of s required to prevent a failure (factor of safety = 1) is

$$s = \frac{W_1 l_1 - W_2 l_2}{R\widehat{AC}} \tag{4}$$

The factor of safety of the slope may be determined by comparing s from equation (4) with the value of shearing strength determined by laboratory or field tests The position of the surface of sliding for nhich the factor of safety is a minimum is found by successive trials.

Most currently used procedures for stability analysis are derived from the Swedish method. Since slides frequently occur in clayey soils. information is needed regarding the shearing strength of clays. Coulomb expressed the relation between shearing strength s and normal pressure on the surface of sliding

$$s = c + p \tan \phi \tag{5}$$

as where c was called the cohesion. or the shearing strength at zero normal pressure, and the other symbols have the same meaning as in equation (2). However, even with the replacement of p by p', equation (1), Coulomb's equation was found to be inadequate because the value of s was found to be a function of the loading history of the clay. Research has not yet fully clarified this aspect of the subject. For saturated clays that do not experience change in water content under stress, however. the shearing strength with respect to total stresses is independent of the pressure. That is. such clays behave as frictionless materials and their strength is where q_u is the ulti-

$$s = c = q_u/2 \tag{6}$$

mate strength of a cylindrical or prismatic specimen tested axially in a simple compression test. Many problems of practical importance can be treated in this manner.

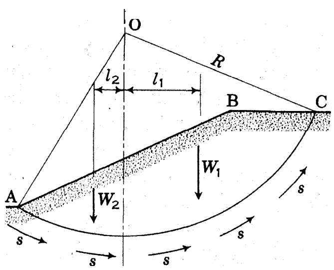

FIG. 2.— FORCES TENDING TO CAUSE AND PREVENT FAILURE OF A SLOPE ALONG A CYLINDRICAL SURFACE

Settling of Structures.— The settling of structures located above deep beds of soft clay long proved baffling to foundation engineers, particularly since such settlings often continued to increase many years after completion of the structures. Inasmuch as the damaging effects of the settling often did not develop until the settling had reached an advanced state, buildings frequently appeared to crack and deteriorate spontaneously. Several engineers had suspected that the settling was the result of slow squeezing of the water from the pores of the clay. but no satisfactory quantitative explanation was available until Terzaghi proposed the theory of consolidation in 1923. According to this theory, clay consists of mineral particles arranged in a structure that is at once relatively compressible and fairly impermeable. The voids between the mineral particles may constitute an appreciable fraction of the total volume, but the openings between the voids are very small and restrict the flow of water. The voids are considered to be filled with water, which is inherently less compressible than the mineral skeleton. Hence, a load when first applied to the clay soil is carried almost exclusively by the water. The compression of the clay structure: and hence the settling of the ground surface, take place. in accordance with the principle of effective stress, only as the stress is transferred from the water to the clay structure.

Terzaghi proposed an instructive analogue to the process of consolidation of clay. In its simplest form. it consists of a water-filled cylindrical container closed by a piston supported by a spring. The spring represents the clay skeleton. The piston represents the boundary between two void spaces in the clay. It is pierced by a hole AB which permits escape of water at a slow rate corresponding to the low permeability of clay. If a load P is suddenly placed on the piston. no shortening of the spring can occur at the first instant because no water has yet escaped from the cylinder. Since the spring must shorten to carry additional load, the load P must produce an additional pressure P/A in the water, and the pressure gauge will indicate this value. There is now set up across the opening AB a pressure differential equal to P/A, which produces a flow of water from the chamber. As the water flows out the spring correspondingly shortens and carries load in proportion to its shortening. With the spring carrying part of the load, the pressure in the water is less than P/A. The pressure differential across AB is reduced, the rate of flow decreases and the rate of settling decreases. The process continues at a decreasing rate until. after a very great time: the excess pressure in the water approaches zero. The rate of settling of the piston corresponds to the rate of transfer of the total pressure P/A from the water to the spring. By analogy, the rate of settling of a clay stratum is governed by the rate of transfer of the total pressure caused by the construction from porewater pressure to intergranular or effective pressure. The rate of transfer, in turn, is a function of the compressibility of the soil structure! the permeability of the clay and the viscosity of the water.

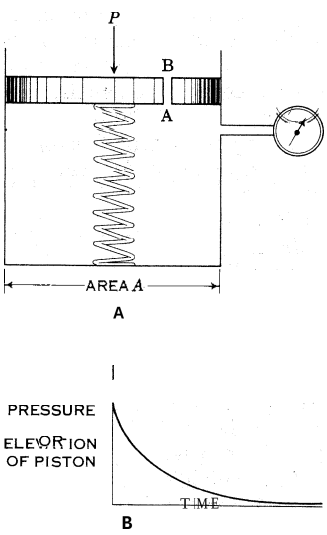

FIG. 3.— PISTON ANALOGY TO PROCESS OF CONSOLIDATION
Diagram (B) shows progress of consolidation with time

The mechanism of consolidation provides an explanation for several hitherto unexplained phenomena, including the settling of the ground surface associated with pumping from underlying aquifers. The reduction in pore pressure associated with pumping induces consolidation of any clay layers above or below the aquifer. Large settlings due to this phenomenon have occurred at many places, including Mexico City and the Santa Clara valley in California.

The accuracy with which settlings can be predicted on the basis of soil mechanics varies to a considerable extent with the geology and character of the deposits involved. Under the most favourable circumstances, computed and observed settlings agree satisfactorily until the settling reaches about 60% of the computed final value. Thereafter the real settlings are likely to exceed the computed ones by an amount that is usually, but not always, a small fraction of the total settling. The additional settling partakes of the character of a slow creep; the discrepancy is greatest for highly organic soils.

Sampling and Testing. — The structure of most compressible soils is sensitive to disturbance If the samples from which values of compressibility and other physical properties are determined have experienced disturbance. the predictions based on the test values may be seriously in error. To avoid this difficulty, drilling and sampling techniques have been devised to permit procurement of specimens as undisturbed as possible. The most refined samplers consist of thin-walled tubes that are pushed steadily, without driving, into the ground. with an internal piston that remains at a fixed elevation such that the length of sample recovered is equal to the distance of penetration. Techniques have been developed for investigating the properties of the soils in *situ;* research is actively being conducted in this field. Nevertheless, errors due to disturbance remain significant; their evaluation requires full-scale field observations.

The greatest source of error in the application of soil mechanics lies in the heterogeneous character of most natural soil deposits. The products of natural processes are almost always complex and cannot economically be investigated in sufficient detail to determine soil properties completely. In some instances. only average values can be estimated. together nith probable variations from the average. Kevertheless, useful predictions of settlement and other aspects of engineering behaviour can be derived from such estimates and the principles of soil mechanics.

See Karl Terzaghi. "Origin and Functions of Soil Mechanics," *Trans. Amer. Soc. Civ. Engrs.*, vol. *CT*, pp. 666–696, contains extensive bibliography (1953); Karl Terzaghi and Ralph B. Peck, *Soil Mechanics in Engineering Practice* (1918). (R. B. P.)

SOIL TESTING AND ANALYSIS. In studying and characterizing the properties of different soils, many kinds of soil analyses are used. Chemical analyses are made to determine the amounts of each element or chemical compound present and the chemical reactions that occur in soils. Analyses of the physical properties of soils provide information concerning soil texture (the proportions of sand. silt and clay), soil structure (the degree of aggregation) and the movement of air and water in soils. The minerals present are identified and studied by mineralogical analyses. Microbiological analyses are used to study the kinds and numbers of different microorganisms and the processes carried on by these microorganisms in the soil.

Research of this kind has led to the development of relatively simple soil analyses commonly referred to as soil tests. In agriculture such tests are used most extensively to evaluate nutrient availability in soils and to predict whether increases in crop yield or quality will result from applications of lime or fertilizer. The development of these simpler tests occurred largely after 1930. Previous attempts to relate nutrient availability in soils to the total amount of a nutrient element present in the soil or to that present in the soil water were not successful. Only when testing procedures were developed to remove and measure certain readily available portions of the nutrient elements present in soils could definite relationships between the soil-test results and plant availability of the nutrients be established.

Following World War II interest in soil testing increased rapidly. The United States. most of the European countries and many other countries developed or expanded soil-testing laboratories to test soil samples from farmers' fields and advise the farmers as to the lime and fertilizer practices best suited for their soil conditions. While the majority of the testing is done for field soils, some laboratories make special tests for soils used in greenhouses or for other special uses. Most soil-testing laboratories are operated by agricultural colleges or universities or by governmental agencies. However, a number of commercial laboratories, especially in the United States, offer this service to farmers.

Individuals may buy small soil-testing kits to test their own soils although this procedure is not generally recommended by soil scientists.

The first step in soil testing is the collection of the sample in the field. Proper sampling is essential if the advice based upon the soil test is to be reliable. If soil conditions in the field vary because of different types of soil or different previous treatments, each condition should be sampled separately. Usually 15 or more small samples from a uniform area are collected and thoroughly mixed to provide one representative sample.

In the laboratory different tests are made for different nutrient elements. The amount of lime that should be applied is usually estimated from the pH (a measure of the acidity) of the soil sample. While tests for phosphorus and potassium are made almost universally, the testing procedures used in different laboratories are extremely varied. Solutions of acids, bases or salts of various concentrations or mixtures of these reagents may be used to extract the phosphorus or potassium from the soil. Then the phosphorus or potassium in the extract is determined. Certain reagents may provide reliable tests of nutrient availability in some soils but not in others, so different reagents are used in different laboratories.

Chemical soil tests for nitrogen are less commonly used. Most of the nitrogen used by plants is made available by microbiological decomposition of organic matter. Tests to measure the rate at which nitrogen is released from the organic matter have been developed but have not been widely adopted. Some laboratories test for calcium and magnesium in soil extracts similar to those used for potassium. Many soils contain soluble salts in amounts that are detrimental to plants. Most laboratories test for soluble salts by measuring the electrical conductivity of a soil-water suspension or of a water extract of the soil.

The boron removed in hot-water extracts of soil samples is determined in some laboratories in areas where boron deficiencies occur. Adequate soil tests for other minor elements such as manganese, copper, zinc, molybdenum, iron, etc., have not been used extensively.

For advising farmers on the use of lime and fertilizer, the soil-test results must be interpreted differently for different crops, soils and environmental conditions. Laboratory tests can provide only a relative measure of nutrient availability, not the actual amount of a nutrient element that will be available to plants during a growing season. Furthermore, different plants have different nutrient requirements. Various environmental conditions and soil properties influence nutrient availability to plants growing in a field. but do not influence the soil-test results. Because of this, the soil-test results must be interpreted differently for these different conditions. The interpretation must be based upon relationships developed between the soil-test results and the results obtained in fertilizer experiments conducted in the field under each of the different conditions.

Where adequate relationships have been developed, soil tests are useful guides in advising farmers on the use of lime and fertilizer. Much research is continually devoted to the development of better testing methods and to improving the relationships between the laboratory and field results for various soils and crops.

See also SOIL.

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SOISSONS, a city of France, capital of an arrondissement in the *département* of Aisne, 65 mi. N.E. of Paris by the railway to Laon. Pop. (1954) 18,901.

Soissons is generally identified with the oppidum of Gallia Belgica, called Noviodunum by Caesar. Noviodunum was the capital of the Suessiones, who occupied 12 towns, and whose king, Divitiacus, one of the most powerful in Gaul, had extended his authority even beyond the sea among the Britons. In 58 B.C. Galba. king of the Suessiones, separated from the confederation of the Belgians and submitted to the Romans. At the beginning of the empire Noviodunum took the name of Augusta Suessionum, and afterward that of Suessiona. and became the second capital of Gallia Belgica, of which Reims was the metropolis. The town was before long surrounded with a wall and defended by a citadel, and it became the starting point of several military roads.

Christianity was introduced by St. Crispin and St. Crispinian, men of noble birth, who, however, earned their livelihood by shoemaking, and thus became patrons of that craft. After their martyrdom in c. 286 their work was continued by St. Sinitius, the first bishop of Soissons. After the barbarians had crossed the Rhine and the Meuse Soissons became the metropolis of the Roman possessions in the north of Gaul, and on the defeat of Syagrius by Clovis in 486, the Franks seized the town. It was at Soissons that Clovis married Clotilde, and, though he afterward settled at Paris, Soissons was the capital of his son Clotaire, and afterward of Chilperic I, king of Neustria. It was not till the time of Chilperic's son. Clotaire II. that the kingdom of Soissons was incorporated with that of Paris. Pippin the Short was at Soissons proclaimed king by an assembly of *leudes* and bishops, and he was there crowned by St. Boniface before being crowned at Saint Denis by the pope himself.

Louis the Pious did penance there after being deposed by the assembly at Compiègne.

Under Charles the Fat (886) the Normans failed in an attempt against the town, but laid waste St. Médard and the neighbourhood. In 923 Charles the Simple was defeated outside the walls by the supporters of Rudolph of Burgundy, and Hugh the Great besieged and partly burned the town in 948. Cnder the first Capets Soissons was held by hereditary counts.

The communal charter of the town dates from 1131. At a synod held at Soissons in 1121 the teachings of Abélard were condemned, and he was forced to retract them. In 1155, at an assembly of prelates and barons held at Soissons, Louis VII issued a famous decree forbidding all private wars for a space of ten years; and in 1325 Charles the Fair replaced the mayor of Soissons by a royal provost dependent on the bailiwick of Vermandois, the inhabitants retaining only the right of electing four *échevins.*

The town had to suffer severely during the Hundred Years' War; in 1414, uhen it was held by the Burgundians, it was captured and sacked by the Armagnacs under the dauphin; and this same fate again befell it several times within 20 years. The treaty of Arras (1435) brought it again under the royal authority. It was sacked by Charles V in 1544 and in 1565 by the Huguenots, who laid the churches in ruins, and, supported by the prince of Condé, count of Soissons, kept possession of the town for six months.

During the league Soissons eagerly joined the Catholic party. Charles, duke of Mayenne, made the town his principal residence, and died there in 1611. A European congress was held there in 1728.

In 1814 Soissons was captured and recaptured by the allies and the French. In 1815, after Waterloo, it was a rallying point for the vanquished, and it was not occupied by the Russians till Aug. 14. In 1870 it capitulated to the Germans after a bombardment of three days.

During World War I Soissons was for most of the time just behind the Franco-British lines, but the Germans passed it in 1918 in their thrust for Paris (May 27) ; it was retaken in the Franco-British offensive of July 18, 1918.

In the middle ages Soissons was the chief town of a countship belonging in the 10th and 11th centuries to a family which apparently sprang from the counts of Vermandois. Renaud, count of Soissons, gave his property in 1141 to his nephew Yves de Nesle. By successive marriages the countship of Soissons passed to the houses of Hainaut, Châtillon-Blois, Coucy, Bar and Luxembourg. Marie de Luxembourg brought it, together with the counties of Marle and St. Pol, to Francis of Bourbon, count of Vendôme, whom she married in 1487.

His descendants, the princes of Condé, held Soissons and gave it to their cadets. Charles of Bourbon, count of Soissons (1566-1612), son of Louis, prince of Condé, whose political vacillations were due to his intrigues with Henry IV's sister Catherine, became grand master of France and governor of Dauphin6 and Normandy. His son, Louis of Bourbon (1604–41), took part in the plots against Marie de Medici and Richelieu, and attempted to assassinate Richelieu. He had only one child, a natural son, known as the Chevalier de Soissons. The countship passed to the house of Savoy-Carignano by the marriage in 1625 of Marie de

Bourbon-Soissons with Thomas Francis of Savoy. Eughne Maurice of Savoy. count of Soissons (1635–73), married the beautiful and witty Olympia Mancini, a niece of Cardinal Mazarin, and obtained high military posts through his wife's influence. He defeated the Spaniards at the battle of the Dunes in 1658; took part in the campaigns at Flanders (16673, Franche-Comté (1668) and Holland (1672); and was present as ambassador extraordinary of France at the coronation of Charles II of England. His wife led a scandalous life, and was accused of poisoning her husband and others. She was the mother of Louis Thomas Amadeus, count of Soissons, and of the famous Prince Eughne of Savoy. In 1734 the male line of the family of Savoy-Soissons became extinct, and the heiress, the princess of Saxe-Hildburghausen, ceded the countship of Soissons to the house of Orleans, in whose possession it remained until 1789.

Soissons, surrounded by wooded hills, stands on the left bank of the Aisne, the suburbs of St. Vaast and St. Médard lying on the right bank. The cathedral of Notre-Dame, partly ruined in World War I, was begun in the second half of the 12th century and finished about the end of the 13th. It is 328 ft. long and 87 wide, and the vaulting of the nave is 100 ft. above the pavement. The single tower dates from the middle of the 13th century and is an imitation of those of Kotre Dame of Paris, which it equals in height (216 ft.). The south transept. the oldest and most graceful portion of the whole edifice, terminates in an apse. The façade of the north transept dates from the end of the 13th century. The apse and choir retain some fine 13th-century glass.

Considerable remains exist of the magnificent abbey of St. Jean-des-Vignes, where Thomas Becket resided for a short time. These include the ruins of two cloisters (the larger dating from the 13th century). the refectory. and above all the imposing façade of the church (restored). Above the three portals (13th century) runs a gallery, over which again is a large window; the two unequal towers (230 and 246 ft.) of the 15th and early 16th centuries are surmounted by beautiful stone spires. which command the town.

The church of St. Léger, which belongs to the 13th century, was formerly attached to an abbey of the Génovéfains. Beneath are two Romanesque crypts. The royal abbey of Notre-Dame was founded in 660 for monks and nuns by Leutrade, wife of Ebroïn, the celebrated mayor of the palace.

The wealthiest of all the abbeys in Soissons, and one of the most important of all France during the first two dynasties. was that of St. Médard. on the right bank of the Aisne, founded about 560 by Clotaire I, beside the villa of Syagrius. which had become the palace of the Frankish kings. St. Médard, apostle of Vermandois, and kings Clotaire and Sigebert were buried in the monastery, which became the residence of 400 monks and the meeting place of several councils. It was there that Childeric III. the last Merovingian, was deposed and Pippin the Short was cron-ned by the papal legate, and there Louis the Pious was kept in captivity in 833. The abbots of St. Médard coined money, and in Abélard's time (12th century) were lords of 220 villages, farms and manors. At the battle of Bouvines (1214) the abbot commanded 150 vassals.

In 1530 St. Médard was visited by a procession of 300.000 pilgrims. But the religious nars ruined the abbey, and. although it was restored by the Benedictines in 1637, it never recovered its former splendour. Of the churches and the conventual buildings of the ancient foundation there hardly remains a trace. The crypt of the great abbey church dates from about 840. In it is a stone coffin said to have been that of Childebert II, and close at hand is an underground chamber, reputed to have been the place of captivity of Louis the Pious.

Among the industrial establishments are iron and copper foundries and factories for the production of boilers, agricultural implements and other iron goods, rubber goods, glass and sugar. There is a large trade in grain for the provisioning of Paris.

SOKOLNIKOV, GREGORY YAKQVLEVICH (1888–), Russian Communist, was the son of a doctor. He studied in Moscow and at Paris. From 1909 until the revolution of Feb. 1917 he lived abroad. After the Kovember Revolution, Sokolnikov at first worked in the Soviet finance department. At the end of 1921. immediately after the proclamation of the New Economic Policy. Sokolnikov was appointed to the committee of the people's commissariat of finance: at the beginning of 1922 he was deputy people's commiisar and commissar soon after. In four years (1922–25) the system of taxes was restored, and the budget was put in order. The reform of the currency was begun at the end of 1922, and the new state bank nas given the right of issuing notes: it nas completed in 1924 with the reorganization of the treasury bills and the stabilization of the Soviet currency. At the end of 1925, when dissensions arose in the Communist party on the economic-political question. Sokolnikov criticized the government policy After the 14th congress of the Communist party in Jan 1926 he mas removed from the post of commissar of finance and appointed deputy president of the Gosplan, or state planning commission. He was ambassador to Great Britain, 1929–32. In Jan. 1937 he was sentenced to 10 years' imprisonment for treason

SOKOLOW, NAHUM (1859–1936), Jewish writer and journalist was born in Wyszogrod Poland. He started writing at an early age, and soon became a regular contributor to many Hebrew periodicals. In 1881 he became editor of the Hebrew journal *Hatzefirah,* and under his direction it grew into the best informed Hebrew newspaper. Sokolow became known as the founder of modern Hebrew j journalism. He became associated with the World Zionist organization, headed by Theodor Herzl, and was made general secretary, and in 1931 president, of that organization. Sokolow founded and became editor of the weekly *Haolam*, official publication of the Zionist organization. He was the most prolific Jewish writer of his time, and among his works are: *Sinath Olam Leam Olam* (1882), a history of anti-Semitism: *Tzaddik Venisgab* (1883), a historical novel; *Eretz Hemdah* (1889), a geography of Palestine.

SOKOTO, a province of the Northern Region of Nigeria. It is bounded on the north by Nigcr and west by Dahomey, covers an area of 36,477 sq.mi. and had a population of 2,680,558 in 1953. The province is divided into two main physiographic zones: the northwestern part is dry and sandy while the south has heavier soils and a higher rainfall. The natural vegetation is thorn scrub. The Sokoto river and its many tributaries combine to drain almost the whole area. Guinea corn. millets and rice are the main food crops and where the soil is suitable peanuts and cotton are grown for export. There is aiso an important trade in the Sokoto red goatskins which are used for making the best "Morocco" leather. Large-scale mechanical cultivation of rice was introduced after World War I The town of Sokoto is both the provincial headquarters and the home of the sultan who is traditionally the religious leader of the Mohammedans of northern Nigeria. Gusau ranks next to Kano as a commercial centre in the north. (X.)

The Mausa States.—The years 1804–05, when Mungo Park was engaged in his last journey in quest of the Niger river, were the years when Shehu Usuman Dan Fodio. leader of the Nigerian Fulani, began his conquest of the seven Hausa states. The Hausas occupy the plains between the Niger and Lake Chad and were conquered about the 10th century by a pastoral people known as the Zaghawa or Berber. Since the Berbers were few in number they must have fused with the indigenous Negro stock. The caravan routes, via the Sahara, linked Hausaland with the Barbary states. In the 14th century Islam was introduced, and with Islam came Arab culture and civilization. Politically the Hausa states were never united; from rime to time each fell a prey to some foreign power. Large sections of the people embraced Islam but the Hausas never wholly abandoned their ancestral religion.

The **Fulani** Empire.—The Fulani (a Hamitic people) entered the Hausa country in the 13th century. From that date til! the last years of the 18th century they wielded no political power as a group and were, for the most part, herdsmen and devout Mohammedans who paid tribute to the Habbe rulers. At the end of the 18th century, however, they had become increasingly influential and not a few rose to positions of importance in the Hausa country. Gobir, militarily the most powerful of the kingdoms, was their stronghold. The Hausa rulers bitterly resented the growing power of their nomadic subjects. About this time arose a great Fula teacher. a fanatical Moslem and a man of vivid eloquence, Shehu Usuman Dan Fodio. His journeys among the people of Gobir produced a religious revival, and he won devoted disciples. His denunciation of the reversion to the ancestral religion, so prevalent at the time, brought him into collision with the Hausa rulers who feared his growing influence. He incurred the wrath of his former pupil, Yunfa, chief of Gobir, who in 1804 threatened to attack him and his followers. The threatened Fulani flocked to the banner of Shehu and so did a great number of Hausas. They elected him *Sarkin Musulmi* or "Commander of the Mohammedans." The Gobir forces marched against the Fulani but in a battle at Tabkin Kwotto they were severely defeated. Thereupon the Shehu unfurled the banner of Mohammed and preached a jihad or religious war. In a few years the Fulani subdued many of the Hausa states. Zaria fell in 1804. Katsina was captured after a long siege in 1805 and. later in the year, Kano fell to the invaders. Other states such as Gobir. Kebbi, Bornu and the hill tribes offered bitter resistance and were never wholly conquered. The shehu remained true to his religious ideal but his adherents degenerated into mere adventurers. Fulani soldiers raided pagans and Moslems alike.

Sokoto.—The Fulani town of Sokoto was converted by Dan Fodio into the headquarters of his growing empire. He and his successors came to be known as sultans of Sokoto and *Sarkin Musulmi,* indicating their spiritual authority. In 1810 nhen his jihad was practically complete, Dan Fodio turned his attention to the organization of his dominions. He divided them into two parts. To his son Bello he gave the east and to his brother Waziri Abdullahi, the west. Bello retained Sokoto as his capital and Abdullahi Gwandu. The empire was administered from those twin capitals for about a century. Shehu adopted the elaborate machinery of government and taxation, based on Koranic law, which he found already existing in the Hausa states.

Advent of British Power.—The rise of the Sokoto Fulani coincided nith the European exploration of the west African interior. Contact nith the outside world, by way of the Niger river, increased with the expansion of British trade, and the Fulani were drawn into the politics and diplomacy of the period when Africa was partitioned among European powers. In 1879 the United African company (later the National African company and in 1886 the Royal Niger company) was founded by George Goldie-Taubman (later Sir George Goldie; *q.v*) and became. from the 1880s, the chief instrument of the British penetration and conquest of Nigeria. In 1900 this company transferred to the British crown certain rights of sovereignty it had acquired through treaties with the Fulani rulers. In the same year the protectorate of northern Nigeria replaced the administration of the Royal Niger company. In March 1903 following the capture of Kano, the city of Sokoto submitted to the invaders. Within a hundred years of its foundation the Fulani empire collapsed Sir Frederick (later Lord) Lugard (*q* v), who completed and consolidated the subjugation of Hausaland, introduced the system of indirect rule. Through this system loyal Fulani rulers were retained as amirs or chiefs of their respective territories and became the instruments of British rule in northern Nigeria. The Fulani thus retained, although in modified form, their position as the rulers of Hausaland. (K. O. D.)

SOKOTRA (also spelled SUQUTRÁ, SOQOTRA and SOCOTRA), an island under British protection in the Indian ocean, about 150 mi. E.N.E. of Cape Guardafui; length, 72 mi., breadth, 22 mi., area, 1,200 sq.mi. It is the largest and most easterly of a group of islands, the others being Abd-el-Kuri, the Brothers (Semha and Darzi) and Kal Farun. Politically, it forms part of the Mahri sultanate of Kishin and Sokotra (or Qishn and Soqotra), within the eastern area of the Aden protectorate.

The centre of the island is formed of Archean gneisses and granites with slightly younger schists. These form the highest peaks, the Haggier mountains, 4.686 ft. Resting on these rocks are Cretaceous and Eocene strata (chiefly limestone), which, scarcely disturbed, form an undulating plateau between 1,000 and 1,500 ft. above sea level. Some of these limestones are pierced by dikes and in the southeast by a small volcanic centre with trachytic and rhyolitic lavas. At many parts of the north coast the edges of the plateau reach the shore in precipitous cliffs, but in others wide alluvial plains. dotted with bushes and date palms, front the heights behind. There are no harbours but there are anchorages off Hadibu (Tamrida), the capital, Qadhub and Kallansiya. The fauna contains no indigenous mammals: there is a wild ass. probably of Nubian origin; the domestic cattle may be a race developed from cattle imported from Sind or Indonesia. Of the flora aloes, dragon's blood *(Dracaena),* myrrh, frankincense, pomegranate and cucumber trees are the most famous species The flora and also the fauna present not only Asian and central African affinities, but, what is more interesting, Mascarene, south African and Antipodean-American relationships, indicating that the island represents part of Gondwanaland. (W. H. Is.)

History.—Sokotra has claims to be reckoned one of the most ancient incense-supplying countries, and it is probably referred to by the Egyptians under the name "Terraces of Incense."

To the Greeks and Romans Sokotra was known as the isle of Dioscorides; this name and that by which the island is now known are usually traced back to a Sanskrit form, Dvipa-Sakhadhara, "the island abode of bliss." The *Periplus* of the Erythraean sea speaks of the island as peopled only in one part by a mixed race of Arab, Indian and Greek traders. It was subject to the king of the incense country, and was a meeting place of Arabian and Indian ships. Cosmas in the 6th century says that the people spoke Greek and were largely Christian. uith a bishop sent from Persia. They appear to have remained Nestorian Christians. with a bishop under the metropolitan of Persia, through the middle ages, though there are indications pointing to a connection with the Jacobite church. As early as the 10th century Sokotra was a haunt of pirates; in the 13th century Abulfeda describes the inhabitants as "Nestorian Christians and pirates" but the island was rather a station of the Indian corsairs who harassed the Arab trade with the far east. The population seems in the middle ages to have been much larger than it is now; Arabian writers estimate the fighting men at 10,000.

The Portuguese under Tristão da Cunha and Alphonso d' Albuquerque seized Sokotra in 1507 in pursuance of the design to control all the trade routes between Europe and the east, but abandoned it in 1511. They found that Sokotra was held by Arabs from Fartak, but the "natives" (a different race) were "Christians." though in sad need of conversion. As late as the middle of the 17th century the Carmelite P. Vincenzo found that the people still called themselves Christians, and had a strange mixture of Jewish, Christian and pagan rites. The women were all called Maria. No trace of Christianity is now found in the island, all the inhabitants professing Islam.

On the withdrawal of the Portuguese the dependence of Sokotra on Arabia was resumed. In the 19th century Sokotra formed part of the dominions of the sultan of Kishin. The opening of the Suez canal route to India led to the island being secured for Great Britain. In 1876 the British government undertook to pay a small subsidy to the sultan of Kishin, and in 1886 he agreed to place Sokotra and its dependencies under the protection of Great Britain. (X.)

Population and Economy.—In 1958 the population was estimated at 15.000. In the coastal settlements the inhabitants are mostly Arabs and Africans, while the nomadic pastoral people in the mountains are the true Sokotri, supposed to be originally immigrants from Arabia. Some of them are light skinned, straight nosed, with straight black hair, while others are shorter and darker with features more resembling those of Semitic people. Their manner of life is simple They live in circular, clay-topped houses, or in caves. Their diet is mainly meat, milk and dates. The Sokotri language is allied to the Mahri language of southern Arabia. Both are probably daughter tongues of the old Sabaean and Minaean. Sokotri is the older of the two languages. and retains the ancient form, which in the Mahran has been modified by Arabic and other influences.

The chief export is ghee, or clarified butter. Aloes, some frankincense, and the resin of the dragon's blood tree are the most valuable vegetable products. Civet are captured to obtain the secretion used in perfumery.

During World War II the Royal Air Force had a base on Sokotra. This brought considerably more contact politically with the Mahri sultan. who had undisputed authority in the island.

Other Islands.—Abd-el-Kuri Island lies between Sokotra and Cape Guardafui, 60 mi. from Sokotra, and is 20 mi. long and $3\frac{1}{2}$ mi. wide. At either end the island is hilly. It is formed chiefly of Archaean rocks and on the north side is a sandy beach; on the south cliffs rise abruptly from the ocean. The highest part (1,670 ft.) is toward its eastern end. It is largely arid and there are no permanent streams. Its fauna resembles that of Sokotra but includes land shells and scorpions peculiar to Abd-el-Kuri. The inhabitants (less than 200), speak Sokotri and Arabic and are chiefly engaged in diving for pearl shell on the Bacchus bank. They live mainly on turtle (which abounds in the island), fish and molluscs. The land is nowhere cultivated.

Kal Farun is the name of two rocky islets rising nearly 300 ft. above the sea, 13 mi. from the western end of Abd-el-Kuri. Birds flock to them in great numbers; in consequence they are completely covered with guano, which gives them a snow-white appearance. The Brothers lie between Abd-el-Kuri and Sokotra. Semha is 69 mi. long and 3 mi. broad. It has rocky shores and rises in a table-shaped mountain to 2,440 ft. As in Abd-el-Kuri ambergris is found on its shores and turtles abound. There is running water all the year and it is a fishing ground of the Sokotri. Darzi lies 9 mi. E. of Semha, is $3\frac{1}{2}$ mi. long by 1 mi. broad and rises almost perpendicularly from the sea to 1,500 ft. The coral banks which surround Sokotra and The Brothers are united and are not more than 30 fathoms below sea level; a valley some roo fathoms deep divides them from the bank around Abd-el-Kuri, while between Abd-el-Kuri and Cape Guardafui are depths of over 500 fathoms.

(W. H. Is.)

SOL. The name Sol, the sun, was given to two distinct deities at Rome. The original Sol, or Sol Indiges. had a shrine on the Quirinal and an annual sacrifice on Aug. 9. The worship appears to be native. The Roman poets, however, equate him with the Greek Helios.

The worship of Sol assumes an entirely different character with the later importation of various sun cults (*e.g.,* Mithraism; *q.v.*) from the east (Syria). Heliogabalus built a temple to him as Sol Invictus on the Palatine and attempted to make his worship the principal religion at Rome. Aurelian re-established the worship and erected a magnificent temple to Sol in the Campus Agrippae. The worship of Sol as special protector of the emperors and the empire remained the chief imperial cult until Christianity replaced it.

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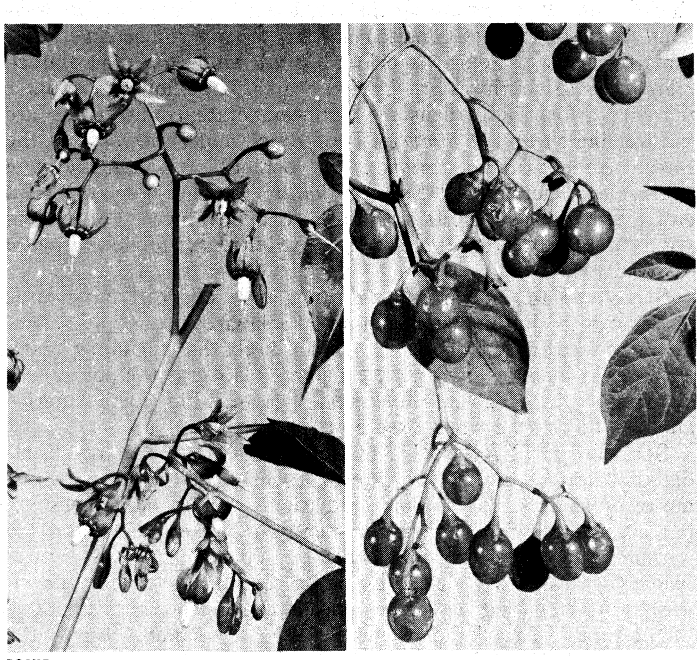
SOL, from 1863, the monetary unit of Peru, equal to roo centavos. Like all other countries of Spanish America, Peru had. at the attainment of its independence, a currency based on the peso (*q.v.*). The peso, or piece-of-eight, was equal at the beginning of the 19th century to about 48 pence, or roughly $1.00. When by a law of Feb. 14, 1863, the sol replaced the peso as the unit of the Peruvian currency it was defined as a silver coin weighing 2 j grams, 900/1000 fine. It was thus equivalent to the silver five-franc piece of the countries of the Latin Monetary union.

From 1872 on Peru was on a silver standard and, because of the decline of silver in terms of gold, the value of the sol fell from 48 pence to less than half that value in 1897. Because of its great economic dependence on Great Britain Peru at that time approximated its currency to the pound sterling and introduced the gold standard. The new exchange value of the sol was established at 24 pence, and a new unit, the Peruvian pound (£P) equal to 10 soles and 1 pound sterling was introduced. Although Peru coined some of its own gold coins, British sovereigns entered the country soon after the currency reform of 1897 and circulated freely.

Up to and during World War I the stable relation between the British and Peruvian pound was maintained, but from the end of 1916 to the early part of 1921 the Peruvian pound had a premium over the pound sterling, which at its peak, in 1920, amounted to $22\frac{1}{2}\%$. The Peruvian pound then stood at $4.59 in New York, whereas the pound sterling was as low as $3.64 In 1921 a gradual decline of the Peruvian exchange began nhich lasted, with few and short interruptions, until after World War II. The decline was caused at first by a flight of capital owing to distrust of the nenly established central bank, later to the weak international trade position of Peru and finally, after 1945, to severe inflationary pressure. Distrust in the stability of the Peruvian government also contributed to the neakness of the currency. (B. F. H.)

SOLANACEAE, a plant family of considerable economic importance, includes a number of species that produce food and drug narcotics or are used as fumitories or ornamentals. Prominent among these species are *Solanum tuberosum* (potato), *S. melongena* (eggplant), *Lycopersicon esculentum* (tomato), *Capsicum frutescens* (red pepper), *Physalis ixocarpa* (tomatillo), *Atropa belladonna* (atropine or belladonna), *Datura stramonium* (stramonium), *Hyoscyamus niger* (black henbane), *Duboisia hopwoodi* (pituri) and *Nicotiana tabacum* (tobacco). Some of the genera that contain ornamental species are *Petunia, Lycium, Solanum, Nicotiana, Datura, Salpiglossis, Browallia, Brunfelsia, Cestrum, Schizanthus, Solandra, Streptosolen* and *Nierembergiu.*

This family of dicotyledons belongs to the subclass Spmpetalae (or Gamopetalae) in the series Polemoniales. It includes about 90 genera with approximately 2,800 species which. though found throughout the world except in polar regions, are most abundant and widely distributed in the tropical regions of Latin America, where about 40 genera are endemic. Very few are to be found in temperate regions; and about 50 species are found in North America, north of Mexico. Only four species in three genera are known from Britain. The genus *Solanum,* which embraces more than two-thirds of all the species in the family, includes about 150 species in its section Tuberarium. This section comprises all the wild potatoes or tuber-bearing species, which are distributed primarily at high elevations in the mountains from Utah and Colorado southward through Mexico, Central and South America to the Island of Chiloe. Some of these wild potatoes, especially S. *demissum* of Mexico, have been widely used in the improvement of the domesticated potato. Alkaloids, especially the glucosidal alkaloid solanine, are the narcotic-poisonous principles prevalent in many of the species. These have given to the family its sombre vernacular name "nightshade." The alkaloids are of increasing interest and importance to the chemical and pharmaceutical industries. Many species in the Solanaceae have been used by primitive people in various parts of the world in their folklore and therapeutic



ROCHE

BITTERSWEET (SOLANUM DULCAMARA) FLOWERS AND FRUIT practices.

Included in the family are annual herbs, as *Solanum nigrum,* a common weed in waste places, and perennial herbs, as *Atropa belladonna,* the deadly nightshade; shrubs, as *Lycium halimifolium,* an old-fashioned garden plant; small trees, as *Datura sanguinea,* a South American ornamental with large reddish flowers; lianas, as *Solanum juglandifolium,* a showy rampant vine of South America; and prostrate creepers, as some Latin-American species of *Solanum.* The alternate leaves (or sometimes opposite near the inflorescence) are simple and entire, as in most species of *Lycium,* or are variously dissected, as represented by the extreme condition found in various species of *Lycopersicon* (tomato). The flowers are usually borne in extra-axillary cymes.

The hermaphroditic, generally regular, flowers have their parts in fives—five sepals, five petals, five stamens in alternating whorls and two carpels, which are generally placed obliquely. The corolla is regular and rotate, as in *Solanum tuberosum,* or bell-shaped, as in *Datura* and *Atropa* or somewhat irregular as in *Hyoscyamus;* in the tribe Salpiglossideae, which forms a link with the closely allied family Scrophulariaceae (*q.v.*), it is zygomorphic, forming, as in *Schizanthus,* a two-lipped flower. The stamens are inserted on the corolla tube and alternate with its lobes; in zygomorphic flowers only two or four fertile stamens are present. The flowers are generally conspicuous and honey is secreted on the disk at the base of the ovary or at the bottom of the corolla tube between the stamens. The ovary is usually bilocular but in *Capsicum* becomes unilocular above. while in some cases an ingrowth of a secondary septum makes it four celled, as in *Datura,* or irregularly three to five celled, as in *Nicandra.* The anatropous ovules are generally numerous on swollen axile placentae. The style is simple and bears a bilobed or capitate stigma. The fruit is a many-seeded berry, as in *Solanum,* or capsule, as in *Datura,* where it splits lengthwise, and *Hyoscyamus,* where it opens by a transverse lid forming a pyxidium. The embryo is bent or straight and embedded in endosperm. The persistent calyx may serve to protect the fruit or aid in its distribution, as in the bladdery structure enveloping the fruit of *Physalis.*

The family is divided into five tribes after Richard von Wettstein; the division is based on the greater or less curvature of the embryo, the number of ovary cells and the regular or zygomorphic character of the flower. These tribes are Nicandreae, Solaneae, Datureae, Cestreae and Salpiglossideae. The great majority of the genera belong to the tribe Solaneae, which is characterized by a two-celled ovary. Some additional species of less importance than those already considered are *Physalis alkekengi* (winter cherry) and *P. peruviana* (cape gooseberry); *Lycopersicon pimpinellifolium* (currant tomato) and *Cyphomandra betacea* (tree tomato), both of South America; *Datura metel* of India and *D. meteloides* of southwestern United States. large-flowered annuals that are grown in gardens in warm-temperate countries, as are the treelike shrubs *D. suaveolens* of Brazil and *D. arborea* of the central Andes; *Solanum muricatum* (pepino), *S. pseudocapsicum* (Jerusalem cherry) and *S. integrifolium* (scarlet eggplant), also cultivated for their fruits and aesthetic appearance. For *Atropa* *see* NIGHTSHADE; for *Hyoscyamus see* HENBANE; for *Mandragora* *see* MANDRAKE. (D. S. CL.)

SOLANUM, one of the largest genera of flowering plants. It belongs to the nightshade family (Solanaceae, *q.v.*) and comprises upvard of 1,200 species, chiefly herbs but including many shrubs. It includes important economic plants, as the potato and eggplant (*qq.v.*). Twenty-five species are found in North America and two in Great Britain (*see* NIGHTSHADE).

SOLAR ENERGY, UTILIZATION OF. Energy is radiated from the sun at the rate of about 43,000 kw. per square metre of solar surface. Solar radiation occupies only the small portion of the electromagnetic spectrum betneen 0.22 and 3.3 microns (μ). The invisibly short but potent ultraviolet naves below 0.4μ carry 9% of the incoming solar energy, while the invisible infrared heat waves beyond 0.7μ are responsible for 50% of the total. The "light" waves between these limits convey the remaining 41%, including the waves of maximum intensity at 0.48μ in the green portion of the visible spectrum. Both the amount and the spectral distribution of the energy radiated from the sun indicate that the effective temperature of its surface is close to 6,000° C. (10,800° F.).

Solar radiation falling on a surface normal to the sun's rays at the outer limit of the earth's atmosphere has an average intensity of 2 ($\pm 2\%$) cal. per minute per square centimetre (1.41 kw. per square metre; 442.2 B.T.U. per hour per square foot). This quantity, known as the solar constant, has apparently remained virtually unchanged, except for periodic minor variations, for several billion years. Only about 46% of the incoming solar energy actually reaches the earth's surface since, on the average, 35% is reflected back into space by clouds and the remaining 19% is absorbed by the atmosphere. The intensity of the sunshine which reaches any particular area on the earth varies from zero at sunrise through a noon maximum which may be as high as 300 to 350 B T.U. per hour per square foot on a cloudless day. Local weather bureau data must be consulted to obtain specific values for any particular locality (*see* SUN; SUNSHINE).

The total amount of solar energy reaching the earth is about 7×10^{17} kw.hr. per year, more than 30,000 times as much as is used in all man-made devices. This prodigious inflow of energy warms the earth and produces, through photosynthesis, all of the food, fuel and free oxygen upon which life depends.

Man has sought for many centuries to make direct use of the sun's radiant energy Thus far. his success has been meagre, primarily because sunshine is intermittent in availability; variable in direction; and relatively low in intensity. Apparatus intended for use with solar energy must in general be large in area; movable. so that it can follow the sun's apparent motion; and provided with some means for storing energy for use when the sun is not shining. Despite these formidable difficulties, significant advances have been made since 1750 in using solar energy to generate heat, to bring about chemical reactions and, most recently, to produce usable amounts of electricity.

Man learned long ago that heat is produced when the sun's rays are absorbed by a blackened surface. He found, too, that the amount of heat thus produced could be greatly intensified by using reflection or refraction to concentrate a large area of sunshine onto a small target. The concave silver mirrors left behind by the Incas and the convex quartz lens found in the ruins of Nineveh were probably used to light sacred fires by means of concentrated sunbeams. Archimedes is said to have devised a battery of mirrors to defend Syracuse in 212 B.C. by burning the sails of an invading fleet "at the distance of a bowshot." In 1747 G. L. L. Buffon set up a group of 140 flat mirrors in a Paris garden and ignited a stack of wood placed about 200 ft. from his reflectors, thus demonstrating that the feat attributed to Archimedes might indeed have been accomplished.

A. L. Lavoisier, who began to use solar energy for scientific purposes as early as 1772. was probably the originator of the device which is known today as the solar furnace. Enclosing specimens of various substances in transparent quartz vessels, he placed them at the focal point of a 52-in. diameter lens and used concentrated solar radiation to heat them in partial vacuum and in controlled atmospheres of oxygen and other gases. He first called attention to one of the principal virtues of the solar furnace when he wrote, "the fire of ordinary furnaces seems less pure than that of the sun."

Because of its unique ability to heat materials by intense radiation alone for long periods of time without contamination, the solar furnace has come into prominence as a tool for high-temperature research. Scientists have found that parabolic reflectors taken from antiaircraft searchlights can concentrate solar radiation so effectively that temperatures as high as 3,400" C. (6.100" F.) can be attained. Equatorial or altazimuth mountings are used to enable the concentrator to follow the apparent motion of the sun across the sky; sleeves or shutters are used to regulate the amount of radiation impinging on the target.

Most of the large solar furnaces in use avoid the inconvenience caused by target movement by using a flat mirror called a heliostat to track the sun across the sky and reflect its rays into a fixed paraboloidal concentrator. The largest furnaces of this type are those at Mont-Louis in the French Pyrenees and at Natick, Mass. Both use concentrators that are more than 30 ft. in diameter, made of many small curved glass mirrors arranged approximately in a paraboloidal configuration.

Solar sream generators were built by many pioneers during the 19th century. All of these used arrangements of movable mirrors to concentrate large amounts of solar radiation upon blackened pipes through which water was circulated and turned to steam. Both steam and hot-air engines were operated in this way with some degree of success as early as 1870, and ice was produced in Paris in 1878 in an ammonia-absorption refrigerator operated by a solar boiler. The use of solar energy for pumping irrigation water was tried in Arizona and California, employing a number of solar pumping stations using conical concentrators 30 ft in diameter. The largest of all solar-power installations was erected in 1912 on the bank of the Nile at Meadi, near Cairo, using a total of 14,000 sq.ft. of concentrating surface in the form of seven parabolic troughs, each 205 ft in length. The 100-h.p. steam engine connected to this great solar boiler actually produced between 50 and 60 h.p. continuously during one five-hour test, but the system was not economically competitive with other pumping apparatus and it nas abandoned during World War I.

All of these early installations suffered from the same deficiencies — irregularity of operation and excessive cost—and none survived. Interest in solar poner revived with the advent of artificial earth satellites, since these applications avoid such earthly problems as clouds, atmospheric absorption and low-cost competitive energy sources. Serious consideration is again being given to vapour cycles which would receive the full complement of solar radiation, 1.4 kw. per square metre, whenever their collectors turn toward the sun, and reject the unused energy by radiation into space.

When heat is needed at moderate temperatures for such purposes as distillation of salt nater, growing and drying of agriculturai products, cooking and the heating of buildings and domestic hot-aater supplies, solar energy can be used with considerable success, thanks to the "greenhouse" effect Common window glass and many plastic films have the property of transmitting nearly all of the solar radiation which falls on them, but they are relatively opaque to the long waves (8 to 40μ in wave length) emitted by any surface heated to 100°–200° C. (212°–392° F.). Thus a simple blackened wooden box, covered with several sheets of glass or plastic film, acts as an effective trap for solar energy when it is turned toward the sun. If its sides and bottom are insulated, the internal temperature can be raised as high as 150° C. (302" F.) by the unaided rays of a bright sun. M. K Ghosh in India (1945) and M. Telkes in the United States (1955) improved this simple solar stove by adding reflective wings to direct more sunshine into well-insulated ovens, achieving temperatures up to 200° C. (392° F.).

Solar water heaters have been in relatively wide use in Florida and the southwestern U.S. for many years. Most of these consist of flat sheets of blackened metal provided with tubes through which water circulates by natural or forced convection whenever the sun is shining. Wastage of the absorbed solar energy is minimized by covering the upper surface of the metal with a glazing of glass or plastic film, separated from the sheet by a small air space. The lower surface is insulated with rock wool, vegetable fibres or a reflective coating which cuts down radiation. Heaters of this type do not have to follow the sun's motion, since they operate efiectively if they are mounted in a fixed position facing the south (in the northern hemisphere) and tilted so that their angle nith the horizontal is equal to the local latitude plus 20". Temperatures up to 60° C. (140° F.) can readily be reached on sunny winter days, and the domestic hot-water requirements of a typical family living in regions south of latitude 35° S. can be met during most of the year by a heater having as little as 40 sq.ft. of surface.

Similar but much larger collectors can supply most of the heat needed in homes of moderate size in favourable localities. Storage of heat for use at night or during cloudy periods is accomplished by using large insulated tanks to store water heated during daylight hours. This system is particularly effective when radiant heating is used, with the warmed water flowing through tubes in floors and ceilings. Air can also be heated in suitably designed collectors and used in conventional warm-air systems. Heat storage can then be provided by using beds of gravel or containers filled with chemicals such as Glauber's salt which absorb heat at a suitable temperature when they melt and give off the stored heat nhen they solidify again.

Direct conversion of solar radiation into electricity can be accomplished on a small scale in several ways The thermoelectric effect, first discovered in 1821 and greatly improved during the 1950s by both Russian and U S. physicists, can be utilized by placing one set of thermocouple junctions in the focal region of a solar furnace while the other set is kept cool. The efficiency of conversion of solar to electric energy was extremely low, less than 1%, when only metallic thermocouple junctions were available. An important advance came with the development of semiconductors, nhich transmit electricity well but are poor conductors of heat; these give energy conversion efficiencies reportedly as high as 10%. The most efficient and most convenient way to convert solar radiation into electricity is through the use of the silicon photovoltaic cells developed in the U.S. in 1954 by the Bell Telephone laboratories. The Bell solar cell is made of thin wafers of ultrapure silicon to which traces of arsenic and boron are added. In bright sunlight it can produce direct current at 0.6 v. and approximately 0.030 amp. per square centimetre of exposed cell area, with a conversion efficiency as high as 16%. Since these cells are chemically inert, have no moving parts and are not harmed either by intense radiation or extremely low temperatures, they were used with marked success to supply power for radio transmitters in the first U.S. earth satellites.

The major areas of usefulness for solar-energy application are those regions such as India and north Africa where sunshine is plentiful, conventional energy sources are scarce and fuel is expensive. When heat is needed rather than electric poner, solar devices will prove to be important in helping the millions of people who live in sunny lands to raise their standards of living. In India, for example, the use of solar stoves and water heaters can go far toward returning to the soil as fertilizer the dried bullock dung nhich is now the principal fuel.

See Association for Applied Solar Energy, *Proceedings of the World Symposium on Applied Solar Energy, 1955 (1956)*; F. Daniels and J A. Duffie (eds.), *Solar Energy Research* (1955). (J. I. Y)

SOLARI (SOLARIO), **ANDREA** (ANDREA DEL GOBBO) (active 1495–d. 1524), Italian painter of the Milanese school and one of the most important followers of Leonardo da Vinci, was probably born at Milan. He received his early training from his brother Cristofano, a distinguished sculptor and architect, who was employed extensively on work at the cathedral at Milan and at the Certosa di Pavia. He probably accompanied his brother to Venice, where he seems to have been strongly influenced by Antonello da Messina, who was then active in the city. The fine portrait of a man with a pink (National gallery. London) displays Antonello's plastic conception of form and was probably painted about 1492. Solari's earliest dated work is a "Holy Family and St. Jerome" (Brera. Milan), with a fine landscape background, executed for S. Pietro at Murano in 1495. The Leonardesque type of the Madonna proves that Solari after his return from Venice became strongly influenced by the great Florentine artist, who was then carrying everything before him. To this period belong a small "Crucifixion" (1503, Louvre, Paris); the portrait of Charles of Amboise (Louvre): the portrait of Longono (1505, National gallery, London); "The Annunciation" (1506, Fitznilliam museum, Cambridge); the beautiful "Virgin on a Green Cushion" (Louvre), for which a sensitive drawing of the Virgin's head is in the Ambrosiana at Milan; and the "Head of the Eaptist in a Silver Charger" (1507, Louvre). In 1507 Solari aent to France with letters of introduction to the cardinal of Amboise and was employed for two years on frescoes in the chapel of his castle of Gaillon in Normandy (demolished during the French Revolution). It has been suggested that Solari may have visited Flanders before returning to his native country, and this may account for the Flemish character of his later work. In 1515 he painted the "Flight Into Egypt" (Poldi-Pezzoli, Milan), with its harmonious and detailed landscape background. To this period belong the "Procession to Calvary" (Borghese gallery, Rome); the portrait of the chancellor Domenico Morone (Palazzo Scotti, Milan); and the "Woman Playing a Guitar" (Hertz collection, Rome). Solari's last work was an altarpiece representing "The Assumption of the Virgin," left unfinished at his death and completed by Bernardino Campi about 1576. Solari died between Aug. 18 and Oct. 7, 1524.

See K. Badt, *Andrea Solario* (1914); W. Suida in *Art Quarterly*, viii, pp. 16 ff. (1945). (I. A. R.; X.)

SOLAR SYSTEM: see PLANET.

SOLDERING. Soldering and brazing are processes for joining metals by the application of heat. A common characteristic of both processes is the use of a filler metal or alloy which melts and wets the surfaces of the joint at temperatures below the melting points of the metals being joined. The distinguishing difference between the processes is the strength of joint and the temperature required for making it. Soldered joints are weaker than brazed joints and the soldering process relates to joints made at temperatures below 800° F. Brazing (including hard soldering) in most applications requires temperatures from 1,000° F. to 2,150° F. The specifications for Solders of the American Society for Testing Materials are given in the accompanying tables.

Soft Solders.—The common soft solders consisting of lead and tin are the principal alloys used in the lower range. The lead content may vary from 30% to 60% with the balance tin. The alloy containing equal parts of lead and tin is entirely liquid at 421° F. and is a general purpose solder suitable for joining copper, brass, nickel silver, iron, tin plate and galvanized iron. Additions of cadmium and bismuth lower the melting temperature: an example is 45% tin, 27.5% lead and 27.5% bismuth which melts at 300° F. A wiping solder for plumbers usually contains about 40% tin, the balance being lead. Lead-tin alloys high in tin can be used for joining aluminum but aluminum alloys in the melting range of 1,000" to 1,100" F. are preferred. Another composition in this lower range contains 5% silver, with the balance cadmium. Small percentages of antimony, arsenic and zinc are sometimes added to the lead-tin alloys. (See also FUSIBLE ALLOYS.)

TABLE I.—Properties of Soft Solder Alloys

Nominal composition %			Temperature °F.		Uses
Tin	Lead		Below which alloy is completely solid	Above which alloy is completely molten	
100	0		449	449	
70	30		361	378	coating metals
60	40		361	374	general purpose
50	50		361	421	most popular general purpose
45	55		361	441	automobile radiator cores
40	60		361	460	wiping solder for lead pipes
35	65		361	477	wiping solder
30	70		361	491	for machine and torch soldering
25	75		361	511	" " " " "
20	80		361	531	filling seams in automobile bodies
15	85		440	550	coating metals
10	90		514	570	
5	95		518	594	" "
0	100		621	621	
Tin	Lead	Antimony			*Note:* Antimony-bearing solders should not be used on galvanized iron
			365		general purpose
			365	478	
30	68.4		364	482	torch or machine soldering
25	73.7	2.3	364	504	" " "
20	79	1	363	517	" " "
Tin	Lead	Silver			
0	97 5	2.5	579	579	torch soldering of copper alloys
1	, 5	1.5	588	588	" " " " "

Hard **Solders and Low-Temperature Brazing Alloys.**—Filler metals in the temperature range above 800° F. include a large number of compositions starting with aluminum solders melting at approximately 1,100° F. and running to copper at 1,983" F. and nickel alloys between 1,900" F. and 2,000" F. Proprietary aluminum alloys containing from 5% to 12% silicon with small additions of other metal are widely used.

Silver alloys composed of silver, copper and zinc with addition of cadmium or tin melt at temperatures from approximately 1,150" to 1,600" F. Formerly classed as hard solders, the term low-temperature brazing alloys is meeting with much favour. In

TABLE 11.—Properties of Silver Solder Alloys

Nominal composition %				Temueature °F.		Uses
Silver	Copper	Zinc	Cadmium	Below which alloy is completely solid	Above which alloy is completely molten	
	52		0	1510	1600	yellow colour used where more read; flow is required than obtained with ordinary copper-zinc brazing alloys
20	45	30	0	1430	1 joo	
	45		5	1430	1500	
45	15	15	25	1125	1145	light yellow colour, very narrow melting range
50	34	16	0	1280	1425	nearly white colour, strong
65	20	15	0	1280	1325	white colour high malleability an6 ductility
	20	10		1335	1390	
	16	4		1360	1460	

general, silver additions are used to produce low-melting alloys but an exception is an alloy containing 85% silver, 15% manganese melting at 1,780° F. Several copper and phosphorus, and copper-phosphorus-silver alloys are used for joining copper and brass but should not be used on nickel, iron or steel. They are fluid at temperatures from 1,300" to 1,500" F.

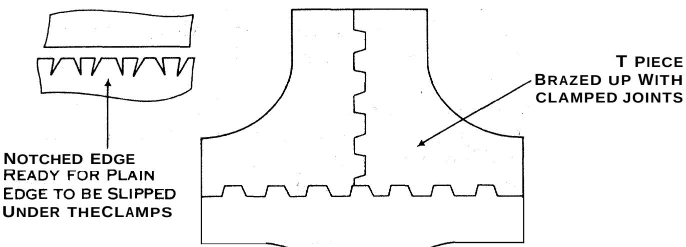


FIG. I.—THE NOTCHED CLAMP JOINT. USED EXTENSIVELY IN COPPERSMITHING

Brazing Solders.—The spelters or brazing solders are composed of copper and zinc with addition of 1% to 3% tin in some of the alloys. Those containing equal parts of copper and zinc are the common spelters which have been in general use for many years and are fluid at 1,600' F. Another group containing copper, zinc and nickel are used with iron, steel and nickel or nickel alloys and melt at 1,700" F. or higher. They are white and produce strong joints. Copper is used for furnace brazing of iron and steel parts at temperatures from 2,000° to 2,100° F. Other high-temperature alloys which form joints that will withstand temperatures of 1,600" F. are combinations of nickel-chromium, nickel-manganese, nickel-boron-silicon. These alloys melt at temperatures from 1,800" F. to 2,000' F.

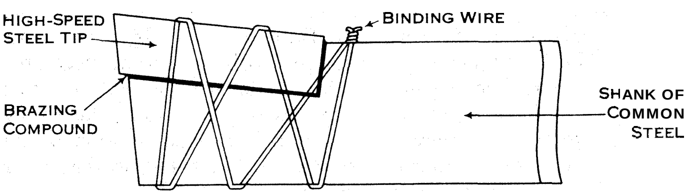


FIG. 2.—BRAZINGA HIGH-SPEED STEEL TIP ONTO A LATHE TOOL

All of these alloys are free flowing when heated to the proper temperature and are, therefore, suitable for those soldering and brazing processes which are limited to making closely fitted joints with clearances between the joint members from a press fit for copper to a maximum of .025 in. in some joints on aluminum. In most applications clearances are in the order of .001 in. to .005 in., and capillary forces play an important part in distributing the molten alloy over the surfaces and in the joint. There are a few exceptions such as the wiping process used by plumbers for joining lead pipe. The closely fitted joints made by these processes distinguish them from the bronze melding process in which the filler metal is fed into a V-shaped groove in layers.

One of the most important factors in the successful use of these processes is to have the joint surfaces clean. They must be free from oil or grease, dirt and oxides or other surface films. Cleaning can be done by mechanical or chemical means. The parts should be supported so that the space between the joint faces is uniform. The alloys may be preplaced between the joint faces or fed into the joint by hand or by spreading the alloys along the outside of the joint.

Fluxes.—Oxide films must be prevented from forming on the joint surfaces or the alloy during the heating process and some type of flux or protective atmosphere is necessary. When the copper-phosphorus alloys are used for joining copper the phosphorus acts as a deoxidizer, but on copper alloys some flux is desirable. For lead-tin alloys in the lower range. resin or zinc chloride made by dissolving zinc in hydrochloric acid is used. The latter is referred to as an acid flux and these lead-tin alloys are supplied in tubular form with resin or zinc chloride cores. When the alloy is used in granular form the flux can be mixed with the alloy. The flux must be fluid and active at a temperature below the melting point of the alloy being used as a filler metal. An effective flux for soft soldering iron. steel. nickel or nickel alloys is a mixture of 71% zinc chloride and 29% ammonium chloride. Plumbers use tallow or stearin when making wiped joints on lead pipe. The mild fluxes such as resin. tallow and stearin do not actively dissolve oxides but offer protective coatings.

Borax is a common flux for hard soldering or brazing processes which use filler metals melting above 1,300" F. The extensive use of the silver brazing alloys melting at temperatures below

TABLE 111.—*Properties of Brazing Alloys*

Nominal composition %				Temperature °F. Below which alloy is completely solid	Temperature °F. Above which alloy is completely molten	Uses
Aluminum	Silicon	Copper				for aluminum
95	5	0		1070	1165	furnace and dip brazing of commercial aluminum
93	7	0		1070	1135	used as coating on aluminum core sheet
86	10	4		970	1085	torch brazing
88	12	0			1080	high corrosion resistance
Phosphorus	Silver	Copper				for copper and copper alloys
5	0	95		1305	1650	for resistance brazing
6	5	89		1195	1500	very fluid
5	15	80		1185	1500	for loose fits
Tin	Zinc	Copper				
0	0	100		1980	1980	furnace brazing ferrous metals
0	40	60		1650	1660	for steels, copper, nickel and alloys
0	48			1570	1595	spelter solders
4	44	5		1585	1610	" "
Aluminum	Zinc	Magnesium				
9	2	89		770	1	for joining magnesium
Nickel	Chro-	Boron	Iron			
70	1	5	10	1850	1950	for joining heat-resisting alloys
Gold	Copper					
37.5	62.5			1755	1815	low vapour pressure, for joining electron tube assemblies

1.200° F. has necessitated the development of fluxes that are fluid and active at 1.100" F. Combinations of borates, fluorides and chlorides provide fluxes which are fluid at temperatures from 700° to 1,100° F. For aluminum soldering, combinations of chlorides and fluorides are used. Borates combined with fluorine compounds are used with the low-temperature silver brazing alloys and are fluid and active at 1,100° F.

Heating.—There are many satisfactory methods of heating depending upon temperature required and size and shape of parts being joined. In the soft soldering range, soldering irons torches, induction heating and furnaces are used. Soldering irons are small blocks of copper pointed at one end. They are heated electrically or with a blowtorch or small furnace. They must be large enough and be heated to a temperature which will not only melt the filler metal quickly but also heat the surface of the joint to a temperature above the melting point of the filler metal as the soldering iron is drawn along the joint. This method of heating is suitable for soldering thin sheet metal, wires. electrical connections and small parts. Torches are used for large parts and special furnaces and conveyer systems are installed when large

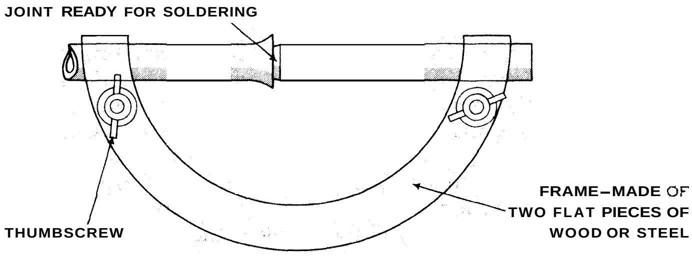


FIG. 3.—METHOD OF HOLDING PIPES IN POSITION FOR MAKING A JOINT

quantities are to be soldered. Baths of the molten filler metal are used when the parts can be securely fastened in jigs and the joint dipped just below the surface of the bath.

Heating for hard soldering or brazing is done with torches, inductive heating, electrical resistance, furnaces, molten salt baths and baths of molten filler metal. The wide use of these processes in industry has led to the development of special furnaces and automatic equipment with particular attention to accurate control of the temperature and careful regulation of the atmosphere. Chemical baths may be used when the parts can be held in position by proper jigs and the filler metal preplaced in the joint before dipping in the bath. Procedure with metal baths is similar but eliminates preplacing the filler metal.

(Ro. H. L.)

SOLE, the name of flatfishes (*q.v.*) of the genus *Solea*, which have the eyes small, on the right side, the head rounded in front and the mouth small, curved, with teeth in the jaws of the blind side only. Several species are known from the Indo-Pacific and the eastern Atlantic.

The common sole of Europe ranges from the North sea to the Mediterranean; it is a valuable food fish, which attains a length of two feet. It often burrows and ieeds mainly at night, seeking worms and other small animals of the sand or mud by smell and touch.

The American soles belong to another genus, *Achirus;* they are small and of no value.

SOLENOIDS, ATMOSPHERIC: *see* BAROCLINIC.

SOLENT, THE, a strait of the English channel, between the mainland (the coast of Hampshire. Eng.) and the coast of the Isle of Wight. It is the submerged valley of an eastward-flowing river of which the present Frome was the headstream and the Itchen and Test, two tributaries. Spithead, the drowned eastern portion of the same valley, is on the whole wider than the western part, and therefore affords a safer approach to Southampton for very large craft. From Southampton water to the Needles is 15 mi., and from Southampton water to Spithead about half the distance; the breadth is from $1\frac{3}{4}$ to 4 mi. Opposite the Needles there springs from the mainland a great shingle bank, nearly 2 mi. in length, on the end of which stands Hurst castle dating from the time of Henry VIII. At the mouth of Southampton water another shingle bar. projecting from the western shore, also bears a Tudor fortress. Calshot castle. The low coast of the mainland is broken by the estuaries of the Beaulieu river and the Lym; the coast of Wight, which rises more steeply, is cut by the Medina, Newton and

Yar estuaries. The Solent is frequently the scene of yacht races. especially from Cowes, and also of naval reviews, off Spithead.

SOLESMES, a village of western France on the left bank of the Sarthe in the *département* of Sarthe, 29 mi. W.S.W. of Le Mans by road. Pop. (1954) 477. In 1010 a priory was founded at Solesmes and placed under the authority of the abbey of La Couture of Le Mans. Suppressed at the Revolution, it became a Benedictine monastery in 1830. In 1837 it was raised to the rank of abbey and a nunnery was later founded beside it, but both institutions were abandoned in 1901.

SOLF, WILHELM (1862–1936), German colonial politician. was born on Oct. 5, 1862, in Berlin. After studying Sanskrit and oriental languages in Calcutta. he returned to Germany and entered the German colonial service, being. sent to Soma. There he was first president of the municipal council (1899) at Apia under the old "condominium" of Great Britain, Germany and the U.S., and afterward governor of German Samoa (1900). In 1911 he became German colonial secretary and effected considerable reforms in colonial administration. When Prince Max of Baden's ministry of desperation was formed toward the end of World War I. Solf was appointed foreign secretary, and as such conducted the negotiations for the Armistice. He resigned on Dec. 17, 1918. In 1920 he was German chargé d'affaires. and from 1921 to 1928 ambassador at Tokyo. He died Feb. 6, 1936.

SOLFATARA, a volcanic vent emitting vapours chiefly of sulfurous character. The typical example is the famous Solfatara. near Pozzuoli, in the Phlegraean fields west of Naples, an old crater which has not been in active eruption since A.D. 1198, but which is continuously exhaling heated vapours, chiefly hydrogen sulfide. sulfur dioxide and steam. Sal ammoniac occurs among the sublimates. The term solfatara has been extended to all dormant volcanoes of this type, and a volcano which has ceased to emit lava or ashes but still evolves heated vapours is said to have passed into the "solfataric stage." *See* VOLCANO; VOLCANISM; FUMAROLE.

SOLFERINO, 5 mi. W. of the Mincio river. was the scene of a battle between the Franco-Sardinians. commanded by Napoleon III, and the Austrians under Francis Joseph. Defeated at Magenta. June 4, 1859. the Austrians under Gyulai retreated across the Mincio and reorganized their forces around Verona. Francis Joseph then assumed personal command, aided by General Hess. His forces comprised two armies under Wimpffen and Schlick. 160,000 strong. Early on June 24, when neither army expected to encounter the other, the armies suddenly met at the Mincio, both having assumed the oifensive. The Franco-Sardinians, 150,000 men, moved on a 25-mi. front from Lake Garda to Castel Goffredo. Outpost firing began at 5:30 A.M.! developing later into more serious fighting. At 7 A.M. Napoleon, who watched the encounter from the church tower at Castiglione, ordered his forces to advance on Solferino, situated on an elevation, seemingly strongly occupied. After desperate fighting it was captured by the French guards, entailing the sacrifice of thousands of lives. This brought about a distinct tactical advantage to the French, the Austrians continuing to make further attempts to recapture this important point. Farther south of Solferino, MacMahon captured Cassiano. but the Sardinians, under King Victor Emmanuel. vainly assaulted the Austrian lines south of Lake Garda, being thrown back on Revoltella by Benedek. At 2 P.M. Francis Joseph gave a fresh order to Wimpffen to advance resolutely and to thrust back the enemy south of Solferino, but all his attempts mere abortive. About 4 P.M. the oppressive heat was succeeded by a severe thunderstorm, of which the Austrians took advantage to retreat, except Benedek's troops. They accomplished this unmolested, the French being too exhausted to pursue them. The Sardinians then again fell on Benedek, who. seeing the Austrian centre retreat, retired. keeping the enemy at a distance. The Austrians recrossed the Mincio that evening, having lost 22,000 men. the Allies 17,000. A meeting of the two emperors took place shortly afterward at Villafranca. after which hostilities ceased.

SOLI (mod. MEZETLÜ), an ancient town of Asia Minor. on the coast of Cilicia. Colonists from Argos in Greece and Lindus in Rhodes are described as the founders of the town. which is first mentioned at the time of the expedition of the younger Cyrus. In the 4th century B.C. it was so wealthy that Alexander could exact a fine of 200 talents. In the Mithradatic War, Soli was destroyed by Tigranes, but it was subsequently rebuilt by Pompey, who settled there many of the pirates whom he had captured. and called the town Pompeiopolis. Soli was the birthplace of Chrysippus the Stoic and of the poets Philemon and Aratus. The bad Greek spoken there gave rise to the term *soloikismos*, solecism. Little remains of the ruins

SOLI (mod. SOLIAIS), a Greek city on the north coast of Cyprus, in the metalliferous country round Karavostasi. Its territory was bounded by those of Marion, Paphos. Tamassus and Lapathus. It was believed to have been founded after the Trojan War by the Attic hero Acamas; and no remains have been found earlier than this Soli is probably the town "Sillu." whose king Irisu was an ally of Assur-bani-pal of Assyria in 668 B C. In Hellenic times Soli had little political importance. though it stood a siege from the Persians soon after 500 B.C.; its copper mines, however, were famous, and a neighbouring monastery is dedicated to "Our Lady of the Slag-heaps."

SOLICITOR, in England, an officer of the Supreme Court of Judicature qualified to conduct legal proceedings for his clients: *see* also LEGAL PROFESSION. Until 1873 there was a distinction between the terms "solicitor" and "attorney." Solicitors appear to have been at first distinguished from attorneys as not having the attorney's power to bind their principals; subsequently the distinction was between attorneys as agents in actions at law, and solicitors in chancery. In practice. however, the terms were synonymous. for it was usual for attorneys to be admitted as solicitors also The Judicature Act 1873 enacted that all persons admitted as solicitors, attorneys or proctors of an English court should thenceforth be called solicitors of the Supreme Court.

Every person, before he can become a duly qualified solicitor, must serve an apprenticeship or clerkship to a practising solicitor for a term of years varying from three to five. Since 1922 he has been required during one of those years to attend a law school provided or approved by the Law Society (long known as the Incorporated Law Society). Service under articles therefore combines academic training with practical experience. The clerk must pass all the necessary examinations, he must be duly admitted, and must take out an annual certificate to practise. The organization of the profession is in the hands of the Law Society. Established 1827, and succeeding a society dating back to 1739, it was incorporated in 1831. The Solicitors Act 1922 transferred to the Law Society disciplinary powers long exercised by the courts. Its Discipline Committee may, after inquiry, strike off the roll or suspend from practice solicitors convicted of crime or found guilty of professional misconduct. In conjunction with the provincial law societies it has taken over the organization of the voluntary services of solicitors in the conduct of poor persons' cases. Apart from its judicial and administrative authority the Law Society has frequently exercised powerful influence by the attitude which it has taken towards proposed legislation. Membership of the society, which is not compulsory, is open to any duly qualified practising solicitor.

No person can be admitted as a solicitor unless he is a British subject, and has attained the age of 21 years. Though admitted as a solicitor and his name entered on the roll, he is not at liberty to practise until he has taken out his annual certificate, the fee for which is larger for London than for country practitioners. The disqualification of women to become solicitors ceased in 1919.

Solicitors now have a right to practise in any court, *i.e.*, in every division of the High Court, in every inferior court, in the ecclesiastical courts (*see* PROCTOR). in the court of appeal, in the Privy Council and in the House of Lords Their right of audience, however, is restricted. They may appear as advocates in most of the inferior courts, as before justices, magistrates, coroners, and county courts. They have no right of audience, however, in the High Court of Justice (except in certain bankruptcy matters), nor in the Privy Council or House of Lords, where, from time immemorial, the right has pertained to rhe bar; but they have right of audience in chambers.

Solicitors have for more than two centuries done all kinds of conveyancing, which, at one time, was claimed to be the exculsive business of the bar and scriveners. The Conveyancing Act 1881 having made changes in the practice of conveyancing, the remuneration of solicitors was placed upon a new basis by an order which provided scales of fees based on the amount involved in the transaction, not, as was generally the case before, simply on the length of the documents perused or prepared.

All communications which pass between a solicitor and his client are privileged; so also is any information or document which he has obtained in his professional capacity on behalf of his client. The relation of solicitor and client disqualifies the former from dealing with his client on his own behalf, while it gives him a lien for his professional charges, over the deeds, etc., of the client in his possession. A solicitor's remuneration is minutely arranged by statute. He has no power of recovering more from his client than his statutory charges, and he is liable to be sued for damages for negligence in his client's behalf. Certain personal privileges belong to a solicitor. He is free from serving on juries, nor need he, against his will, serve as a mayor, sheriff, overseer or churchwarden.

In Scotland "law agent" is the general term devised by the legislature to embrace the various writers, solicitors and procurators entitled to practise as agents in the supreme and inferior courts. The Law Agents (Scotland) Act 1873 now regulates the admission of applicants to the roll of law agents entitled to practise in Scotland. The apprenticeship varies from three to five years and the applicant must also pass a general examination and an examination in law unless he is a university graduate. A law agent is removable from the roll upon a petition to the court of session. Separate rolls are kept of law agents entitled to practise (a) in the court of session and (b) in each of the sheriff courts. As in England, the law agent has a limited right of audience, *i.e.*, only in the bill chamber of the court of session and in the inferior courts. Many law agents are members of one or other of the incorporations of which the principal are His Majesty's writers to the signet, the solicitors in the supreme courts, the faculty of procurators in Glasgow, and the society of advocates in Aberdeen. In the United States the term solicitor is used in some States in the sense of a law agent practising before a court of equity.

Some of the great public offices in England and the United States have their solicitors. In England the Treasury solicitor fills an especially important position. He is responsible for the enforcement of payments due to the Treasury, and conducts generally its legal business and that of most Government departments. The office of king's proctor is combined with that of Treasury solicitor. The Treasury solicitor as nominee of the Crown acts as administrator of the personal estate of an intestate which has lapsed to the Crown, and as king's proctor intervenes in cases of divorce where collusion is alleged *(see* PROCTOR). In Ireland solicitors called Crown solicitors are attached to each circuit, their duty being to prepare the case for the Crown in all criminal prosecutions. In the United States the office of solicitor to the Treasury was created by Act of Congress in 1830. His principal duties were to take measures for protecting the revenue and to deal with lands acquired by the United States judicial process or vested in them by security for payment of debts.

See E. B. V. Christian, *A Short History of Solicitors* (1896); A. Cordrey, *The Law Relating to Solicitors* (1878); A. P. Poley, *Law Affecting Solicitors* (1897).

SOLICITOR-GENERAL, in England, one of the law officers of the Crown, first appointed by letters patent in 1461 as deputy of the attorney-general (*q.v.*), and so called because he was more concerned with matters in chancery. His duties are now practically the same as those of the attorney-general, to whom he is subordinate, and whose business and authority devolves upon him in case of a vacancy. The position of the solicitor-general for Scotland in the main corresponds with that of the English solicitor-general. He ranks next to the lord-advocate. In the United States the office of solicitor-general was created by Act of Congress in 1870.

SOLIDS, GEOMETRIC. The term solid is not widely used in geometry as a precise generic term, but it commonly appears in the names of certain special classes of geometric configurations. A geometric configuration is any set of points in space which, unless the contrary is stated, is understood to be the space of euclidean three-dimensional geometry. We may set down that any geometric configuration is a geometric solid, or simply a solid, if every point of the configuration is the centre of a sphere whose interior contains only points of the configuration, and if the configuration is not composed of two configurations which have no points in common and which are such that every point of each configuration is the centre of a sphere whose interior contains only points of that configuration. It will be seen readily that according to this definition the interior of a sphere is a solid, while the configuration consisting of that interior and the sphere, *i.e.*, the spherical surface, is not a solid. It is easy to modify the given definition so as to permit calling the latter configuration a solid. This requires making precise the idea of the boundary of a configuration. A *boundary point* of a configuration is a point such that every sphere having it as centre contains points of the configuration and also points which do not belong to the configuration. A boundary point of a configuration need not belong to the configuration. The set of all boundary points of a configuration is called the *boundary of the configuration.* We shall now define a solid as any configuration consisting of a solid according to the original definition and the boundary of the latter configuration, and shall refer to the latter configuration as the interior of the solid thus newly defined. There are simple solids such as those commonly referred to as the sphere, cube, pyramid, ellipsoid, cylinder and the less simple ones, such as the torus or anchor ring and a sphere with a number of holes bored through it, and so on to solids of great complexity; *e.g.*, the abstract analogue of natural objects, such as a sponge or the steel framework of a building. The task of making a complete detailed classification of solids is thus an enormous one. For certain restricted, though important, classes of solids the problem of classification has been solved to such an extent that the associated theory is an interesting and important chapter of mathematics. An example of such a class is the class of polyhedra, which is taken up in some detail below.

A useful procedure in attacking the general problem of classification is the study of the boundaries of solids. Although several solids may have the same boundary the ambiguity thus arising in the determination of a solid by its boundary is easily settled in the case of a great class of solids; viz., all those which have been studied in a systematic way. Thus a classification of the boundaries of solids determines a classification of solids. The boundaries of solids may be extremely complicated configurations, but in the case of the solids of the large class just referred to the boundaries have a speciality which is sufficient for a quite complete classification and theory. The solids referred to are those whose boundaries are closed surfaces. A sphere, a torus, a polyhedron are examples of closed surfaces, and a more complicated example of such a surface is the surface of the solid which results from boring any number (finite or infinite) of holes, properly located, through a sphere. A precise definition of the concept of closed surface will not be given now and an ordinary intuitive counterpart of that concept will serve provisionally.

In studying the properties of solids, it is helpful to divide those properties into metric and non-metric properties. A general property of the latter kind involves merely the way in which parts of the solid are attached to each other, *i.e.*, the connection of the solid; while a metric property refers to size and shape, thus involving a comparison with other solids in regard to such relations as congruence and similarity. A special kind of non-metric property, sometimes called descriptive, involves such notions as linearity, parallelism and convexity. The non-metrical properties are the more primitive and simple, but metrical relations (such as congruence) are also fundamental.

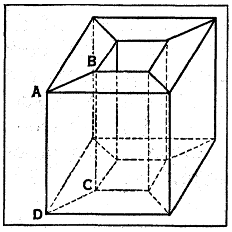
Polyhedral Solids.—In the study of solids aid is obtained from the study of a special class, polyhedral solids, *i.e.*, solids bounded by configurations formed by polyhedra. The theory of polyhedra suggests means of classifying more general solids and also methods of attack in the solution of problems of more general solids. Furthermore, the fact that any solid can be approximated to as closeiy as desired by a polyhedral solid adds to the importance of the theory of such solids to a study of solids in general. A precise formulation of the fact just alluded to is the following: If S denotes any solid, then there exists a sequence of polyhedral solids, P_1, P_2, P_3, . . ., P_n . . ., such that every point of the solid P, is a point of the interior of S and also of the interior of the solid P_{n+1}, and every point of the interior of S is a point of the interior a polyhedral solid P_m of the sequence. In particular, there exist such sequences of polyhedral solids such that each polyhedral solid is composed of a finite number of cubes such that no two of the cubes have interior points in common and every cube has a face in common with another one of the cubes. Another method of approximating to a solid by means of polyhedral solids is that in which the vertices of the approximating polyhedral solids are points of the boundary of the given solid, or, as it is usually stated, the polyhedron which bounds the polyhedral solid is inscribed in the boundary of the given solid. However, the existence of sequences of approximating polyhedral solids of the latter kind has been established only in the case of special solids.

POLYHEDRA

Definitions. — According to the definition of polyhedral solids, it is immediately evident that the theory of polyhedra is of much importance in the study of those solids. Preparatory to the consideration of the properties of polyhedra the following definitions are made. A *segment* is the set of all points of a (straight) line which are between two points of that line, and each of the latter points is called an end of the segment. A *simple* polygon is a finite set of points (vertices of the polygon) and segments (sides of the polygon) such that (a) each point of the set is the end of two and only two segments of the set, (b) the ends of each segment of the set are points of the set, (c) no two elements (*i.e.,* points or segments) of the set have a point in common, and finally (d) no proper subset of the set of points and segments satisfies (a), (b) and (c). It is a theorem of euclidean plane geometry that every simple polygon in a plane π is the planar boundary of a unique connected region of finite extent which is contained in a. The planar boundary of a set of points in a plane and a connected region in a plane are the two-dimensional analogues of the boundary of a solid and the interior of a solid respectively as defined above, circles of the plane replacing the spheres in the definitions referred to. Saying that a set of points is of finite extent means that it is contained in the interior of a sphere. The planar region thus determined by a simple plane polygon is called a polygonal region.

A finite set of points, segments and polygonal regions is called a *polyhedron,* if and only if (a) every segment of the set is a side of the boundaries of two and only two polygonal regions of the set, and every side of the boundary of a polygonal region of the set is a segment of the set, (b) every point of the set is an end of at least one segment of the set, and the ends of any segment of the set are points of the set, (c) if P is any point of the set, the set a of all polygonal regions of the set whose boundaries have P as a vertex form a cycle, *i.e.,* every segment of the set which has P as an end is a side of the boundaries of two polygonal regions of the set σ and no proper subset of σ has that property, (d) no two elements (*i.e.,* points, segments or polygonal regions) of the set have a point in common, and (e) there is no proper subset of the set of points, segments, and polygonal regions which satisfies (a), (b), (c) and (d). By omitting some of the conditions of this definition, more general configurations which are also called polyhedra are defined thereby, and the set just defined is called a simple or an ordinary polyhedron. Just so there are polygons which are not simple and which are defined by less restrictive definitions than that given above. In what follows, the words polygon and polyhedron signify respectively, simple polygon and simple polyhedron. Despite the qualifying term simple, the class of simple polyhedra has a most interesting and important theory which still leaves much to be done.

Non-metrical Properties. — That every polyhedron is the boundary of a unique solid of finite extent and also the boundary of a unique solid not of finite extent is a theorem of euclidean three-dimensional geometry which requires a proof of considerable length. This theorem is analogous to the theorem of euclidean two-dimensional geometry concerning the separation of a plane by a polygon contained in it; but at this point the spatial theory becomes much richer. Considering merely the internal connection of the elements of a polygon, one is very much like the other, but in the case of polyhedra that is not so. Besides polyhedra such as the tetrahedron, cube octahedron, etc., there are those which can be obtained by cutting one or more square holes out of the limited solid bounded by a cube, tetrahedron, etc. Between a polyhedron thus obtained and a cube or tetrahedron there is a fundamental difference. The diagram illustrates one of these polyhedra of more complicated structure. It consists of 16 vertices, 32 edges and 16 faces. In the case of a cube any polygon P consisting of vertices and edges of the cube separates the cube; *i.e.,* there is a pair of points (and, of course, many pairs) of the cube, which do not belong to any polygonal line which is made up of points of the cube and which contains no points of the polygon P. (It should be emphasized that the terms cube, tetrahedron, octahedron, etc. are used here to denote polyhedra and not solids bounded by certain polyhedra.)



In the case of the polyhedron of the illustration the polygon ABCDA does not separate that polyhedron in the above sense; however, any pair of polygons contained in the polyhedron, *i.e.,* every vertex and every point of the sides of the polygon, are points which are either vertices or belong to edges and faces of the polyhedron, and having no points in common separates the polyhedron in the sense that a set S of polygons separates a polyhedron π if the polygons of S are contained in π and if there are two points of π such that any polygonal line which contains them and which is contained in π also contains a point of a polygon of S. For any polyhedron there exists a finite set T of polygons which have no points in common and such that the set Γ does not separate the polyhedron, while any set of non-intersecting polygons on the polyhedron, which contains more polygons than T, separates the polyhedron. The number of polygons in the set T is called the genus of the polyhedron. Thus it can be easily shown that the cube, tetrahedron, and the more common polyhedra are of genus zero, while the genus of the polyhedron of the above illustration is one. Speaking roughly, a polyhedron of genus p is not disconnected when it is cut along the circuits (polygons) of a certain set of p circuits, but it is disconnected when cut along any $p+1$ circuits.

A most important theorem may now be stated. If $v=$ the number of vertices, $e=$ the number of edges, and $f=$ the number of faces of a polyhedron of genus p, then $v-e+f=2-2p$. Thus in the case of the polyhedra of genus zero (such as the cube, octahedron, and icosahedron) $v-e+f=2$, while for the polyhedron illustrated above $v-e+f=0$. The number $v-e+f$ is called the clzaracteristic of the polyhedron. A remarkable fact in this connection is that, if two polyhedra have the same characteristic (or genus), then a subdivision of the elements of each exists so that the polyhedra thus derived are isomorphic; *i.e.,* any vertex, edge and face of one is paired respectively with a vertex, edge and face of the other such that a pair of elements of the first polyhedron which are incident corresponds to a pair of elements of the second polyhedron, which also are incident, and conversely. Thus, if a vertex A' and an edge a' of the second polyhedron are paired with the vertex A and the edge a of the first polyhedron respectively, and if A is an end of a, then A' is an end of a'; and similarly if a vertex and a face or an edge and a face are incident. The integer 2 minus the characteristic of a polyhedron is known as the *connectivity* number of the polyhedron and, as implied above, for a polyhedron in euclidean three-dimensional space it is either positive and even, or zero.

Classes of Polyhedra. — In the theory of polyhedra, considered merely as sets of objects, called vertices, edges and faces, which satisfy the relations of incidence and order of the definition of a polyhedron given above and which are not sets of points in any particular space, it is shown that there exists a polyhedron having any positive integer or zero as its connectivity number. In this theory two classes of polyhedra are distinguished. Any polyhedron of one of these classes has the property that there is at least one polygon on it which does not separate any region which is on the polyhedron and which contains the polygon. The term region is used here in a sense which, though analogous to, is a simple extension of, its meaning given above. All other polyhedra make up the other class. Polyhedra of the latter class are sometimes said to be *two-sided;* those of the former *one-sided.* The basis of this terminology is suggested above in reference to the separation of euclidean space by polyhedra. Only two-sided polyhedra exist in euclidean space and any two-sided polyhedron is isomorphic with a polyhedron in euclidean space. A generalized polyhedron *(see* below) in euclidean space may be one-sided.

The terms *non-orientable* and *orientable* are also applied to polyhedra of the former and latter classes respectively, because either of two senses can be defined on an orientable polyhedron just as in the case of the euclidean plane or sphere, while that is impossible in the case of so-called non-orientable polyhedra. In the general theory of polyhedra, also called *manifolds* (*q.v.*) in that context, the above equation relating v, e, f and p holds for all orientable polyhedra, while the equation $v-e+f=2-p$ is the corresponding equation for non-orientable polyhedra, the letters in both cases having analogous meanings. In the following, as in what preceded this digression, it is understood that the polyhedra are in euclidean three-dimensional space, and are therefore two-sided or orientable.

Classification of Polyhedra.— It is suggested immediately that polyhedra may be classified according to genus but then the question of a finer classification arises. The goal is the complete description of the classes so that any two polyhedra of the same class and no two of different classes are isomorphic. Each of the classes of such a classification shall be called a *type.* It is obvious that the polyhedra of the same class have the same genus, but that the converse is not true. It is also obvious that polyhedra which are not isomorphic may form the boundary of the same solid. No such exhaustive classification has ever been completed, not even for the class of all polyhedra of genus zero.

A most useful general method of thus classifying polyhedra is based on the problem of the determination of all types of polyhedra of $f+1$ faces or $v+1$ vertices, assuming that all the types of polyhedra of f faces or v vertices, respectively. are known. For example, any type of convex polyhedron (for definition *see* below) of $f+1$ faces can be obtained by cutting with a plane all the faces of a certain convex polyhedron of f faces, which are incident with the same vertex. In the case of the special convex polyhedra which Rave only vertices which are incident with three and only three edges, this process of "cutting off the corners" results in a polyhedron of the same speciality and gives a comparatively complete result. If $\psi(f)$ denotes the number of types of convex polyhedra which have f faces and all of whose vertices are incident with exactly three edges, then $\psi(4)=1$, $\psi(5)=1$, $\psi(6)=2$, $\psi(7)=5$, $\psi(8)=14$, $\psi(9)=50$, and $\psi(10)=233$.

Very little, indeed, is known of the general behaviour of the function $\psi(f)$. If the polyhedra also satisfy the special condition that each polyhedron contains a face which is adjacent to all of the remaining faces, then a recursion formula for the value of $\psi(f)$ is known, but even in this very special case it is sufficiently complicated. A similar degree of completeness exists in the theory of the convex polyhedra, *i.e.,* the so-called duals of those just considered, *i.e.,* those which have only triangular faces. A polyhedron is said to be the dual *(see* DUALITY) or *reciprocal* of another if each vertex of the former is paired with a unique face of the second, so that thereby every face of the second is paired with just one vertex of the first, and if each edge of the first is paired with a unique edge of the second in a reciprocal way, and if a pair of incident elements of the second polyhedron corresponds to a pair of incident elements of the first.

Another general procedure in studying different types of polyhedra consists of making simple replacements of some of the elements of a polyhedron by new elements. For example, a face may be replaced by the two faces and the edge. which result from the division of the original face by a line which cuts its boundary in exactly two points, and different replacements are made according as the dividing line passes through no vertex, one vertex or two vertices incident with the face. For some such replacements the type of the polyhedron is not changed, while for others the type of the resulting polyhedron is different from but simply related to that of the original one. Many important theorems result from the consideration of such replacements of elements.

Regularly Connected and Convex Polyhedra.— In the case of certain special but important classes of polyhedra, the general ideas considered above lead to quite complete information about those classes. An important sub-class of polyhedra is that which consists of regularly connected polyhedra. A polyhedron is said to be *regularly connected* if every pair of vertices of the polyhedron which are incident with two of its faces are the ends of an edge of the polyhedron, which edge is also incident with those two faces. The type of a regularly connected polyhedron is completely determined by the incidence relations of its vertices and faces. Also, if the boundary of a face of a regularly connected polyhedron is removed the remaining set of vertices and edges is connected, but the converse, as is easily seen, is not true. It is interesting to note that the converse of the original statement with the phrase "regularly connected polyhedron" replaced by "polyhedron of genus zero," is true but not the modified statement. Finally there is the important special case of a regularly connected polyhedron of genus zero. Such a polyhedron will be said to be *convex-like,* because with regard only to incidence relations of its elements it does not differ from a convex polyhedron. The precise fact is given in the fundamental theorem that every convex-like polyhedron is of the same type as that of a certain convex polyhedron. As an important preliminary theorem here we have that every convex-like polyhedron is derivable from a tetrahedron by simple replacements of elements such as referred to above.

A convex polyhedron, already referred to several times, is defined in several equivalent ways. One definition requires that no line which is not in the plane of any face of the polyhedron contains more than two points of the elements of the polyhedron, and another is that, if α is any face of the polyhedron, then all of the elements of the polyhedron except a and the vertices and edges incident with a are on the same side of the plane which contains a. Again, a polyhedron which forms the boundary of a convex solid is a convex polyhedron. where by a *convex solid* is meant a solid which is such that, if two ends of a segment are points of the solid, then every point of the segment is a point of the solid. It is worth noting that these definitions require that a convex polyhedron be contained in a three-dimensional space, while the concept of a convex-like polyhedron is independent of any surrounding space.

Some further results of the foregoing will now be noted. If v, e and f respectively denote the number of vertices, of edges and of faces of a polyhedron then, since at least three edges are incident with each vertex and also with each face, $3v\leqq 2e$ and $3f\leqq 2e$; and if the polyhedron is of genus zero, then $v-e+f=2$. Conversely, it is proved that, if v, e and f are positive integers which satisfy these three conditions, the two inequalities and the equality, then there exists a polyhedron, in particular' a convex polyhedron, with v vertices, e edges and f faces. Further, it follows easily from the latter equality that every polyhedron of genus zero and, therefore, in particular every convex polyhedron (for it is shown easily that the genus of a convex polyhedron is zero) has at least one face that is bounded by a polygon and at least one vertex which is incident with 3, 4 or 5 edges. and has at least either one triangular face or one trilinear vertex, *i.e.,* a vertex incident with exactly three edges. Also, there exist polyhedra and, in particular, convex polyhedra having any number of edges, if that number is an integer greater than five and different from seven. There is no polyhedron having exactly seven edges.

Finally a fact that is remarkable (even in view of the greater richness of the theory of polyhedra in euclidean three-dimensional space as compared to the theory of polygons in a plane) is that there exist polyhedral solids evidently not convex. in euclidean three-dimensional space, which are not decomposable into a finite number of tetrahedral regions which have no points which are not on their boundaries in common, and whose vertices are vertices of the polyhedral solid. That an analogous decomposition of a polygonal region into triangular regions always exists is a theorem of euclidean plane geometry.

Metrical Properties of Polyhedra. — The preceding exposition has been concerned largely with non-metrical properties. In succeeding paragraphs metrical properties of polyhedra are also considered. These properties being based on the intuitive notions of size and shape were the chief objects of study in the very early development of the subject. The chief topics here are the congruence of polyhedra and the properties of polyhedra which have elements or groups of elements which are congruent respectively. Two configurations are said to be congruent in the narrow sense if, and only if, one can be transformed into the other by a rigid motion. Two configurations are said to be congruent in the broad sense if, and only if, one can be transformed into the other by a succession or product of a finite number of rigid motions and planar symmetries; *i.e.,* reflections in a plane. An equivalent set of definitions is the following: Two configurations are congruent in the broad sense if, and only if, the points of one are in one-one correspondence with the points of the other such that the distances between pairs of corresponding points are equal. If sense as well as distance is preserved by the correspondence, then and only then are the two configurations congruent in the narrow sense. The terms of these definitions have precise abstract meanings but in order to save space they are omitted here; their ordinary meanings should give a sufficient understanding.

An outstanding theorem on the congruence of polyhedra is that if two convex polyhedra are isomorphic such that corresponding faces are congruent, then the polyhedra are congruent in the broad sense. The theorem is obviously not true in the case of polyhedra which are not convex, and an interesting theory concerning the infinitesimal and finite deformations of non-convex polyhedra, which preserve length, presents itself.

Regular and Semi-regular Polyhedra. — The question of the congruence of polyhedra suggests the consideration of a single polyhedron whose elements satisfy certain relations of congruence. At the extreme of speciality there are the so-called regular polyhedra. Because of their very conspicuous regularity they are among the oldest objects of study in the theory of polyhedra. A polyhedron is a *regular* polyhedron if, and only if, the boundary of each face is a regular polygon which is congruent to the boundary of every other face and each polyhedral angle of the polyhedron is regular, *i.e.,* having congruent face angles and dihedral angles resp., and congruent to every other polyhedral angle of the polyhedron. There are exactly five types of regular polyhedra; further details of these are given in the table below. A generalization of the regular polyhedra are the *Archimedian* polyhedra; all the faces of such a polyhedron are bounded by regular polygons, not all congruent to each other, and all the polyhedral angles are convex and congruent to each other. There are thirteen types of such polyhedra besides the semi-regular prisms and prismoids.

A *prism* is a polyhedron of which two faces, called its bases, lie in parallel planes and each of the remaining faces is bounded by a parallelogram and is adjacent to each base. A prismoid is a polyhedron which also has two faces, its bases, which are in parallel planes, while each of its other faces is triangular and incident with a vertex of one base and a side of the other. If every face of a prism or prismoid is regular, *i.e.,* bounded by a regular polygon, and if the bases of the prismoid are congruent, then the prism or prismoid are said to be semi-regular. The Archimedian polyhedra and their reciprocals form the class of the so-called semi-regular polyhedra. The semi-regular polyhedra can be obtained by such simple operations as taking plane sections of and combining regular polyhedra, and by dualizing. For example, the cuboctahedron is obtained by cutting off the vertices of the cube or octahedron by planes passing through the midpoints of the edges; the icosidodecahedron by a similar treatment of the dodecahedron or icosahedron. The reciprocals of these two Archimedian polyhedra are respectively the rhombic-dodecahedron and the rhombic triacontahedron, which have in all twelve and thirty faces respectively, each face being a rhombus. For further details of semi-regular polyhedra, see table p. 945.

The idea of semi-regular polyhedra leads to the later generalization of the notion of regularity, which is contained in the idea of a polyhedron transformable into itself by a congruence transformation, in the broad sense, such that any polyhedral angle of the polyhedron is transformed thereby into any other. Reciprocally there is defined a polyhedron which is transformable into itself by a congruence transformation so that any face of the polyhedron is transformed into any other. Polyhedra of the former kind have a circumscribing sphere while those of the latter have an inscribed sphere. The mere requirement of the congruence of all of the polyhedral angles or of all of the faces of a polyhedron does not imply the existence of a circumscribing or an inscribed sphere respectively. Archimedian polyhedra are polyhedra of the former kind which have their faces bounded by regular polygons which are not all congruent to each other. A complete classification of the convex polyhedra satisfying this more general definition of regularity has been made, according to the kind of faces and the various relations of symmetry which are satisfied, and the number of distinctive types is finite. When the requirement of convexity is removed the complexity of the problem of classification is very great, and no classification of any satisfying degree of completeness has been made. In conformity with the present viewpoint a regular polyhedron may be defined as a polyhedron which is transformable into itself by a congruence transformation, in the broad sense, so that any vertex is transformed into any other vertex, any edge incident with the former vertex into any edge incident with the latter vertex, and any face incident with the former edge into any face incident with the latter edge.

The notion of symmetry furnishes another basis for the investigation of properties of regularity of polyhedra. It is a fundamental concept in the definition of an important class of polyhedral solids known as crystals. A configuration is called *symmetrical* if it admits of a congruence transformation, in the broad sense, into itself, which is not the identity. In this scheme of classification, two configurations are in the same class if the group of congruence transformations which transform one of the configurations into itself is the same as the group of congruence transformations which transform the other into itself.

A Crystal. — A crystal is a solid whose boundary is a polyhedron which has the following properties: In the first place its vertices, edges and faces are respectively on points, lines and planes of a rational space net. A rational space net is the set S of all points, lines and planes such that there are five points, P_1, P_2, P_3, P_4 and P_5, no four of which are in a plane, such as the vertices of a tetrahedron and a point interior thereto, with the property that if a denotes any element (point, line or plane) of *S,* then there exists a finite sequence of elements of S, P_1, P_2, P_3, P_4, P_5, α_1, α_2, a,,. . ., a,, α, such that the first five elements are the five points mentioned above and any other element of the sequence is uniquely determined by being common to or containing preceding elements of the sequence. Secondly, the polyhedron is transformed into itself by the transformations of a finite group of congruence transformations, in the broad sense, which transform a rational space net into itself. Such a group is known as a crystallographic group. There exist thirty-two crystallographic groups which thus determine the same number of classes of crystals.

Generalized Polyhedra. — At this point, perhaps, there should be mentioned a generalization of the notion of regular polyhedron, which is obtained by generalizing the idea of a polyhedron itself, although these generalized polyhedra are not the boundaries of unique solids. The boundary of a face of a polyhedron is, as stated early in this article, a simple plane polygon. A generalized *polygon* satisfies the conditions of the definition of a simple polygon, except that one which states that no elements of the polygon have a point in common. (One might generalize further by requiring an even number, not necessarily two, of sides inci-

Tables Giving Data cf Regular and Semi-regular Polylzedra

dent with each vertex.) *A regular generalized polygon* is defined accordingly; *e.g.,* any regular generalized polygon, sometimes called a *star polygon,* with n vertices is obtained by joining in order every k th vertex of a regular simple polygon of n vertices, where k is any integer between 1 and $n/2$.

In an analogous way the notion of a *generalized polyhedron* is defined; *i.e.,* by relinquishing the condition that two elements have no points in common. and at the same time allowing a face to be determined by a generalized plane polygon The generalized polygon is not the boundary of the face in the ordinary sense. For example, the sides of each pentagon which bounds a face of a regular dodecahedron when prolonged form a star pentagon, and all such star pentagons determine the faces of the small stellated dodecahedron. The latter generalized polyhedron is regular in a sense which is an obvious extension of the meaning of that term as applied to ordinary polyhedra. There are just four such *regular generalized polyhedra* and detailed data concerning them are given in an accompanying table. The other definitions involving the idea of regularity as applied to ordinary polyhedra evidently admit of like extension so as to apply to generalized polyhedra, and many interesting types of generalized polyhedra accordingly present themselves.

Explanation of Tables.—The symbols of the tables have the following meanings: f denotes the number of faces of the polyhedron, v the number of vertices, and e the number of edges; of the f faces m_1 are bounded by polygons of m sides, and m_2 of these m_1 faces are incident to each vertex. Similarly, in the case of the numbers n, n_1, n_2 and s, s_1, s_2. a is the number of times that the projection of the generalized polyhedron from its centre on to a sphere about that centre covers the sphere; a_1 and a„ are respectively the analogous numbers for a polygon which determines a face of the polyhedron, and for a polyhedral angle of the polyhedron; p is the genus of the polyhedron (the genus of all polyhedra in the first table is, of course, zero). Each polyhedron of a bracketed pair is dual to the other; the tetrahedron is self-dual.

GEOMETRIC SOLIDS IN GENERAL

The boundary of a solid may consist. of course, of several polyhedra; *e.g.,* a cube and one or more smaller cubes inside of the former. Some of these polyhedra may have points in common. The great diversity of such disconnected boundaries makes classifying them difficult; a rough classification is according to the number of pieces into which the boundary falls. As remarked earlier, the boundary of a solid may be a closed surface or consist of a number of such, or it may be a set of points of great irregularity. Solids with such irregular boundaries can be obtained by limiting processes in which certain constructions are repeated an infinite number of times.

The study of the general properties of solids of the class of solids whose boundaries are closed surfaces is made along lines suggested by the theory of polyhedral solids, a subclass of the former: for a closed surface can be transformed continuously into a polyhedron. This property may be taken as the defining property of a closed surface. The concept of genus carries over directly, when simple continuous curves are used in place of the polygonal lines and polygons of the definition of that term given above. Simple examples of closed surfaces are the sphere, ellipsoid, the surface of a cone, of a cylinder, and of an anchor ring, *i.e.,* a torus. With regard only to the primitive properties of continuity and connectivity, the first four closed surfaces are not different; the torus, however, is different from all of the other four. The genus of each of the first four is zero, that of the torus, one; it is impossible to transform continuously the torus into any of the others, but any one of the first four can be continuously transformed into any other. The similarity between the torus and the polyhedron illustrated above should be noted; the genus of each is unity and either is continuously transformable into the other. When projective or metric properties are regarded, distinctions between any two of the examples cited immediately appear. *(See* MATHEMATICAL MODELS.)

See V. Eberhard, *Zur Morphologie der Polyeder* (Leipzig, 1891); M. Briickner, *Vielecke und Vielfläche* (Leipzig, 1900); E. Steinitz, "Polyeder und Raumeinteilungen," *Encyklopadie der math. Wissenschaften,* Bd. III₁, Heft 9 (Leipzig, 1922); C. Wilner, *Ueber Vielecke und Vielfläche* (Leipzig, 1864); O. Veblen and J. W. Young, *Projective Geometry,* vol. ii., ch. 9 (N.Y., 1918); H. G. Forder, *The Foundations of Euclidean Geometry,* ch. 12 (London, 1927); W. W. Ball, *Mathematical Recreations and Essays,* ch. 5, 11th ed. (New York, 1942).

(G. A. P.)

SOLID STATE PHYSICS. A solid may be defined as any body which possesses an innate tendency to return to its original form after forces have been applied to it and removed. This definition, as do most, possesses defects. Most prominent among these is the fact that the definition does not draw a sharp distinction between solids which undergo a slow permanent deformation, or creep, when they are loaded, and thixotropic liquids (*i.e.,* liquids which behave in a gelatinous fashion when small stresses are applied to them) which do not flow under small loads. The situation may be summarized best by saying that in nature there is not a sharp boundary line between those substances that we commonly think of as ideal solids and those we think of as ideal liquids.

The development of solid state physics is linked with the coniparatively recent adoption of the inductive method in science—the drawing of general principles from specific facts. in contrast to the deductive logic of the ancient philosophers, who began with generalizations and tried to fit these to the facts.

Even so great a pioneer of inductive science as Sir Isaac Newton did not believe it could go much beyond the deductive logic of Aristotle in explaining the structure of matter. In his *Opticks,* published in 1704, he wrote:

It seems probable to me that God in the beginning iormed Matter in solid, massy, hard, impenetrable, moveable Particles, of such Sizes and Figures, and with such other Properties, and in such Proportion to Space as most conduced to the End for which he formed them; and that these primitive Particles being Solids, are incomparably harder than any porous Bodies composed of them; even so very hard, as never to wear or break in Pieces; no ordinary Power being able to divide what God Himseli made one in the first Creation.

Gron-th of the various phases of solid state physics is summarized in the following section. The dominant factors in the tremendous expansion of the science in the 20th century were discovery of the structure of the atom and the industrial urgencies of the World Wars I and II.

This article is divided into the following sections:

I. Historical Development
II. Physical Properties of Solids
  1. Types of Solids
  2. Atomic Structure of Solids
  3. Chemical Composition oi Solids
  4. Principies Determining the Physical Form of Solids
  5. Elastic Properties of Soiids
  6. Plastic Properties of Solids
  7. Application of Quantum Mechanics to the Theory of Solids
III. Theoretical Methods of Treating Solids
  1. Atomic Approximation
  2. Free-Electron Approximation
  3. Treatment oi the Properties oi Solids
IV. Synthesis of Imperfections and Their Importance

I. HISTORICAL DEVELOPMENT

The physics of solids has gone. successively through a number of eras of development. each era being an essential steppingstone for the next stage of development.

Macroscopic Developments.—Starting in the 16th century a fundamental interest in natural crystals, mainly minerals, emerged along with other aspects of science. Many natural crystals show well-developed crystal faces and exhibit interesting optical or mechanical properties. Such substances were subject to systematic measurement and study with the relatively crude tools of the day. It was found that crystals often are anisotropic: that is. they exhibit different properties in different directions although they may be the same in two or more equivalent directions. By 1830 the cataloguing of the properties had revealed that all crystalline materials may be divided into 32 classes on the basis of symmetry. ranging from those which are completely anisotropic (*i.e.*, possess the same properties in no two directions) to those having the 48 symmetry elements corresponding to a cube. Correlated examination of the angles between crystal faces showed that such angles are accurately the same for a given mineral regardless of the source or the chance form of a given specimen (*see* CRYSTALLOGRAPHY). This type of study eventually reached its peak toward the end of the 19th century with the improvement of methods for making a wide variety of physical measurements on appropriately prepared specimens. The subject still has great interest since it provides information concerning the uses we may make of crystals; however. it is no longer the central field of research.

Lattice Theory.—Late in the 18th century and early in the 19th, interest arose in the origin of the remarkable regularity and symmetry propcrties of crystals. With the development of atomic theory it nas inevitably concluded that the macroscopic properties must reflect a highly ordrred arrangement of atoms or molecules. A Bravais. following earlier investigations, proposed that the molecules in crjstals are arranged in regular three-dimensional lattices, that is, all crystals possess translational symmetry in three directions. He showed that this hypothesis would explain the existence of the 32 symmetry types found in nature. The topic of lattice symmetry evolved slowly during the century but by 1890, W. Barlow, E. S. Federov and A. Schoenflies had demonstrated that 230 types of lattice symmetry (*i.e.,* 230 space groups) are possible. Unfortunately little was known about the actual arrangements of atoms in lattices although ingenious proposals were made for the simpler crystals, such as rock salt.

The subject of lattice theory came into its own in 1912 when Max von Laue and his colleagues demonstrated that the lattice spacing in typical crystals is exactly right to diffract X-rays in much the same manner that a finely ruled grating will diffract ordinary light. This discovery permitted both the development of X-ray (*see* SPECTROSCOPY, X-RAY) and the determination of the structures of many crystals. Within 10 years of von Laue's discovery the structures of many simple inorganic materials were known. During the 1920s the analysis was extended to more complex inorganic minerals. After 1930 a great advance was made in the study of organic crystals. In addition. X-ray techniques proved useful in studying imperfections in lattice structure through analysis of the deviations from ideal diffraction.

The use of X-rays was eventually supplemented by electron and neutron diffraction which provided rich additions to the harvest of material that grew with each passing year.

Electronic Properties of Ideal Crystals.—Soon after the discovery of the electron, near the end of the 19th century, great interest arose concerning the way in which electrons enter into matter. Much of this interest was focused on solids, as part of a broad investigation of the chemical and physical properties of substances. There were several attempts to develop detailed theories of particular types of solid. P. K. L. Drude and H. A. Lorentz presented a detailed theory of metals based on the notion that the valence electrons in good metals behave as a gas which is free to move under applied electric and magnetic fields. Similarly, E. Madelung and Max Born developed an electronic theory of ionic crystals which assumes that the substances are composed of regular arrays of the ions found in aqueous solutions. The theory of ionic crystals was particularly successful. By 1925 it had provided great insight into the nature of these substances. The theory of metals faced continuous difficulties. however, until the development of wave mechanics in the period between 1925 and 1928. Then rapid advances were made as a result of the application of quantum statistics and quantum mechanics (*see* QUANTUM MECHANICS: *Wave Mechanics).*

Studies of the behaviour of electrons in a potential field possessing lattice symmetry led to the development of the band theory of solids, which will be discussed below, and provided clarification of the striking differences between the ideal crystal types. In 1932 E. P. Wigner and F. Seitz discovered a practical method lor developing wave functions for simple solids. This method was extended by J. C. Slater, N. F. Mott, C. Herring and J. H. Van Vleck during the subsequent decade. By 1940 one had a fairly detailed semiquantitative picture of the behaviour of electrons in the four types of ideal solids. This subject advanced in many detailed ways after 1940.

Imperfection-Determined Properties.—During the period of clarification of the electronic propcrties of ideal crystals a new phase of study was opened. that concerned with the properties determined by imperfections in the ideal structure or arrangement. This topic developed slowly before 1940 but matured rapidly in the late 1940s. It was a well co-ordinated discipline by 1950. Just prior to World War I. K. Baedeker pointed out that the materials later known as impurity semiconductors owe their electrical properties to imperfections. namely, foreign atoms. This discovery can probably be regarded as the initial step in the evolution of the subject. In 1927 J. Frenkel demonstrated that the electrolytic conductivity of ionic crystals must be associated with mobile charged lattice imperfections. The proposed models for such imperfections was amplified in 1930 by W. Schottky and C. Wagner.

By 1934 E. Orowan and G. I. Taylor had proposed models of imperfections, termed dislocations, which explained the plastic properties of ductile crystals. Thus the full importance of understanding the nature and properties of imperfections in crystals was appreciated by 1940. The subject was not quite ripe at that time, however. for reduction to a few relatively broad principles. Such clarification came only after World War II. For a more detailed presentation of our understanding of imperfections in crystals see *Synthesis of Imperfections and Their Importance* below.

Surface Properties. — The latest phase in the development of our understanding of solids is concerned with the physical properties of the surface. Chemists had been familiar with the importance of surfaces for many decades, principally through studies of catalysis (*q.v.*) and surface adsorption (*see* ADSORPTIOS). Similarly, experiments on the emission of electrons from metals and oxides during the period from 1920 to 1940 demonstrated that surface conditions have an important bearing on the ease with which electrons can pass through crystal boundaries. In 1932 I. Tamm pointed out that one could expect special electronic states to be associated with surfaces.

The subject of surface physics received great stimulus in 1947 when J. Bardeen proposed that the properties of contacts between metals and semiconductors depended upon the behaviour of electrons in surface energy levels. After that time the subject received increased attention both through theoretical study and by the development of special experimental techniques. Presumably it would grow rapidly into a major field of scientific investigation.

II. PHYSICAL PROPERTIES OF SOLIDS

1. Types of Solids. — There are two main classes of solids: crystalline and noncrystalline. The first type. which is most thoroughly understood, is an aggregate of crystals. As a result it possesses a very high degree of order in atomic arrangement. Practically all metals and minerals are of this type. Noncrystalline solids. which include glasses, plastics and gels, are those in which the atoms and molecules are not arranged in a definite lattice pattern.

Four distinct types of crystalline solid may be recognized: (1) metals and alloys; (2) salts (ionic crystals) ; (3) valence crystals; (4) molecular crystals. Metals and alloys are distinguished by their high electrical and thermal conductivity and "metallic lustre." (For information on particular metals and other classes of solids see articles under their names.) The conductivity of metals and alloys is known to he the result of the migration of free electrons. Salts may commonly be formed by precipitation from ionic solutions and may be viewed as aggregates of charged ions. They commonly possess an ionic conductivity that increases with increasing temperature. Valence crystals are hard. often brittle, materials such as diamond, silicon, germanium and silicon carbide. The more abrasive types have high melting points. Like salts, they tend to form in accordance with the rules of valence (*q.v.*) chemistry. The atomic arrangement in the simpler monatomic types, such as diamond, has the characteristic property that each atom is surrounded by a number of atoms equal to its valence. Unlike salts, they are not ionic conductors in the pure state and cannot be formed by aqueous precipitation. Molecular crystals are solids such as dry ice (the crystalline form of carbon dioxide [CO_2]), the solid forms of the rare gases and crystals of many organic compounds, which have a relatively high vapour pressure at ordinary temperatures. Their sublimation products, such as CO_2 in the case of dry ice, are usually stable molecules.

Many alloys, salts, valence crystals and molecular crystals which are good electrical insulators at low temperatures become electronic conductors at elevated temperatures. the conductivity increasing rapidly nith increasing temperature. The electronic conductivity is usually small compared with that of the good metals, such as copper, silver or gold, in which the electrical conductivity decreases rather than increases nith increasing temperature. Such materials are termed semiconductors. In general. the class cuts across the four divisions given above. Some solids. such as silicon, germanium and tellurium, show semiconducting properties even in the highly purified state; whereas others are semiconductors only when appropriate foreign additions are present or when their composition deviates from ideal combining proportions. The two types are commonly designated as intrinsic and impurity semiconductors. Cuprous oxide and zinc oxide are typical impurity semiconductors. Actually, the conductivity of most intrinsic semiconductors can be altered substantially by suitable additions of impurities. Although semiconducting solids had been of interest because of their ability to act as electrical rectifiers from about 1920, they received relatively tremendous attention, both during and after World War II. In particular. silicon and germanium. which were available in pure form only as chemists' curiosities prior to 1940, later became the basis for vast developments in the electronics industry. During World War II, they proved to be excellent materials for diode rectifiers in the range of radio frequencies used for radar. After the war they made possible the development of triode devices, of which the surface contact transistor (*q.v.*) invented by Bardeen and W. A. Brattain was the forerunner. Acute technological interest in these materials led to purification and fabrication on a scale previously unknown in the solid state. Basic research on such pure crystals, in turn. expanded our range of understanding of many properties of solids, particularly those governed by imperfections (see *Synthesis of Imperfections and Their Importance* below).

It should be emphasized that many crystalline solids belong midway between two of these classifications since they partake of the properties of two ideal types. For example, the silicates possess properties that resemble both those of salts and of valence crystals; and there are many alloys, such as Mg_3Sb_2, which possess compositions that resemble those of ionic crystals. It may be said that most crystalline materials partake of the properties of two of the ideal types.

The foregoing classification also can be applied to noncrystalline solids if a proper point of view is maintained. Most noncrystalline organic materials possess properties that are common to molecular and valence crystals. They frequently are composed of large molecules. between which there is a relatively weak cross linkage and an occasional strong valence bond. Most glasses are compounds which lie intermediate between the ideal valence and ionic types. It is noteworthy that both ideal metals (and alloys) and ionic substances always form crystalline solids.

2. Atomic Structure of Solids. — The differences between solids may be ascribed to two factors: the differences in the forces between the atoms of which they are composed and the differences in the manner in which the atoms are arranged. It is a general principle of atomic theory that a given pair of atoms attract one another when far apart and reuel one another at small separations. (*See* ATOM.) When expressed in terms of the energy of interaction. this principle is illustrated in fig. 1. If the energy of interaction is arbitrarily chosen to be zero at infinite separation, it is found to decrease as the atoms approach one another. pass through a minimum and then increase very rapidly as the atoms are brought very close together. The separation at which the minimum occurs is that for which the forces of attraction and repulsion are at equilibrium and represents the actual separation of atoms in the diatomic molecule. The depth of the minimum and the position at which it occurs is dependent upon the chemical species to which the atoms belong Thus, the minimum is shallow for two atoms of the rare-gas type and very deep for atoms which form strong chemical bonds. The depth of the minimum is a direct measure of the strength of the bond between atoms

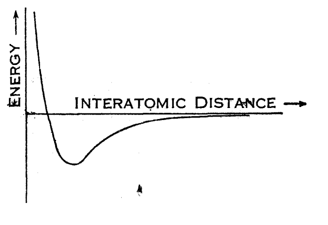


Fig. 1. — Variation of the energy of interaction of two atoms as a function of the interatomic spacing. The minimum of the curve represents the position of eauilibrium. The depth of the minimum provides a measure of the stability of the bond

The energy of interaction between a given pair of atoms usually is altered by the presence of other atoms. As a result. it is not possible in general to determine the cohesive forces in a solid by treating it as if it were composed of isolated pairs of atoms. In spite oi this it is very useful for qualitative work to regard each atom as if it were a definite spherical unit, with a fixed diameter, nhich attracts its neighhouring atoms until the spheres representing the boundaries of each come into contact. whereupon the sign of the forces is reversed. Extensive analysis of experimental observations shons that many of the properties of solids can be correlated with the use of this simple rigid sphere picture of the atoms. From the standpoint of the ultimate structure of the atom. its nucleus may be regarded as occupying a position at rhe centre of the sphere, whereas the electrons move in the volume about the nucleus.

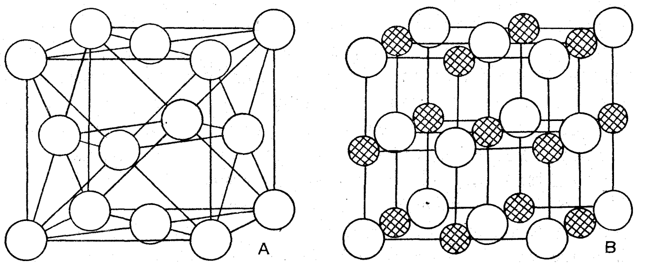


Fig. 2.—(A) The face-centred cubic lattice. About one-third of the metals possess this structure. (B) The sodium chloride lattice. One type of ion is designated by an open circle, the other by a full circle. Most of the alkali halides possess this structure, which is typical of ionic crystals

The distribution of atoms in solids may be determined with the use of X-rays. This science developed extensively after its start in 1913 and provided a large amount of exact information concerning the structure of all types of matter. The principal conclusions concerning solids that were obtained from it are the following:

a. Within each of the individual crystals or grains of which crystalline solids are composed, the atoms are arranged in a three-dimensional lattice. Typical three-dimensional lattices are shown in fig. 2. Fig. 2A shows the face-centred cubic lattice that is characteristic of many metals such as copper and nickel, whereas fig. 2B shows the lattice of sodium chloride. which is characteristic of most of the alkali halides.

b. Noncrystalline solids possess a lower degree of order of atomic arrangement than crystalline solids. In the most extreme case, which occurs in glasses (and in liquids), the immediate neighbours of a given atom are symmetrically disposed about it; however, relative to a given atom, this order does not extend beyond the first few sets of its neighbouring atoms. This difference between crystalline and noncrystalline solids is sometimes charactrrizrd by saying that the former possess both long-range and short-range order, whereas. the latter possess only short-range order. Fig. 3 shows the type of structure that is observed in the glasseous form of B_2O_3. Similarly, each silicon atom in silica glass is surrounded tetrahedrally by four oxygen atoms and each osygen atom possesses two silicon atoms as nearest neighbours. Yet, in both of these the total arrangement does not form a three-dimensional lattice as it does in crystalline quartz. The degree of order is frequently higher in fibrous materials than in glasses, for in such cases the long-chain molrcules of which the fibres are composed may be parallel to one another and linked together in such a way that there is an appreciable amount oi long-range order relative to the fibre-axis. Rubber and similar plastic substances or polymers frequently show a semicrystalline structure mhcn placed under tension.

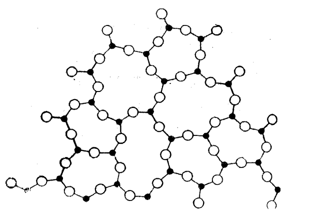


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Fig. 3.—The two-dimensional network characteristic of boric oxide glass. The boron atoms are indicated by full circles, the oxygen atoms by open circles. It is to be* noted that the structure does not form a network with periodic or long-range symmetry

The diameter of a given atom may be found by determining the spacing between nearest atoms in the pure elemental substance. It is readily seen that the distance between the centres of such neighbouring pairs is equal to the atomic diameter. The accompanying table contains values of the atomic diameters of a number of elements that were determined in this way from X-ray data.

Diameters of a Number of Atoms and Ions

(Values expressed in units of 10^{-8} cm.)

Fl	0.75	Mg	3.20	W	2.73	Na^+	1.96
C	1.54	Zn	2.65	Pt	2.71	Mg^{+2}	1.56
Li	3.00	Al	2.86	F^-	2.66	Ca^{+2}	2.12
Na	3.67	Ti	2.89	Cl^-	3.62	Zn^{+2}	1.66
Cu	2.55	Sn	2.80	O^{-2}	2.64	Al^{+3}	1.14
Ag	2.88	Pb	3.48	S^{-2}	3.48	Fe^{+2}	1.66
Be	2.28	Fe	2.58	Li^+	1.; 6	Pb^{+2}	2.64

3. Chemical Composition of Solids.—Most solids which possess a low electrical conductivity, such as the saturated hydrocarbons and the oxides and chlorides of the simpler metals, conform to the usual rules of combining proportions that are summarized in elementary valence chemistry. Examples of this type are the alkali halides, magnesium oxide and the paraffins. This obedience to simple valence theory is reflected in the structure of these materials by the fact that their atoms are arranged in definite and simple ways. In crystalline materials each type of atom forms its own lattice and the complete lattice may he regarded as the result of combining these lattices. Similarly, in insulating noncrystalline solids, the short-range order exhibits a high degree of regularity and simplicity, as in the case of silica glass described above.

Metals, on the other hand, do not obey the usual rules of valence chemistry when they combine with one another. In the first place, they have a pronounced tendency to combine over wide ranges of composition; *e.g.*, copper will dissolve up to 30% of zinc without altering its face-centred cubic lattice structure. In the second place. they commonly form compounds the compositions of which bear little relation to the usual rules of combining proportions. Thus copper and zinc form compounds of approximate composition CuZn, Cu_5Zn_8 which have their own lattice structures.

W. Hume-Rothery and G. Hagg attempted to systematize the rules of combining proportions of metals for substitutional and interstitial alloys, respectively. Substitutional alloys have the property that as the composition is varied within the solubility limits of a given phase, atoms of one type are replaced by another. For example, atoms of copper are replaced by those of zinc as the amount of zinc in any given phase of brass is increased. Interstitial alloys differ from substitutional in that one type of atom is sufficiently small to fit into the interstices of the lattice formed by the other. Thus. only the fraction of occupied interstitial positions is altered as the composition of an interstitial alloy changes. Typical examples of interstitial alloys are those formed by dissolving carbon in iron or by dissolving hydrogen in palladium.

Hume-Rothery pointed out that substitutional alloys form for wide ranges of composition as long as the atomic diameters of the constituent elements do not differ by more than 15%. When the difference in diameter is more than this. few substitutional phases form and these possess very narrow solubility range. Moreover, he found that there is a very close relationship between the crystal structure of a substitutional alloy and the ratio of the number of valence electrons within it to the number of atoms. For example, the body-centred cubic lattice. which is characteristic of beta brass (CuZn), forms whenever the ratio of valence electrons to atoms is 1.;. In the case of beta brass, each zinc atom contributes two valence electrons and each copper atom contributes one, so that the ratio is $3:2=1.5$. The composition of the corresponding phase in the bronze (tin-copper) system has approximately the composition Cu_5Sn.

Hägg found that interstitial alloys form readily if two conditions are satisfied: if the reacting metals lie very close together in the electromotive series of elements and if the diameter of the smaller atom is less than 0.59 times the diameter of the larger. The only systems of alloys which satisfy these two conditions are those formed by combining the so-called metalloid atoms (hydrogen, boron, carbon and nitrogen) with the transition metals. such as those of the iron. platinum and palladium groups. In these systems the metalloid atoms fit into the interstices of the lattices formed by the transition metal atoms. Hagg also found that there is a close correlation between composition and structure among the interstitial metals.

It is interesting to note that two elements will not alloy well if the ratio of their diameters is larger than 0.59 or smaller than 0.85. When the ratio of diameters lies in this range the smaller atom is too large to fit into the interstices of the lattice formed by the larger, and too small to form an ideal substitutional alloy. Thus. this range constitutes something of a "no-man's land" for alloy formation. It should be added that the ratio is very near to the borderline limit of 0.59 for the iron-carbon system, Were the value somewhat larger it is entirely possible that we would have been denied the use of one of the most valuable of all alloy systems. that of steel.

The relatively feeble electronic conductivity of the intrinsic semiconductors indicates that they lie between the ideal metallic solids and the ideal insulators We shall see later (fig 6) that this transition between ideally insulating and ideally metallic solid can be given a clear picturization in terms of the energy levels of the valence electrons in solids. Practically all the impurity semiconductors also possess properties somewhat intermediate between insulators and metals Either they possess appreciable solubility for foreign atoms having appropriate size relations. or they are compounds ahich tend to form over an appreciable range of composition. Ferrous oxide (FeO), which is a typical semiconductor, frequently shows deviations from ideal combining proportions of the order of 1%. Similar deviations nere observed in zinc oxide, lead sulfide, selenide and telluride, cuprous oxide and even in specimens of the alkali halides that were transformed into semiconductors by being heated in the presence of alkali metal vapour. In such cases, the crystal lattice exhibits imperfections on an atomic scale which are distributed throughout the specimen (see *Synthesis of Imperfections and Their Importance* belou). Thus in iron oxide. some of the lattice sites that would be occupied by iron ions in the normal crystal are vacant. In zinc oxide, on the other hand. the deviation from ideal composition is associated with the presence of interstitial zinc atoms in the lattice of the oxide. Extensive experiments showed that the electronic conductivity of any one of these semiconductors increases as the deviation of the composition from the ideal value increases.

4. Principles Determining the Physical Form of Solids.— The lans of thermodynamics (*q.v.*) describe the manner in which the stable state of a system that is maintained at constant pressure is determined by the condition that the free energy

$$F=E+PV-TS \qquad (1)$$

be a minimum. Here E is the energy of the system, P is the external pressure, V is the volume, T is the temperature and S is the entropy. The variations in PT that normally occur when solids are maintained at atmospheric pressure are negligible. so that this term may be discarded. Thus. it usually is adequate for practical purposes to deal with the expression

$$F=E-TS. \qquad (2)$$

The term in TS vanishes at the absolute zero of temperature so that in this special case the equilibrium state is determined by the condition that E be a minimum. This is just the condition for the equilibrium of a mechanical system. Thus. the TS term in equation (2) has the nature of a correction factor which takes into account the influence of temperature fluctuations in altering the equilibrium state of a system from the value it would have at the absolute zero of temperature. As the temperature of a solid is raised. energy is absorbed and E grows larger. It can be shown that the entropy S, which measures the thermally induced disorder of the system, also increases. Thus the two terms on the right hand side of (2) compete with one another as the temperature is raised. the first desiring to increase and the second to decrease F. At low temperatures the atoms in solid systems tend to be in highly ordered arrangements for which E is small; whereas at high temperatures disordered states for which S is large are preferred. The tendency toward disorder as the temperature is raised may make itself felt in one or more of the following ways.

a. The atoms are set into oscillation about the positions of equilibrium at the absolute zero of temperature. This type of disordering is a universal characteristic of solids and starts as soon as the temperature is raised above absolute zero.

b. The system may decide to change irom one lattice structure to another in which the atoms have greater freedom of movement. This change is termed an allotropic transformation and is very common. For example, iron changes from the body-centred cubic to the face-centred cubic lattice at 903° C. Sulfur exhibits several different allotropic transformations which occur at successively higher temperatures.

c. Pairs of atorns of different types may interchange places, thereby disordering the lattice. This interchange is most commonly observed in alloys, for the net energy required to interchange two different atoms is smaller in these materials than in those in which the constituents are of widely different nature, as in salts. For example, at the absolute zero oi temperature the stable form of beta brass (CuZn) is a body-centred cubic structure in which one type oi atom occupies the body-centred positions and the other occupies the position at cube corners. As the temperature is raised, the different atoms at the two positions begin to change places until at 480° C. there is equal probability that a given position will be occupied by either type of atom. It is important to note that the basic lattice of the alloy remained unchanged in this type of transiormation. Only the relative likelihood oi finding a given type of atom at a given lattice site is altered as the temperature is raised.

d. In molecular crystals and in salts in which radicals appear, such as ammonium chloride, disordering may be introduced by the onset of rotation or libration oi the individual molecules or radicals. This type of disordering bears a close resemblance to that described in the preceding paragraph.

e. Disordering may result irom the migration of occasional atoms from normal positions in the lattice to interstitial position or to the suriace. In either of these events the lattice may be left with vacant lattice sites. In any given case of this type it can be shown that the number of disordered atoms, or lattice defects, per unit volume increases very rapidly with temperature, obeying the same law as the density of vapour above a liquid.

Experiments showed that diffusion (*q.v.*) and ionic conductivity in solids are intimately related to lattice defects of this type. It was shown that diffusion occurs in substitutional alloys because the vacancies produced in the lattice by the migration of atoms to the suriace are free to wander irom one lattice site to another. Their motion permits a shuffling of atoms within the lattice. Similarly, it was shown that the ionic conductivity of the alkali halides is related to the migration of vacancies in the lattice of both the halogen ions and alkali metals ions.

f. It is evident that changes from the solid to the liquid or gaseous state represent more extreme types of disordering than any of rhose mentioned above. Nevertheless, melting and sublimation End their origin in the same basic principles.

g. Metals contain iree electrons whose motion is responsible for the high thermal and electrical conductivity of the solids. The free electrons may contribute to the disorder of the solid by increasing their rate of motion. Ferromagnetism (*q.v.*) in iron, nickel and other metals and alloys originates in an ordered coupling of a fraction of the valence electrons. This order is disrupted at elevated temperatures and the ierromagnetism vanishes. For instance, it disappears at 780° C. in iron.

The onset of any given type of disorder increases the internal energy of the system and, as a result, requires the absorption of a corresponding amount of thermal energy. This absorhed energy makes itself evident either as the specific or latent heat necessary to raise the temperature. It frequently is possible to identify the nature of the disordering process by its contribution to the absorbed thermal energy. For example, the contribution to the specific heat that is associated with an increase in the amplitude of oscillation of the atoms as the temperature is raised varies as the third power of the temperature near the absolute zero of temperature and. attains a limiting value at high temperatures.

Allotropic changes, like melting, are accompanied by the appearance of a latent heat at the temperature where the phase change occurs. The observation of this latent heat is commonly used to detect allotropic changes.

The onset of order-disorder in alloys and of molecular rotation in molecular solids is usually distinguished by a very large increase in the specific heat of the solid over the temperature range neighbouring that at which the disordering. or rotation. becomes complete. In certain instances the transition is also marked by the appearance of a latent heat.

The disordering associated with changes in the state of the electrons present in the solid is also marked by thermal effects. For example. the free electrons in metals add a term to the specific heat which increases linearly with temperature. This term is particularly large in the transition metals such as iron and nickel. Similarly, the disappearance of ferromagnetism in iron at elevated temperatures is accompanied by the appearance of a peak in specific heat of the type observed during the disordering of alloys.

5. Elastic Properties of Solids.—As mentioned previously, each atom in a solid is normally at equilibrium under the action of the attractive and repulsive forces its neighbours exert upon it. The atoms take up new positions when external forces are applied to the solid, or in more technical terms the solid becomes strained. As long as the applied forces are sufficiently small, the atoms return to their original positions when the forces are relieved. A strain of this type is said to be elastic. The material is said to have been strained beyond its elastic limit if the strain is not reversible. The extent of the elastic range depends much upon the nature of the applied stresses, upon the material being stressed and upon its previous history. Most homogeneous materials are highly elastic when placed under hydrostatic pressure. In general, a tensile stress, a unidirectional compressive stress or a shearing stress is necessary for a deviation from elasticity.

Very large elastic strains were produced by hydrostatic pressure, particularly by P. W. Bridgman (*q.v.*), who employed pressures as high as 100.000 atmospheres. Changes in crystal structure may be produced by hydrostatic pressure. This pressure was used in 1953 to convert graphite into diamond. It is interesting to note that Bridgman discovered a variety of forms of ice which can exist at high pressures. most of which will sink rather than float in water.

For small pressures the relation between stress and strain is found to be linear for small stresses; however, quadratic and higher terms appear in the stress-strain relation at elevated pressures. If no phase change is induced by the pressure, the nonlinear terms usually have such sign as to imply that an ever-increasing increment of pressure is required to obtain a given increment of strain. This decrease in the compressibility of materials as the pressure increases is a consequence of the fact that the repulsive forces between atoms invariably increase with decreasing atomic separation. The linear relation between force and strain for small forces is valid only because the interatomic forces vary linearly for small displacements.

The force-strain relation is invariably linear within the elastic range whenever shearing stresses or tensile stresses are present, for in such cases the material either flows plastically or breaks before the absolute magnitude of the components of stress attain values as large as those employed in Bridgman's experiments. When a solid becomes strained under the action of applied forces, work is done upon it. The reversible component of this work represents a change in the free energy of the solid, and the elastic properties may readily be described in terms of the changes in free energy that accompany the atomic displacements associated with various strains. In most solids this change in free energy arises principally because of a change in E, the internal energy of the material; that is, the TS terms in equation (2 j above merely determine the relatively small amount by which the elastic constants at a finite temperature differ from those at the absolute zero. There are. however. notable exceptions to this rule. For example, the elastic properties of rubber are determined principally by the manner in which the entropy changes as the material is strained. The elastic constants of materials of this type are usually strongly dependent upon temperature.

***6.* Plastic Properties of Solids.**— Most noncrystalline solids, such as glasses. become brittle at low temperatures; that is, their elastic range is determined by the stresses at which they break. Many crystalline solids, however, most notably the metals. exhibit surprising ductility even near the absolute zero of temperature. This type of plastic flow was extensively examined in large single crystals and several important laws concerning it were discovered. These laws may be summarized as follows:

a. Crystals deiorm plastically as the result oi the displacement of one part of the crystal relative to another along a crystallographic plane. The planes are called slip planes (or glide planes) because one part of the crystal appears to slip relative to the other along it. The nature of the slip planes depends upon the particular material involved. For example, they are the octahedral planes of closest packing in the case of iace-centred cubic crystals and are the basal planes. which are normal to the hexagonal axis, in hexagonal crystals. There are three different types of slip planes in the body-centred cubic metals, such as alpha iron and tungsten. Under favourable conditions the displacement along a given plane is sufficiently great so that it is visihle either to the naked eye or under a low-powered microscope. In such cases the crystal gives the appearance of being composed of lamellae that become displaced relative to cine another much as the individual cards in a deck are displaced relative to one another when the deck is sheared. X-ray evidence indicates, however, that plastic flow occurs even within the lamellae that apparently move rigidly relative to one another. Thus, we may conclude that slip occurs extensively throughout the crystal even though the amount is much larger on certain preierred planes than on others.

b. The condition under which slip occurs along a given family of parallel slip planes is determined by the magnitude of the resolved shearing stress in these planes. In general, slip will occur in a given set of planes only if this shearing stress exceeds a critical value σ_c, which depends upon the previous history of the specimen and upon its purity. This limiting stress is called the critical shearing stress. It increases as the amount of plastic strain increases, a phenomenon reierred to as work-hardening. This property of solids is responsible for the fact that they become harder as they are deformed by mechanical action such as by drawing or rolling. The critical shearing stress may also be raised by the addition oi soluble impurities. It is by this type of alloying that metals such as copper, silver and gold can be made sufficiently hard for coinage. The values of the critical shearing stress for pure metals that have been annealed at elevated temperatures range between 1 and 100 kilograms per square centimetre; whereas values as high as 1.000 kg. per square centimetre are common for metals that have been work-hardened or alloyed.

c. There is a more or less well-defined temperature above which the effects of work-hardening may be removed by annealing in a reasonable time, such as half an hour. This temperature is called the resoftening temperature. In metals such as lead, zinc and tin it is near or below room temperature; however, it is well above room temperature for many useful metals. Resoftening probably occurs to some extent at any temperature above the absolute zero, although the rate is negligibly slow at temperatures below the resoitening temperature.

d. The critical shearing stress is slightly dependent upon temperature below the resoftening point; *e.g.*, the value for a specimen of very pure zinc was found to increase from 75 kg. per square centimetre to 140 kg. per square centimetre in going irom room temperature to 20° K. This means that metals retain a great deal of their ductility at low temperatures. Thus, the specimens of zinc bend under their own weight near the absolute zero of temperature.

A careful analysis of the origin of the high ductility of metals indicates it must be related to the presence of imperfections. For it can readily be shown that if two parts of an ideally perfect crystal were to be displaced relative to one another along a slip plane as rigid units. the stresses required mould be of the order of $\frac{1}{10}$ of Young's modulus (see ELASTICITY; MATERIALS, STRENGTH OF) ; that is, about 500,000 kg. per square centimetre. This is at least 1.000 times larger than the values normally observed in pure single crystals. It is interesting to note that hairlike microscopic crystals of the order of 0.0001 in. in diameter, which possess the theoretical strength, were produced by several methods. It is believed that such crystals may not contain the imperfections responsible for the ductility of most materials. Thus far such strong "whiskers'! constitute a scientific curiosity; however, they may prove to be the basis of practical developments. Two major conclusions were drawn from this analysis:

a. The planes of atoms on each side of a slip plane do not move relative to one another at once. Instead, the displacement must be propagated along the plane as a wave. Both Taylor and Orowan described imperfections which, if present in the crystal, could produce the observed results oi slip at the observed values of the critical shearing stress by moving across the slip plane. This type of imperfection is shown in fig. 4 and is called an edge dislocation. The manner in

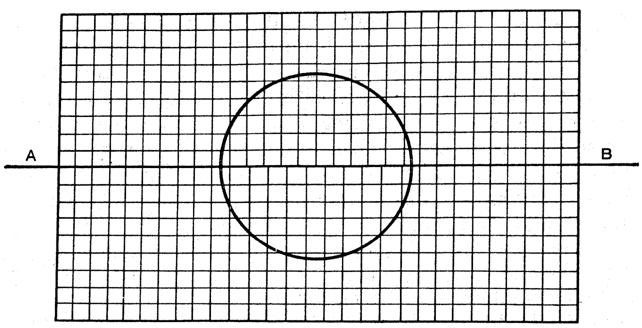

Fig. 4.—A dislocation. It is believed that this type of distortion pattern of the lattice plays an important role in plastic flow (see fig. 5). (After Orowan)

which it can produce slip is shown in fig. 5. It may be observed that there are two types of edge dislocation which produce the same effect by moving across the slip plane in opposite directions. They are called positive and negative edge dislocations. In 1938 J. M. Burgers demonstrated that other types of dislocations can play a role in plastic flow. It is known that a wide variety oi dislocations are possible.

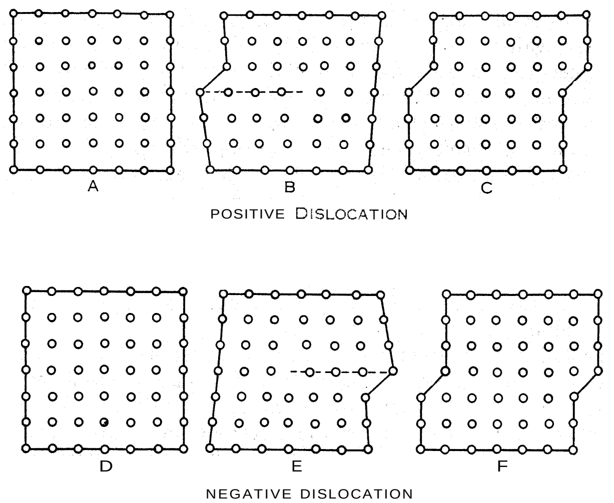

Fig. 5.—The manner in which motion of dislocations permits a crystal to flow without requiring that the slip planes move past one another simultaneously as rigid units. In the upper sequence the unit of plastic flow is produced as the result of the motion of a positive dislocation across the slip plane from left to right, whereas in the lower sequence the same unit of flow is produced by motion of a negative dislocation in the opposite direction. (After Taylor)

b. Although the stresses required to make dislocations move across the slip plane are as small as, if not smaller than, the observed values of the critical shearing stress, much larger local stresses are required to generate them in a perfect crystal. As a result, it is necessary to assume either that dislocations are produced during growth of the crystal or are generated at regions of the specimen where irregularities occur. Some of these irregularities could be regions of the specimen where tiny cracks or particles of foreign matter occur and where the applied stress is magnified by factors of the order of 100 or more. In addition, F. C. Frank and W. T. Read showed that appropriate arrays of dislocations may act to generate other dislocations in almost endless quantity. As of the mid-1950s it was not known to what extent the two types of imperfections act as the sources of the dislocations which produce plastic flow in typical materials. Probably each plays a role under appropriate circumstances.

It should be added that independent evidence for the presence of stress-raising cracks or foreign objects is provided by the observation that the rupture strength of crystals is usually much lower than would be the case if they were perfect. The weak regions used to explain the generation of dislocations are sufficient to account for the low values of the rupture strength.

The dependence of the hardness of a specimen of metal upon its previous mechanical treatment and upon its purity is readily interpreted in terms of the theory of dislocations on the basis of a principle first pointed out by Mott. If, in moving across a slip plane, a dislocatibn encounters a region of the specimen which had been strained irregularly and in which there are residual stresses which oppose the motion of the dislocation. the dislocation will not be able to proceed until the externally applied stresses become sufficiently large to reverse the sign of the stress in the regions opposing the motion. Thus, residual stresses will raise the critical shearing stress for plastic flow and harden the material. Various sources of residual stress are as follows:

a. Each dislocation is the centre of a stress field. As a result, pairs of dislocations interact with one another. Hence, as the concentration of dislocations in a specimen increases during continued plastic flow, they impede each other's motion because of the field of residual stresses they produce. This principle was made the subject of a theory of work-hardening by Taylor, who computed the relation between the increase in critical shearing stress and strain on the basis of the assumption that the positive and negative dislocations are produced in equal numbers, are arranged into a simple lattice and moved a distance of the order of one micron before becoming stuck.

b. Impurity atoms being more or less misfitted in the lattice produce stress fields which can impede the progress of dislocations and hence produce hardening. There appear to be two important ways in which the impurities or foreign atoms may affect hardening. (1) The misfit atoms are distributed more or less randomly through the lattice so that the dislocations encounter an increased resistance for motion whenever they move. The extra hardness determined by the amount of foreign material, in general, is more or less proportional to the addition. This hardness is produced by the simple alloying of metals (*e.g.,* by the addition of zinc or tin to copper). Usually the alloys retain ductility and related properties although they are less easy to deform than the pure metals. (2) The foreign atoms become attached to the dislocations and hence tend to lock them into position. This possibility was first pointed out by J. S. Koehler and A. H. Cottrell. In particular, Cottrell pointed out that the carbon atoms in plain carbon steels probably precipitate at dislocations. It is very difficult to initiate plastic flow when dislocations are locked in this way. However, the dislocations may move relatively freely once they are torn free from the locking atoms. Thus plastic flow can be continued with much lower stresses than those needed to initiate it. In other words, an alloy with locked dislocations exhibits an instability, the stress needed to initiate plastic flow being much higher than that needed to sustain it once started. Such behaviour is characteristic of steel and other alloys.

The pinning of dislocations by foreign atoms is particularly marked in valence crystals of diamond, silicon and germanium. In such cases it is necessary to hold the crystals at elevated temperatures before plastic flow can be initiated. The high temperature aids the dislocation in becoming free of the pinning atoms so that it can move relatively freely.

c. Newly formed crystals of a precipitated phase in a two-component alloy, such as small agglomerates of copper in a supersaturated solution of copper in aluminum, will distort the surrounding lattice because the average volume occupied by the atoms in the precipitate differs from that which they occupied when in solution. The residual stresses produced in this way are believed to explain the phenomenon of precipitation hardening by which copper is used to harden aluminum and beryllium to harden copper. They probably also explain the way in which martensite, a phase produced in steel by rapid quenching, hardens that alloy in normal quench-hardening.

7. Application of Quantum Mechanics to the Theory of Solids.—The most irnportant developments in the theory of solids during the years after 1930 were those arising from the application of quantum mechanics to the problem of determining the behaviour of the valence electrons. These developments permitted a much deeper understanding of the qualitative differences between the solids types than was possible before the discovery of the complete form of atomic dynamics. Moreover, they made it possible to calculate the properties of some of the simpler solids in a quantitative manner from first principles.

The mode of application of quantum mechanics to solids resembles closely the application to molecular systems in that the co-ordinates of the nuclei are treated as parameters when the wave functions for the electronic states are determined. This procedure is permissible because under ordinary conditions the electrons move so much faster than the heavier nuclei that the former may be regarded as if in a stationary state for each position of the nuclei even when the latter are in motion) as when executing thermal vibrations. This method of separating the electronic motion from the nuclear motion was first introduced by M. Born and J. R. Oppenheimer and can be shown to be accurate for most practical problems.

The complete wave function for the electrons in a solid is much too complicated to determine in a precise form. As a result the following simplifications are usually made in solving problems.

a. The electrons in the inner shells of an atom, which are not appreciably affected by changes in chemical binding, are treated as though part of the nucleus and their influence upon the valence electrons is taken into account by assuming that they merely contribute a static potential field which is centred about the nucleus.

b. In first approximation each valence electron is assumed to possess its own wave function. This approximation, which is known as the Hartree-Fock scheme, or the one-electron approximation, does not neglect the interaction betueen the valence electrons; however, its use is equivalent to assuming that the interaction between electrons can be taken into account by a field similar to that which is used to express the influence of the electrons in inner shells. It is easy to show that this approsimation is rather rough and that the results obtained from it are mainly of qualitative value. The principal advantage gained from its use is the fact that the motion of each electron can be described independently; that is. each electron can be assigned its own constants of motion. This procedure is always to be regarded as a first approximation to the correct one.

There are two ways in which the one-electron approximation is commonly used. The choice between the methods is made in each case on the basis of physical reasonableness. The two methods are:

Atomic Approximation.—In this scheme it is assumed that each electron is attached to a given nucleus or group of nuclei, much as if it were in an isolated atom or molecule. Thus, the entire solid has the aspect of an aggregate of atoms or molecules. Since the electrons are bound to definite nuclei, the solid described in this way is always an insulator; that is, the electrons are not free to move about the solid. This approximation is particularly good when one is describing the normal state of a rare-gas solid such as solid argon, a molecular solid such as solid methane or any molecular solid with a low boiling point, or an ionic crystal such as one of the alkali halides. In the last-named case, the units to which the electrons are bound are positive or negative ions rather than neutral atoms or molecules.

Free-Electron *Approximation*.—In this scheme it is assumed that each valence electron is free to wander throughout the lattice so that the wave function used to describe it has a finite amplitude throughout the specimen. In the simplest case this wave function has the same form as that for a free electron; however, the approximation is not restricted to this simple situation. At first sight it appears that a solid which is described with the use of free-electron functions must always be a metallic conductor, since the electrons are free to wander everywhere. Actually, this is not the case, for as we shall see below, the motion of the electrons is restricted by the Pauli exclusion principle; in certain cases this principle limits the electrons in such a way that they cannot conduct a current. It can be shown that the ground state of any insulator may be described with equal accuracy with the use of either the free-electron approximation or the atomic approximation. Thus, the free-electron approximation is of more general use than the atomic approximation in treating the normal states of solids.

Since the ground state of an insulating solid can always be approximated as well with the free-electron picture as with the atomic picture. whereas the ground state of metals can be described only with the first method, one may reasonably ask why the second should ever be used. The answer to this question lies in the fact that the excited states described by the two schemes differ in notable respects and that both types of excited state are observed in practice. Any neutral atom or molecule is characterized by the fact that it possesses a number of excited electronic states in which the electrons are bound to the nuclei. Similarly, a solid which is described with the atomic approximation may possess excited electronic states in which the excited electrons are bound to definite atoms or molecules so that the solid is not conducting. On the other hand, it can be shown (see Free-Electron Approxintation, below) that an excited state of a solid that is described with the use of the free-electron approximation is always conducting, even though the ground state represents an insulator. Thus, the atomic approximation can describe excited states that cannot be treated appropriately in the free-electron approximation. Since these nonconducting excited states have been observed in the alkali halide crystals, we may conclude that the atomic approximation is the more appropriate one to use in such cases.

To summarize. it may be said that the free-electron approximation can always be used as a first approximation when describing metals and the ground state of insulators. On the other hand, the atomic approximation is frequently better when the excited states of insulators are being described. It may be noted that the atomic approximation has sufficient flexibility to describe conducting excited states of insulators. These are the analogues of the ionized states of atoms and molecules. Neither of the one-electron approximations is perfect in any given case, since neither ever furnished an exact solution of the equations of the quantum mechanical equations of motion.

In spite of this defect. the one-electron schemes provide us with useful qualitative pictures of the behaviour of electrons in solids and give us a clear insight into many experimental facts which were not understood before the development of quantum mechanics. The difficult problem of modifying the approximations so as to give a more exact solution was solved only in a few simple cases in which special methods were used. More exact solutions were obtained in the case of the alkali halides, for which the atomic scheme is almost exact, and in the alkali metals, for which the free-electron approximation is almost correct. The development of high-speed. digital electronic computers after 1945 made it possible to apply the approximate methods of handling the theory more widely than was possible prior to World War II. The machines serve as labour-saving devices and reduce the drudgery of extensive calculations. (See COMPUTING MACHINES, ELECTRONIC; OFFICE MACHINES AND APPLIANCES.) We shall now survey the on -electron approximations more fully and illustrate their application to the important problems of the solid state.

III. THEORETICAL METHODS OF TREATING SOLIDS

1. Atomic Approximation. — In applying the atomic approximation to insulating solids we may employ most of the concepts which are gained from a study of the behaviour of isolated atoms and molecules. Most important of these are: (1) electrons move normally in orbits which are clustered into groups of nearly equal energy, called the electron shells, and (2) no two electrons can move in a given orbit unless they have opposite spin. The second fact is simply one form of statement of the Pauli exclusion principle (see also NUCLEUS; PERIODIC LAW; SPECTROSCOPY). which has universal applicability. This principle can also be expressed by saying that no two electrons can have the same one-electron wave function unless they possess opposite spin and in this form can be applied to the case in which the free-electron approximation is being employed.

As noted in the preceding section, a solid described by the atomic approximation is necessarily an insulator because the valence electrons are not free to roam about the specimen. In addition, it may remain an insulator when the electrons are excited to higher states of motion provided the orbits of the excited electrons are still bound to the atoms. The excited electrons will always become free if given sufficient energy for the same reason that atoms and molecules become ionized when excited sufficiently, viz., only a finite energy is required to remove any electron from an atomic system. If the specimen is excited by irradiation with light there may be certain ranges of frequency that are absorbed, but which do not make the crystal conducting. This is the case in which there are nonconducting excited states. On the other hand. as the energy of the light quanta increases sufficiently there will come a point at which the electrons are freed and the specimen becomes photoconducting. Most of the common insulating solids behave in the manner which is to be expected from this model. That is, they do not become conducting when irradiated with the longest wave lengths which are absorbed by the atoms of the bulk material.

The insulating solid may contain impurity atoms, a stoichiometric excess of one of the constituents or imperfections. In this case, the electrons attached to the foreign atoms, or those in the vicinity of the imperfections, will not be bound in the same way as the electrons of the bulk solid. They will. as a result, have their own characteristic excited states and ionization potentials. If these excited levels lie closer to the ground state than those of the bulk solid, the longest wave lengths of light absorbed by the specimen will be characteristic of the foreign atoms or imperfections. Hence, an impure crystal may become photoconducting as a result of its impurities. Most photoconducting solids that are used in practice are of this variety. If electrons may be freed from the atoms of an insulator by thermal fluctuations at ordinary temperatures the solid evidently is an intrinsic semiconductor. Similarly, if an otherwise ideal insulator contains foreign atoms which may be ionized thermally at normal temperatures the material is an impurity semiconductor.

2. Free-Electron Approximation. — Electrons moving in identical orbits on different atoms have the same energy in the atomic approximation. As a result, the energy level spectrum of the electrons resembles closely that for a gas. On the other hand, it is generally true that the electronic states have different energies in the free-electron approximation. We do not have sufficient space to enter into a detailed discussion of the free-electron wave functions and their energies; however, the pertinent facts map be summarized in the following manner.

a. The energy levels of the states of individual electrons may be grouped into bands which are nearly continuous. The separation of neighbouring levels in a band decreases with increasing size of the specimen and is so small in all practical cases that it cannot be resolved by any direct means of measurement.

b. The different bands of levels may be separated or may overlap, depending on the material being investigated (fig. 6, A and B). The principal factors that determine whether or not the bands overlap are: (1) the magnitude of the variation of the potential fields from position to position within the solid and (2) the crystal structure. In general, the larger the likelihood that the bands will be separated the larger the fluctuations in field intensity. It is more likely that the bands will be separated in a monatomic solid containing quadrivalent atoms, such as carbon, than in one containing alkali metal atoms, for the field electrostatic strength will be larger and will fluctuate more strongly in the first case. Similarly, it is more likely that the bands

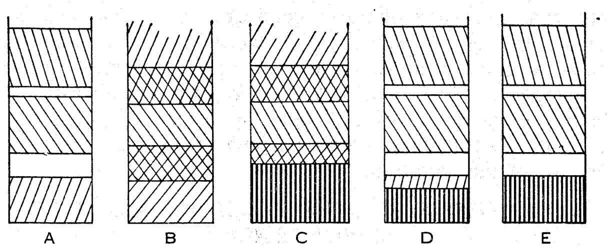

Fig. 6.—Energy levels of the electrons in solids and the manner in which they are occupied by electrons. The shaded area designates quasi-continuous bands of levels; the darkened area indicates occupied levels. (A) A situation in which the quasi-continuous bands of levels do not overlap. The gaps represent forbidden regions of energy. (B) A case in which the bands of levels overlap. (C) The manner in which the electrons fill the levels in a case in which the bands overlap. This case always represents a metal since the occupied levels border unoccupied levels infinitely closely. (D) A case in which the bands do not overlap and in which the uppermost occupied band is only partly filled with electrons. This situation represents a metal. It is unknown in practice. (E) Same as (D) except that the occupied region extends to the top of the highest occupied band. This solid is an insulator

will be separated in a salt containing strongly charged ions than in a monatomic solid in which each is neutral.

Although the spacing between levels in a band is very small, the actual magnitude is of practical importance because of the Pauli exclusion principle. A specimen solid of ordinary size contains of the order of 10^{23} atoms and hence has at least that number of valence electrons. Qnly two electrons at most may possess the same wave function and these must have opposite spin. Although the energy levels are degenerate (that is, more than one wave function is associated with each), the degeneracy is small so that only a few electrons may occupy any given level. As a result the electrons are distributed over a large number of levels, or over a large range of the spectrum. In the normal state of the solid the occupied levels will be those which lie as low as possible. Thus. all levels below a given point in the spectrum will be occupied as densely as possible. It is evident that the width of the occupied region depends upon the spacing of levels; hence, the importance of this spacing.

It can be readily shown that under normal conditions the electrons in the densely occupied portion of the spectrum are so paired that there is no net flow of current in spite of the fact that each electron is moving through the solid at a very rapid rate. In other words, for each electron moving in one direction in the solid there is another moving in the opposite direction with equal speed. If the bands of levels overlap, it follows that the uppermost occupied level of the energy spectrum is always very near to the lowest occupied level (fig. 6, C). Hence, when this type of solid is placed in even a very weak electrostatic field some of the electrons are excited from the occupied to the unoccupied levels, statistical balance between motions of electrons is upset and an electrical current flows. This situation is evidently characteristic of a metal. We may conclude that any solid in which the top of the occupied region is very close to unoccupied levels is a metal. This situation evidently will always obtain when the bands overlap. It will also obtain if the bands do not overlap and if the top of the occupied band does not extend to the upper edge of the highest band occupied (fig. 6, D).

If, however, the bands do not overlap and if the occupied range extends to the top of a band (fig. 6, E), the solid will not be a metal. For in this case the statistical balance between electrons can be disturbed only if the externally applied electrostatic field is so large that electrons can be stimulated from the highest occupied band to the lowest unoccupied one. The field usually required to do this is of the order of 1,000,000 volts per centimetre. Thus, in the free-electron approximation, an insulator is described by the situation shown in fig. 6, E in which the occupied region is separated from the unoccupied one by a large margin.

If the spacing between the highest filled band and the lowest empty band is sufficiently small in the case corresponding to fig. 6, E, electrons may be thermally excited from the lower to the upper band. A solid of this type will be a semiconductor even when pure and having ideal stoichiometric composition. That is, it will be an intrinsic semiconductor. Intrinsic semiconductivity of this type has been found in germanium, silicon and diamond. One can determine the width of the gap from the dependence of electronic conductivity upon temperature in such cases.

It should be emphasized that the crystal gains conductivity for two reasons when an electron is removed from a filled band and transferred to an empty band (see fig. 7): (1) it contains an unimpeded electron in the empty band and (2) the electrons in the filled band are no longer completely impeded, for one electron is absent. The filled band from which an electron is removed is said to contain a hole. It is conventional to describe the conductivity associated with the absent electron in terms of the presence of the hole, much as one gives individuality to a bubble or void in an otherwise filled container of liquid. The hole behaves as a positively charged particle, complementary to the electron, since it is derived by subtraction of an electron from an otherwise neutral system. It is possible to show that the hole behaves as a positive charge in the presence of both electric and magnetic fields.

Considerable success was achieved in determining the arrangements of bands and the manner in which they are occupied for a large number of simple solids. Reasonably accurate diagrams of the bands are available for many relatively simple metals and salts and for valence crystals such as diamond, silicon and germanium.

Van Vleck and H. Brooks developed a method for relating the behaviour of the electrons in simple solids to the behaviour in the free atom without solving the equations of quantum mechanics directly. This method is successful in treating the cohesive properties of a number of simple solids, particularly the metals. In a sense, the procedure enables one to relate the properties of the solid to easily measured properties of the free atoms without resorting to all the complexities of solving the basic equations of the theory.

3. Treatment of the Properties of Solids.—The solution of the equations of quantum mechanics obtained by use of the methods described in the previous sections were used to correlate many of the properties of solids. The following are the most important of these.

Cohesion.—The cohesive energy of a solid may be expressed in terms of the energy required to remove an atom from the surface to infinity; that is, the heat of sublimation. This quantity can be computed once the energies of the electrons are known. The one-electron approximations usually are not sufficiently good to give accurate values of the cohesive energy so that better approximations must be found. Such calculations were made of a number of simple solids, such as the alkali metals and the alkali halides, and the agreement obtained with experiment leaves little doubt that quantum mechanics can give reliable answers to problems involving the bonding of solid matter. The foregoing methods were much more widely used to obtain estimates of the relative magnitudes of the cohesive energies of different solids. H. Jones succeeded in giving a satisfactory interpretation of the Hume-Rothery rules (see Chemical *Composition* of Solids, above) with the use of the band approximation and thereby explained the importance attached to the electron-atom ratio in substitutional alloys. The same procedure mas used to explain the comparatively great stability of the metals containing partly filled d and *f* shells.

Electrical Conductivity.—Solids may conduct electricity because they contain either mobile ions or free electrons. In the first case, the quantity determining the conductivity is the probability that a given ion will become sufficiently free, as a result of thermal fluctuations, to jump from one equilibrium position to another. This process was examined in detail for a number of simple salts and as a result. many aspects of the subject became fully understood.

One of the greatest successes incurred in the application of quantum mechanics to solids was the understanding of the nature of electronic conduction in metals and semiconductors. The theory provided a much deeper insight into the nature of the current carriers in these solids and the manner in which they move. It became known that metals would possess an infinite electrical conductivity if all of the atoms were at complete rest and the lattice were perfect. The conductivity is finite only because the free electrons which are accelerated by the applied field are deflected from their course by imperfections in the lattice. Most important of these in a pure material are those caused by the thermal vibrations of the lattice. However, foreign atoms play an important role in raising the resistivity in impure metals and in alloys.

It is apparent that the free electrons in a metal attempt to avoid one another because of the repulsive forces originating in their identical negative charge. As a result. a free-electron gas does not behave quite the same as a perfect gas of neutral atoms. Cnder certain circumstances the electrons undergo highly co-operative motion. This co-operative behaviour is normally treated in the plasma theory of electron behaviour. first developed systematically for solids by D. Bohm and D. Pines.

The phenomenon of superconductivity. which is observed in some metals at very low temperatures. excited interest after it was first discovered by K. Onnes in 1911. A number of metals, such as lead and tin, abruptly lose all their resistivity on being cooled below some temperature near the absolute zero. The onset of superconductivity is accompanied by a marked change in magnetic properties. In effect the superconductor attempts to expel the lines of magnetic force from the metal or to become an ideal diamagnetic. Stimulated by the observation that the transition temperature at which superconductivity occurs depends upon the composition of isotropic masses present in the specimen. H. Frohlich and Rardeen proposed that the conduction electrons became interlocked with the lattice vibrational waves in the superconducting state in such a manner that the metal behaves as an insulator in which the gap between bands is exceedingly small. This approach has been developed by L. Cooper, T. Schrieffer and J. Bardeen into a very promising semiquantitative theory of the phenomenon.

A typical specimen of a ferromagnetic metal, such as iron, is not homogeneously magnetized but can be divided into blocks or domains which are magnetized in different directions. It can be shown that the energy of the system is lower in the absence of an externally applied magnetic field if domains are present. L. Neél demonstrated that the observed patterns of domains can be explained on relatively elementary principles regarding the interaction of one part of a magnetized specimen with another. much as one can discuss the stable orientations of simple bar magnets.

For many years magnetic iron oxide, magnetite (Fe_3O_4), a ferromagnetic insulator, was regarded merely as an interesting curiosity. During World War II, J. L. Snoek developed a number of similar oxides which proved to have useful magnetic properties. Such ferrites found service in many high-frequency applications because the eddy current losses are small.

One aspect of magnetism which received considerable attention after the war is that associated with the changes in absorption of high-frequency radio waves which occur when materials are placed in magnetic fields. The energy of the nuclei and the electrons will depend upon their orientation relative to the magnetic field if they have a resultant magnetic moment; that is, if they behave as tiny magnets. Nuclei of odd mass number and unpaired valence electrons usually have a magnetic moment. Radio waves of an appropriate frequency can induce changes in the orientation of the electrons or nuclei and thereby lose energy to the solid. Studies of such magnetic resonance furnished a great deal of information concerning the properties of solids and other systems. (See also ELECTRICITY., CONDUCTION OF).

Magnetic Properties.—The quantum theory was widely used with outstanding success in the exploration of the magnetic properties of solids. It served to give a clear-cut explanation of the origin of the differences between diamagnetic. paramagnetic and ferromagnetic substances. Moreover, it made possible the development of detailed pictures of the properties of materials in each of these categories. Most prominent among these were: the theory of the paramagnetism (*q.v.*) of simple metals developed by W. Pauli; the theory of ferromagnetism developed by W. Heisenberg, F. Bloch and a number of other investigators: the treatment of the paramagnetic salts by Van Vleck; and the investigation of the strongly diamagnetic metals, such as antimony and bismuth, by Mott and Jones.

Optical Properties.—As in the preceding cases, the application of quantum mechanics offered a good explanation of many of the optical properties of solids which were previously mysterious. Perhaps the greatest advance was made in the treatment of metals. For example, the free-electron theory gives a straightforward explanation of the colour of gold and copper and of alloys such as brass. and nhy the alkali metals become transparent in the ultraviolet part of the spectrum.

IV. SYNTHESIS OF IMPERFECTIONS AND THEIR IMPORTANCE

In the preceding sections it was seen that imperfections play an exceedingly important role in determining some of the most interesting and useful properties of crystals. Among these are the electronic conductivity of semiconductors, the electrolytic conductivity of salts and the plastic properties of all ductile materials. There was ample appreciation of the importance of imperfections prior to 1940; however, one might have supposed at that time that an essentially unlimited number of imperfections were possible and that new imperfections would be introduced almost indefinitely to describe the various properties of solids. Actually. the number required is relatively small and a substantial part of the seeming complexity of imperfection-determined properties arises through the circumstance that a small number may play an intricate role by the combination of individual behaviour and complex interactions.

The principal imperfections appear to be the following.

Lattice Vibrations (**Phonons**).—Since the atoms in crystals interact with forces that obey Hooke's law (see ELASTICITY; MATERIALS. STRENGTH OF) to a first approximation. they can be made to vibrate. Such vibrations are stimulated by heating the crystal; *i.e.*, raising its energy. The simplest mode of vibration is obtained by allowing a sound wave of fixed frequency and direction of motion to pass through the crystal. Vibrational waves of this type can exhibit particle properties, for their energies are limited to discrete values. much as are the energies of light waves or light quanta. As a result the vibrational waves are frequently termed phonons. by analogy with the term photons employed for light waves.

If there is a random group of vibrational waves, as when obtained by heating the solid. the waves may interfere with one another both constructively and destructively. Thus the phonons may impart a large amount of energy to a single atom when the constructive interference is appropriate. Such an event corresponds to a large thermal fluctuation, which may be sufficient to eject an atom from a normal position in the lattice or cause a similar change.

Free Electrons and **Holes** in Insulators.—As mentioned. the ideal insulating solid is one in which an uppermost filled band is separated from an empty one by an appreciable energy gap. Such an insulator becomes conducting if free electrons are introduced into the empty band and free holes are introduced into the filled band (see fig. 7). The conductivity depends upon the number of free electrons and holes and the ease with which each moves. It is clear that free electrons or free holes in an otherwise perfect insulator can be looked upon as a type of imperfection. A free electron in an insulator behaves in much the same way as a free electron in a vacuum. However, as was seen previously, a free hole behaves as a positively charged particle, originating in the dearth of an electron.

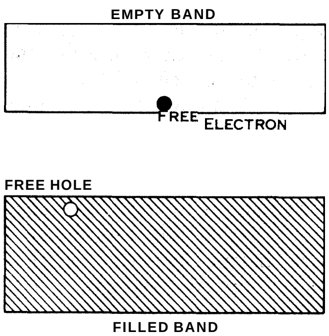

Fig. 7.—Schematic diagram showing a free electron in the otherwise empty conduction band and a free hole in the otherwise filled valence band. Both the electron and the hole may contribute to the conductivity of the insulator. An electron–hole pair may be produced by exciting an electron from the filled to the empty band. The hole and electron have an electrostatic attraction for one another and may form a bound (exciton) state, analogous to the bound state of the electron and proton in the hydrogen atom

Excitons.—A hole and an electron in a given insulator have opposite charges and, as a result, attract one another in accordance with the Coulomb law (see ELECTRICITY). Just as an electron and a proton in a hydrogen atom have bound states in which the two particles rotate about a common centre. an electron and a hole can form a bound state in which they move about as a closely coupled unit. This unit carries no charge because the two opposite charges compensate. It can, however, transport energy from one part of the crystal to another. In place of regarding the exciton as formed by the coupling of a free electron and a free hole, one can view it as generated by the excitation of the insulating crystal to an excited electronic state. similar to the discrete states of an atom which lie below the ionization limit. The coupled electron–hole pair is commonly termed an exciton. It is relatively difficult to detect, except by indirect means, because it is uncharged and cannot be deflected easily by electric or magnetic fields. Excitons were detected, however, in salts such as the alkali halides and cuprous oxide. They play probably an important role in many photochemical processes involving solids. This is particularly true in cases in which energy associated with incident light is absorbed in the interior of a crystal and plays eventually a role in a chemical reaction at the surface. In such cases the energy may be transferred from the interior, where the light was absorbed, to the surface by means of excitons.

Vacancies and Interstitial Atoms. — Thermal fluctuations can disorder a lattice at sufficiently high temperatures. Atoms may be driven from normal lattice sites' into interstitial positions, thereby producing vacant lattice sites or vacancies and interstitial atoms. Such imperfections can, either in unison or independently, contribute to the transport of atoms from one region of the solid to another; *e.g.*, one of the atoms in a normal site neighbouring a vacancy may jump into the vacancy and thereby gain a freedom of motion which it would not have if the vacancy were absent. It is evident that the vacancy is somewhat the counterpart of a hole in a filled band of electronic states. In the same way, an interstitial atom may push a neighbouring normal atom into another interstitial place and replace it at the normal site. Thus interstitial atoms may also impart freedom of motion to the typical atoms of a lattice. The migration of thermally induced vacancies and interstitial atoms is responsible for diffusion and electrolytic conductivity in most solids.

Vacancies and interstitial atoms can be produced pairwise by bombarding a lattice with fast particles such as protons, neutrons and electrons produced by high-voltage accelerators. The defects may also be produced by radioactive disintegrations of atoms within the lattice. Such changes in the lattice are conventionally referred to as the results of radiation damage. Studies of such damage and its recovery give exceedingly valuable information on the behaviour of interstitial atoms and vacancies in typical solids.

Foreign Atoms. — Foreign atoms may modify the properties of crystals in many ways. As was seen, atoms which have loosely bound electrons or holes may transform an insulator into an impurity semiconductor. Similarly. appropriate foreign ions in ionic crystals may be accompanied by vacant lattice sites or interstitial atoms which are attached relatively loosely and mhich become free at normal temperatures and thereby increase both electrolytic conductivity and diffusion. For instance, divalent ions such as Ca^{+2} replace two Na^{+} ions when dissolved in NaCl. The calcium ion occupies one site but the other is vacant and may become mobile. Similarly. S^{-2} can be dissolved in silver chloride by substituting for Cl^{-}. The ion is acco'mpanied by an interstitial Ag^{+} ion in an interstitial site.

Extra electrons associated with foreign atoms in insulating solids usually absorb and emit their own characteristic frequencies of light. Thus, such foreign atoms may absorb or emit radiation and render the crystal fluorescent. It is also possible for the crystal to possess intrinsic fluorescence; that is, to absorb and emit light even when pure.

Dislocations. — The dislocation is the most intricate of the imperfections in the lattice. We saw previously that it was first introduced in order to explain plastic flow in ductile solids. However, it has many other properties. Dislocations of the type shown in fig. 4 may act as relatively easy sources or sinks for vacancies or interstitial atoms. Such imperfections can be produced by thermal fluctuations at dislocations in the interior with the same ease as at the crystal surface.

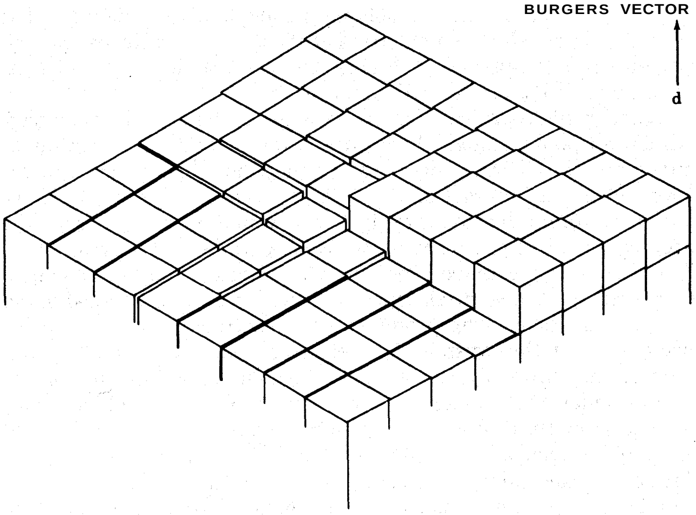

Fig. 8.— Schematicdrawing of the region where a screw dislocation breaks through the surface of a crystal (after F. C. Frank). As on a spiral staircase, one can pass continuously from one crystallographic plane normal to the dislocation to the next by passing around the dislocation. The ridge or step associated with the terminus of the dislocation on the surface may act as a region of catalytic activity or as one for nucleation of growth or solution of the crystal

Another dislocation introduced by Burgers in 1939, termed a screw dislocation, can terminate at a ridge on the surface as shown in fig. 8. The name is derived from the fact that the crystallographic planes which would normally be at right angles to the axis of the screw dislocation wind about the dislocation line similar to the surface of a screw. The ridge (Burgers vector) shown in fig. 8 remains, even if the crystal grows or dissolves by the addition or subtraction of atoms to or from the ridge. An imperfect surface region of this type. produced by an intersection of a screw dislocation at the surface, is an ideal catalyst for the growth of the crystal by deposition of atoms from solution or from the vapour. This characteristic property of the screw dislocation was pointed out by W K. Burton, N. Cabrera and Frank. in 1949. It led to a new understanding of the mechanism of crystal growth from solution or vapour when the degree of supersaturation is low.

The regions where dislocations break through to the surface can be detected by etching the surface with appropriate reagents. The point of emergence becomes the centre of an etch pit. Studies of such etch pits give much valuable information concerning the properties of dislocations.

Interaction of **Imperfections.**—Many of the most interesting properties of crystals are the result of the interaction of two or more imperfections. Lattice waves or phonons may interact with electrons and holes and affect the current flowing through a crystal. Similarly, impurity atoms of an appropriate type may capture free electrons or holes produced by light or other means of excitation and prevent them from contributing to the current. When edge dislocations are forced to move, as during plastic flow, it appears that they leave a trail of vacant lattice sites which can enhance diffusion and other atomic migrational processes in crystals.

Dislocations, particularly those present after plastic flow, which are someuhat irregular, can capture free electrons and holes.

Negative ion vacancies in salts, which are positively charged, may capture free electrons and produce what can be regarded as new imperfections. These neutral units are termed F-centres. They alter the colour and many other properties of the specimens containing them. They may be introduced in controlled amounts by heating an alkali halide crystal, such as sodium chloride, in alkali metal vapour. An excess of metal is absorbed by the crystal but actually appears in such a form that some of the halogen ions are replaced by electrons. Extensive investigations of the alkali halides containing F-centres by R. W. Pohl and his colleagues made the topic an almost self-sustaining field of science. The vacant lattice sites which are necessary for F-centres can be produced in a number of ways; *e.g.*, by plastic flow or by irradiation with ultraviolet light or X-rays.

When a photographic film is exposed to light. a latent image which can be developed chemically is formed within the grains of silver bromide. The process of forming the latent image appears to involve the interaction of a large number of imperfections. The first comprehensive physical theory of the process from the atomic point was put forward by R. W. Gurney and Mott in 1938. The theory was extended somewhat after that time but remained unaltered in its essential aspects. Gurney and Mott postulated that the incident light produces free electrons and holes which wander about the crystal. The electrons become trapped at imperfections, probably dislocations, although possibly at foreign atoms under the proper circumstances. The trapped electrons attract interstitial silver ions which are produced thermally and are mobile even at room temperature. Clusters of silver atoms formed by the union of electrons and interstitial ions in this way constitute the latent image. Such specks of silver may catalyze the transformation of the entire grain into free silver when a developer is present. The deposition of silver atoms at dislocations in silver bromide was demonstrated by J. W. Mitchell. S. Amelinckx demonstrated in a similar way that F-centres in the alkali halides will precipitate along dislocations if the crystals containing F-centres are held at a temperature where the formation of colloids is favoured.

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SOLIHULL, a municipal borough in Warwickshire, Eng.. 8 mi. S.E. of Birmingham, became a separate division of the parliamentary county of Warwick in 1948. Pop. (1961) 96,010. Area 31.5 sq.mi. Though mainly a residential area for Birmingham. Solihull has motor car and light industries.

The parish church of St. Alphege, with its 13th-century chancel. is the most important old building. Solihull hall (14th century), Grimshaw hall (16th century) and Old Berry hall (partly moated) are timber framed. Packwood house (15th century) is owned by the National trust and has a unique yew garden. Solihull school was in existence in 1560.

The borough of Solihull, constituted in 1954, includes, besides the central area of Solihull. Shirley, Olton and Sheldon.

SOLIKAMSK, a town in Perm *oblast* in the Russian Sdviet Federated Socialist Republic of the U.S.S.R., stands on the small Usolka river, 7 mi. above its confluence with the Kama. Pop. (1959) 82,000. The town, probably'the first Russian settlement in the Urals, was founded in the early 15th century as a salt-mining centre and it has remained so to the present. Its deposits of potassium salts are among the world's largest. The important chemical industry based on them produces fertilizers, chlorides, bromide, sulfides and industrial alcohol. The magnesium works are the largest in the U.S.S.R. A railway and highway join the town to Berezniki on the Kama.

In 1959 the satellite town of Borovsk was merged with Solikamsk. (R. A. F.)

SOLIMAN: *see* SULEIMAN I; SULEIMAN II.

SOLINGEN, a town in North Rhine-Westphalia, Ger., on a height above the Wupper, 13 mi. E. of Diisseldorf, and 20 mi. N.E. of Cologne. The population in 1959 (est.) was 168,455.

Sword blades have been made there since the early middle ages, and tradition affirms that the art was introduced during the Crusades by smiths from Damascus.

Solingen is one of the chief seats of the German iron and steel industry, its specialty consisting in all kinds of cutlery, knives, razors; scissors, files, steel frames and the like, produced in enormous quantities. Other metalwares are also manufactured. These articles are largely made by the workmen at their own homes and supplied to the depots of the large dealers.

Solingen received its municipal charter in 1374.

SOLIPSISM (Lat. *solus,* "alone," *ipse,* "self"), in philosophy, a term originally applied to moral egoism (*q.v.*) but now used in an epistemological sense to denote the extreme form of subjective idealism which denies that the human mind has any valid ground for believing in the existence of anything but itself. F. H. Bradley, in his *Appearance and Reality,* characterized the solipsistic view as follows: "I cannot transcend experience, and experience is *my* experience. From this it follows that nothing beyond myself exists; for what is experience is its (the self's) states." Presented as a solution of the problem of explaining our knowledge of the external world (see KNOWLEDGE, THEORY OF), it is generally regarded as a *reductio ad absurdum. See* further IDEALISM; and compare PHENOMENALISM.

SOLÍS, JUAN DÍAZ DE (1470?–1516), Spanish navigator and one of the early explorers to enter the Rio de la Plata estuary. As a pilot major of Spain he led an expedition which left San Lúcar de Barrameda, Spain, on Oct. 8, 1515, in three ships. After touching the coast of modern Brazil around Cape São Roque, he sailed down the east coast of South America and in Jan. 1516 reached the Rio de la Plata (River Platej which he called Mar Dulce. He entered the estuary and named the first island he found Martin Garcia after one of his sailors who had died. Sailing partly up the Uruguay river, he landed with eight men on the left bank, in modern Uruguay, inhabited at the time by the Charrúa Indians, who attacked his party while they were taking possession of the land for Spain. All but one were killed and eaten by the Indians in sight of the remaining crewmen on the ships. Francisco del Puerto, the sole survivor, was made prisoner, and later gave valuable information about the area to Sebastián Cabot when he arrived in the region in 1526.

The ships sailed back to Spain, but one was wrecked off the island of Santa Catarina near the south coast of Brazil, and 11 of the crew saved themselves by swimming ashore. Survivors of this group were rescued by Sebastián Cabot and told him of great wealth in the interior of South America. Cabot, as a result, sailed south, entered the Rio de la Plata and ascended the Paraná river looking for the kingdom of silver. After 1948 Argentine historians accepted the contention of their colleague (Roberto Levillier) that Amerigo Vespucci and not Solís discovered the Rio de la Plata, as early as 1502. (F. L. HN.)

SOLITAIRE, the name given to certain American birds of the thrush family (Turdidae) and to an extinct flightless bird. The present-day solitaires (*Myadestes* and *Cichlopsis* speciesj are noteworthy songsters. The best known is Townsend's solitaire (M. *townsendi),* found in the Rockies from Alaska to northern Mexico; it is a slim gray bird

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TOWNSEND'S SOLITAIRE (MYADESTES TOWNSENDI) OF WESTERN NORTH AMERICA with a white eye-ring, white sides of the tail and a buffy wing patch.

The extinct solitaire (*Pezophaps solitaria*), which formerly lived on the island of Rodriguez, was exterminated, along with the closely related dodos, by man and introduced animals (see also DODO).

SOLITAIRE is the preferred name in the United States for all games of patience, or card games that may be played by one person. There are more solitaires than all other card games together, and solitaire is the most widely played of all forms of cards.

Most games are played with one or two 52-card packs. the cards ranking king (high), queen, jack, 10, 9, 8. 7, 6, 5. 4. 3, 2, ace. Sometimes the sequence is continuous, the ace ranking next to the king. Many solitaire games are known by a variety of names; even the game probably played by most players, Klondike, is more often miscalled Canfield. properly the name of a quite different game. The following terms describe features common to most games:

1. The *layout.*—The array of cards as first dealt on the table, comprising all cards that do not remain in the hand.
2. The *tableau.*—A distinctive arrangement into which the cards that may be "worked" are first dealt.
3. The *foundations.*—Usually all the cards of a designated rank, upon which other cards are built in sequence.
4. The stock.—A special pile of cards that is part of the layout in some games.
5. *The* Itand.—Any remainder of the pack not used in the layout.
6. The talon.—A waste or discard pile into which are placed those cards turned up from the hand that cannot be immediately built upon the tableau or foundations.
7. Available Cards. — Those cards of the tableau, stock, etc., that are subject to transfer to other parts of the layout. In most games, certain cards of the tableau are not available until uncovered by the transfer of cards above them.
8. A space.—An empty place in the tableau created when all the cards of one pile have been transferred elsewhere.
9. Rows.—Lines of cards across the table horizontally.
10. Columns.—Lines of cards extending vertically away from the player.

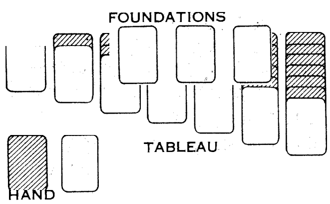

FIG. 1.—LAYOUT OF CARDS FOR KLONDIKE

A few of the popular forms of solitaire are here described.

Klondike.—One pack is used and a tableau dealt of seven columns in a row, with one card in the column at the far left, two in the next, three in the third, etc., the column at the far right containing seven cards. Only the topmost card in each column is turned face up. The foundations are aces, which are put in a row above the tableau as soon as they become available. Each foundation must be built up in the same suit in sequence to the king (*i.e.*, ace, deuce, trey, etc.). A card placed in a foundation may not thereafter be moved.

On the uppermost card of any tableau pile may be placed a card of next lower rank and opposite colour. When transferring cards within the tableau, all the face-up cards on any tableau pile must be moved as a unit onto a card of next higher rank and opposite colour to the highest card of the unit. If the highest card of the unit is a king, it may be moved only into a space, and a space may be filled only by a king (or a unit built upon a king). The lowest card of a unit may be removed and played in proper sequence upon a foundation pile.

Whenever a transfer leaves a face-down card uncovered, this card is turned up and becomes available.

The hand is turned one card at a time and is run through once only. A card not added to the foundation or the tableau is placed face up on the talon. Top card of the talon is always available.

Game is won if all cards can be built upon the foundations.

Double **Klondike.**—Many solitaires can be played by two, but Klondike is by far the favourite for this purpose and is the game referred to as double solitaire. Each player deals his own layout with his own deck. Neither may build on the other's tableau; but foundation piles are common property. Turn to play alternates, ending when a player lays a card on his waste pile. Play continues until one player has built all his cards on the foundations or until neither can make a further play. It is not compulsory to play a card to the centre; strategy may dictate withholding a play that would help the opponent get rid of a great number of cards.

In a blocked game, winner is determined by counting the cards each has played to the foundations.

Canfield. — From a single pack, a stock of 13 cards is counted out and the pile turned face up, with only the top card visible. The next four cards are dealt face up in a row to the right of the stock, forming the tableau. The next card is placed face up above the tableau to start the foundation row. Other cards of the same rank as this starter are placed in the foundation row as soon as available. Foundation piles are built in continuous ascending sequence in the same suit. (Thus, with ♡Q turned as the starter, other queens are played to the centre as soon as available. After the king has been added, the next card in sequence is the ace, then the 2. 3, etc.)

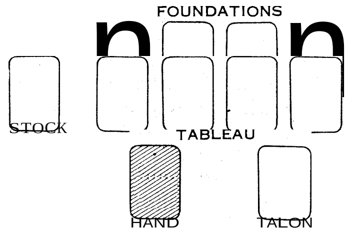

FIG. 2. — CANFIELD

Tableau columns are built in downward sequence and alternate colour, black on red, red on black. The king plays on the ace unless either rank is the foundation starter. Piles may be combined when the touching cards are of correct sequence and colour. Customarily, the entire column must be moved as a unit but some play that the available card may be individually shifted; *i.e.*, a column of ♡ 8, ♤ 7, ◇ 6 may be placed as a unit upon the ♤ 9 or ♧ 9, or the ◇ 6 may be shifted separately onto ♧ 7 if available. after which ♤ 7 may be placed on ◇ 8.

The hand is turned up in packets of three cards at a time, each packet being placed face up on the talon. The top card only of the talon or stock is available; the card immediately below becomes available when the top card is played. A space must be filled by the top card of the stock, but when the stock is exhausted the player may use any available card of the talon.

After the hand is run through once, the talon is turned over and, without shuffling, is run through again, continuing as often as plays can be made. Game is won if all cards are played onto the foundations.

Others. — The wide variety of solitaire games offers simple layout and count-out pastimes suitable for children, such as clock and accordion, as well as games that are a challenge to skill, such as calculation. Few who know how to play cards of any kind do not know at least one kind of solitaire.

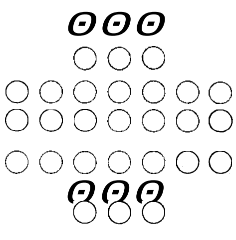
FIG. 3.—ARRANGEMENT OF HOLES FOR ...SION PEGBOARD GAME

Pegboard Game. — Solitaire also is the name of a pegboard game or solo puzzle, similar to a game the American Indians played with arrows stuck into the ground. In one version, the board is pierced with 33 holes arranged in a pattern of three vertical and three horizontal rows intersecting to form a cross. Pegs are set in all but one hole. One peg at a time is jumped over another and into a vacant hole, the peg thus jumped being removed from the board as in checkers. Jumps must be horizontal or vertical. never diagonal; the object of the basic puzzle is to remove from the board all but a single peg.

To make the game even more difficult, one variation calls for the last peg to be left in the centre hole.

See Morehead and G. Mott-Smith, Complete Book of Solitaire and *Patience* Ganzes (1949). (R. L. FY.)

SOLNA, an industrial suburb 4 mi. N.W. of Stockholm, Swed. Pop. (1960) 50,864. It is an ancient settlement and antedates Stockholm, having historic buildings including an 11th-century church and old palaces and manors. Ulriksdal palace on Lake Edsviken is the royal residence for part of the year; the Haga palace on Lake Brunnsviken, is the crown prince's residence; and the Karlberg palace is now the Royal Military school.

There are also a Nobel institute for scientific research, an institute for the blind and the Karolinska hospital with a medical school. Sports facilities include a racecourse and football stadium. Its expanding industrial development includes printing works and electronic industries. It is also a centre of the Swedish film industry. (L. E. MA.)

SOLO (BENGAWAN), a river (*Kali*) in East Java. Indonesia, and the longest river (335 mi.) of Java. Its headwaters are on the slope of the Lawu volcano and the southern limestone range (Gunungkidul). Flowing through several small basins the river enters the densely populated Surakarta plain near Wonogiri. Several tributaries join it in this volcano-bordered plain. North of Surakarta (or Solo) the river gradually bends eastward round the central limestone range (Gunungkendeng). Its longest tributary, the Madiun, joins the Solo at Ngawi, where it begins its 20 mi. breakthrough of the Gunungkendeng and emerges into the region called the Solo valley. There the river has little gradient and meanders through a lowland 10 mi. wide and 80 mi. long between the Gunungkendeng and the northern limestone ridges in the district of Bodjonegoro.

A project to use the Solo river for large-scale irrigation was never completed. The delta is very marshy and used for fish ponds. In order to reduce silting of the strait between Madura and Java (the northern approach to the port of Surabaja) the main mouth of the Solo was diverted to the north, away from the strait.

In the dry season much of the river bed is dry; in the wet season (November–April) the average volume (in the Solo valley) is 440 cu.m., the maximum 2,800 cu.m.

The Solo is navigable for river *prahus* (fishing boats) from Ngawi downstream. Sea-going *prahus* in the wet season can reach Tjepu. (J. O. M. B.)

SOLOGNE, a region of France extending over portions of the *départements* of Loiret. Loir-et-Cher and Cher. Area 1,800 sq.mi. Its boundaries are, on the north the Loire, on the south the Cher, on the east the districts of Sancerre and Berry. The Sologne is watered by the Cosson and the Beuvron, tributaries of the Loire, and the Sauldre, an affluent of the Cher. The impermeable mixture of sand and clay has given rise to numberless pools and marshes; portions were being drained largely by Huguenots, when persecution scattered them and the work was delayed until Napoleon III led the way in the reclamation of swamps and the planting of pines and other trees. These changes much improved the climate of the district. Arable farming and stock raising flourish in the Sologne, but there is little manufacturing activity, the cloth manufacture of Romorantin being the chief industry. Game is abundant, and the region owes much of its revived prosperity to the creation of large sporting estates.

SOLOGUB, FEDOR (pen name of FEDOR KUZMICH TETERNIKOV) (1863–1927); Russian man of letters, was born on Feb. 17, 1863 in St. Petersburg, the son of a tailor. On the latter's death, his mother became a domestic servant and the son was brought up by her employers. He studied at the Teachers' institute in St. Petersburg and was a schoolmaster for 25 years, retiring in 1907. He died on Dec. 6, 1927.

In 1897 Sologub published his first volume of poetry and also some short stories. He is considered the greatest figure of the Symbolists in prose and poetry. His best novel is *The Little Demon* (1907), in which he has created a universal type of evil in the central figure, the schoolmaster, Peredonov. He also wrote several plays.

His other works include *The Sorcery of Death* (a series composed of *The Created Legend, Drops of Blood, Queen Ortruda,* and *Smoke and Ashes*). *The Little Demon, The Created Legend, The Old House and Other Tales* have been translated into English.

SOLOLÁ, a department in the central highlands of Guatemala, and location of the beautiful Lake Atitlán. Area 410 sq.mi., of which 53 sq.mi. are covered by the water of the lake, pop. (1950) 82,921; (1957 est.) 95,308. The lake and town of Atitlan (*q.v.*), a favourite tourist area, occupy a valley dammed by volcanic ash at an altitude of about 4,500 ft. On the borders of the lake are three cone-shaped volcanoes, Atitlin, Tolimán and San Pedro. The Maya Indians, who make up the greater part of the population, grow maize, wheat and beans. On the southern shore of the lake there are plantations of coffee. Much land in the department is used for the feeding of beef cattle and hogs. The lake is used also for fishing. The department is served by the Inter-American highway which passes through Sololá on the way from Guatemala City to Quezaltenango.

Sololá, the departmental capital (pop. [1960 est.] 4,231) is near the northern shores of the lake, about 45 mi. W.N.W. of Guatemala City. It is 6,900 ft. above sea level. It is a colourful market centre for the Indian farmers of the highlands who come to buy or sell cotton and woolen textiles and foods. (P. E. J.)

SOLOMON, son of David, succeeded his father on the throne of Israel *c.* 974 and reigned to c. 937 B.C. In the story of David's intrigue with Bathsheba Solomon is the second child of the union, born after David had made her his wife, and after the death of the illegitimate child. But in the lists of David's children he seems to be the fifth child of the union. a discrepancy indicative of the uncertainty attaching to much of his history.

The name Solomon may mean peaceful; according to I Chron. xxii, 6–19, David was directed by Yahweh so to name his son as symbolizing the "peace and quietness" which, in contrast to the turbulence of his own reign, should be the characteristics of Solomon's. A variant reading in II Sam. xii, 24, however, states that Bathsheba herself chose the name. The following verse says that the prophet Nathan gave to the child the name Jedidiah, "beloved of Yahweh," the first element in which is from a root akin to David. This name is found nowhere else.

The Accession.—In contrast to the summary notices given in the books of Kings to the beginning of a new reign the circumstances of Solomon's accession are related with very full detail. To call Solomon not the true heir to the throne is mistaken, for in the case of a monarchy such as that of Israel there was no rule that the king's eldest son was his legitimate successor; the king might nominate any one of his sons to take his place: yet it is probable that Solomon had not been regarded as the son most likely to succeed David. The eldest son, Amnon, had been slain by Absalom, the third son, who was himself killed in an abortive revolt against his father. Of the intermediate son, Chileab, nothing is known.

When David was evidently on the point of death his son Adonijah, who "was born after Absalom," set to work to ensure for himself the right of succession. Like Absalom he was a man of fine appearance and seemingly popular. He appears also to have been a favourite with his father (I Kings i, 6). 'He surrounded himself with a royal bodyguard and enlisted the aid of the two foremost men in David's court, the warrior Joab and the priest Abiathar. At a feast he prepared he seems to have received support from the men of Judah and most of the king's sons, but his deliberate exclusion of the prophet Nathan, the warrior Benaiah, the "mighty men," and Solomon, from the invitation would suggest that the succession had already been the subject of intrigue, and that there was a pro-Solomon party.

At Nathan's instigation Bathsheba reminded the feeble old king of an oath he had sworn to make Solomon his successor, which story the prophet came in and confirmed. Whether this mas really the case or not—on one view of the narrative it would seem that David in his weakness was persuaded that he had made such a promise—the king immediately caused Nathan, Benaiah and Zadok the priest to proclaim Solomon. This action met with approval on the part of the citizens, and Adonijah's party collapsed without a struggle, he himself seeking asylum at the altar, and being sentenced to confinement in his own house.

Subsequently Joab was killed by Benaiah and Abiathar replaced by Zadok, at Solomon's command, Adonijah having been previously slain for preferring a request that Abishag, the damsel who had cherished David in his last days, should be given to him as wife. This would, according to oriental ideas, have been equivalent to claiming the succession, and it is indeed difficult to believe the story that Adonijah made such a request through Bathsheba. It is possible that this narrative, and also the instruction given by David to Solomon that Joab should be slain, are invented to palliate the ruthlessness with which Solomon removed from his path those who had challenged his position.

The King. — The general impression which the biblical narratives seek to convey is that Solomon's reign was most prosperous and peaceful, and this impression has substantial evidence in its favour. The fact that his reign endured for 40 years shows that he must have consolidated the kingdom, though he had no love for military adventure and made no attempt to enlarge its borders. Rather he sought to make his position secure by allying himself with his neighbours. Early in his reign he ensured the friendship of Egypt by espousing the pharaoh's daughter. This alliance brought about also a further gain, for the pharaoh, who had attacked and reduced the important Canaanite fortress Gezer, handed it over to Solomon as a dowry for his daughter, and Solomon rebuilt it. Perhaps even more advantageous was the extension of the alliance which David had earlier concluded with Hiram of Tyre. This afforded Solomon security on his northern frontier, and enabled him to use freely the Mediterranean. The erection of high places near Jerusalem for the worship of the deities of Zidon, Moab and Ammon is indicative of friendly relations with those peoples. That he was able to use a port at the head of the Gulf of Aqaba (I Kings ix, 26) for commerce with Ophir implies that Solomon controlled Edomite territory on the southeast.

The commercial activity of Solomon seems to have been extensive. His imports were on a scale so lavish that he is said to have made silver as common as stones, cedars as sycamores, in Jerusalem. In partnership with Hiram of Tyre he maintained a fleet of ocean-going ships trading at regular intervals to Mediterranean ports, bringing "gold, silver, ivory, apes and peacocks" (I Kings x, *22)*. In his trading ventures down the Gulf of Aqaba he was assisted by skilled Tyrian navigators supplied by Hiram (I Kings ix, 27–28). This passage was evidently misunderstood by the chronicler, who took it to mean that Hiram supplied the ships (II Chron. viii, 18). Ophir, the land to which these vessels ventured is not identified with certainty, but may be southern Arabia. Solomon brought Israel for the first time fully into the current of oriental commerce and civilization, and during his reign Jerusalem, at any rate, was a city of wealth and luxury.

The Builder. — The long and peaceful reign of Solomon permitted him to indulge his passion for building, and his activities completely transformed his capital city, Jerusalem. David had built a palace there, being furnished with artificers and material by Hiram. This was, however, not regarded by Solomon as sufficiently splendid, and he spent 13 years in constructing a magnificent royal dwelling. He built also a temple, the details of which occupy a disproportionate space in the records, for it was, after all, in the nature of an appanage to the palace, and took little more than half the time devoted to the latter. Like his father, he relied largely upon Hiram for material and artisans. He also built and fortified numerous cities which were used as barracks, arsenals and storehouses.

In order to obtain supplies for his grandiose schemes he divided the land into 12 districts, seemingly independent of the old tribal divisions. upon which levies were made in rotation. Forced labour was exacted from the Canaanites. But though the boast is made that the Israelites were not treated as bond servants, the exactions made from them for the upkeep of the court and harem, and the expenses of building, must have reduced many of the people to a condition hard to distinguish from slavery. However splendid the court and capital may have been, the state of the ordinary folk must have been far from hayyy. and in the lavish expenditure of Solomon may be found a prime cause of the discontent which led under his successor to division of the kingdom.

Factors of Unrest.—Nor was the political situation quite as easy as the picture in Kings might lead us to suppose. The exact interpretation of I Kings ix. 12–14 is uncertain, but evidently Solomon was compelled to part with territory in the north to placate Hiram. An Edomite, Hadad, who had escaped the ruthless slaughter of Edomites by Joab under David, took refuge at the Egyptian court. where he attained a considerable position. He returned to his 'native country after the death of Joab, and evidently was a thorn in Solomon's side. Rezon, an Aramean, too, established himself in Damascus; and was "an adversary to Israel all the days of Solomon." And, though the attempt of the able Jeroboam at revolt was crushed by the king, he had established a sufficient personal ascendancy to gain the allegiance of the northern tribes after Solomon's death. Undoubtedly the shadows have been toned down in the Old Testament records of Solomon's reign. This does not, however, prevent us from recognizing that he was, with all his limitations, an able ruler. Though very little of the wisdom which is attributed to him in the Old Testament is correctly assigned, it is extremely unlikely that the attribution would have been made had not the facts of his rulership provided a basis for the picture of Solomon the Wise.

Religion. — Solomon was a sincere worshiper of Yahweh, more cultured but less passionate in his devotion than David. His erection of altars to foreign deities for the sake of his foreign wives, and even his participation in the rites connected with them, would not be in his eyes apostasy. These things were of the political rather than the religious sphere. But in the eyes of later puritans they were departures from orthodoxy. So we have the curious double picture of Solomon as on the one hand a most pious benefactor to the national religion in his building of the temple and care for its ceremonial — though even here the doubt insinuates itself as to whether he did not consider to some extent the prestige which was reflected on himself; on the other hand as an apostate, who when his obituary notice is written (I Kings xi, 43) receives no glowing testimonial, and about whom it is said that he "went not fully after Yahweh, as did David his father" (I Kings xi, 6). Yet even the passage which contains this censure shows that the other side of the picture was not forgotten, because it represents with more charity than truth the participation of Solomon in the rites of foreign altars as a lapse of his old age. (W. L. W.)

SOLOMON, ODES OF, is a collection of *42* short pseudepigraphical hymns resembling the canonical Psalms in their general nature. They are characterized by a spirit of adoration; only exceptionally do they touch some theological theme, and then the religious lyric tends to veil it, wrapping it in mystical speech. But not everything fades away from our sight: the centre of salvation is not the cross but God's self-humiliation (as in Phil. ii); virginity is a prerequisite for perfection, and the congregation is envisaged as a mystical union.

Until 1908, when a Syriac manuscript containing both the Odes and the Psalms of Solomon was discovered, they were known only from fragments: a citation of one ode (xix, 6) in Lactantius' *Divinae Institutiones* (early 4th century A.D.); and five odes (i, v, vi, xxii, xxv) in the *Pistis* Sophia, a 3rd–4th-century Gnostic work in Coptic. One ode (xi) in Greek has subsequently come to light in a 3rd-century papyrus.

The question of provenance has been much discussed. The idea that the odes stem from Gnosticism is untenable; dualism is lacking and there is nothing else in them that indicates a Gnostic background. Nor are there any reasons for postulating a Montanist origin. These texts reflect the oriental Christianity of the 2nd century and are not unorthodox. Greek has been regarded as their original language, but their content — an amalgam of covenant consciousness, baptismal imagery and Encratism — indicates that their home must be sought in Mesopotamia. There seems to be an echo of the history of Edessa, the home of Syriac literature, and the style and rhythm savour of a Syriac original, which shines through even in the Greek version. Syriac provenance also would explain some affinities with the Thanksgiving Psalms found at Oumran (*see* DEAD SEA SCROLLS).

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SOLOMON, PSALMS OF, a collection of 18 pseudepigraphical psalms extant in Greek and Syriac versions. The ascription to Solomon, which probably goes back to the editor who first put them into their present form, makes them analogous to the canonical psalter ascribed to David. The poet (or poets) who composed the Psalms of Solomon seems not to have thought of ascribing them to Solomon, for they contain not even an allusive reference to him. It makes little difference whether more than one author is concerned, for the psalms all come from the same period and milieu and share the same religious and political views. The most that can be said is that the three great political psalms (ii, viii and xvii) were written by one and the same author, a man of poetic vigour and imagination.

The Hebrew original of the Psalms of Solomon is not extant, but the Syriac translation as well as the Greek seems to have been made directly from it. This is indicated by a number of passages in which the Greek is incomprehensible because the Hebrew it translated must have been corrupt, whereas the Syriac reveals the correct reading in the Hebrew. (The reverse situation also occurs.) Only occasionally did the Syriac translator correct himself by reference to the Greek version.

The Psalms of Solomon were clearly composed in Palestine, and some certainly originated in Jerusalem. This accounts for the important role which Jerusalem plays in them. The three political psalms can be dated fairly exactly because they make a clear reference to Pompey the Great. Thus most of xvii was composed shortly before Pompey entered Jerusalem in 63 B.C., though verses 11–14 are a later addition which refer back to this event and date from after 61 B.C. In ii, 26 ff. there is a reference to the death of Pompey in 48 B.C. As all the psalms belong to the same period, the collection can be dated to between 80 and 40 B.C.

The importance of the Psalms of Solomon lies chiefly in their vivid and contemporary presentation of the political and religious thought of the "pious of Israel" (*i.e.,* the Pharisees) in the last century B.C. The author of the psalms was certainly a Pharisee. Psalm xvii is particularly interesting for its detailed description of the eschatological messianic king and the political and religious expectations of his reign. This is the conception of the Messiah still current among the Jews during Jesus' lifetime; as the Gospels show. it lies behind the reaction of the common people to Jesus' teaching, the opposition of the Pharisees, high priest and scribes, and the hopes and expectations of the disciples.

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SOLOMON, SONG OF (or SONG OF SONGS; in the Douai version of the Bible, CANTICLE OF CANTICLES, from *Canticum Canticorum* in the Vulgate; derived from the title in the Hebrew Bible. SHIR HASHIRIM), a book of the Old Testament, one of the Megilloth, or "Rolls," the others being Ruth, Lamentations, Ecclesiastes and Esther. The Megilloth are read in the synagogue at certain festivals, the Song of Solomon being used at Passover, which celebrates the Exodus from Egypt. The reasons for this are not entirely clear, but the fact that spring is referred to in ii, 11 ff. and vi, 11 (Passover being also celebrated in spring), and the allegorical interpretation of the book as referring to God's love for Israel and the events of the Exodus, especially the Covenant at Mt. Sinai, should be considered in this connection.

Contents. — There is no coherent story in the book. It consists of a series of love poems in which a man and a woman speak alternately. A number of songs describe systematically the beauty and excellence of the beloved (called by a modern Arabic term wasf, "description"): iv, 1–7; v, 10–16; vi, 4–7; vii, 1–6. There is reference to the bride's seeking for her beloved: i, 7 ff.; iii, 1–5; v, 6–8. There is a description of a festive procession: iii, 6–11. And there are dialogues between the two partners: *e.g.,* i, 9–ii, 7, etc.

Author. — The Hebrew title of the book mentions King Solomon as its author, but several considerations make this improbable. Solomon is referred to in the third person; the language of the book seems to reflect a much later epoch (*e.g.,* there are Persian and perhaps even Greek loanwords); and the city of Tirzah is referred to (vi, 4) in such a context as to make it probable that it is the capital of the northern kingdom of Israel (9th century B.C.). This, alongside the fact that the language contains some archaic elements, seems to suggest that an older text has been revised at a later epoch. The author of the book remains unknown.

Interpretation. — The Song of Solomon has been interpreted in many different ways of which four, described below, are important.

Allegorical. — The allegorical interpretation takes the book as an allegory of God's love for Israel or of Christ's love for the church. This type is represented by the Jewish Targum (the free Aramaic rendering given in the synagogue when Hebrew was no longer understood), which makes it refer to the lawgiving on Mt. Sinai, the history of Israel and the coming of the Messiah. In the Christian Church this interpretation is maintained by the early Fathers, by the Eastern Churches and by many modern Roman Catholic scholars. In medieval mysticism the Song of Songs was applied to the love between Christ and the human soul, and Bernard of Clairvaux gave a famous exposition of it to that effect. The earliest traces of an allegorical interpretation seem to be Rev. iii, 20 (which may reflect S. of Sol. v, 2) and II Esd, v, 23–26 (1st century A.D.).

Dramatic. — The dramatic interpretation is based on the fact that a considerable part of the book is clearly in dialogue form. According to this view, the heroine of the book is a peasant maiden in Solomon's harem. who longs for her shepherd lover and utters her feelings to the ladies of the court; they lead her on to describe her lover and to tell how she came to be carried off by Solomon. Finally her constancy secures her release, and the curtain falls on the sentiment of true affection in viii, 6, 7. This theory is attractive in certain respects, but in view of the absence of drama in the Semitic literatures it is not very probable. Moreover, any progress of action from first to last is difficult to prove. Most advocates of the theory find it necessary to rearrange the sequence of the sections considerably in order to get a coherent story, which seriously weakens their case.

Literal. — The so-called literal interpretation considers the book to be a collection of secular love songs without any religious implications. This theory was introduced in modern research by J. G. Wetzstein, who during the 19th century was Prussian consul at Damascus and whose observations of the wedding customs of Syrian peasants led him to believe that the biblical book is substantially a collection of songs originally sung at such festivities. During the first seven days after the wedding the man and his young wife play the part of king and queen. A threshing board is erected on the threshing floor as a throne, and after the royal couple have taken their seats a dance in their honour begins. The accompanying song to a great extent consists of wasf, *i.e.,* a description of the physical perfections and the ornaments of both. Wetzstein's contribution, which was originally published in the *Zeitschrift für* Ethnologie in 1873, was reprinted by F. J. Delitzsch in an appendix to his Commentary, and his theory was accepted by K. Budde (1898) and by many other scholars.

The songs edited by Wetzstein, and folk songs from Palestine later published. indeed show a striking similarity in language and imagery with the Song of Songs—*e.g.,* apart from the wasf, the description of the bride as a garden (iv, 12; vi, 2, 3) and many other details. This theory would also account for the reference to Solomon in the Song of Songs: it would be another way of saying that the bridegroom is playing the role of a king. However, the very fact that the young couple in Syria are celebrated as king and queen calls for an explanation. Another difficulty arises from the fact that almost throughout the Song of Solomon it is the bride and not the bridegroom who takes the initiative, which would be inconceivable in an ordinary Syrian or Palestinian wedding. This has given rise to a fourth theory.

Cultic-Mythological. — The cultic-mythological interpretation is based on the fact that the poems of the Song of Songs are strongly reminiscent of the songs connected with the Sumerian rite of the sacred marriage. This ceremony, an element of the fertility cult of ancient Mesopotamia, most frequently implies the consummation of a ritual marriage between the king and a goddess, represented perhaps by a temple prostitute or priestess, the king playing the role of the fertility god Tammuz. Description songs (wasf), the goddess's search for the god and several other typical motifs and expressions occur here for the first time in history, much earlier than the Song of Songs and the modern Arabic folk songs.

The cultic interpretation was inaugurated by Erbt in 1906 and further elaborated by a number of scholars. It implies that rites similar to the Sumerian ones were practised in ancient Canaan—this is to some extent substantiated by the Ras Shamra texts, dating from the 14th century B.C.—and that these practices were in some way or other taken over by Israel. It is known at least that this was the case during the reign of King Manasseh (II Kings xxi). But it is difficult to explain how a collection of more or less pagan cult songs was introduced into the Hebrew canon of Holy Scriptures. One suggested explanation assumes that these songs were used for centuries in popular celebrations in springtime until their original meaning was forgotten, and then were adopted because of the allegorical interpretation which was given to them partly because their performance happened to coincide with the celebration of the Exodus at Passover.

This theory has the advantage over all the others: it accounts for the dialogue form; it is "literal" in that it understands the text as it is without looking for hidden implications; and it even provides a certain basis for an allegorical interpretation, if it may be assumed that the sacred marriage forms the background of the prophetic description of the relationship between Yahweh and Israel as a marriage (Jer. ii, 2; Isa. liv, 4 ff.; lxii, 4 ff.).

The cultic interpretation is accepted by an increasing number of writers, especially since the discovery and publication of many new parallels in Sumerian texts. The main reason for rejecting it is the difficulty of explaining the book's presence in the canon on these premises. The only alternative is the interpretation as secular love songs, the similarity with Sumerian cult poems being accounted for by the assumption that they are dependent on a common tradition of love songs. Some Egyptian collections of love songs, which also offer some parallels to the Song of Solomon, seem to be of a more secular character, although many of them are thought to have originated in the cult of the love goddess Hathor.

BIBLIOGRAPHY.—A good survey of the different interpretations is given by H. H. Rowley in his collection of essays *The Servant of the Lord* (1952). For commentaries, *see* T. J. Meek in *The Interpreter's Bible* (1956); *H.* Ringgren in *Das Alte Testament deutsch* (1958). For folk songs, *see* St. H. Stephan, *Modern Palestinian Parallels to the Song of Songs* (1923; also in *Journal of the Palestine-Oriental Society*, vol. ii, 1923); S. Linder and H. Ringgren, *Palästinische Volksgesange*, 1–2 (1952–55). (H. RI.)

SOLOMON ISLANDS, a chain of islands in the Melanesian area of the southwestern Pacific, which extends in a northwest-southeast direction for almost 900 mi. between latitudes 5° and 11° S.. and longitudes 154° 40' and 162" 30' E. The group includes the Santa Cruz Islands, about 300 mi. to the east of the southernmost Solomons, and the Lord Howe (Ontong Java) Islands. The northernmost islands, Buka and Bougainville, are administered by Australia as part of the trust territory of New Guinea (*q.v.*); the remaining islands—including Guadalcanal, San Cristóbal, Malaita, Santa Isabel, Choiseul, New Georgia, Santa Cruz. Lord Howe, Reef and Duff groups and Mitre Island—form a British protectorate. The area of the Australian-administered islands is about 4,100 sq.mi. and that of the British protectorate about 11,500 sq.mi.

The group contains a number of low coral atolls, but the larger islands are all volcanic and rugged. Heights of more than 8,000 ft. are reached on Bougainville and Guadalcanal. Geologically the islands form a continuation of the volcanic arc to the east of New Ireland.

Bougainville (*q.v.*) is the largest of the group. South of Bougainville the islands are arranged in two parallel chains, the western including Vella Lavella, Kolombangara, New Georgia and Guadalcanal, and the eastern, Choiseul Island, Santa Isabel Island and Malaita. The two chains converge on the southernmost island, San Cristóbal.

The climate is equatorial, with constant heat, high humidity and no dry season. Rainfall on most of the islands exceeds 100 in. a year. The vegetation is a heavy forest and, as in most island groups, the animal life is restricted.

The islands were discovered in 1568 by the Spaniard Alvaro de Mendaña, who tried to establish a colony in 1595. The expedition, which failed miserably, is the subject of a novel by Robert Graves (see Bibliography). Only toward the end of the 18th century was European knowledge of the group completed, by the voyages (1766–92) of Philip Carteret, Count Louis Antoine de Bougainville, John Shortland, Antoine Raymond Joseph de Bruni d'Entrecasteaux and others. The British protectorate was established over the southern islands in 1893, after a century of European contact with generally unfortunate results.

A German protectorate over the northern Solomons was declared about 1885, but in 1899 all except Buka and Bougainville were transferred to Great Britain in return for recognition of German claims in western Samoa. The German islands were occupied by Australian troops in 1914, and after 1920 the two northern islands were administered by Australia. In 1942 the Japanese advance into the Pacific swept the Solomons where its further progress was checked. The fighting in the following three years was among the bitterest in the Pacific, particularly the long struggle on Guadalcanal (see WORLD WAR II: The War in the Pacific).

The total population of the Solomons is about 180,000, of whom 124,076 (1959 census) live in the British protectorate. The most populous island is Malaita, with (1957 est.) 47,000 inhabitants. The larger islands are almost entirely populated by Melanesians, but there has been much racial admixture and there is a great variety of physical types and linguistic groups. Ten separate languages are spoken on Bougainville. A few Polynesians are found on the atolls.

There are only two towns, Kieta on the east coast of Bougainville, and Honiara, administrative capital of the protectorate, on the north coast of Guadalcanal.

In 1960 a new constitution was brought into operation for the protectorate. The legislative council, presided over by the high commissioner for the western Pacific, has an official majority. The executive council is divided equally between official and unofficial members.

Primary education is mostly provided at subsidized mission schools, and there are a secondary boarding school and a training college for teachers and carpenters. There is a central hospital at Honiara, besides a leprosarium at Tetere, and district, rural and mission hospitals.

Copra is the mainstay of the economy of the Solomons, and is produced by both native growers and European estates, the latter mainly on Guadalcanal, the Russell Islands, San Cristóbal Island and Santa Isabel Island. Great damage was done to the coconut plantations during World War II, and even by 1960 only about two-thirds of the prewar area of 64,000 ac. were productive. No new estate plantings of coconuts had taken place, although there had been a small increase in native copra production from Santa Isabel Island and Malaita. There had, however, been a marked improvement in the quality of copra produced, following the granting of a premium for the better grades by the copra board, which is the sole purchaser of copra in the islands.

The administration had endeavoured to introduce cacao as an alternative cash crop; it was taken up by some native growers on Malaita, and a little is produced by Europeans in the western Solomons.

Only two other commercial activities have more than a local importance: the Kieta area of Bougainville produces a little gold, and the islands of Guadalcanal and Vanikoro support a lumbering industry that makes a small contribution to the export trade. About four-fifths of the exports by value, however, are accounted for by copra.

See PACIFIC ISLANDS; *see* also references under "Solomon Islands" in the Index volume.

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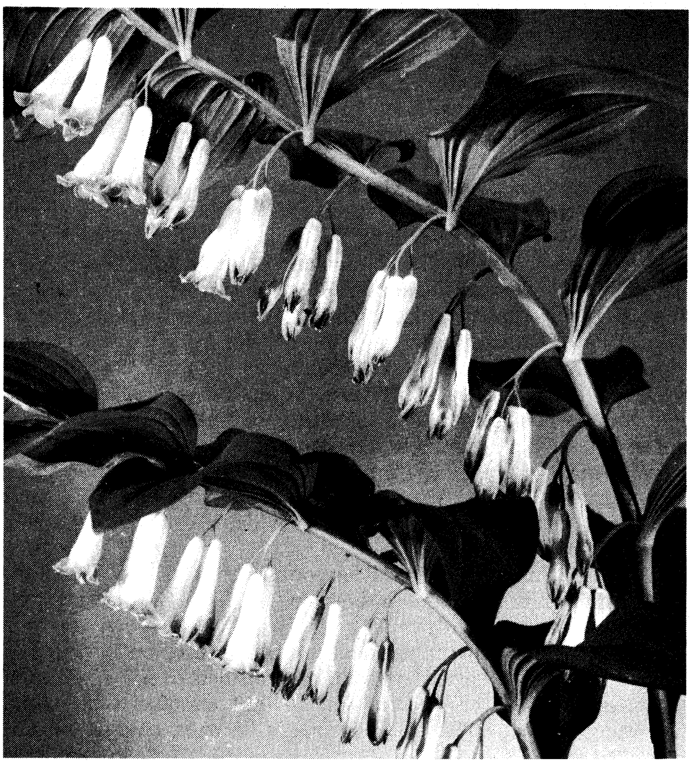
SOLOMON'S-SEAL, the common name for perennial herbs of the genus *Polygonatum,* of the lily family (Liliaceae), comprising about 30 species native to north temperate regions. The plant springs from a fleshy, creeping rootstock on which the scars of the previous year's shoots leave curious seallike marks—hence the common name. Two species occur in eastern North America and three are found in Great Britain.

The single erect or arching stem, one to eight feet high, bears



ROCHE

SOLOMON'S-SEAL (POLYGONATUM)

ovate or lance-shaped, sharp-pointed, sessile leaves in the axils of which appear narrow greenish, whitish or pinkish bell-shaped flowers, on slender, drooping stalks, followed by globular, pulpy, usually bluish berries.

In the United States various species of *Smilacina,* a closely allied genus. are called false Solomon's-seal.

SOLOMOS, DIONYSIOS, COUNT (1798–1857), was the first poet of modern Greece to show the capabilities of its spoken language (the *dimotiki*) when inspired by wide culture and a first-rate lyrical fancy. Born in Zante, he was educated in Italy (1808–18), at Venice, Cremona and Padua, after which he returned to Zante. His earliest poems were written in Italian but in 1822 he finally determined to write in the spoken tongue of Greece. His noble *Hymn to Liberty,* in 158 four-line stanzas, was composed in May 1823, and his poem on the death of Lord Byron in 1824–25.

The unfinished *Lambros,* a romantic poem of the revolutionary times written in ottava rima (*q.v.*), was begun in 1826. To this period (1823–28) belong also some shorter lyrical pieces and some satires, of which the most notable is I *Gynaika tis Zakynthos* ("The Woman of Zante"), a long sketch written mostly in poetical prose. In 1828 he migrated to Corfu, where he remained until his death.

His lyrical exuberance was curbed by a growing preoccupation with German theories of dramatic form and by an inhibiting dissatisfaction with the as yet meagre resources of his chosen linguistic medium. These impediments, together with a disastrous family quarrel (1833–38), explain why his major poems of this period remain fragmentary.

Nonetheless, *O Kritikos* ("The Cretan," 1833), the second and third sketches of *Oi Eleftheroi Poliorkimenoi* ("The Free Besieged") of Missolonghi (before and after 1844), and *O Porphyras* ("The Shark," 1849) exhibit, even in their fragments, a sense of rhythm, a "curious felicity" and a melody of cadence not found in his *juvenilia.*

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SOLON, Athenian statesman, the son of Execestides of the family of Codrus, was born about 638 B.C. The prodigality of his father made it necessary for Solon to maintain himself by trade. especially abroad. In his youth he became well known as the author of amatory poems and later of patriotic and didactic verse. Hence his inclusion among the Seven Sages.

Solon's first public service was the recovery of Salamis from the Megarians. A law had been passed forbidding any reference to the loss of the island; Solon solved the difficulty by feigning madness, and reciting an inflammatory poem in the agora. It appears that Solon was appointed to recover the "fair island" and that he succeeded in expelling the Megarians. Sparta finally arbitrated in favour of the Athenians (c. 596). About a year later Solon seems to have moved a decree before the Amphictyons declaring war on Cirrha. At this period the distress in Attica and the accumulating discontent of the poorer classes, for whom Draco's code had proved inadequate, reached its height. Solon was summoned by all classes unanimously to discover a remedy.

Under the legal title of Archon, Solon received unlimited powers nhich he exercised in economic and constitutional reforms *(see* below). These reforms met with considerable opposition, and Solon left Athens for ten years. After visiting Egypt, he went to Cyprus, where Philocyprus, king of Aepea, received him with honour.

Herodotus (v, 113) says that Philocyprus, on the advice of Solon, built himself a new town called, after his guest, Soli.

The story that Solon visited Croesus in Lydia, and made to him the famous remark—"Call no man happy till he is dead"—is unfortunately discredited by the fact that Croesus seems to have become king nearly 30 years after Solon's legislation, whereas the story must be dated within ten years of it. Subsequently Solon returned to Athens. to find civil strife renewed, and shortly afterward his friend Peisistratus made himself tyrant.

About 558 B c. Solon died and, according to the story in Diogenes Latrtius i, 62 (but *see* Plutarch's *Solon,* 32), his ashes were scattered around the island of Salamis.

If the story is true, it shows that he was regarded as the oecist of Salamis.

Reforms.—The date of Solon's archonship has been usually fixed at 594 B.C. (Ol. 46, 3), a date given by Diog. Laert. (i, 62) on the evidence of the Rhodian Sosicrates (fl. 200–128 B.C.; *see* Clinton. *Fast. Hell.* ii, 298, and Busolt, 2nd ed., ii, 259). The date 594 is confirmed by statements in the Aristotelian *Constitution of Athens* (ch. 14). For various reasons the dates 592, 591 and even 590 have been suggested by various historians *(see* the concluding paragraph of this article).

The historical evidence for the Solonian reforms has always been unsatisfactory. There is strong reason to conclude that in the 5th and 4th centuries there was no general tradition as to details. In settling differences there is no appeal to tradition, and this though there occur radical and insoluble contradictions. Thus the *Constitution of Athens* (ch. vi) says that the Seisachtheia ("shaking off of burdens") consisted in a cancelling of all debts public and private, nhereas Androtion, an elder contemporary, denies this specifically, and says that it consisted in the reduction of the rate of interest and the debasement of the coinage. The *Constitution* denies the existence of any connection between the coinage reform and the relief of debtors. The absence of tradition is further confirmed by the fact that the Constitution always appeals for corroboration to Solon's Poems. Of the Laws it is probable that in the 4th century, though some dealing with agrarian distress were in existence, those embodying the Seisachtheia were not, and few if any of the purely constitutional laws remained. The main source of the account in the Constitution is, therefore, the Poems of Solon, from which numerous quotations are made (see chs. 5–12).

The reforms of Solon may be divided under three heads—economic, constitutional and miscellaneous. They were necessary owing mainly to the tyrannical attitude of the rich to the poorer classes. Of these many had become slaves in lieu of payment of rent and loans, and thus the land had fallen gradually into the hands of capitalists. It was necessary to readjust the economic balance and to provide against the evil of aristocratic and capitalist predominance.

A. Economic Reforms.—Solon's economic reforms consisted of the Seisachtheia and certain commercial laws (*e.g.,* prevention of export trade except in olive oil, Plut. Solon 24). By far the most important of these was the law encouraging trade and manufactures (Plut. Solon, 22) which laid the foundation of the future commercial greatness of Athens. Even within a century from the time of its making the trade of Athens with Sicily increased, as is shown by archaeological discovery in that island, to such an extent that, though negligible in quantity at the beginning of the century, it almost rivalled that of Corinth at the end of it. (See Grundy, *Thucydides* and the History of his Age, p. 66 ff.). Among all the problems connected with the Seisachtheia, it is clear (1) that Solon abolished the old Attic law of debt which permitted loans on the security of the debtor's person; (2) that he restored to freedom those who had been enslaved for debt; (3) that he refused the demand for the division of the land (*γῆς ἀναδασμός*). As to the cancelling of all debts (*χρεῶν ἀποκοπή*) there is some controversy; Gilbert and Busolt maintain that all debts were cancelled; strong reasons may, however, be advanced against it, amongst others, that the Greek, unlike the Roman revolutionary, though ready to deal freely with the property of others, did not seek to remedy financial difficulties by abolishing debts. It is possible that the statement in the *Constitution* is a hypothesis to explain the restoration of the slaves to freedom. Further, Solon seems to have regulated the accumulation of land (cf. in Rome the legislation of Tiberius Gracchus) and the rate of interest; and to have simplified commerce by replacing the Pheidonian standard by the Euboic, which was in use among the Ionian traders, in commerce with whom he foresaw thai prosperity lay. It is impossible here to enter into the details of the controversy in connection with Solon's land reforms; it must suffice to give the bare outlines of the dispute. There is no question that (1) the distressed class whom Solon sought to relieve were the *Hektemoroi*, and that (2) the achievement on which he prided himself was the removal of the ὅροι or stones which were seen everywhere in Attica, and were symbolic of the slavery of the soil. Almost all writers say that these ὅροι were mortgage-pillars: that they were originally boundary stones and that when land was mortgaged the terms of the agreement were carved on the stones, as evidence. Now, firstly, though such mortgage-pillars existed in the time of Demosthenes, none are found earlier than the year 400 B.C., nor is there any reference before that year to this special sense of the word. If then these stones which Solon removed were mortgage-pillars, it is strange that none should have been found till 200 years later. Secondly, it is highly improbable that the terms on which land was then cultivated admitted of mortgaging at all. The Hektemoroi who, according to the Constitution, paid the sixth part of their produce as rent,[1] were not freeholders but tenants, and therefore, could not mortgage their land at all. From this it follows that when Solon said he had "removed the stones" he referred to the fatal accumulation of land by landowners. The tenants failed to pay rent, were enslaved, and the "boundary stone" of the landowner was moved forward to include their land. Thus the removal of the *ὅροι* was a measure against the accumulation of land in the form of enclosures (*τεμένη*), and fits in with the statement at the end of chapter iv. of the Constitution, "the land was in the hands of a few." It should be noted (1) that from this releasing of the land it follows that Solon's law against lending on the security of the person must have been retrospective (*i.e.,* in order to provide a sufficient number of freeholders for the land released); and (2) that it is one of the most remarkable facts in Athenian economic history that when at the end of the Peloponnesian War a proposal was brought forward to limit the franchise to freeholders, it was found that only 5,000 failed to satisfy this requirement. It is noteworthy that the Hektemoroi disappear from history after Solon's time. This looks as if they had been converted into freeholders. Antiquity ever tended to regard the cultivation of land as the best title to its possession, a development of an earlier idea that property in respect to land did not reside in the land itself but in the crop grown on it. The Diacrii of the time of Peisistratus are quite a different class.

[1] Others say they were: (1) labourers who received one-sixth of the produce as wages; (2) tenants who paid five-sixths as rent and kept one-sixth, or (3) tenants who paid one-sixth as rent and kept five-sixths. As to (3) it is said such tenants could not have been in real distress, and as to (1) and (2) it is said that such a position would have meant starvation from the first.

B. Constitutional Reform.—It is on this part of his work that Solon's claim to be considered a great statesman is founded. By his new constitution, he laid the foundations of the Athenian democracy and paved the way for its later developments. It should be noted in the first place that the following account is written on the assumption that the Draconian constitution described in chapter iv. of the Constitution of *Athens* had never existed (see DRACO). In some respects that alleged constitution is more democratic than Solon's. This, coupled with the fact that Solon is always spoken of as the founder of democracy, is one of the strongest reasons for rejecting the Draconian constitution. It will be seen that Solon's state was by no means a perfected democracy, but was in some respects rather a moderate oligarchy in which political privilege was graduated by possession of land. To Solon are generally ascribed the four classes—Pentacosiomedimni, Hippeis, Zeugitae and Thetes. Of these the first consisted of those whose land produced as many measures (medinzni) of corn and as many measures (*metretae*) of oil and wine as together amounted to 500 measures. The Hippeis (the horsemen, *i.e.,* those who could provide a war-horse for the service of the state) were rated at over 300 and under 500 *medimni;* the third class (those who tilled their land with a yoke of oxen) at 200 medimni and the Thetes below 200 medimni. The Zeugites, probably served as heavy-armed soldiers, and the Thetes were the sailors of the state. It is likely that the Zeugites were mainly Hektemoroi (see above) whom Solon converted into freeholders. Whether Solon invented these classes is uncertain, but it seems clear that he first put them into definite relation with the political organism. The Thetes (who included probably the servants of the Eupatridae, now secured as freemen), the fishermen of the Paralia (or sea-coast), and the artisans (cerameis) of Athens for the first time received political existence by their admission to the sovereign assembly of the Ecclesia (*q.v.*). Of these classes the first alone retained the right of holding the offices of archon and treasurer; other offices were, however, opened to the second and third classes (*sc.* the Poletae, the Eleven and the Colacretae; see Cleisthenes [1]). It is of the utmost importance to observe that the office of Strategus (*q.v.*) is not mentioned in connection with Solon's reform. It is often said that Solon used his classification as the basis of a sliding scale of taxation. Against this, it is known that Peisistratus, whose faction was essentially the poorer classes, established a uniform 5% tax, and it is highly unlikely that he would have reversed an existing arrangement which was particularly favourable to his friends. The admission of the Thetes to the Ecclesia was an important step in the direction of democracy (for the powers which Solon gave to the Ecclesia, see ECCLESIA). But the greatest reform of Solon was undoubtedly the institution of the Heliaea (or courts of justice). The jury was appointed by lot from all the citizens (including the Thetes), and thus the same people elected the magistrates in the Ecclesia and subsequently tried them in the Heliaea. Hence Solon transferred the sovereign power from the areopagus and the magistrates to the citizens as a whole. Further, as the archons, at the expiry of their year of office, passed into the areopagus, the people exercised control over the personnel of that body also (see AREOPAGUS). In spite of the alleged Draconian constitution, alluded to above, it is still very generally held that Solon invented the Boulē or Council of Four Hundred, 100 from each of the old tribes. The importance of this body as an advisory committee of the Ecclesia, and the functions of the Prytaneis are explained under BOULĒ. It is sufficient here to point out that, according to Plutarch's *Solon,* (ch. 19) the state henceforth rested on two councils "as on anchors" and that the large powers exercised by the Cleisthenean Boulē were not exercised by the Solonian. From this and the articles AREOPAGUS, BOULĒ, ECCLESIA and GREEK LAW, it will be seen that Solon contrived an absolutely organic constitution of a "mixed" type, which had in it the seeds of the great democratic growth which reached its maturity under Pericles. It should be added here, in reference to the election of magistrates under Solon's constitution, that there is discrepancy between the Politics and the *Constitution;* the latter says that Solon gave to the Thetes nothing but a share in the Ecclesia and the courts of justice, and that the magistrates were elected by a combination of selection and lot (κληρωτοὶ ἐκ προκρίτων), whereas the *Politics* says that Solon gave them only the power to elect the magistrates and try them at the end of their year. It seems likely for other reasons that the former scheme should be assigned to the years after Marathon, and therefore, that the account in the *Politics* is correct (but see ARCHON).

C. Miscellaneous.—The miscellaneous laws of Solon are interesting primarily as throwing light upon the social condition of Athens at the time (see Evelyn Abbot, History *of Greece,* i xiii §18). In the matter of trade it has been said that he favoured one export only, that of olive oil, in which Athens was peculiarly rich; further he encouraged the settlement of aliens (*metoikoi*) engaged in commerce, and compelled fathers to teach their sons a useful trade under penalty of losing all right to support in old age. The influence of women Solon regarded as most pernicious. Wealthy wives he forbade; no bride might bring more than three changes of raiment and a little light furniture to the house; all brothels and gymnasia were put under stringent state-control (*see* PROSTITUTION). Solon also regulated intestate succession, the marriage of heiresses, adoption, the use and sinking of wells, bee-farming, the planting of olives and figs, the cutting down of olive trees, the calendar. Further, he ordained that each citizen must show how he obtained his living (Herod. ii 177) and must, under penalty of losing the franchise, adhere to one or other party in a sedition (for these laws *see* Plutarch's *Solon,* chs. 20–24).

The laws were inscribed on Kyrbeis or tablets framed in wood which could be swung round (hence also called *axones*). The boulē as a body swore to observe the laws, and each archon undertook to set up a life-size golden statue at Delphi if he should be convicted of transgressing them.

Solon appears to have supplemented his enactments by a law that they should remain in force for 100 years, and according to another account that his laws, though not the best, should stand unchanged for ten years (Plut. Solon, 25; *Herod.* i. 29). Yet according to the *Constitution* of *Athens* (chs. 11–13) (without which the period from Solon to Peisistratus was a blank), when Solon went abroad in 593 (?) the city was disturbed, and in the fifth year dissension became so acute that no archon was elected (for the chronological problem, see J. E. Sandys, *Constitution* of *Athens,* ch. 13, note); again four years later the same *anarchia* (*i.e.,* no archon elected) occurred. Then four years later the archon Damasias (582?) continued in office illegally for two years and two months. The office of the archon was then put into commission of ten: five from the Eupatrids, three from the Agroeci and two from the Demiurgi, and for 20 years the state was in a condition of strife. Thus we see that 12 years of strife (owing to Solon's financial reforms) ended in the reversal of Solon's classification by assessment. We are, therefore, driven to conclude that the practical value of his laws was due to the strong and enlightened government of Peisistratus, whose tyranny put an end to the quarrels between the Shore, the Upland and the Plain, and the *stasis* of rich and poor.

See editions with notes of *Constitution of Athens* (*q.v.*); histories of Greece later than 1891 (*e g.,* Busolt, Eduard Meyer, etc.). *See* also Gilliard, *Quelques reformes de Solon* (1907); Cavaignac, in *Revue de Philol.,* 1908. *All* works anterior to the publication of the *Constitution* are so far out of date, but reference should be made to the work of Grote. (J. M. M.; X.)

SOLOR and **ALOR** ISLANDS, a group of islands between Flores and Timor, an eastward extension of Flores, one of the Lesser Sunda islands, in the Netherlands Indies. They are from west to east Solor, Adunara (both small), Lomblen, Pantar and Alor (the largest).

Alor, divided from Timor by Ombai passage, 17 mi. wide, is very mountainous (Mt. Kolana in the east, is 6,000 ft. and Mt. Muna, in the southwest, is 4,680 ft., both old volcanoes), and is much broken up by steep ravines, with only one plateau, and some small coastal plains. It is mostly covered with low trees and *alang alang* grass. The coast is mostly rocky, with few indentations, but on the west coast, Kaiabahi bay, 10 mi. long and nearly a mile wide, divides a northwestern promontory from the rest of the island, with which it is connected by a very low alluvial isthmus about $2\frac{1}{2}$ mi. wide. Pantar is high (Mt. Laki in the south is 4,450 ft.), with a rugged coast; Lomblen has mountains in the north and south (Mt. Kedang in the northeast is 4.979 ft. and Mt. Lamahero in the south is 3,350 ft.), one of which, Lobetola (5.400 ft.), is an active volcano; Adunara has a volcano, Ili Buleng (5,446 ft.), in the southeast and a plateau, ringed with hills, reaching 3,000 ft.; Solor is hilly also. All the islands are attached: administratively, to the residency of Timor and dependencies. Alor has a population (1930) of 51,423, resembling the natives of Timor, a warlike race of strong physique, suspicious of strangers. fond of hunting and fishing (bow and arrow the chief weapon) and leaving agriculture to the women and children, but direct Dutch rule is curbing the warlike spirit. Villages, in the hills, are in well-nigh inaccessible positions, with strong bamboo fences, the houses being on piles, and solidly built; houses on the coast are better built. Most of the people are pagans (some Mohammedans live in the northwest), the mountain folk being divided into tribes, worshipping animals (snakes and crocodiles), observing *pomali* (Tabu), growing rice, maize, tobacco, fruit and vegetables, and keeping pigs. Clothing, except at places along the coast, is very primitive. The coastal folk weave sarongs. Many tongues are spoken, differing greatly.

Pantar has about 8,000 people, in the northern part of the island; pagans. tall and strongly-built, with Mohammedans on the coast. Conditions of life, etc., resemble those of Alor, but Pantar is poor, and the people often emigrate to Timor. Houses and villages are scattered and unfenced. As in Alor, many languages are spoken, one an Alorese. The population of the Solor islands is estimated at 35,000, the people being Malayo-Papuan (Wallace terms them "of dark Papuan type"), with dark skin, curly hair and strong frame. Agriculture and fishing are practised; many coco-nut trees are found on Lomblen and Adunara; the Lomblen folk weave sarongs and build boats, and all three islands have smiths. Horses, buffaloes and chickens are kept. In coastal villages houses are on the steep hillside, almost overhanging the water. Inland villages are larger and grouped about a square, in which stands a large tree, and sometimes a round platform, where feasts are celebrated. Under European influence the defensive method of village- and house-planning tended to disappear, house's being built on flat ground. Each village has its barns and *pomali* house. Stone-carved seats for graves are known, also stone offering-places. The Adunara people prize very greatly elephants' teeth, imported, in earlier days, from Further India. Marriage is by dowry, the woman having no freedom of choice, and young girls are so highly prized that kidnapping is known on Lomblen and Adunara. The standard of married morality is high. In one part of Lomblen, some time after burial, the head is dug up and preserved in a shed. The languages spoken vary considerably from those of Alor. There is communication with Dilly, in Portuguese Timor, and with Flores and Macassar.

A Portuguese claim to Larantuka, in East Flores, and the Solor islands, led the Dutch, in 1757, when there mas a fear lest the Portuguese should cede Larantuka to the French, to send an agent to Solor to acquire the island for the Dutch East India company, but Portuguese claims to both Solor and Adunara were not given up until 1848, when a Dutch agent was sent to Lawajong, in Solor, to recruit labour, and the treaty between Holland and Portugal by which Larantuka, Solor, Adunara, Alor and Pantar were surrendered was not ratified until 1859, though Dutch garrisons were placed in Larantuka and Lawajong in 1851. Disturbances at Lawajong in 1889 compelled the Dutch official there to withdraw to Larantuka, and in 1909 armed intervention in Solor became necessary, after which Solor, Adunara and Lomblen were formed into a subdivision and included in the province of the civil governor of East Flores.

The island group fell to the Japanese during World War II.

(E. E. L.; X.)

SOLOTHURN (Fr. *Soleure*), a canton in northwest Switzerland; the total area is 305.5 sq mi., of which about 97% is reckoned as productive. This is higher than for any other Swiss canton. Solothurn has a most irregular shape, dependent on the fact that the canton consists of territories won at different dates by the town from which it takes its name. It includes an area of plain along the Aar valley projecting into Canton Berne, with the Bucheggberg in the southwest between the Aar and Emme, a right-bank tributary joining the larger river near the town of Solothurn. Farther downstream, a part of the Aar valley belongs to Berne, but Solothurn resumes possession somewhat later and here the Aar receives the Wigger on the right bank at Aarburg, and the Dunneran from the Jura on the left bank at Olten. This section of the canton may be described as the foot of the Jura. The Hasenmatt (4751 ft.) is the highest point of the Weissenstein section of the main Jura range which runs through the country north of the capital. Across this range, Solothurn stretches in a broad belt to the north where, at various points, it shares with Berne the river Birs, a tributary flowing into the Rhine near Basle. Beyond the Birs, are two separated districts belonging to the canton: Hofstetten, including the famous pilgrimage centre Mariastein, and Kleinlützel. The north part of the canton and its detached fragments touch the cantons of Berne and Basleland. Highroad and railway communications are excellent. Olten is a great railway junction where the direct lines from the St. Gotthard via Lucerne, from Geneva, from Zürich, and from Basle all unite. Formerly various districts were in the dioceses of Lausanne, Basle and Constance, but since 1814 they have all ranked as part of the diocese of Basle, with the town of Solothurn as the site of the bishop's palace. In 1930 the population was 144,198 and in 1941 was 154,872, all but a few of whom were German-speaking. Roughly two-thirds of the inhabitants are Catholics, the rest practically all Protestant. The capital is Solothurn (15,432 pop. in 1941), and the only other fairly large town is Olten (15,282), both on the Aar. Between Solothurn and the small industrial town of Grenchen, to the west-southwest, lies the village of Selzach, noted for its annual passion-play.

Till about 1850 the cantonal activities were mainly agricultural and pastoral, and though these are still important, yet its density of population (502.3 per sq.mi. in 1939, against 263.4 for Switzerland as a whole), is largely dependent on the variety of its manufactures, e.g., watches, jewellery, shoes, cotton, motor parts and cement, particularly around Solothurn and Grenchen.

Soleure is divided into ten administrative districts with 132 communes. The cantonal Constitution dates from 1887, but was substantially revised in 1895. The *Kantonsrat*, or legislative assembly, is now elected according to the principles of proportional representation. The 146 deputies are chosen on the basis of one member for each 1 000 of the total resident population. The *Regierungsrat* or executive consists of five members. Both groups hold office for four years, but any 4,000 citizens can demand a popular vote on Abberufung, or recall, to decide as to whether the existing members shall continue to sit or not. In addition, the "obligatory referendum" and the "initiative" exist. By the former, since 1869, all laws and financial resolutions passed by the *Kantonsrat* must be approved by a popular vote. By the latter, since 1869, 2,000 electors can compel the legislative assembly to consider any legislative proposal. Further, since 1856, the demand of 3,000 electors is sufficient to necessitate a popular vote as to the advisability of effecting some constitutional change. The two members of the federal *Ständerat* and the seven members of the federal Nationalrat (according to the census of 1941) are also chosen by a popular vote.

SOLOTHURN (Fr. *Soleure*), the capital of the Swiss canton of that name, an ancient little town, situated on the river Aar. In 1941 it had 15,432 inhabitants. almost all German-speaking, with a small Catholic majority. A 16th-century rhyme claims for the town of Solothurn the fame of being the oldest place in "Celtis" save Trier. Certainly its name, "Salodurum," is found in Roman inscriptions and the remains of the Roman "castrum" still exist. Its position as commanding the approach to the Rhine from the south-west has led to its being more than once strongly fortified. The mediaeval town grew up round the house of secular canons founded in the 10th century in honour of St. Ursus and St. Victor by Queen Bertha, the wife of Rudolph II., king of Burgundy. The prior and canons had many rights over the town; but in 1218 it became a free imperial city, and in 1252 shook off the jurisdiction of the canons and took them under its protection. In 1295 we find it allied with Bern, and this connection is the key to its later history. In the 14th century the government of the town fell into the hands of the gilds, whose members practically filled all the public offices. Through Bern, Solothurn was drawn into association with the Swiss Confederation. An attempt to surprise it in 1382, made by the Habsburgs, was foiled, and resulted in the admittance of Solothurn in 1385 into the Swabian League and in its sharing in the Sempach War. It was included in the Sempach ordinance of 1393 and in the great treaty of 1394 by which the Habsburgs renounced their claims to all territories within the Confederation. In 1411 Solothurn sought in vain to be admitted into the Confederation, a privilege only granted to it in 1481 at the diet of Stans. It was also in the 15th century that by purchase or conquest the town acquired the main part of the territories forming the present canton. In 1529 the majority of the "communes" went over to the reformed faith, and men were sent to fight on Zwingli's side at Kappel (1531); but in 1533 the old faith regained its sway, and in 1586 Solothurn was a member of the Golden, or Borromean, League. Solothurn was the usual residence of the French ambassador from 1530 to 1797. From 1681 onwards, it had an aristocratic form of government; but this was finally broken down in 1831, Solothurn in 1832 joining the league to guarantee the maintenance of the new cantonal constitutions. Though distinctly a Roman Catholic canton, it did not join the "Sonderbund," and voted in favour of the federal constitutions of 1848 and 1874.

The position of Solothurn at the foot of the Jura and close to the navigable portion of the Aar has always made it a meeting-point of various routes. Six railway lines now branch thence. Its chief building is the minster of SS. Ursus and Victor, which dates from the 18th century, though it stands on the site of a far older edifice. Since 1828 it has been the cathedral church of the bishop of Basel. The ancient clock tower and the older portions of the town-hall date still further back. The early 17th century arsenal contains the finest collection of armour and old weapons in Switzerland, while the modern museum houses a splendid collection of fossils from the Jura, rocks collected by F. J. Hugi (1796–1855), a native of Soleure, and a Madonna by the younger Holbein. The building now used as the cantonal school was the residence of the French ambassadors to the Swiss confederation from 1530 to 1797. There are some fine 16th century fountains in the town, which in its older portions still keeps much of its mediaeval aspect, though in the modern suburbs and in the neighbouring villages there is a certain amount of industrial activity (watch-making, motor manufactures, etc.). One mile N. of the town is the Hermitage of St. Verena, in a striking rock gorge, above which rises the Weissenstein ridge.

See K. Meisterhaus, *Kurze Entwicklungsgeschichte der Stadt Solothurn* (1895)

SOLOVIEV, SERGEI MIKHAILOVICH (1820–1879), Russian historian. was born in Moscow on May 17, 1820. and died on Oct. 16, 1879. From 1842–44 he travelled in Europe as tutor in Count Stroganov's family. He wrote treatises on *The Relations between Novgorod arid the Grand Princes* (1845). and on the *History of the Relations among the Russian Princes and the House of Rurik* (1847), and was appointed professor of history at and later rector of the university of Moscow. His *History of Russia* (29 vols.; Moscow, 1851–79), was the first complete scientific treatment of Russian history. from its origins up to 1774, since Karamzin's *History of the Russian State* (1818–29). Other works by him are *Historical Letters* (1858) ; *History of the Fall of Poland* (1863) ; and *The Political and Diplomatic History of Alexander I.* (1877).

SOLOVIEV, VLADIMIR SERGEVICH (1853–1900), Russian idealistic philosopher, critic and poet, son of the historian, Sergei Soloviev (*q v.*), was born in Moscow on Jan. 16, 1853, and died at Uzkoe, near Moscow, on July 31, 1900. Vladimir studied theology at the University of Moscow, publishing in 1875 his Ph D. thesis on *The Crisis of Western Philosophy.* After visiting England and Egypt, where he studied eastern philosophical ideas. he returned to Russia and was appointed reader in philosophy at Moscow university in 1877. But his outspoken criticism of the government cut short his career as a lecturer; a speech against capital punishment lost him his readership at Moscow, and he nas soon removed from the minor professorship at St. Petersburg (now Leningrad) to which he was next appointed. The rest of his life nas devoted chiefly to writing. The chief tenet of Soloviev's theology, the union of eastern and western beliefs in a universal church, led him to take up a pro-Roman attitude for a time and in 1889 he published in French *La Russie et l'Église Universelle* (3rd ed.. 1922). He upheld the Christian ideal of universal brotherhood as opposed to Slavophilism. Philosophically he laid stress on the spirituality of all being, the idea of absolute one-ness, and the evolution of the God-man. His best known works are a *History of Materialism* (1894); *History of Ethics* (1896–98); *The Justification of the Good* (1898; Eng. trans. in Constable's Russian Library, 1915); *War, Progress, and the End of History, including a short story of the Anti-Christ* (1900; Eng. trans. 1915, with biographical notice by Dr. Hagberg Wright). *See* also *War and Christianity from the Russian Poznt of View,* three conversations, translated 1915, with an introduction by Stephen Graham. For a brief account of Soloviev's philosophy *see* L. M. Lopatin, *The Philosophy of Vladimir Soloviev* (1916).

SOLSTICE, in astronomy either of the two points at which the sun reaches its greatest declination north or south (Lat. *solstitium,* from *sol,* sun, and *sistere,* to stand still). Each solstice is upon the ecliptic midway between the equinoxes, and therefore 90° from each. The term is also applied to the time at which the sun reaches the point thus defined (about June 21 and Dec. 21).

SOLUNTUM (Gr. Σολόεις or Σολοῦς), an ancient town of Sicily, one of the three chief Phoenician settlements in the island, situated on the north coast, 10 mi. E. of Panormus (Palermo), 600 ft. above sea level, on the southeast side of Mt. Catalfano (1,225 ft.), in a naturally strong situation, and commanding a fine view. It was a Carthaginian possession until the First Punic War, when, after the fall of Panormus, it opened its gates to the Romans. Excavations have brought to light considerable remains of the ancient town, belonging entirely to the Roman period.

SOLUTIONS.— The concept of a liquid solution is familiar to everyone. Sugar and salt dissolve in water to form solutions, alcohol mixes with water in all proportions to form solutions and sea water is a solution containing a high concentration of salt and relatively small amounts of other substances. The general subject includes morc than liquid solutions, and a rigorous definition is required to fix its limits and its terminology.

Definitions.— A phase is a homogeneous portion of a system with definite physical boundaries. Thus, water can exist in three phases: ice, liquid and vapour. In general, a phase which contains two or morc substances (components) is a solution. Consequently, mixtures of gases; gases, liquids or solids dissolved in liquids; and solids in solids are solutions. This discussion will be restricted to liquid solutions containing two components. It is customary but somewhat arbitrary to regard one of the two components of a binary mixture as being dissolved in the other. The substance which dissolves is called the solute and the dissolving medium the solvent.

Composition.— The formula weight of a substance is the unit most suitable for expressing the composition of a solution. This is the quantity of substance which contains the number of molecules equal to the number of atoms contained in 16 g. of oxygen. (*See* AVOGADRO'S CONSTANT.) This quantity is called the gram-molecular weight of the component. Depending on the experiment and the kind of system to be investigated, different composition scales have been employed. If a solution contains n_1 and n_2 formula weights of the first and second components, respectively, the composition may be expressed by: $N_1=\frac{n_1}{n_1+n_2}$; $N_2=\frac{n_2}{n_1+n_2}$ whereby N_1 and N_2 are denoted the mol fractions of the first and second components. Another practical scale is the "molal," in which concentrations (molalities) are given by the number of formula weights of dissolved substance (solute) in 1,000 g. of solvent. Frequently, it is more convenient to employ a volume concentration scale. The "molar" concentration is the formula weight of a component in one litre of solution and the "normal" concentration, so useful to analytical chemists, is given in gram equivalents of solute per litre of solution. For expressing the properties of solutions containing large molecules, the volume fraction has proved the most useful. The total volume, V, is given by the expression $V=n_1v_1+n_2v_2$, where v_1 and v_2 are the volumes per formula weights of the two components in the solution so that n_1v_1 and n_2v_2 are their actual volumes. Their volume fractions become $\frac{n_1v_1}{n_1v_1+n_2v_2}$ and $\frac{n_2v_2}{n_1v_1+n_2v_2}$ –

General Classification of Properties.—The properties of solutions fall into two groups: (1) those of systems which are in equilibrium (static); (2) those of systems in which disturbances cause relative motion of parts of the solution (dynamic). The first group can be treated by the exact methods of thermodynamics where specially defined "reversible" processes are considered. The second group comprises the class of irreversible processes among which are the flow of the solution as a whole (viscous flow), the movement of one component into the other (diffusion) or the movement of parts of the solution under the influence of an electrical field (electrical conductance).

The properties of solutions which conduct the electric current depend upon the presence of electrically charged particles, or "ions." Although the presence of ions was suspected by R. Clausius (1857), it was not until 1887 that S. Arrhenius recognized that ions are present in considerable quantities in many solutions of acids, bases and salts. Thereafter it was found convenient to consider solutions from two points of view, *nonelectrolytic* and *electrolytic.* Nonelectrolytic solutions comprise a large class of mixtures containing substances which have a high resistance to the flow of electricity, such as alcohol-water, carbon tetrachloride-benzene, etc. Their properties are determined by the individual characteristics of their molecules and molecular interaction. Electrolytic solutions may contain both electrically charged atoms and neutral molecules so that they possess certain electrical properties.

THERMODYNAMIC PROPERTIES

The thermodynamic properties are universal for all liquid solutions, and the application of the methods of thermodynamics effects a simplification in an otherwise extremely complicated situation. J. H. van't Hoff (1887) was the first to apply thermodynamics to solutions systematically, but his treatment lacked the generality which could have been achieved if he had employed the thermodynamic system devclopcd by J. W. Gibbs (1875–78).

Solubility.— When a solute is brought into contact with a liquid at a given temperature and pressure, it will dissolve and its concentration in the resulting solution will increase if it is soluble in the liquid. When no more solid dissolves and a state of equilibrium is reached, the solution is saturated with the solute. The concentration of the solute in this saturated solution is its solubility. Other procedures may yield saturated solutions, but care must be exercized in establishing a stable state of equilibrium and avoiding the unstable state of supersaturation in which the solute concentration is greater than its solubility. It is important to note that the process of solution is one of transference whereby the solute passes from its pure state into the solution. If the solute is a solid the reverse process of crystallization is also a transfer process whereby this component leaves the solution and appears in the solid state. The thermodynamics of solutions is concerned with such transfer processes, of a very specially defined nature: "thermodynamically reversible processes." (See THERMODYNAMICS.) Thus, consider a solid in equilibrium with its solution and imagine a process whereby a gram molecule passes from the solid state into a sufficiently large (infinite) amount of solution without producing a change in the solubility concentration. Every stage in such a process would be infinitesimally close to state of equilibrium rnd the entire process would be a reversible one in the thermodynamic sense.

Osmotic Pressure.—Abbé J. A. Nollet (1748) reported that when an animal bladder was filled with alcohol and immersed in water, water entered the bladder and caused a considerable distension. M. Traube (1867) first produced artificial membranes of cupric ferrocyanide which permitted the passage of one of the components of a solution and not the other. The first quantitative determinations of osmotic pressure were made by W. Pfeffer (1877) Pfeffer's apparatus (fig. 1) consists of a porous cup. P, in the interior of whose walls is deposited a membrane of cupric ferrocyanide This membrane allows the passage of water but does not permit the passage of the solute, cane sugar. The cell containing the solution, S, is immersed in water in the vessel, W. The water enters through the membrane into the solution and exerts a pressure which causes the mercury to rise in the outer limb of the manometer, M. After equilibrium is reached, the osmotic pressure is measured by the difference, h, in heights of the mercury in the two limbs of the manometer.

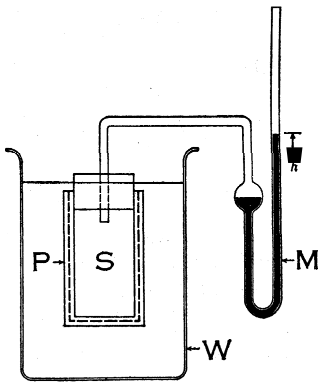

FIG 1—APPARATUS FOR THE DETERMINATION OF OSMOTIC PRESSURE

Pfeffer obtained the first numerical data indicating how the osmotic pressure varies with the temperature and concentration of solute and it was van't Hoff who pointed out that the mathematical relation between the osmotic pressure, concentration and temperature of dilute solutions has exactly the same form as the ideal gas laws (see CHEMISTRY: Physical *Chemistry*). More exact measurements of the osmotic pressures of cane sugar and some salt solutions, performed by H. N. Morse and J. C. W. Frazer (1902–12) in the United States and the earl of Berkeley and E. G. J. Hartley (1906–09) in England, confirmed these observations.

The process of osmosis consists in a transfer of the solvent from the solvent to the solution and is similar in principle to the phenomenon of solubility in which the solute is transferred. Therefore, we can imagine the reversible transfer of one mol of solvent from solvent to solution or vice versa under the condition that the system is in equilibrium, or differs from equilibrium by an infinitesimal amount only.

Vapour Pressure.—When a liquid is placed in a closed evacuated vessel at a given temperature, it evaporates until the vapour acquires a definite equilibrium pressure, which is termed the vapour pressure of the liquid. If an external pressure greater than the vapour pressure is applied to this vapour, it will condense to form liquid. Thus, evaporation or condensation is a transfer process subject to thermodynamic treatment.

If a substance which possesses no appreciable vapour pressure is dissolved in a liquid, the resulting solution is found to have a lower vapour pressure than the solvent. Although A. Wüllner (1858–60) observed that this lowering was proportional to the amount of dissolved substance, the formulation of general law of the lowering of the vapour pressure should be accredited to François Marie Raoult (1886). Thus, if p_1° is the vapour pressure of the solvent and p_1 that of a solution containing a nonvolatile solute, the relative lowering of the vapour pressure is proportional to the mol fraction of the solute, N_2. Thus: $\frac{p_1^\circ - p_1}{p_1^\circ} = N_2$. Now, since the sum of the mol fractions of the two components is unity, $N_2 = 1 - N_1$, where N_1 is the mol fraction of the solvent, and Raoult's law becomes $1 - \frac{p_1}{p_1^\circ} = 1 - N_1$, or $p_1 = p_1^\circ N_1$. This law is fundamental to the whole science of liquid solutions. A solution which conforms to this law at all values of the concentrations is called "ideal." Most solutions are not ideal, but for all solutions the prediction of this law agrees more and more closely with experiment as the concentration of the sclute decreases, or when the mol fraction of the solvent approaches unity.

Elevation of the Boiling Point.—The vapour pressure of a liquid increases with the temperature and when it exceeds the external pressure on the liquid it boils. The boiling point is defined as the temperature of the liquid when it boils at atmospheric pressure (1 atm. = 760 mm. of mercury). Since the addition of a nonvolatile solute to a solvent lowers its vapour pressure, a higher temperature is required to cause the solution to boil, and the difference between the boiling points of the solution and of the pure solvent, denoted by the elevation of the boiling point, is always positive. Since in dilute solution equal mol fractions of different nonvolatile solutes produce the same relative lowering of the vapour pressure, they always produce the same rise in boiling point, and this rise per mol of solute is a characteristic property of the solvent.

If T_b° is the boiling point of the pure solvent and T_b that of the solution of molality, m, the observed rise in boiling point is $(T_b - T_b^\circ)$. The observed rise per mol in 1,000 g. of solvent is $\frac{(T_b - T_b^\circ)}{m}$. The limiting value of this quantity as m approaches zero is called the molal boiling point elevation, ΔT_b. From the laws of thermodynamics, van't Hoff showed that ΔT_b is given by $\Delta T_b = \frac{M_1 R T_b^2}{1{,}000\, L_v}$, where M_1 is the molecular weight of the solvent, L_v the latent heat of vaporization of one mcl of solvent, and R the gas constant (R=1.9865 cal. per mol degree). For water **at** the boiling point, L_v is 9,710 cal. per mol whence

$$\Delta T_b = \frac{18.016 \times 1.9865 \times (373.16)^2}{1{,}000 \times 9{,}710} = 0.512^\circ.$$

For ethyl alcohol and acetic acid at their boiling points, 78.3° C. and 118.3° C., ΔT_b is 1.214° and 3.15° C., respectively, and other liquids possess molal boiling point elevations of the same order of magnitude.

Lowering of the Freezing Point.—The temperature at which a liquid exists in equilibrium with its solid phase is its freezing point. If a liquid containing a small amount of a solute is cooled, the solvent will freeze out and the freezing point of the solution will be the temperature at nhich this solid exists in equilibrium with the solution. The addition of a solute to a solvent always causes a lowering of the freezing point and, like the elevation of the boiling point, this lowering is characteristic of the solvent and depends on the number of mols of the dissolved substance. For dilute solutions, the lowering, ΔT_f, per mol of solute in 1,000 g. of solvent was shown by van't Hoff to be given by $\Delta T_f = \frac{M_1 R T_f^2}{1{,}000\, L_f}$, where M_1 is the molecular weight of the solvent, T_f the temperature of the freezing point, R the gas constant and L_f the molecular latent heat of melting of the solvent. The values of the molal lowering of the freezing point for water at 0° C. and acetic acid at its freezing point (16.6° C.) are 1.858° and 3.73' C., respectively.

Electromotive Force of Galvanic **Cells.**—The processes of osmosis, vaporization, boiling and freezing result in transferring solvent, whereas the solution process transfers the solute. Another very important method for transferring solute applicable in electrical conducting systems is obtained by the use of galvanic cells, the theory of which was developed by Gibbs and H. von Helmholtz in 1878. Such a cell which among others has proved of great value in the study of solutions may be represented by

$$\overset{-}{\mathrm{Pt}}-\mathrm{H_2}|\mathrm{HCl}(m_1)|\mathrm{AgCl}-\overset{+}{\mathrm{Ag}};\ \mathbf{E}_1,$$

where a platinized platinum electrode over which hydrogen gas passes ($Pt-H_2$) and a silver chloride-silver electrode ($AgCl-Ag$) are immersed in hydrochloric acid of molal concentration m_1[$HCl(m_1)$]. This system spontaneously generates an electric current. The electromotive force, $\mathbf{E}_1$, can be measured with very high precision. The electrical work obtained from a cell is associated with definite chemical changes which take place in the cell and for scientific purposes it is essential to know just what these changes are. In this case, the chemical reaction taking place is simply the reduction of silver chloride by hydrogen gas to form silver and hydrochloric acid at concentration m_1 according to the equation

$$\tfrac{1}{2}\mathrm{H_2}+\mathrm{AgCl}=\mathrm{Ag}+\mathrm{HCl}(m_1);\ \mathbf{E}_1.$$

For thermodynamic purposes, this cell must be reversible and therefore its electromotive force must be determined when the system is in equilibrium, or, in other words, when no current is flowing. Such a measurement can be effected by a potentiometer circuit in which the electromotive force of the cell is balanced against an external electromotive force. If the electromotive force of a cell containing the acid at another concentration, m_2, is measured, then the cell reaction is

$$\tfrac{1}{2}\mathrm{H_2}+\mathrm{AgCl}=\mathrm{Ag}+\mathrm{HCl}(m_2);\ \mathbf{E}_2,$$

where $\mathbf{E}_2$ is the corresponding electromotive force. Since in the first and second of these reactions everything is identical with the exception of the hydrochloric acid concentrations, subtraction of the second equation from the first yields

$$\mathrm{HCl}(m_2)=\mathrm{HCl}(m_1);\ (\mathbf{E}_1-\mathbf{E}_2),$$

and the difference ($\mathbf{E}_1-\mathbf{E}_2$) corresponds simply to the work involved in the reversible transfer of hydrochloric acid at concentration m_2, from the second to the first solution, nhere its concentration is m_1.

Thermodynamic Generalization.— These considerations show that all the processes just described have one common element, the reversible transfer of one of the components from pure solid or liquid to the solution or vice versa, or from a solution of one concentration to a solution of another concentration. This permits thermodynamics to effect the great simplification that all these measurements may be employed to determine one thermodynamic quantity, which mill be found to be the change in chemical potential of a component. Without thermodynamics all such properties and the various methods used to investigate them would have to be treated independently. The thermodynamics of solutions is thus resolved into the science of evaluating the chemical potentials and related quantities as functions of the component concentrations, the nature of the solvent media, the external pressure, the temperature and any other variables of importance.

To understand fully the properties of the chemical potential, a brief exposition of the general theory is required. It was shown by Gibbs that the energy, E, of a phase of c components may be expressed as a function of the pressure, P, the volume, V, the temperature, T, the number of mols of each of the components, n_1, 122, ... n_c, and other variables such as surface area, electric charge, etc. Including only those variables which are essential for the moment, the energy is expressed by

$$E=f(p,\ V,\ T,\ n_1,\ n_2,\ \ldots\ n_c)+E^\circ. \tag{1}$$

The energy is not an absolute quantity but is measured relatively to some standard value, E°. From the equation of state which relates one of the variables of a phase to the others, it is always possible to eliminate one variable. The first law of thermodynamics requires that the increase in energy of a system at constant composition is equal to the heat absorbed by the system plus the work done upon it. In differential form, the first law may be written

$$dE=dQ-PdV+dW, \tag{2}$$

where dQ is the heat absorbed, PdV is the work done by the system against pressure and dW symbolizes any additional work terms which for simplicity will not be required for this development. The second law of thermodynamics requires that the entropy change, dS, must equal the reversible heat change divided by the absolute temperature, or

$$dS=\frac{dQ}{T}. \tag{3}$$

By differentiation of equation (1) and introduction of these expressions for the two laws, it is found that, for reversible processes,

$$dE=TdS-PdV+\mu_1dn_1+\mu_2dn_2+\ldots\mu_cdn_c, \tag{4}$$

where μ_1, μ_2, ... μ_c are substituted for the partial differential coefficients, $\frac{\partial E}{\partial n_1}, \frac{\partial E}{\partial n_2}, \ldots \frac{\partial E}{\partial n_c}$. These are the chemical potentials first introduced by Gibbs.

Since for practical purposes other variables than the entropy and volume are more suitable, the thermodynamic functions H, A and F, denoting the heat content, the work content and free energy, have been introduced by means of their definitional equations

$$H=E+PV, \tag{5}$$
$$A=E-TS, \tag{6}$$
$$F=E-TS+PV. \tag{7}$$

The general equations for their differentials are

$$dH=Tds+VdP+\mu_1dn_1+\ldots\mu_cdn_c, \tag{8}$$
$$dA=-SdT-PdV+\mu_1dn_1+\ldots\mu_cdn_c, \tag{9}$$
$$dF=-SdT+VdP+\mu_1dn_1+\ldots\mu_cdn_c, \tag{10}$$

in which

$$\begin{aligned}\mu_1=\left.\frac{\partial E}{\partial n_1}\right]_{S,\ V,\ n_2\ldots n_c} &= \left.\frac{\partial H}{\partial n_1}\right]_{S,\ P,\ n_2\ldots n_c}\\ =\left.\frac{\partial A}{\partial n_1}\right]_{V,\ T,\ n_2\ldots n_c} &= \left.\frac{\partial F}{\partial n_1}\right]_{P,\ T,\ n_2\ldots n_c}\end{aligned} \tag{11}$$

Similar relations can be written for μ_2, μ_3, ... μ_c.

Consideration of these differential coefficients clearly indicates their relation to the transfer processes which have been described. Each one of these coefficients represents a change in the respective quantities per mol of the component; for example, $\frac{\Delta F}{\Delta n_i}$ as An, approaches zero, all other indicated variables remaining constant. It is implied that the composition of the phase is constant. Consequently, the chemical potential is associated with a transfer process of a component into or out of a phase. It is thus easy to see that the removal of a component from a solution at one concentration and its introduction into a solution of another concentration is associated with a differencein two values of the chemical potential of this component. Indeed, this type of reversible transfer corresponds to the galvanic cell process described in the last section.

Gibbs deduced from the relations given by equations (10) and (11) applied to a system composed of p phases that at equilibrium at constant pressure and temperature the chemical potential of each of the components was the same in all phases. In symbolic form, this condition is given by

$$\begin{aligned}\mu_1'&=\mu_1''=\ \ldots\ \mu_1^p,\\ \mu_2'&=\mu_2''=\ \ldots\ \mu_2^p,\\ &\ldots\ldots\ldots\ldots\\ \mu_c'&=\mu_c''=\ \ldots\ \mu_c^p,\end{aligned} \tag{12}$$

where μ_1', μ_1'', ... μ_1^p represent the chemical potentials of the first component, μ_2', μ_2'', ... μ_2^p those of the second component, etc., in each of the p phases, respectively. This equality of the chemical potentials is the basis for the theoretical study of transfer processes involved in freezing and boiling, solubility and vapour pressure measurements. For, imagine a process of three steps whereby water initially at its freezing point is transferred to a solution containing a solute. (1) One mol of water is frozen reversibly at 0°. During this process the system is in equilibrium so that its chemical potential is the same in water as in ice and the change in this quantity is zero. (2) Cool the ice to the temperature of the freezing point of the solution. This step involves a change in the chemical potential of the ice. (3) Melt the ice reversibly at this temperature. No change in chemical potential occurs. Thus, a measurement of the change in chemical potential for the second step will determine its change for the entire process. Similar considerations are involved in transfer of the solute or solvent by boiling, evaporation, osmosis, solubility or galvanic cell transfer.

There remains one further very important consideration deduced by Gibbs. At constant pressure and temperature, equation (10) becomes

$$dF=\mu_1 dn_1+\mu_2 dn_2+\ldots\mu_c dn_c. \qquad (13)$$

Since this equation is homogeneous and of the first degree in the extensive variables, n_1, n_2, ... n,, it can be integrated to give

$$F=\mu_1 n_1+\mu_2 n_2+.\quad \mu_c n_c \qquad (14)$$

which upon complete differentiation and recombination with equation (13) yields

$$n_1 d\mu_1+n_2 d\mu_2+\ldots n_c d\mu_c=0.$$

This relation although applicable to a phase of any number of components is particularly useful for the computation of the properties of a two component solution. In this case,

$$n_1 d\mu_1=-n_2 d\mu_2, \qquad (16)$$

which immediately yields the integrals

$$\int d\mu_1=-\int\frac{n_2}{n_1}d\mu_2;\ \int d\mu_2=-\int\frac{n_1}{n_2}\partial\mu_1. \qquad (17)$$

If the change in chemical potential of one component in a two-component solution can be measured, the chemical potential of the other component may be calculated. Therefore, all the above processes in which transfer of one or the other component occurs can be used to determine the chemical potential of either component.

SOLUTIONS OF NONELECTROLYTES AND ELECTROLYTES

Cane sugar in water does not conduct electric current and causes a lowering of the freezing point per mol of solute in 1,000 g. of solvent of 1.858° C. A dilute solution of salt conducts electricity and possesses a molecular lowering of twice this amount. These differences in behaviour are typical of solutions of nonelectrolytes and electrolytes, respectively, and led to the generalization by van't Hoff (1887) that all substances which produced such abnormally large lowerings of the freezing point or elevations of boiling point were electrically conducting. As a measurement of this abnormality, van't Hoff introduced the factor i which for sodium chloride is nearly 2. Arrhenius (1887) interpreted this fact to indicate that one mol of salt dissolved in water yields twice as many molecules as a solution of one mol of cane sugar, and is dissociated in water according to the scheme: $NaCl \rightarrow Na^+ + Cl^-$, where Na+ and Cl^- represent the sodium and chloride ions. Electrolytes of higher valences such as barium chloride, lanthanum chloride and lanthanum sulphate were thought to dissociate according to: $BaCl_2 \rightarrow Ba^{++}+2Cl^-$; $LaCl_3 \rightarrow La^{+++}+3Cl^-$; and $La_2(SO_4)_3 \rightarrow 2La^{+++}+3SO_4^{--}$, respectively, and their values of the van't Hoff i derived from data in very dilute solutions will approach 3, 4 and 5, respectively, if their solutions are sufficiently dilute. Electrolytes are classified according to their valence types and in the following sections salts like NaCl, $BaCl_2$, $LaCl_3$, $La_2(SO_4)_3$, etc., will be designated 1–1, 2–1, 3–1, 3–2, etc., electrolytes, respectively.

The experimental knowledge of the thermodynamic properties of electrolytic solutions since 1900 have been investigated principally by A. A. Noyes, G. N. Lewis, H. S. Harned, V. K. LaMer, D. A. MacInnes, G. Scatchard, T. F. Young, F. T. Gucker, Jr., O. Redlich and others in the United States, N. Bjerrum, J. N. Brönsted and E. Güntelberg in Denmark, E. Lange in Germany and R. A. Robinson in New Zealand. The thermodynamics of nonelectrolytic solutions has been developed largely by J. H. Hildebrand (1911), G. Scatchard and S. E. Wood.

Solutions of Nonelectrolytes.—The Ideal *Solution.*—For a solution containing a nonvolatile solute, Raoult's law is $p_1=p_1^\circ N_1$ which equates the vapour pressure of the volatile component over the solution with the vapour pressure of this pure component, p_1°, times its mol fraction. For solutions containing two volatile components miscible in all proportions, Raoult's law may be generalized to give $p_1=p_1^\circ N_1$ and $p_2=p_2^\circ N_2$ for the first and second component, respectively. These relations are illustrated by fig. 2, where the graphs of p_1 and p_2 versus N_1 and N_2 appear as straight lines. If the vapours of both components obey Dalton's law that the total pressure (p_1+p_2) is the sum of the partial pressures in the mixture of gases, then this latter quantity is also a straight line as shown in the figure. Conformity of actual vapour pressures with the requirement of Raoult's law has been used as a criterion of an ideal solution. A few combinations of liquids agree closely with this law of perfect mixtures but the properties of a great many solutions vary from this law to a lesser or greater degree. The more nearly alike the molecules of the two components are in all their properties (structure, size, shape, etc.), the closer will their mixture conform to the law. As a corollary, deviations from the law become very important because they are a measure of the various interactions between different kinds of unlike molecules.

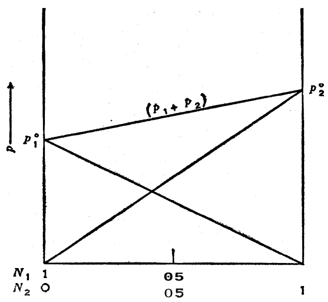

FIG. 2—ILLUSTRATING RAOULT'S LAW FOR THE VAPOUR PRESSURE OF IDEAL MIXTURES

Solutions *Which* Are Not Ideal.—The behaviours of two mixtures which exhibit negative and positive deviations from Raoult's law, taken from the partial vapour pressure measurements of J. von Zawidski (1900), are shown in fig. 3 and 4. Fig. 3 illustrates the negative deviations indicated by the occurrence of the solid curves below the dashed straight lines for chloroform-acetone mixtures, while positive deviations appear in fig. 4 for carbon disulphide-methylal solutions. More nearly ideal solutions, such as propylene bromide-ethylene bromide mixtures, composed of molecules show the ideal behaviour represented by the dotted lines. Many mixtures exhibit much larger deviations than those illustrated by these figures and in some cases such as pyridine-water both positive and negative deviations occur.

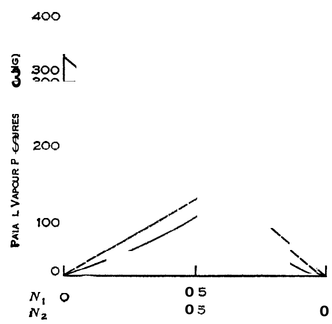

FIG. 3—PARTIAL VAPOUR PRESSURES OF CHLOROFORM-ACETONE MIXTURES AT 35 17° C. N_1=MOL FRACTION OF CHLOROFORM; N_2=MOL FRACTION OF ACETONE. (DATA OF J. VON ZAWIDSKI)

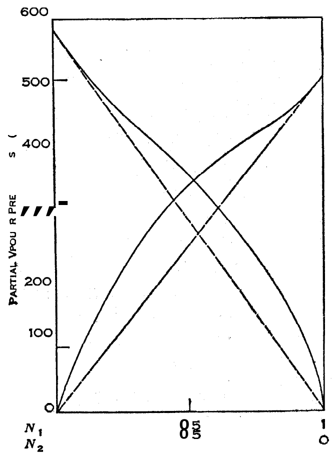

FIG. 4—PARTIAL VAPOUR PRESSURES OF CARBON DISULPHIDE-METHYLAL MIXTURES AT 35.17° C. N_1=MOL FRACTION OF CARBON DISULPHIDE; N_2=MOL FRACTION OF METHYLAL. (DATA OF J. VON ZAWIDSKI)

The departures from the ideal law of gases which occur at high pressures were successfully interpreted by J. D. van der Waals (1890) by assuming attractive forces or "internal pressures" between the molecules as well as short-range repulsive forces resulting from the fact that the molecules have volumes. In liquids, these forces are very much larger than in gases because the distances between the molecules are smaller, so that in all cases, molecular force interactions will play a role. On the other hand, in a mixture containing molecules A and B, the possibility of formation of chemical compounds, A_2, B_2, AB or higher complexes cannot be excluded.

F. Dolezalek (1906), by employing the law of mass action, was able to show that compound formation can account for both positive and negative deviations from Raoult's law. When the two components react with each other to form AB, negative deviations are to be expected according to this theory, and when associated molecules A_2 and B_2 and AB are present, positive deviations occur. The fact that the formation of these compounds affects the moi fractions of the components is the reason for these behaviours. The properties of systems such as those shown in fig. 3 and 4 can be computed by this theory. In most cases, no direct proof of the existence of such compounds has been observed and the theory of Dolezalek has yielded to the more general one based on attractive forces which will now be described.

In a liquid the molecules have a thermal random motion which tends to cause them to escape and this tendency is balanced by forces of attraction which tend to prevent the molecules from leaving the liquid state. The vapour pressure depends on both these factors. In a liquid mixture in which both molecules have identical forces of attraction, replacement of a molecule of A by B will cause no effect which will lead to a departure from Raoult's law, but if the force of attraction of A for B is greater or less than A for A and B for B, deviations may be expected to occur.

Hildebrand (1916) suggested the use of internal pressures as a means of interpreting the properties of liquid mixtures. He computed extended tables of the relative internal pressures of liquids. He showed that when both molecules in a binary mixture had the same individual internal pressures, their vapour pressure conformed to Raoult's law and that deviations of increasing magnitude occurred when the differences in internal pressures increased.

The modern attempts to develop a quantitative theory of the effects of attractive forces, which followed the work of J. J. van Laar (1928), W. Heitler (1928) and H. Menke (1932), have been based on the conclusion of F. London (1930) that the forces between molecules is given by the law $\frac{-k}{r^6}+\frac{k'}{r^{12}}$. where k and k' are specific attractive and repulsive force constants. and r is the distance between the molecules. The forces of attraction and repulsion are inversely as the 6th power and 12th power of the distance, respectively. From such considerations Hildebrand (1929) and Scatchard (1931) have deduced equations which include both this factor and also the effect caused by the difference in volumes (repulsion force effect) occupied by each of the two components. These equations contain three constants which correspond to the forces of attraction of molecules A for A, B for B and A for B, respectively, and have been reasonably successful in describing the behaviour of mixtures of "nonpolar" molecules. These molecules possess internal electrical symmetry. Molecules which are electrically unsymmetrical contain permanent dipoles and are called "polar." Substances containing them are characterized by higher dielectric constants than nonpolar compounds. The permanent dipole moment defined by P. Debye (1929) is a measure of polarity which varies from o in molecules like benzene to 4.2×10^{-18} electrostatic units for nitrobenzene. Polarity was recognized by Hildebrand to be an important factor in determining the effects of specific interactions and orientation of the different kinds of molecules upon the properties of two component liquid systems.

Very large deviations from Raoult's law occur in solutions containing large molecules, such as linear polymers (see POLYMERIZATION) and proteins (see PROTEINS). In these solutions, the volumes and shapes of the molecules, in addition to the intermolecular forces, are predominating factors.

Solutions of Electrolytes.— The fact that solutions of acids, bases and salts conduct the current led R. Clausius (1857) to conclude that relatively small numbers of charged particles must be present in these solutions. The Arrhenius theory (1887) assumed that in many solutions the molecule of solute is dissociated to a large extent into two, three, four or more ions. This conception is fundamentally correct but its early application failed to establish to what extent electrolytes are dissociated and to estimate correctly the effects of the electrical forces between these charged ions. One very important generalization was made simultaneously by W. Nernst and J. J. Thomson (1893) that, since the electrostatic field between charged particles was less in a medium of high than low dielectric constant, D, dissociation would depend on this factor. Since water has a dielectric constant of 78.5 at 25° C., high dissociation occurs in this solvent but very low dissociation and low electric conductance is to be expected in media such as benzene of dielectric constant of the order 2. Qualitatively, this rule is universally valid.

Properties of Ionic Solutions.— *Thermodynamic Properties.* —It can be shown by the application of thermodynamics that, at constant pressure and temperature, the chemical potential, μ_1, of a volatile solvent in a binary solution is related to the chemical potential of the pure solvent, μ_1°, by the equation

$$\mu_1=\mathrm{k}Tln\frac{p_1}{p_1^\circ}+\mu_1^\circ, \tag{18}$$

where k is the gas constant per molecule. If as before we define an ideal solution as one which obeys Raoult's law, $p_1=p_1^\circ N_1$, then

$$\mu_1=\mathrm{k}TlnN_1+\mu_1^\circ \tag{19}$$

is the expression for the ideal behaviour of the solvent. A similar equation may be obtained for the other component. If equation (16) be divided by (n_1+n_2), the mol fractions N_1 and N_2 are introduced so

$$d\mu_2=-\frac{N_1}{N_2}\,d\mu_1. \tag{20}$$

If the value of μ_1 given by equation (19) is introduced and if N_1 be replaced by $1-N_2$, then equation (20) reduces to

$$d\mu_2=\mathrm{k}TdlnN_2, \tag{21}$$

which upon integration becomes

$$\mu_2=\mathrm{k}TlnN_2+\mu_2^\circ, \tag{22}$$

exactly analogous to equation (19).

Relations (19) and (22) define the behaviours of the components of an ideal solution and approach exact validity only as the concentrations of the components approach zero. In order to express the thermodynamic properties of real solutions, G. N. Lewis (1907) introduced a function, a, which he denoted the "activity." For any component, the activity may be defined by the equation

$$\mu=kTlna+\mu^\circ, \tag{23}$$

which can be rewritten in the form

$$\mu=\mathrm{k}TlnNf+\mu^\circ. \tag{24}$$

In this equation, f, the rational activity coefficient, is a pure number which measures the deviation of the chemical potential of a real solution from ideality. The chemical potential of the reference state, μ°, is a function of pressure and temperature but not of concentration.

If the solute component is an electrolyte, it is necessary to take into account the dissociation of the molecule. For an electrolyte of the simplest type which dissociates into one equivalent of cation and one equivalent of anion according to: $CA\rightarrow C^++A^-$, a mean activity $a_\pm$ may be defined by

$$a=a_+a_-=a_\pm^2, \tag{25}$$

where a+ and a_- are the conventional activities of the ionic constituents. Then, equations (23) and (24) become

$$\mu=2kTlna_\pm+\mu^\circ \tag{26}$$

$$\mu=2kTlnN_\pm f_\pm+\mu^\circ, \tag{27}$$

where $N_\pm$ and $f_\pm$ are the mean mol fraction and mean activity coefficient, respectively. Similar equations which involve complicated algebraic expressions for these mean quantities are required for electrolytes which dissociate into more than two ions. The standard chemical potential, μ°, is defined in such a way that $f_\pm$ equals unity as $N_\pm$ approaches zero so that-the ideal law for infinitely dilute solutions becomes simply

$$\mu=2kTlnN_\pm+\mu^\circ, \tag{28}$$

which is similar in form to equations (19) and (22).

The characteristic behaviour of the activity coefficient both in water and in media of lower dielectric constant is illustrated in fig. 5, in which log $f_\pm$ of hydrochloric acid is plotted against the square root of the molar concentration. The five curves refer to pure water and 20%, 45%, 70% and 82% dioxane in water solutions with dielectric constants of approximately 80, 60, 40, 20 and 10, respectively. If the law represented by equation (28) were valid, then $\log f_{\pm}$ would be zero for all values of c. Increasingly wide deviations from this condition are to be noticed as the dielectric constant decreases, and these departures, measured by the decrease in $\log f_{\pm}$, are large even in the dilute solutions. This behaviour is typical of electrolytes which are highly dissociated in water. Further, the three top curves approach the dashed straight lines from above as the square root of the concentration approaches zero. The two bottom curves approach this condition from below.

These facts can be generalized into a limiting law,

$$\log f_{\pm} = -\alpha\sqrt{c}, \quad (29)$$

where a is a constant. Thus, for an electrolyte $\log f_{\pm}$ approaches proportionality to the square root of the concentration as this latter quantity approaches zero.

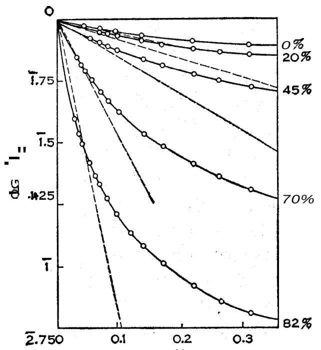

FIG 5—LOGARITHM OF THE ACTIVITY COEFFICIENT OF HYDROCHLORIC ACID IN DIOXANE-WATER MIXTURES AT 25° C THE STRAIGHT LINES (DASHED) REPRESENT THE LIMITING LAW. THE FIGURES ON THE RIGHT GIVE THE WEIGHT PERCENTAGES OF DIOXANE IN THE MIXTURES. (DATA OF H. S. HARNED *et al.*)

Irreversible Processes *and* Dynamic *Properties*.—Three ways in which the ions of an electrolytic solution can move are subject to quantitative computation. Under the influence of an electrical field, the cations move in one direction and anions in the opposite direction and the result is a phenomenon of electrical conduction. Second, when an electrolyte flows freely into a solvent, both ions move with equal velocities in the same direction and diffusion occurs. Third, the motion of the solution as a whole is determined by its viscosity.

Conduction. —The conductance of a solution is equal to the sum of the cationic and anionic currents under a potential gradient of one volt (see ELECTROLYSIS). It is customary to employ the equivalent conductance, A, which is defined as the conductance of a solution containing a gram equivalent of electrolyte between electrodes one centimeter apart. In fig. 6, the values of Λ at 25° for hydrochloric acid in water and in water-dioxane mixtures of the same composition as those in fig. 5 are plotted against the square root of the acid concentration. This series of graphs illustrates the behaviour of many solutions of acids, bases and salts in media of high and low dielectric constants. As in fig. 5. the three top curves approach the straight lines tangentially from above as the concentration approaches zero. The two bottom curves approach the straight lines from below and reach coincidence with them only at extremely dilute solutions. At $c=0$, Λ equals the limiting conductance, $\Lambda°$. This latter quantity. unlike the values of $\log f_{\pm}$, differs for each electrolyte and each solvent medium, and therefore the limiting law, represented by the straight lines, is expressed by

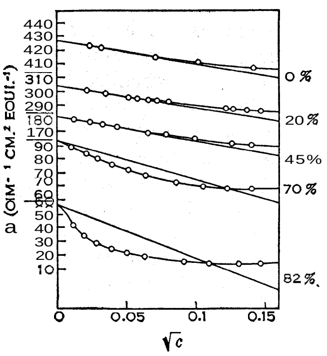

FIG. 6— MOLECULAR CONDUCTANCE OF HYDROCHLORIC ACID IN DIOXANE-WATER MIXTURES AT 25° C THE STRAIGHT LINES REPRESENT THE LIMITING ONSAGER CONDUCTANCE EQUATION. THE FIGURES ON THE RIGHT GIVE THE WEIGHT PERCENTAGES OF DIOXANE IN THE MIXTURES. (DATA OF B. B. OWEN AND G. W. WATERS)

$$\Lambda°-\Lambda=\beta\sqrt{c}. \quad (30)$$

This law was found empirically by F. Kohlrausch (1900) to be valid for many electrolytes from measurements of conductances in media of high dielectric constant. Rohlrausch also found that the limiting values of the individual ionic conductances are additive, or that $\Lambda°=\lambda_1°+\lambda_2°$. Thus, under the influence of the electric field, the ions migrate independently with different velocities and, as the concentration decreases, their properties become additive.

Diffusion.—When an electrolyte is allowed to diffuse freely in a solvent, both positive and negative ions move with the same velocity. If this were not so, a solution would become electrostatically charged by simple diffusion. The electrostatic forces between the positive and negative ions prevent this. The diffusion coefficient, $\mathscr{D}$, is a measure of the rate of diffusion and has a characteristic value for each electrolyte in a given medium. It possesses a limiting value, $\mathscr{D}_0$, at zero concentration of electrolyte which can be calculated from the limiting ionic conductances by an equation first derived by Nernst (1588). As the concentration of electrolyte approaches zero, $\mathscr{D}$, like the equivalent conductance, approaches a limit according to the law

$$\mathscr{D}_0-\mathscr{D}=\gamma\sqrt{c}, \quad (31)$$

where γ is a constant. Thus, $\mathscr{D}$ reaches a limiting value when c equals 0.

Viscosity.—The coefficient of viscosity is a measure of the rate of flow of a fluid and may be determined from measurements of the relative rates of flow through capillary tubes. In dilute solutions of electrolytes the viscosity, η, of the solution is a linear function of the square root of the solute concentration. Thus,

$$\eta_0-\eta=-\delta\sqrt{c}, \quad (32)$$

where η_0 is the viscosity of the solvent and δ is a constant.

To summarize these considerations, it can be stated that the logarithm of the activity coefficient, $\log f_{\pm}$, which is involved in all the thermodynamic properties, the conductance, A, the diffusion coefficient, $\mathscr{D}$, and the viscosity, η, for electrolytic solutions at constant temperature and pressure approach their limiting values according to the same formal law of variation with the concentration of dissolved substance. It will now be shown how the modern theory of electrolytes succeeds in interpreting this common property in terms of the operation of electrostatic forces.

Theory of Dilute Electrolytic Solutions.—The quantitative theory of electrolytes in contradistinction to that of nonelectrolytes depends on two factors: (1) To a first approximation, the properties of electrolytic solutions may be derived by additions of contributions by the individual ions. Deviations from additivity increase slowly with the ionic concentrations. (2) The law of force between the electrically charged ions is known.

The early theory of S. Arrhenius did not include an estimate of the effect of the electrostatic forces and attempted to account for the deviations from the ideal law for the chemical potential (equation [28]) and the variation in the equivalent conductance with concentration by assuming the presence of fewer ions because of incomplete ionization of the electrolyte. Because of the extent of additivity of the properties of electrolytes in dilute solution, this idea was questioned by W. Sutherland (1902), A. A. Noyes (1904) and others who suggested that many electrolytes in water are completely dissociated. If this is true, then the deviations from ideality must be caused by interactions among the ions and between the ions and the solvent. The importance of electrostatic forces was recognized by Laar (1894) and unsuccessful attempts were made to compute their effects by P. Hertz (1912) and J. C. Ghosh (1918). S. R. Milner (1912) successfully analyzed the problem and obtained a square root law for the variation of $\log f_{\pm}$ but his mathematical treatment was involved and did not give an entirely satisfactory solution. P. Debye and E. Huckel (1923) were able to solve the problem for the thermodynamic properties and Debye's fundamental conceptions were soon extended by L. Onsager (1927) and H. Falkenhagen (1928), who are responsible for the interionic attraction theories of conductance, diffusion and viscosity.

In an electrolytic solution the ions have a random distribution because of thermal agitation, but this randomness is restricted somewhat by the attractive and repulsive forces between the ions. These coulombic forces obey the inverse square law

$$\mathscr{F}=e_ie_j/Dr^2, \quad (33)$$

where $\mathscr{F}$ is the force between ions of charges e_i and e_j, r their distance apart and D the dielectric constant of the medium.

The net effect of the thermal and electrostatic factors was shown by P. Debye to produce a condition in which on the average each ion is surrounded by an atmosphere of ions of opposite charge. The presence of this "ionic atmosphere" is a result of the tendency of unlike charges to attract and like charges to repulse one another. Debye's theory makes possible the calculation of the electrical potential due to the ion and its atmosphere, the electrical potential due to the atmosphere alone, the work of charging an ion in the field of this potential and finally the chemical potential and the logarithm of the activity coefficient, $\log f_{\pm}$. Taking into account the actual sizes of the ions, or, more particularly, the mean distance of approach of both positive and negative ions, Debye obtained the equation

$$\log f_{\pm} = \frac{-\alpha\sqrt{\ }}{(1+A\sqrt{c})}, \tag{34}$$

where at constant temperature and pressure α is a constant calculable from the magnitudes of the charges on the ions, the dielectric constant, the gas constant per molecule and Avogadro's number. The parameter, A, is a function of the distance of approach of the ions, the dielectric constant and the temperature. As the concentration of the electrolyte c approaches zero, the denominator approaches unity so that this equation equals the limiting equation (29), $\log f_{\pm} = -\alpha\sqrt{c}$, at infinite dilution. The straight lines in fig. 5 represent this theoretical limiting law from which it is apparent that agreement is approached as the concentration approaches zero. Thus, in dilute solutions, the effect of coulombic forces is sufficient to account for the variation of the quantity $\log f_{\pm}$.

Fig. 6 shows that the equivalent conductance decreases with concentration of the electrolyte, so that, if the electrolyte is completely dissociated, the difference $\Lambda^\circ - \Lambda$ must be accounted for by the action of the electrostatic forces. This means that the mobilities (velocities under a gradient one volt per centimeter) of the ions must decrease with increasing concentration. On the basis of Debye's theory, two factors contribute to this retardation. The first, computed by Debpe, is caused by "electrophoresis," whereby, as the ion moves in the electrical field, its oppositely charged atmosphere and associated solvent must move in a direction opposite to that of the ion. Thus, the ion is moving in a counterflow of medium like a swimmer against a current and obviously its migration is retarded. The second factor which retards the motion of the ions is a hydrodynamic effect first computed by L. Onsager (1927). When an ion is moving in a low electrical field, it is migrating within an atmosphere which has a charge of opposite sign to that of the ion. As a result, the ion will have to drag an oppositely charged atmosphere with it, an effect which will retard its velocity. Onsager's limiting equation may be written

$$\Lambda^\circ - \Lambda = (\alpha^*\Lambda^\circ + \beta^*)\sqrt{c}, \tag{35}$$

in which α^* is a theoretical quantity depending on the temperature, the dielectric constant and the ionic charges. β^* can be computed from these quantities and the viscosity of the solution. The first coefficient, $\alpha^*\Lambda^\circ$, is a result of the hydrodynamic effect and the second, β^*, of electrophoresis. At a given temperature and in a given medium $(\alpha^*\Lambda^\circ + \beta^*)$ is a constant so that this equation is formally in agreement with Kohlrausch's empirical equation (30). Comparison of Onsager's equation with experiment is shown in fig. 6 in which the theoretical requirement is represented by the straight lines. Exact confirmation is obtained with the experiments in media of high dielectric constants represented by the three top curves. The two bottom curves which approach the limiting slopes from below are characteristic of incomplete ionization of an electrolyte. Later, it will be shown that this Nernst-Thomson dielectric constant effect is universal.

Further confirmation of the correctness of the fundamental postulates of this interionic force theory may be found in the effects produced by high electrical fields upon the conductance of electrolytes, a phenomenon discovered by M. Wien (1927) and investigated by Wien and his colleagues. In high fields, the ions can acquire a velocity great enough to draw them out of their atmospheres, in which case the hydrodynamic effect is obliterated acd the conductance of the solution is increased. This conclusion is in theoretical agreement with the observed results. The conductance of an electrolytic solution becomes greater in fields of higher frequency. Debye and Falkenhagen developed a theory of this frequency effect which is in accord with experimental knowledge.

The interionic attraction theory of electrolytic diffusion has been developed by Onsager and R. M. Fuoss with the result that their limiting equation agrees in form with equation (31). Experimental determinations of the diffusion coefficient of very dilute potassium chloride solutions obtained by H. S. Harned and R. L. Nuttall (1947) are in close agreement with the theory. Since in diffusion both positive and negative ions move with equal velocities. the hydrodynamic effect is found to disappear, but an electrophoretic factor is present which depends on the forces between the ions and the solvent molecules, as the solvent moves in a reverse direction to the ions. This effect is not so large as that caused by the gradient of the chemical potential of the electrolyte.

The interionic attraction theory was also extended by Falkenhagen to account for the increase in viscosity of the solvent produced by the addition of ions. He succeeded in deducing a theoretical expression for the constant, δ, in equation (32) and his theory mas confirmed for dilute aqueous solutions of many electrolytes of various valence types of G. Jones, M. Dole and colleagues (1927–40).

Electrolytic **Dissociation and Ionic Association.**—There are two ways in which ions may combine. Because of the electrostatic forces. they can form unchanged ion pairs, charged triple ions. uncharged quadruple ions and ion clusters of still higher order. Second, the positive and negative ions can combine more closely to form undissociated molecules with covalent chemical bonds. Such molecules, of which acetic acid and ammonium hydroxide are examples, are ionized to a small extent in media of high dielectric constants and are known as weak electrolytes According to the rule of Nernst and Thomson, the tendency to form both ion pairs, etc., and undissociated molecules will be greater the lower the dielectric constant of the medium, and qualitatively this prediction is universally valid. This behaviour is illustrated by the lower graphs in both fig. 5 and 6 which approach the limiting laws from below. In the 45% dioxane-water mixtures ($D \sim 40$), the theoretical result for Λ is approached from below but the effectis hardly noticeable. In the 70% mixtures ($D \sim 20$) and the 82% mixtures ($D \sim 10$), this effect is much more pronounced. This decrease in conductance below the limiting law for a completely dissociated electrolyte is to be explained by the removal of the ions as effectively charged carriers of electricity to form ion pairs. Similar behaviour is to be observed for the log $f_{\pm}$ in fig. 5, although the effects are less pronounced. Extended studies of the conductances of various electrolytes in nonaqueous solvents were carried out by P. Walden and after 1915 by C. A. Kraus and co-workers.

A quantitative theory of ion-pair formation was developed by N. Bjerrum (1926). By considering the distribution of ions under the influence of their electrostatic forces, he showed that the probability of ion-pair formation is very small until the distance apart of the positive and negative ions reaches a certain value, q, and that at distances less than this the probability of such combination increases very rapidly. If the ionic sizes are great enough so that the sum of their radii is greater than q, they cannot approach each other closely enough to pair, but if this sum is less than q, ion-pair formation occurs. In water, q depends on the valences of the ions and equals approximately 3.5 A and 7.0 A for sodium and barium chlorides, respectively. It also depends on the dielectric constant and becomes larger as this quantity decreases. The equation derived b~ Bjerrum may be written

$$K^{-1} = \frac{B}{D^3}Q(b), \tag{36}$$

where K is a constant, characteristic of ion-pair dissociation; B is a function of the charges carried by the ions, Avogadro's number, Boltzmann's constant and the temperature, and $Q(b)$ is a complicated function of these quantities as well as the sum of the ionic radii If the dissociation of the ion pair is represented by $[C^+A^-] \rightleftarrows C^+ + A^-$, then the ionization constant, K, is defined by

$$K=\frac{c_+c_-}{c_\pm}\Big]_{c\to 0} \tag{37}$$

where c_+, c_- and $c_\pm$ are the concentrations of the species denoted by subscripts. It is to be noted that K is the limiting value of the right member of this equation as c approaches zero. Since K^{-1}, the association constant, varies inversely as the cube of the dielectric constant, it increases extremely rapidly as the dielectric constant decreases. $Q(b)$ also decreases in a similar manner.

Bjerruin's theory received confirmation from the experiments of Kraus and Fuoss, who measured K of tetraisoamylammonium nitrate in water and in dioxane-water mixtures. In water, this salt is completely ionized since the sum of its ionic radii is of the order of six angstroms. The enormous extent of the variation of its ionization constant is shown in fig. 7, in which log K is plotted against log D. The curve is derived from theory and the circles represent the observed results. Fuoss developed the theory to account for triple- and quadruple-ion clusters and obtained satisfactory agreement by experiment.

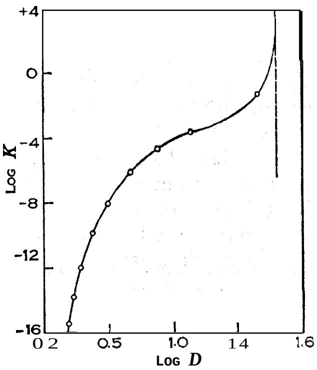

FIG. 7— ION-PAIRDISSOCIATION AS A FUNCTION OF THE DIELECTRIC CONSTANT. TETRAISOAMYLAMMONIUM NITRATE IN DIOXANE-WATER MIXTURES AT 25° C. (DATA OF R. M. FUOSS AND C. A. KRAUS)

The general situation is too complicated to be explained by this relatively simple action of electrostatic forces. Although studies of Raman spectra and of other properties indicate that many electrolytes in water are completely dissociated at all concentrations, there are a great many that are not. Silver nitrate and thallous chloride are examples of 1–1 salts which are not completely ionized. The 2–1 salts show various degrees of dissociation. Whereas calcium chloride and zinc iodide are highly dissociated, cadmium chloride dissociates to a much smaller extent and cadmium iodide and mercuric chloride are weak electrolytes. In these cases the dissociation occurs in stages:

$CdI_2 \rightleftarrows CdI^+ + I^-$; $CdI^+ \rightleftarrows Cd^{++} + I^-$

and it is probable that the cadmium and iodine are joined by a covalent bond; *i.e.*, that CdI^+ is not a loose electrostatically bound ibn pair.

Weak Electrolytes.— Only a few acids and bases, such as hydrochloric acid and sodium hydroxide, are strong in water, but there is a very large number which form a class of weak electrolytes. Most of these are organic acids, bases and ampholytes and their relative strengths vary greatly. The extent of dissociation is measured by the thermodynamic constant of equilibrium between the undissociated molecule and the ions, represented by the reaction: $CA \rightleftarrows C^+ + A^-$. This constant is given by the equation

$$K=\frac{a_C a_A}{a_{CA}}=\frac{\gamma_C\gamma_A m_C m_A}{\gamma_{CA} m_{CA}}, \tag{38}$$

valid at constant temperature. In this equation a, γ and m denote the activities, the activity coefficients and the concentrations in mols per 1000 gs. solvent of the undissociated molecule, the cation and the anion, as denoted by subscripts. It is to be noted that in this equation the molar concentrations have been employed and not the mol fractions. This procedure conforms with the customary method of expressing ionization constants. When the concentration of electrolyte is zero, this equation assumes the same form as equation (37) since by definition the activity coefficient function becomes unity.

Some precise values of K_A for a few acids and water are given in the table. These illustrate how widely this quantity varies with the nature of the electrolyte. Thus, the ionization constant of chloroacetic acid is of the order of 10^{11} times that of water and 10^7 times that of boric acid. It is to be noted that the ionization constant of acetic acid becomes less as the dielectric constant of the medium (water-dioxane) decreases, a phenomenon exhibited by all electrolytes.

Ionization Constants at 25° C.

Acids	Medium	D	K_A*
Chloroacetic	Water	78.54	1.379×10^{-3}
Formic	"	"	1.772×10^{-4}
Acetic	"	"	1.754×10^{-5}
	Water—20% dioxane	60.8	5.11×10^{-6}
	Water—45% "	38.5	4.93×10^{-7}
	Water—70% "	17.7	4.78×10^{-9}
	Water—82% "	9.5	7.24×10^{-11}
Boric	Water	78.54	5.79×10^{-10}
Water	"	"	1.008×10^{-14}

*Concentrations are in mols per 1,000 g. water.

As first pointed out by Brönsted (1920), a property common to all weak electrolytes may be deduced from equation (38). In dilute solution, the activity coefficient of a neutral molecule, CA, changes little when the ion concentration is increased by the addition of neutral salt. On the other hand, the activity coefficients of the ions decrease rapidly as shown by fig. j. Consequently, the quantity $\gamma_C\gamma_A/\gamma_{CA}$ decreases in dilute solutions, and since K is constant, $m_C m_A/m_{CA}$ must increase. Extensive determinations of the ionization of water and some weak electrolytes in various salt solutions were made by Hained *et al.* from cells without liquid junction, and optical measurements of the same effect were carried out by H. von Halban which confirm the universality of this phenomenon.

Ampholytes, or molecules which in solution possess both acid and basic properties, form a class of solutions whose properties depend to a considerable extent upon their unique electrical nature. Of these the most important are the amino acids whose neutral molecules, as suggested by Bjerrum (1923), are amphions (zwitter ions) which carry both a positive and negative charge. If such dipolar molecules be denoted by $Z^\pm$, their acid and basic equilibria can be represented by

$$ZH^+ \rightleftarrows Z^\pm + H^+$$
$$ZOH^- \rightleftarrows Z^\pm + OH^-$$

The ionization constants of ZH^+ (K_A) and ZOH^- (K_B) are of the same order of magnitude as those of other weak acids and bases. For example, K_A and K_B for glycine at 25° are 4.47×10^{-3} and 6.04×10^{-5}, respectively.

In order of complexity, the ampholytes include the simple amino acids, the peptides, hetaines, phospholipids and finally the proteins. Because of the presence of many amino groups, a protein molecule carries a very large number of charges and its properties are conditioned to a great extent by the presence of many dipolar groups in the molecule. They have high permanent dipole moments and their solutions possess very high dielectric constants. Similar enhanced effects occur with many of their other properties (*see* PROTEINS).

Hydrolysis.— Hydrolysis is chemical change brought about by the action of water and may be represented by the chemical reaction, $RX + H_2O \rightleftarrows ROH + HX$. If in aqueous solution, RX is a completely dissociated electrolyte, hydrolysis occurs to a considerable extent when either the hydroxide, ROH, or the acid, HX, are weak electrolytes. Thus, when ROH is a weak hydroxide $R^+ + H_2O \rightleftarrows ROH + H^+$ the solution is acidic, and when HX is a weak acid, $X^- + H_2O \rightleftarrows HX + OH^-$ and the solution is basic. The equilibriums represented by these equations can be computed from the equilibrium constants of the weak electrolytes. For example, sodium acetate in water may be represented by the equation $Ac^- + HOH \rightleftarrows HAc + OH^-$. This equation may be obtained by subtracting the equation for the ionization of acetic acid, $HAc \rightleftarrows H^+ + Ac^-$, from that representing the ionization of water, $HOH \rightleftarrows H^+ + OH^-$. Therefore, the equilibrium constant K of the hydrolytic reaction is given by the ratio of the ionization constant of water to that of acetic acid. Thus, at 25° C. (*see* table)

$$K=\frac{a_{HAc}a_{OH}}{a_{Ac}a_{H_2O}}=\frac{a_H a_{OH}}{a_{H_2O}}\ \frac{a_{HAc}}{a_H a_{Ac}}=\frac{1.008\times10^{-14}}{1.754\times10^{-5}}=5.75\times10^{-10} \tag{40}$$

where a_{HAc}, a, etc., are the activities of the species denoted by the subscripts.

Concentrated Solutions of Strong Electrolytes.—In concentrated solutions, electrolytes show wide variations in their properties. This is illustrated in fig. 8, where graphs of $\log f_\pm$ versus $\sqrt{c}$ for a number of 1–1 electrolytes at 25° C. are drawn. The lower curve represents the limiting law, $\log f_\pm = -0.509\sqrt{c}$, and the curve designated (å = 4) is the plot of equation (34). The parameter A as computed from a value of mean distance of approach å of four angstroms, an approximate value for many strong 1–1 electrolytes in water. All these results approach the curve (å = 4) as the concentration decreases, but it is apparent that only in very dilute solutions ($\sqrt{c}<0.01$) do they approach the predictions of the limiting law. In concentrated solutions, the individual effects become large. The electrolytes whose graphs lie above the curve (å = 4) have minima and curve upward to greater or lesser extents in the very concentrated solutions. Since these graphs lie above the theoretical curve, the electrolytes are probably completely dissociated. Caesium chloride solutions begin to exhibit evidence of ion-pair association, and thallous acetate and silver nitrate are most probably incompletely dissociated electrolytes.

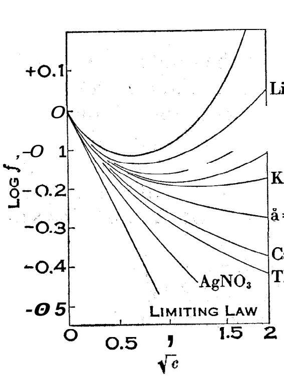

FIG. 8— ACTIVITYCOEFFICIENTS OF SOME 1-1 ELECTROLYTES (DATA OF R. A. ROBINSON)

The interpretation of the nature of these concentrated solutions is very difficult and no general theory exists for computing their properties The effects caused by the interactions of the ions with the solvent water molecules, which are not the predominating ones in very dilute solutions, become increasingly large in concentrated solutions. In addition to these ionic hydration effects, a change in dielectric constant of the medium occurs with change in composition of the solution. This latter effect has not been measured nor has it been estimated with any degree of accuracy. These considerations as applied to 1–1 electrolytes, let alone the more complicated behaviour of higher valence electrolytes, are sufficient to show that a detailed interpretation of the individual behaviour of electrolytes in concentrated solutions is accompanied with the greatest difficulties.

Solutions of Large Molecules and Suspensions.— The foregoing discussion was restricted from its beginning to the properties of binary solutions in a "homogeneous" phase. It is to be observed, however, that every species of molecule with its individual mass, size, shape and force field retains its identity and therefore, microscopically, a solution containing two or more kinds of molecules is heterogeneous. In all the solutions described above, the molecules are too small for direct observation by any instrument now available. The diameters of the molecules in these so-called homogeneous solutions are roughly of the order of ten angstroms in diameter and their molecules possess molecular weights relative to the oxygen molecule ($O_2^{16}=32.0000$) of 20 to 500 or somewhat higher. Now, solutions of synthetic polymers, of proteins with molecular weights in the neighbourhood of 100,000 and viruses with molecular weights of the order 10,000,000 to 2,000,000,000 are important examples of systems containing large molecules. Virus molecules of diameters of 230 A have been observed directly by the electron microscope, an instrument with a linear magnifying power of 100,000. Systems containing even larger particles which to the eye are homogeneous but whose heterogeneity may be observed by means of the ultramicroscope are known as disperse systems and have been classed under the general title of colloids.

The science of solutions containing large molecules requires the extension of the methods of thermodynamics and hydrodynamics to the statics and dynamics of these systems, with proper allowance for their sizes, shapes and the large number of charges on their ions (*see* POLYMERIZATION; PROTEINS; VIRUSES). Considerable progress is being made in this domain as well as in the field of colloidal solutions where modifications caused by surface action become important (*see* COLLOID).

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SOLVAY, ERNEST (1838–1922), Belgian industrial chemist and social reformer, who developed an important process for making alkali commonly known as the ammonia-soda process, was born at Rebecq on April 16, 1838. The son of a salt refiner, he attended school in Malonne and later worked for his father at Rebecq. Solvay read books on elementary chemistry and physics and in 1860 became an assistant to an uncle who was head of a small gasworks at Schaerbeek.

In 1863 Solvay developed his process for the production of soda ash, which is considered one of the most important 19th-century advances in industrial chemistry, and founded Solvay and company, with headquarters at Couillet. After initial difficulties, the daily production was 1,500 kg. by 1866. Replacing the old Leblanc "black-ash" process, Solvay's process was widely utilized in many countries. (*See* also CHEMICAL INDUSTRY and ALKALI MANUFACTURE.)

Solvay became wealthy and contributed to various philanthropies and research organizations. In 1894 he established in Brussels the Institut des Sciences Sociales, which became the Institut de Sociologie in 1901.

Solvay opposed the amassing of "unearned" inherited wealth and proposed a system of social accounting which would replace money. His works include *Science contre religion* (1879); *Du rôle de l'électricité dans les phénomènes de la vie animale* (1894); *Le comptabilisme socia* (1897); *L'Energétique considérée comme principe d'orientation rationnelle pour la sociologie* (1904); and *Questions d'énergétiques sociales* (1910).

Solvay died at Brussels on May 26, 1922.

SOLWAY FIRTH, an inlet of the Irish sea between England and Scotland. Bordering it are Wigtownshire, Kirkcudbrightshire and Dumfriesshire in Scotland and Cumberland in England. The outer portion is really a gulf at whose head is the shallow joint estuary of the Nith, Lochar, Annan, Esk, Eden, Wampool and Waver. Between St. Bees head and Abbey head it is 22 mi. wide and it stretches some 35 mi. northeastward from that line. The waters of the firth are generally shallow (under 10 fm.). Wide stretches of sand are exposed at low tide, particularly on the Scottish side. and the estuarine section is choked by shifting sandbanks. Craft of fair size can reach Silloth, on the English side, without difficulty.

A viaduct. $1\frac{1}{2}$ mi. long, carries the railway across the head of the estuary almost on the line of an ancient ford from Bowness to Annan. The firth was also fordable at two higher points. That across the Esk estuary, the *sulwathe* (*i.e.,* "muddy ford") gave its name to the firth. The tide runs quickly in the estuary and periodically gives rise to a bore. The normal tidal range is about 2j ft. (T. HER.)

SOMA, in Vedic India personified the *Asclepias acida,* whose sap, fermented. is an intoxicant. As a Bacchuslike god Soma is lauded in 114 hymns of the *Rig-ceda* IX and as a co-equal of Indra, Agni and Rudra in other Books. Its uses. like its name (*Haoma* in the *Avesta*), go back to Iranian times, and it was prized both in India and Iran as a medicine conducive to longevity.

The celestial variety, distinct from that of earth, was drunk by the gods, and incited Indra to establish the universe. In the post-Vedic Epics Soma is the Moon, who wanes when drunk by gods but is replenished by the Sun.

SOMALILAND, so named from the Somali inhabitants. descended from Arab immigrants from the 7th century onward, is the Horn of Africa, bounded by the Gulf of Aden on the north, the Indian ocean on the southeast, and an ill-defined line on the west, running from the south end of the Red sea to the Tana river in Kenya. To the west of Somaliland lie Eritrea, Ethiopia proper and the Boran area of Kenya toward Lake Rudolf. The area is roughly triangular, approximately between long. 41° and 51° 25′ E., and between lat. 12° N. and 1° 40′ S. About 600 mi. along the Gulf of Aden and 1,000 mi. along the Indian ocean, the triangle is completed by about 900 mi. of irregular inland boundary to give a total area of about 425,000 sq.mi., of which 120,000 sq.mi. are in Ethiopian-controlled Somaliland (Ogaden) and 50,000 sq.mi. in the northern frontier district of Kenya. The remainder is split up between French Somaliland and the Somali Republic (est. July 1, 1960; area 246,201 sq.mi.), comprising the former British Somaliland Protectorate and Italian Somalia, which are described below.

The total population of the British, French and Italian parts of Somaliland was estimated in 1958 at more than 2,000,000, including 25,000 Danakils in French Somaliland; and local pockets of Galla, Negroes (especially along the fertile river valleys), Arab and Indian traders. and European traders and government officials. The Ethiopian Ogaden province probably accounted for 600,000 Somalis and 200,000 Galla and other Africans, while Kenya had about 50,000 Somalis north and east of the Tana river.

PHYSICAL GEOGRAPHY

Geology.—The metamorphic basement, probably Archaean, with some later less metamorphosed Inda Ad series, crops out along the scarps facing the Gulf of Aden. Both are intruded by Younger Granite and pegmatites, while the older basement is much granitized. Some mineralization is probably associated with the Younger Granite.

The basement is upwarped again in the upper Juba area, but over most of the territory it is covered with sediments dipping usually to the south-southwest. Karroo sandstones of Trias or Lias Age! and Jurassic shales and limestones, locally kerogenous, occur in some faulted basins. These or the basement are covered, over most of the territory, by terrestrial Cretaceous sandstones with some shales. but in the northeast by marine Cretaceous limestones. In the south both Jurassic and Cretaceous include lagoonal evaporite deposits.

Above the Cretaceous a Paleocene or Lower Eocene marine transgression laid down limestones over most of the country, including the main feature-forming rock. A regression of the sea eastward resulted in huge deposits of Eocene evaporites followed by a further incursion to form Middle Eocene limestones in the eastern areas.

The country was then uplifted, and much faulted, especially in east-west and northwest-southeast lines. In the Lower Miocene a minor transgression formed a limestone fringe a little inland from the present shore line. capped locally along the Gulf of Aden lowlands by Plio-Pleistocene basalt flows, with some rhyolites. In French Somaliland these cover all other rocks except two small exposures of Jurassic and Cretaceous, and the later Pleistocene and Recent reefs. evaporites and gravels.

There are sand dunes along much of the coasts, but the greater part of the country is covered by Recent sandy clays or calcareous or gypseous rock.

Physiography. — From the Gulf of Aden coast line the land rises rapidly to the main watershed range between Guardafui in the east. with mountains up to 4.000 ft. high near the coast, to the Harar plateau in the west about 7,000 to 8.000 ft. There are some passes in this range. but often steep cliffs facing north. with some stretches of permanent water in the drainage north to the Gulf of Aden. There in the highlands are the highest rainfall and the pleasantest climatic conditions South of the watershed are low foothills soon dying out into gently undulating waterless plains, sloping south to the Indian ocean. Inland in the Ogaden and Kenya is some higher ground whence come the permanently flowing Webi Shebeli. Juba and Tana rivers.

Climate. — Rainfall varies from about 20 in. annually in the highlands (with local freak records up to 50 in.), to less than 3 in. on the coast, though in the northeast and on parts of the Indian ocean coast, where hills or dunes are near the shore, a narrow coastal belt may have more than 1j in. Rainfall is snoradic.

Temperatures vary from occasional frost in the mountains to maxima of about 116° F. in the shade on the coast. Owing to the generally dry climate, diurnal variation of temperature is about 10° on the coast to 20° F. in the hills. Much of the country has poor soil, tending as a result of rapid evaporation of rainfall to become caked with lime or other salts. The irregular heavy storms tend to cause excessive erosion wherever the natural balance of vegetational cover is disturbed, as in locally overgrazed areas or in neglected agricultural clearings.

NATURAL RESOURCES

Vegetation. — In the mountains over about 5,000 ft. are relict juniper and box forests. with some acacias. euphorbias and gums, stretching in a broken line from their Ethiopian highland habitat in the west to northeastern Somali Republic.

The plateau is dominated by open savannah of acacias (especially *A. etbaicu, A. bussei, A. spirocarpa* and *A. mellifera*), and *Commiphora* shrubs and grasses, though in the gypseous areas the stone-croplike *Suaeda, Limonium,* etc., are dominant and valuable salt grazing. There are also large areas of open treeless grassy plains, and in the nongypseous areas reddish anthills, up to 23 ft. high, dominate wide tracts both in the bush and on the plains.

In the lowlands similar vegetation to that of the plateau persists, though with more bare soil, stunted trees and stunted shrubs, especially *Indigofera,* replacing much of the grass. Along the coast are more *Suaedas,* and rarely mangroves. *Acacia spirocarpa* seems to be ubiquitous at any altitude in any soil. The acacias are popularly referred to as camel-thorn. Along the southern rivers are giant acacias, doum palms and other vegetation of the wet tropics along the narrow flood plains and along the equatorial coast

Animal Life. — Mosquitoes. sand flies, houseflies, ticks, scorpions and locusts are temporary seasonal pests, usually in limited areas. except for the mosquitoes near permanent water Termites are important soil makers except on gypsum. Snakes are well distributed but do little harm, and there are crocodiles in the southern rivers. There are a few fresh-water fish inland, as well as in the big rivers, and important shark. tunny and kingfish, especially in the Gulf of Aden. Birds include several kinds of bustard, guinea fowl and other game birds, wild ostrich, vultures, secretary birds, eagles, hawks and the ubiquitous lesser raven. Wart hogs are common within range of water, giraffe occur near the equator. and there are a dozen or so species of antelope including greater and lesser koodoo, oryx and many gazelles, among which are the rare beira and Clarke's gazelle. Hartebeeste now occur only in the south. Wild asses are restricted to a few local herds, and there are zebras in the south. Elephants and some hippopotamuses occur along the Webi Shebeli, Juba and Tana rivers. By mid-20th century rhinoceros were limited to the equatorial region. Common small mammals are hyrax, hare, porcupine, rat, jerboa. ground squirrel, badger, mongoose and some stoat and ant bear. Jackals and striped and spotted hyenas are well distributed, and there are black-eared fox. Wildcat, lynx, cheetah and lion are common, but the leopard is becoming rarer. Bats live in wells and caves, and tribes of baboons range near any water supply, while there are tree monkeys in the west and south.

(J. A. Ht.)

POPULATION

The Somali belong to the Hamitic race which includes among its northeast African members the Beja, the Afar or Danakil, the Agaw of Ethiopia, the Galla, and the Sidama peoples. They are probably the most recent of the Hamitic migrants from southern Arabia. According to their traditions. heavily coloured by an ultra-Moslem bias, at various times between the 7th and 16th centuries AD. Arabs (many fleeing from persecution) landed on the northern Somali coast, and by intermarriage with the Galla who then lived there produced the Somali nation. Except for the fact that the Galla did once live in northern Somaliland, the general trend of this account is unlikely for both historical and anthropological reasons, for the arrival of the first of the Somali in Africa must antedate Islam by a considerable time; and the Somali language so far from being a hybrid derived from Galla (as has been suggested) is a separate but related language, phonetically perhaps the most difficult of all the Hamitic languages. In the 20th century a Somali named Usman devised an alphabet for writing the language. which at first was known as Usmaniya, but is now generally called Somalia Writing by the Somali. There is a large body of oral literature, including alliterative poetry. The name Somali first occurs in'the form *Sumule* in a praise song of Yeshaq I of Abyssinia (1412–27); the meaning is obscure, but it may be derived from the Arabic words *zu mal,* "possessors of wealth"

The Somali are pastoralists owning camels and sheep, with cattle and horses where suitable. The camel is a source of both nourishment and transport; it also forms the basis of wealth, and is thus of the highest value. Cattle are kept in parts of the Somali Republic, especially by the Habar Awal in the west, and in parts of southern Somali, the chief cattle onners there being some of the Ogaden tribes, and the Harti and Jiddu. Horses are owned by the Dulbahante. Warsangeli, Habar Awal, and some of the Ogaden tribes. Agriculture is practised in western Somali Republic; on the "high plateau" round Isha Baidoa; and sporadically in the country between the middle Webi Shebeli and the Juba. A primitive plow drawn by two oxen is used in places Water is one of the dominating factors in Somaliland, much of nhich is a barren region of stunted thorn trees, aloes, dry watercourses and rocky hills. Tribal rights over water and grazing are of vital importance and are strictly regulated; and recognized seasonal stock routes have become established to grazing grounds which are in many cases outside the normal tribal area.

The Somali comprise more than a hundred tribes divided into six groupings or "confederacies" called Is'haq, Dir, Darod. Hawiya, Digil, and Rahanwein. These are classed in three major divisions: a northern, comprising Dir, Is'haq and Darod; the Hawiya and associated tribes; and the Sab, comprising Rahanwein and Digil. The word *sab,* "people," acquired a pejorative significance, for it nas also applied by the northerners to certain pariah groups living among the Somali: so to counteract this association with inferior (and therefore "unclean") peoples an ancestor called Sab was invented. A Somali tribe, *qabil,* is divided into clans, *qolo;* subclans or family groups, *jilib* (literally "joint"); and families, *rer;* the last is a political unit under the control of one of its elders. The *jilib* is the group of people who combine to pay and receive blood money, and is thus an important unit among an excitable people who are quick to kill, and assess compensation for homicide at 100 camels for a man and 50 for a woman. In some tribes there is no chief, and the maintenance of law and order rests with the family elders. In other tribes there is a chief, whose title varies; the terms sultan, *garad, ugas, boqor, islan,* and *waber* are recorded. An important element in Somali life is the custom of *magan* (*shegat* in the south): whereby an individual or group can arrange for protection from another group, receiving the full rights of the new group and in return accepting all the customary obligations.

The Somali have produced at least two outstanding leaders, the soldier Ahmed ibn Ibrahim el-Ghazi, called Grañ ("left-handed") by the Abyssinians, who ravaged Abyssinia in the 16th century; and Mohammed Abdallah Hasan, "the mad mullah." who dominated the Somali during the first 20 years of the 20th century (see *British Somaliland Protectorate: History* below).

Somali material culture is poor. The typical house is no more than a tent of matting placed over an arched framework of long sticks fixed in holes in the ground; these are taken down and carried on camels when the owners move. The spear is the main weapon, sometimes with a single or double blood course (a longitudinal channel in the blade); the shield, made of hide, is circular, with a central boss. Swords are also used.

In religion the Somali are Moslems of the Shafi' sect of Sunni (orthodox). Though inclined to be fanatical, their religious fervour varies with distance from the coast and contact with external Islam. The more remote and backward Somali are little more than nominal Moslems. and itinerant preachers called *wadad* (mullah) go about keeping Islam alive. There are also religious fraternities called *tariya.* The Somali are somewhat lax in their observance of the rules of Islam. Their women, for example, do not veil; many pray but three times a day; and in some places there are survivals of pre-Islamic pagan festivals. The mosque is not the centre of Somali Islam; instead there is a form of worship at the graves of local holy men.

The tribal groupings of the Somali are:

1. *Is'haq* confederacy: the Eidagale, Habar Awal, Habar Ja'alo or Tol Ja'alo and Habar Yunis.

2. *Dir* confederacy: the Isa, Gadabursi and Biyemal.

3. *Darod* confederacy, divided into three groups: (1) those of the Ogaden, which run through central and south Somalia (there is no Ogaden tribe); (2) those of the Majertein or Mijertein in northeastern Somalia (there is no Majertein tribe); (3) a third group comprising some nine scattered main tribes. Tribes of the Ogaden include the Aulyehan, Bahgiri, Makahil, Makhabul, Mahamud Zubeir. Malingur, Rer Adan Khair, Rer Ali Nasar, Rer Dalal, Rer Hamadin; the Rer Ugas Guled, Rer Ugas Ilmi, Rer Ugas Koshin, Rer Ugas Nur, and Rer Warfa which form a group on both sides of the Fafan river; and the Talamuge. Tribes of the Majertein include the Ali Jibril, Ali Suleiman, the Oman Mahamud, in whose area are the smaller tribes of Aurtable and Lelkase, the Rer Bi'dyahan, Siwakhron, Usman Mahamud and Wabeneiye. Other Darod tribes are the Abaskul, Bartireh, Dashishe, Dulbahante, Gelimeis, Harti, Kaptanle, the Marehan in two divisions, and the Warsangeli.

4. *Hawiya* confederacy: in two main geographical groups, an eastern to the east of the Webi Shebeli, and a western in Kenya between Wajir and the Ganale Doria. The Hawiya include the Abgal, Abgal Waaisle, Daud Abgal, Eli Omar Abgal, and Matan Abgal in central Somalia; the Ajuran (western group), the Auramale in two divisions, the Badi Ado, Habar Gidir Air, Habar Gidir Saad, Habar Gidir Suleiman, Jijele, Karanle, Mobilen, Murosada in two divisions, and the Wanjel. Tribes associated with the Hawiya include the Awadle, Digodia (western group), Galjal in three divisions, Gare (western group) and the Huber.

5. *Digil* confederacy: the Dabare, Gerirkhe, Gurre, Jiddu, Tunni, Tunni Tore and Tunni Doi.

6. *Rakanwein* confederacy: most of the tribes of this confederacy live in an area extending east of the Juba for about 140 mi. inland from the coast, and for about 120 mi. to the north and to the south of Isha Baidoa. They include the Begedi. Diso, Eimit, Elai, Gamale, Geledi, Gelidle, Harau, Harian, Helledi, Jilible, Jihron. Komal, Leisan, Lowai, Maalin Wein. Yalalle and Yantar.

There is a number of outcast or pariah groups scattered throughout Somaliland and living in subjection to and under the protection of the Somali. The three chief groups are the *Tomal* or blacksmiths. who are also magicians; the *Midgan* or hunters, who are also traders. metalworkers and physicians; and the *Yibir* or leatherworkers. who also provide charms and whose women perform the operation of clitoridectomy on the Somali girls. Among the Hawiya there are also pariah groups of *Madaral* (tanners) and *Dardo* (weavers). These peoples (who are called collectively *Bon* by the Hawiya) are not Somali, and may be related to the hunting peoples in Ethiopia known as Watta. (G. W. B. H.)

EXPLORATION

The Somali coast is believed to be the land of Punt of the 15th-century B.C. Egyptians, and was probably known to all the middle eastern empires of Assyria, Persia. Greece and Rome. British Indian army officers began to explore the interior in 1848, when C. J. Cruttenden. Lieutenant (later Sir Richard) Burton and J. H. Speke first landed there. Burton made a journey to Harar in disguise in 1854. F. L. James and his brother, with G. P. V. Aylmer and E. Lort-Phillips, H. G. C. and E. J. E. Swayne, and A. Donaldson Smith, an American, continued exploration in the latter part of the 19th century from the Gulf of Aden, penetrating as far as the Indian ocean. Lake Rudolf and the Tana river. Meanwhile two Italians, Luigi Robecchi-Bricchetti and Vittorio Bbttego, explored westward from the Indian ocean, and Georges Révoil, a Frenchman, in the northeast.

Many hundreds of soldiers, administrators, traders, scientists and others have continued the exploration since then, and most of the area is covered by air photography. Much has also been mapped geologically, but many areas each of several hundred square miles or so between motorable tracks, remain practically unknown. except to the local nomads who graze those particular localities.

SOMALI REPUBLIC

British Somaliland Protectorate.— This former protectorate, along the African shore of the Gulf of Aden between long. 42" 40' and 49° E., and lat. 8° and 11° 25' N., was bordered to the northwest by French Somaliland, to the southwest and south by Ethiopia (mostly by the Somali Ogaden province), and to the southeast and east by the former Italian Somalia with which it united in 1960 to form the Somali Republic. Roughly 400 mi. along the coast from east to west, the area of the former protectorate extends inland about 80 mi. in the west to 200 mi. farther east, and covers an area of about 68,000 sq.mi.

Physically the country can be divided into three parts: coastal lowlands with some hills up to 3,000 ft. above sea level; the main watershed mountains rising abruptly from the coastal lowlands to between 4,000 and 8,000 ft. (Surud Ad near Erigavo is 7,900 ft.); and the plateau sloping gently southward from 4,000 to 2,500 ft. The southern part of this plateau is the valuable Haud grazing area which straddles the Ethiopian Ogaden boundary.

From the main watershed short, dry river beds, with some permanently flowing reaches, drain north to the Gulf of Aden. South of the watershed most of the drainage is collected in the three west-southwest flowing valleys: the Daror in the northeast, the Nogal diagonally across the centre of the plateau and the dry Bokh in the south. The Nogal flows mostly below the surface till the Somalia boundary at Geroweh, and into the Indian ocean. The Daror has a subsurface flow, but the Bokh, which disappears into the Mudugh area of Somalia, appears to have dried up, despite the rainfall flowing into it.

The northeast monsoon blows from October to March when the sun is south of Somali, and the unpleasant hot dusty southwest monsoon from May until September. There are hot calm periods between the monsoons. The main rains are from April to June, and short rains in October and November. In the higher parts of the plateau rain is usual in July and August (August is the wettest month of the year in Hargeisa), and in the northeast in

January or December. The rainfall cannot be relied upon except over a period of years. Ten to 20 in. of rainfall above 4,000 ft. altitude, with freak local rainfalls of over 40 in. In the lower country the average rainfall is nil to 10 in. Much runs off or is evaporated, and the greater part of the country is semidesert to dry savannah. Maximum average monthly temperatures are from 87° to 108° F. with absolute maxima on the coast up to 115° in the shade. Minimum temperatures are 32° in the mountains to 70° on the coast. There is always a diurnal range of 10° and usually 20°.

The People.—Apart from about 200 Europeans, mostly government servants, a few hundred Indian officials or traders, and 1,000 or more Arabians, the population (1957) was estimated to be 650,000 Moslem Somalis. Of these about 100,000 were Dir (Isa and Gadabursi), 420,000 Is'haq, and 120,000 Darod.

Some Somalis are educated in Roman Catholic missions in Aden or Jibuti, and some in Egypt, the Sudan or Syria. There are local Koranic schools and from 1944 an expanding government educational program provided primary and secondary schools, scholarships abroad and some girls' schools.

Excellent government hospitals were established at district headquarters, and a main one at Hargeisa with modern equipment and nursing staff. Tick fever is practically unknown since new insecticides destroyed the carriers, and wet-tropic diseases, such as typhoid and amoebic dysentery, are rare.

Berbera (pop., 1956, est., 7,500), the old capital, is the only good natural harbour on the African coast between Jibuti and Mombasa, but needs dredging and lacks modern port facilities. Zeila is a poor shallow harbour, overshadowed by Jibuti, and there are open roadstead ports at Bulhar, Karin, Onkhor, Shalau, Heis, Mait, Las Khoreh and Elayu. Inland on the plateau, Hargeisa (pop., 1956 est., 45,000) was the capital of the protectorate, and Borama, Burao, Erigavo and Las Anod were district headquarters.

History.—This coast was known in Egypt at least 1,500 years B.C., and traces of Persian culture still remain in Zeila. In the 7th century Arabs conquered Zeila and later Harar. The main Moslem Arab invasion, by infiltration, conquest and absorption of the Galla inhabitants, began on the Makhir coast in the northeast during the 13th century, the resulting Somali people spreading over the Horn of Africa from there. In the 16th century, Galla from Abyssinia drove the Arabs in the Zeila area back to the coast, where for a few years Zeila, as well as Berbera, were occupied by the Portuguese. Before the end of the century a further immigration of Arabs landed near Zeila to found the Dir tribes, Isa and Gadabursi, as well as other Dir tribes which spread south to mingle inamicably with the Is'haq and Darod waves from the northeast. Anchorage and trading agreements were made by British sea captains in 1827 and 1840, Aden having been annexed in 1839.

With the opening of the Suez canal in 1869 there was renewed European interest in the area, but in 1874 khedivial troops under Turkish sovereignty occupied the coast and Harar. With the mahdi's Sudan rebellion in 1882 these troops began to withdraw, and a British consul from Aden (then under the India office) came to Berbera, Bulhar and Zeila, in 1884. The Turks then withdrew to Suez, and in the next few years treaties were made by the British with the tribes. Germans and Russians visited the coast during this period. In 1888 a protectorate was declared, and accord reached with the French at Obok. The consuls, with a platoon of troops, kept the peace near the coast. In 1898 the foreign office took over from the India office. In 1894 boundaries were agreed with Italy and in 1897 with Ethiopia.

From 1900 until 1920 the "mad mullah," Mohammed Abdallah Hasan, of the Ogaden, fought the British, retiring into Italian- or Ethiopian-controlled territory when worsted by military expeditions. During a lull in this war in 1905 the colonial office took over control of the protectorate and in 1906 the Anglo-Franco-Italian agreement defined spheres of influence in the whole area of the Somalilands.

Another lull in the "mad mullah" wars in 1910 resulted in a British withdrawal to the coast for reasons of economy. They armed the friendly tribes, which promptly started to fight each other. The mullah's raids increased, and in 1913 Richard Corfield, commandant of the camel constabulary, was killed with much of his force. In 1914 the British reoccupied part of the interior, but the defeat of the mullah was postponed until after World War I. In 1920, the mullah was finally beaten, but once again escaped, and died of influenza in Ethiopia in 1921.

Thereafter followed a period of peaceful administration by colonial administrative officers, though in 1922 a district commissioner was shot during a riot over proposed direct taxation.

In 1936 the Italians had conquered Ethiopia. Their frontier patrols interfered with seasonal nomadic movements of graziers. In 1940, during World War II, British troops withdrew. The Italians occupied the protectorate until they in turn were driven out in March 1941 by the British. A military government, with a core of colonial service officers, took over the protectorate. In Aug. 1944 the Somaliland camel corps mutinied without bloodshed and was disbanded, to be replaced later by the Somaliland scouts. From 1945–56 there were intertribal feuds and battles at intervals, some of them serious, and in 1945 antilocust-control riots.

In Nov. 1948, the colonial office again took over from the war office, and in Feb. 1955 the Haud grazing areas, which had been administered by the British government since 1941, were returned to Ethiopian control. The protectorate gained its independence on June 26, 1960, and joined Italian Somalia on July 1 to form the Somali Republic.

Administration.—The protectorate was administered by a governor at Hargeisa, with six district commissioners. The chief secretary, secretariat and most departmental headquarters were at Hargeisa. An indigenous advisory council in 1957 became a legislative council, with increasing powers as Somalis were beginning to take over senior administrative posts. There was a colonial force, the Somaliland scouts, a police force, and an irregular force of Illalos controlled by district commissioners. A judge of the high court, district courts, kadi's (Moslem law) courts and subordinate (Somali) courts were established.

On July 1, 1960, the legislative assemblies of the former protectorate and Italian Somalia met in joint session to elect a provisional president as chief of state. A premier was designated to form a government, and work on a constitution was begun.

Economy.—The most important industry is stock herding. In 1955 there were estimated to be 1,200,000 camels, 2,355,000 black-headed fat-tailed sheep, 1,645,000 goats, 223,100 humped zebu cattle, 5,100 donkeys and 650 horses with the British protected tribes. The camel, last to survive in a drought, is the mainstay of the local economy providing transport, meat, milk and hides. Sheep and goats provide meat, milk and ghee (clarified butter), and are the most important export for meat and for the world-prized Berbera sheepskin. Cattle and donkeys are limited to better-watered or agricultural areas. Erosion is locally serious where overstocking due to maldistribution upsets the balance of vegetative cover suitable to the climate.

Agriculture is confined to about 5% of the country, millet and some maize being grown in rain gardens above 4,000 ft., or in flood gardens in inland deltas. There are also some vegetable gardens irrigated from permanent streams or wells, and some government experimental date gardens near the coast. Gums (frankincense, myrrh, gum arabic) are collected from wild trees for export. Guano from Mait island is all exported to Arabia. The growing of *Catha* edulis, chewed as a drug, is forbidden.

There are some areas declared forest reserves, and some timber is obtained from relict forests of Juniperus procera. Conocarpus *lancifolia* is exported for dhow building, and some plantations were developed near the coast in the 1950s. In the internal economy Acacia bussei is the most important tree.

Small quantities of beryl, columbite and cassiterite have been exported, while rutile, mica, galena, samarskite and monazite are known to occur. There are three known oil seepages, and exploration for mineral oil was carried out after mid-century. Apart from possible oil, the only potentially valuable mineral is the large reserves of gypsum and anhydrite, millions of tons of which outcrop within 10 mi. of Berbera harbour.

Currency, in East African shillings, was valued at 20 to the pound sterling. There is a weekly steamer service between Aden and Berbera, and from October to April a monthly ship from Great Britain. There are well-distributed landing grounds, and good air-fields at Hargeisa and Berbera, which are linked by the all-weather Berbera-Harar road. Wireless telegraphy is available at all district headquarters. From Hargeisa are the main roads through Mogadishu to Nairobi, and to Jibuti.

In 1955 revenue was £701,417 and expenditure £1,197,004, the balance made up by Great Britain. Import duty produced about £465,000 and export duty £90.000 of the revenue. The only direct tax was a business profits tax. The main imports are cloth, rice, sugar, tea, dates. millet, gasoline and cigarettes in that order. a third from India, a quarter from Great Britain and a third from countries outside the commonnealth. Exports, in order of value, are sheep. sheep and goat skins. goats, cattle, gums, camels and hides. Most commodities were transshipped at Aden, severely taxing the economy of the former protectorate. Considerable transit trade, mostly taxed 1.5%, is especially to Ethiopia and parts of Somalia.

Italian Somaliland.—Former Somalia, the easternmost strip of Africa, bounded by the Gulf of Aden, round Guardafui to the Indian ocean, southwest to Dicks Head on the Kenya border, then north to hfandera on the Kenya-Ethiopia border. east-northeast and northeast bordering Ethiopia and former British Somaliland, and finally north to Bender Ziada on the Gulf of Aden, lies between lat. 12° N. and 1° 40' S, and long. 41° and 51" 25' E., including the most easterly point of Africa. Ras Hafun.

The capital of the trust territory, Mogadishu (Mogadiscio), became the capital of the Somali Republic; other important towns include Kismayu (Chisimaio), Brava, Merca, Obbia, Eil and Bender Beila on the Indian ocean. Bender Cassim on the Gulf of Aden, and Galkayu. Bardera, Lugh Ferrandi. Isha Baidoa and Villagio Duca degli Abbruzzi in the interior. Its area is 178.201 sq.mi.

The land rises rapidly from the Gulf of Aden to the Al Maskat hills about 4,000 ft., thence sloping southward through plateau lands to low-lying semidesert. relieved by the well-watered flood plains of the Webi Shebeli and Juba in the southwest and south. Little of the country is over 2,000 ft. above sea level. and to the south of 8° N most is less than 1.000 ft.

Short river beds, with some permanent water, flow north from the Al Maskat, and to the south the Daror and Nogal, with some flowing reaches, drain east to the Indian ocean South of the Nogal most of the rainfall goes underground in semidesert gypsum country. The Webi Shebeli from the Ethiopian highlands flows southeast irom Belet Wein to near Mogadishu, where it turns southwest behind the coastal sand dunes in which it is lost. The Juba, also permanent water, crosses Somalia from Bardera to the Indian ocean just north of Kismayu.

In the north (the Mijertein), the climate is similar to that of iormer British Somaliland, with rainfall of 3 to 6 in. on the coast, to 10 in. or more in the Al Maskat. The northeast monsoon blows from October to March, and the stronger southwest monsoon irom May to September, with calm periods between. Most of the rainfall is during the southwest monsoon, except around Guardafui where local winter rainfall is important. Average minimum temperatures fall to 70° F. on the coast, and perhaps 40° in the Al Maskat. Average maxima are 100° on the coast to 90° in the highlands. South, nearer the equator, is a different climatic region, though records are scarce. At Mogadishu average annual rainiall is about 15 in., the southwest monsoon from July to September and the northeast from December to March.

The People.—In 1953 the estimated population was 1,263,584, including about 30,000 Arabs, 1,000 Indians, and 4,916 Italians and 124 other Europeans. There are, however, many Negroid and half-Negroid tribes especially along the big rivers and south of Kismayu. All the Somalis are Sunni Moslems.

Apart from Moslem schools, Catholic missions and orphanages date from about 1900. The medical department expanded rapidly after 1941 and qualified Somalis began to replace Italian doctors.

History.—The first Hamitic invaders were forebears of the non-Moslem Galla. The second invasion in the 13th century was of Moslem Arabs through the Makhir coast of British Somaliland. Later the Darod tribes spread southward to the Tana river. The Hawiya, starting near Jibuti, spread south and east to central Somalia. The Galla, converted to Islam, were mostly driven west to Ethiopia or south, though the "outcast" tribes, Midgan, Tumal and Yibir, probably originate irom Galla ioreiathers.

In 1507 Brava was sacked by the Portuguese Tristan da Cunha, and by the end of the 19th century the imam of Oman, from Zanzibar, controlled the east African coast irom Mogadishu to Mozambique. Italy made trade treaties irom 1889 and in 1892 leased the Benadir coast ports of southern Somalia from the sultan of Zanzibar, finally buying them in 1895 for 3,800,000 lire. In 1895 Vittorio Bbttego founded the station at Lugh on the upper Juba, and agreements with other European powers and Ethiopia were made, in 1897, 1906 and 1907. The hinterland of the Benadir coast in agreement with Ethiopia was undefined.

Meanwhile the "mad mullah" of the Ogaden tried to drive the British into the sea from 1900 until his death in 1921. The Italians made some halfhearted attempts at settling this quarrel, as the mullah used to retire to the Mudugh, inland oi Illig and Obbia, and was getting arms and supplies through the Somalia coast. In 1919 Britain ceded Kismayu and the Jubaland to Italy, and in 1920 Belet \Vein was occupied.

After the defeat by the British of the mullah, the Italians started to occupy the Mijertein in the northeast and brought it under control between 1925 and 1927. They then followed and encouraged the westward migration of the tribes, setting up posts as iar inland as Walwal, where in 1934 they attacked Ethiopian troops with the Anglo-Ethiopian boundary commission, and then annexed all Ethiopia in 1935–36. Money was poured into Somalia and Ethiopia for development and to build up military power. In Aug. 1940, during World War II, the British were driven from British Somaliland by the Italians. Late in Jan. 1941 the British began to invade Somalia from Kenya, captured Mogadishu a month later, and by the end of April had swept on to the Ethiopian highlands leaving Somalia and British Somaliland occupied.

Somalia was administered by a skeleton staff of military political officers, and agriculture, industry, education and medical services improved, while the country continued to be administered according to Italian and sheriat (Islamic) law. Italy, as trustee of the United Nations, took over the administration of Somalia again on April 1, 1950, after which the training and education oi Somalis ior self-government a decade later progressed rapidly. The Somali Republic, formed by the union of British Somaliland and Italian Somalia, was proclaimed on July 1, 1960.

Administration.—The trusteeship government was on the colonial pattern with an elected legislative assembly and provincial and district administrators outside the capital. Most of these were Somali. There was universal suffrage, and principal parties in the assembly were the republican Somali Youth league, the Hisbia Dighil Mirifle (in favour of conservative tribal responsibility and increased education), and the Partito Democratico Somalo consisting mostly oi townsmen.

Economy.—About 70% of the population live by herding stock, which in 1957 was estimated at 1,156,000 camels, 1,200,000 cattle, 2,000,000 sheep, 2,135,000 goats and 20,000 donkeys. Average stock per head of population is slightly lower than that for former British Somaliland, and proportion of cattle to camels higher.

In Mijerteinia are some small irrigated date gardens and some maize, millet and vegetable flood gardens locally. In the south the valleys of the Webi Shebeli and Juba, and the dune lands of the Benadir coast, produce millet, sesame, maize, cotton, bananas, sugar and some rice and dates. Some higher inland areas such as Isha Baadoa have enough rainiall to produce millet and maize. These agricultural areas are of considerable economic value.

Kismayu is a poor natural harbour, and Mogadishu a fair artificial one, the other ports being mere roadsteads. Good main roads built by the Italians were added to during British military occupation. Most of the agricultural .produce is absorbed locally, but bananas, sugar and sometimes millet are exported, as are ghee, hides, skins and gums and tunny irom the Mijertein, salt from Hafun and some dressed leather from Brava.

Under UN trusteeship there was only 8% direct taxation, the rest of revenue being derived by indirect taxation. In 1953 the annual expenditure amounted to 99,956,000 somalos (20 somalos = $2.80 = £1), including 58,332,000 somalos contributed by Italy.

FRENCH SOMALILAND

French Somaliland, or Côte française des Somalis, lies on the African coast where the Red sea meets the Gulf of Aden, between lat. 10° 55' and 12° 43' N., and long. 41° 38' and 43° 25' E. It is bounded to the north and the west by Ethiopia, and to the south by the Somali Republic. The ports of Obok and Tajura are on the north side of the Gulf of Tajura, and Jibuti (Fr. Djibouti), the capital, on the south. The area is 8,996 sq.mi. in extent, and consists of very broken country with mountains up to 6,630 ft. (Musa Ali), separated by a series of rifts some of which contain salt lakes below sea level.

The drainage flows partly eastward to the coast and partly inland to the lakes, but few streams flow above the surface except after rain. At Jibuti, irom October to March the northeast monsoon brings temperatures of 75° to 85° F., with an average rainfall, mostly between October and December, of 3.76 in. April and September are calm, hot and humid, and irom May to August the southwest monsoon blows with average temperatures of 85° to 99° F., often reaching 113° or more in July. The southwest monsoon is complicated by dust-laden khamsin winds from the northwest, and average rainiall is 0.9 in. between April and September.

The People.—Outside Jibuti most of the people are transhumant stock herders, many passing through the country from British Somaliland to Ethiopia and back, seasonally. In 1954 the population was estimated at 63,734, including 28,000 Somalis of the "black" Isa tribe, 25,000 Danakils, 6,000 Arabs on the coast and 3,132 Europeans, two-thirds of them French. The people are Moslems, but there are Roman Catholic schools at Jibuti and Ali Sabieh, as well as secular government schools, a hospital in Jibuti, dispensaries in other centres and a hygiene department. Population of Jibuti (1954 est.) was 31,000.

History.— The original Galla population, conquered by Ethiopia in the 14th century, were invaded from Arabia by the forbears of the Danakil, who fought the Ethiopians until 1530 when their leader Mohammed Grañ died. A further wave of Arab invasion south of the Gulf of Tajura gave rise to the Isa Somali there, and for a short time in the 16th century Portuguese occupied the coast. In 1839, a French naval lieutenant, obtained a concession at Amphala, and in 1840 the British took the Moucha islands in the Gulf of Tajura. Rochet d'Héricourt got a concession of Tajura and made a treaty with the king of Shoa in 1842. In 1858 Henri Lambert, French consul in Aden, made further approaches, and by 1862 Danakil chiefs made a commercial treaty ior the area between Doumeira and Tajura, and the French purchased Obok ior 50,000 ir. This area was occupied in 1881, the Italians occupied Assab to the north in 1882, and an Egyptian agent in Zeila ceded Sagallo to the French. In 1884, the French commandant of the territory signed treaties with the Danakil sultans of Tajura and Gobad, and in 1885 with the Isa Somalis. After some squabbling with Great Britain, and a feint at occupying Sagallo by the Russians, accord was reached and the Franco-British frontier settled in 1888, the French withdrawing their claim to Dongarita (between Zeila and Bulhar), and the British giving up the Moucha islands.

In 1892 the capital was moved from Obok to Jibuti, and plans for a railway to Addis Ababa made in 1896. The Ethiopian boundary was agreed in 1897 and the Eritrean frontier in 1900–01. By 1902 the railway reached Diredawa, and in 1915 Addis, whereupon the territory prospered, exports in 1916 being valued at 51,000,000 fr. as against 39,000,000 ir. worth of imports. Lej Yasu, Moslem former king of Ethiopia, led a Somali rebellion in 1917–18, but was quelled.

In 1940 the territory joined the Vichy French government thereby exposing the British flank and withdrawing the only Allied air support. The British evacuated Somaliland and on their return blockaded Jibuti from 1941 until 1943, when it joined the Free French and again entered the war against Germany, Italy and Japan.

Administration.— After initial periods as a number of trading posts, and more direct rule on the coast after 1890, the country was administered by a governor aided by a local legislative council, partly elected and partly nominated.

In 1957 a new system of government was introduced. A territorial assembly, elected by universal suffrage, thereafter elected an executive council composed of a vice-president and ministers, the governor remaining president. The country was also represented in the metropolitan French parliament and in the assembly oi the French Union.

Economy.— Domestic stock, which forms the livelihood of most of the indigenous population, consisted in 1955 of about 40,000 camels, 40,000 cattle, 200,000 goats and 100,000 sheep and about 1,500 donkeys.

Apart from stock herding, and the production of meat, milk, ghee, hides and skins, the wealth of the country depends on the iree port of Jibuti, and the railway to Addis Ababa. Salt by evaporation of sea water and from Lake Assal is exported. The port of Jibuti has six deep-water quays (10–30 ft.), and is well equipped. The airport has a 2.400 m. runway, and the railway after 60 mi. in French Somaliland continues ior 430 mi. more to Addis Ababa, carrying up to 750,000 metric tons of traffic a year. About 3,500,000 tons gross of shipping use the port annually, exporting salt, coffee, grain, hides and skins, and importing oil and coal for fueling and to provide electric power. In 1949, Jibuti became a iree port, and the Jibuti franc, valued at 1.63 metropolitan francs, was created as freely convertible currency. Exports exceeded imports till 1952 since when adverse trade balances were probably due to the capital development and competitive development of Massawa by the Ethiopians. There was little direct taxation escept 15% on consumer goods.

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SOMBART, WERNER (1863–1941), German economist, author of a widely read history of capitalism, was born at Ermsleben in the Harz on Jan. 19, 1863. He was appointed professor at the University of Berlin in 1917. Sombart's chief work, *Der Moderne Kapitalismus*, first appeared in 1902, and was enlarged and amended in the second edition of 1916. His history of capitalism was brought to a close with the publication of *Hochkapitalismus* in 1928. In Sombart's view the capitalist organization was created by a spirit that generated in the late middle ages; it combines economic rationality with the exclusive direction of economic activity toward maximizing money profits. The most controversial aspect of his study is the role he assigns the Jews as the chief creators of capitalism. He divided the development of capitalism into three stages: early capitalism, from about the 15th to the middle of the 18th century; high capitalism, 1760 to 1914; and late capitalism, the period of disintegration, which began at the close of World War I. In his early career he was a convinced Marxist. Later he rejected Marxism as a program of social reform, but he never ceased to consider himself as Marx's heir in the "scientific!' study of capitalism. His *Deutscher Sozialismus* (1934) is generally considered an apology for German Naziism.

Sombart died on May 19, 1941. (A. L. Hs.)

SOMBOR, a town of Vojvodina, Yugos. Pop. (1953) 26,637. It is in a fertile plain and is a centre of corn and cattle trade.

SOMERS, JOHN SOMERS (or Sommers), **Baron** (1651–1716), English lord chancellor, was born on March 4, 1651, near Worcester, the eldest son of John Somers, an attorney, and of Catherine Ceaverne of Shropshire. Educated at Worcester and at Trinity college, Oxford, he studied law under Sir Francis Winnington, and soon became intimate with the leaders of the country party, especially with Essex, William Russell, and Algernon Sidney, but never entered into their plans so far as to commit himself beyond recall. He was reputed to have written the *Just and Modest Vindication of the Two Last Parliaments*, in answer to Charles II's declaration of his reasons for dissolving them. This, however, was by Sidney, though probably Somers was responsible for the final draft. As counsel for the sheriffs Pilkington and Shute before the court of King's Bench, and junior counsel in the trial of the seven bishops, Somers won a reputation which was further enhanced by the part which he took in the secret councils which preceded the revolution. Elected to the Convention parliament, he was appointed one of the managers for the Commons in the conferences between the houses, and was further distinguished by being made chairman of the committee which drew up the Declaration of Right.

In May 1689 Somers was made solicitor-general and knighted, and he now became William III's confidential adviser. In the controversy which arose between the houses on the question of the legality of the decision of the court of King's Bench regarding Titus Oates, and of the action of the Lords in sustaining this decision, Somers was again the leading manager for the Commons, and has left a clear and interesting account of the debates. He was appointed chairman of the select committee of the House of Commons on the Corporation Bill (1690), by which those corporations which had surrendered their charters to the Crown during the last two reigns were restored to their rights. On March 23, 1693, the great seal having meanwhile been in commission, Somers was appointed lord-keeper and a privy councillor. Somers now became the most prominent member of the Junto, the small council which comprised the chief members of the Whig party. When William left in May 1695 to take command of the army in the Netherlands, Somers was made one of the seven lords-justices to whom the administration of the kingdom during his absence was entrusted; and he was instrumental in bringing about a reconciliation between William and the princess Anne.

In April 1697 Somers became lord chancellor, and was created a peer by the title of Baron Somers of Evesham. Somers had been free from attack at the hands of political opponents; but his connection in 1699 with Captain William Kidd, to the cost of whose expedition Somers had given £1,000, afforded an opportunity for a vote of censure, in the House of Commons which was rejected by 199 to 131. The attack was renewed shortly on the ground of his having accepted grants of Crown property to the amount of £1,600 a year, but was again defeated. On the subject of the Irish forfeitures a third attack was made in 1700, a motion being brought forward to request the king to remove Somers from his counsels; but this again was rejected by a large majority. In consequence, however, of the incessant agitation Somers was finally compelled to resign. In 1701 he was impeached by the Commons for his share in the negotiations relating to the Partition Treaty in 1698, and defended himself most ably before the house, answering the charges seriatim. The impeachment was voted and sent up to the Lords, but was there dismissed. On the death of the king Somers retired into private life, but he actively opposed the Occasional Conformity Bill (1702), and in 1706 was one of the managers of the union with Scotland. In the same year he carried a bill regulating and improving the proceedings of the law courts. He was made president of the council in 1708 upon the return of the Whigs to power, and retained the office until their downfall in 1710. He was also president of the Royal Society from 1699–1704. He died on April 26, 1716. Somers wrote *The History of the Succession of the Crown of England,* as well as several poems and pamphlets

For a contemporary character of Somers Addison's paper in the *Freeholder* for the 14th of May 1716 should be referred to; and there is in Macaulay's History (iv. 53) an eloquent tribute to his character and comprehensive learning. A catalogue of his publications will be found in Walpole's Royal and *Noble Authors.*

SOMERSET, EARLS AND DUKES OF. In the 11th century Somerset and Dorset were under the jurisdiction of one sheriff, and for a considerable period titles derived from each of these shires were borne by the same person. (See DORSET, EARLS, MARQUESSES AND DUKES OF.)

The earldom of Somerset in the Beaufort family dated from 1397, in which year it was granted by Richard II. to JOHN BEAUFORT (*c.* 1373–1410), the eldest of the three illegitimate, but afterwards legitimated, sons of John of Gaunt, duke of Lancaster, by Catherine, wife of Sir Hugh Swynford, and daughter of Sir Payne Roelt. He was followed in the earldom successively by his three sons: Henry, who died unmarried in 1418; John (1404–1444), who in 1443 was created earl of Kendal and duke of Somerset, both of which titles became extinct at his death; and Edmund, who was created earl of Dorset in 1441, marquess of Dorset in 1443, and duke of Somerset in 1448 (*See* SOMERSET, EDMUND BEAUFORT, DUKE OF.) On the execution of Edmund's son Henry, 5th earl and 2nd duke of Somerset, by the Yorkists in 1464, his titles were forfeited by act of parliament; but his brother Edmund was from that date styled duke of Somerset by the Lancastrian party till his death in May 1471, when the house of Beaufort became extinct (See BEAUFORT) The title. conjoined with the dukedom of Richmond, was, however, borne by Henry Fitzroy, illegitimate son of Henry VIII., from 1525 till his death without heirs in 1536.

EDWARD SEYMOUR, duke of Somerset (*q.v.*), known as the Protector, was the first of the line of dukes to which the holder of the title at the present day belongs, having been created Viscount Beauchamp of Hache, Co. Somerset, in 1536; earl of Hertford in 1537; and in 1547 Baron Seymour and duke of Somerset. His honours, which were entailed on the issue of his second in priority to that of his first marriage, being forfeited by attainder in 1552, Robert Carr became earl of Somerset (q v) in 1613, but died without male issue in 1645, when his title became extinct. A curious incident in the history of this title was the grant by Charles I. in 1644 of a commission to Edward Somerset, son of Henry, 1st marquess of Worcester, empowering him to fill up certain blank patents of peerage with a promise of the title of duke of Somerset for himself. After the Restoration this instrument was cancelled in consequence of a resolution of the House of Lords declaring it to be "in prejudice to the peers"; and the grantee, who had meantime succeeded to the marquessate of Worcester, surrendered his claim to the dukedom of Somerset in Sept. 1660. In the same month the dukedom of Somerset and barony of Seymour were restored to WILLIAM SEYMOUR (1588–1660), great-grandson of the I'rotector, who in 1621 inherited the titles of earl of Hertford and Baron Beauchamp which had been granted to his grandfather Edward Seymour in 1559, and who, in 1640, had himself been created marquis of Hertford. He died in Nov. 1660, a few weeks after his restoration to the dukedom, and was succeeded by his grandson William, 3rd duke of Somerset (c. 1651–1671). As the latter died unmarried, the Ssmerset title devolved on John Seymour (c. 1628–1675), the 2nd duke's fifth and youngest son, at whose death without issue in 1675 the marquessate of Hertford became extinct; his cousin Francis Seymour (1658–1678) becoming jth duke of Somerset.

CHARLES SEYMOUR, 6th duke of Somerset (1662–1748), who succeeded his brother Francis, the 5th duke, was educated at Trinity college, Cambridge; and in 1682 he married Elizabeth, daughter of Joceline Percy, earl of Northumberland, who brought him immense estates, including Alnwick castle, Petworth, Syon House and Northumberland House in London. (See NORTHUMBERLAND, EARLS AND DUKES OF.) In 1683 Somerset received an appointment in the king's household, and two years later a colonelcy of dragoons; but at the revolution he bore arms for the prince of Orange. He became a great favourite with Queen Anne, receiving the post of master of the horse in 1702. He made friends with the Tories, and succeeded in retaining the queen's confidence, while his wife replaced the duchess of Marlborough as mistress of the robes in 1711. In the memorable crisis when Anne was at the point of death, Somerset acted with Argyll, Shrewsbury and other Whig nobles who. by insisting on their right to be present in the privy council, secured the Hanoverian succession to the Crown. Dismissed from his office of master of the horse in 1716, he retired into private life, and died at Petworth on Dec. 2, 1748. At the death of his son ALGERNON (1684–1750), 7th duke, without male issue, the earldom of Hertford, and the baronies of Beauchamp and of Seymour of Trowbridge became extinct; and the dukedom of Somerset, together with the barony of Seymour, devolved on a distant cousin, Sir Edward Seymour, 6th baronet of Berry Pomeroy, Devonshire. (*See* SEYMOUR or ST. MAUR.)

The Seymours of Berry Pomeroy were the elder branch of the family, being descended from the protector Somerset by his first marriage, the issue of which had been excluded from succession to the titles and estates until after the failure of the issue of his second marriage. (*See* above.) SIR EDWARD SEYMOUR (1695–1757), who thus became 8th duke of Somerset, was grandson of Sir Edmund Seymour, Speaker of the House of Commons in the reign of Charles II. EDWARD ADOLPHUS, 12th duke (1804–1885), held various offices in Lord Melbourne's administration from 1835 to 1841; was a member of Lord John Russell's cabinet in 1851; and first lord of the admiralty from 1859 to 1866. In 1863 he was created Earl St. Maur of Berry Pomeroy. He married (1830) Jane Georgiana, youngest of the three celebrated daughters of Thomas Sheridan, who was the "Queen of Beauty" at the famous Eglinton Tournament in 1839. The duke was the author of *Christian Theology and Modern Scepticism* (1872), and *Monarchy and Democracy* (1880). At his death the family titles, except the earldom of St. Maur, which became extinct, devolved on his two brothers successively.

See SEYMOUR OR ST. MAUR.

SOMERSET, EDMUND BEAUFORT, DUKE OF (c. 1404–1455), was the younger son of John, earl of Somerset, and grandson of John of Gaunt, duke of Lancaster He was taken prisoner at Baugé in 1421 during his first campaign, and did not return to England till 1431. He was then styled earl of Mortain, and in 1432 was one of the envoys to the council of Basel. In 1436 he served at the relief of Calais, two years later he commanded with some success in Maine, and in 1440 recovered Harfleur. Next year he was made earl, and in 1443 marquess of Dorset. In 1444 on the death of his elder brother he became duke of Somerset. As head of the Beaufort party he was the rival of Richard of York, whom in 1447 he superseded as lieutenant of France. Me lacked statesmanship, and as a general could do nothing to stop French successes. The loss of Rouen and Normandy during the next four years was precipitated by his incompetence. and his failure made him a special object of Yorkist censure. The fall of Suffolk left Somerset the chief of the king's ministers. and the Commons in vain petitioned for his removal in January 1451. In spite of York's active hostility he maintained his position till Henry's illness brought his rival the protectorate in March 1454. For a pear he was kept a prisoner in the Tower "without any lawful process." On the king's recovery he was honourably discharged. and restored to his office as captain of Calais. Mistrust of Somerset was York's excuse for taking up arms. The rivalry of the tno leaders was ended by the defeat of the Lancastrians and death of Somerset at St. Albans on May 22, 1455.

For further information *see* Sir James Ramsay, *Lancaster and York* (Oxford, 1892); C. Oman, *Political History of England, 1377–1485* (1906), with authorities there cited. (C. L. K.)

SOMERSET, EDWARD SEYMOUR, 1ST DUKE OF (*c.* 1500–1552), was protector of England in the reign of Edward VI. Born about 1j00, he was the eldest surviving son of Sir John Seymour (d. 1536) of Wolf hall, Wiltshire. The Seymours claimed descent from a companion of William the Conqueror, who took his name from St. Maur-sur-Loire in Touraine; and the protector's mother was descended from Edward III. Edward was page of honour to Mary Tudor at her marriage mith Louis XII in 1514, served in the duke of Suffolk's campaign in France in 1523 and accompanied Cardinal Wolsey on his embassy to France in 1527. Henry VIII, to whom he became (1530) squire of the body, married his sister Jane in 1536. and Edward was created Viscount Beauchamp. and. after the birth of Edward VI. earl of Hertford.

In 1541, during Henry's absence in the north, Hertford, Thomas Cranmer and Baron Audley had the chief management of affairs in London; in Sept. 1542 Hertford was appointed warden of the Scottish marches, and in December lord high admiral. a post which he almost immediately relinquished in favour of John Dudley, Viscount Lisle. later earl of Warwick and duke of Northumberland (*q.v.*). In Feb. 1544 Hertford was made lieutenant general in the north and instructed to punish the Scots for their repudiation of the treaty of marriage between Prince Edward and the infanr Mary Queen of Scots. He landed at Leith in May, captured and pillaged Edinburgh. and returned a month later. He then served at Boulogne, returning to Scotland in Sept. 1545 to avenge the Scottish victory at Xncrum moor. In March 1546 he was sent to Boulogne to supersede Henry Howard, earl of Surrey (*q.v.*); and from October to the end of Henry's reign he 1%-asin attendance on the king, engaged in that unrecorded struggle for predominance which was to determine the complexion of the government during the coming minority. Personal, political and religious rivalry separated him and Lisle from the Howards, and Surrey's attempt to secure the predominance of his family led to his own execution and his father's imprisonment.

Their overthrow had barely been accomplished when Henry VIII died. He had had no statutory power to appoint a protector, but in the council of regency which he nominated, Hertford and Lisle enjoyed a decisive preponderance; and the council determined to follow precedent and appoint a protector. They chose Hertford (now duke of Somerset), and he quickly emancipated himself from the trammels originally imposed on him; he was king in everything but name. He used his authority to divest the government of the apparatus of absolution perfected by Thomas Cromwell. In his first parliament, which met in Nov. 1547, he procured the repeal of all the heresy laws and nearly all the treason laws passed since Edward III. In foreign affairs, also, he at first adopted a more liberal policy. He had protested against his instruction in 1544, and now dropped the claim to suzerainty over Scotland which Henry VIII had revived. He sought to win over the Scots by promises of autonomy, free trade and equal privileges with England. But Scottish sentiment, backed by Roman Catholic influence and by French intrigues, money and men. proved too strong for Somerset's amiable invitations. The Scots turned a deaf ear to his persuasions ; the protector led another army into Scotland in Sept. 1547 and won the battle of Pinkie (Sept. 10).

Somerset apparently thought that the religious question could be settled. by public discussion and throughout 1547 and 1548 England went as it pleased so far as church services were concerned. All sorts of experiments were tried and the country was involved in a grand theological debate. in which Protestant refugees from abroad hastened to join. The result convinced the protector that the government must prescribe one uniform order which all should be persuaded or constrained to obey; but the first Book of Common Prayer, which was imposed by the first Act of Uniformity in 1549, was a studious compromise between the new and the old learning. very different from the Protestantism of the second book imposed in 1552 after Somerset had been removed. The Catholic risings in the west in 1549 added to Somerset's difficulties. but were not the cause of his fall. The factious and treasonable conduct of his brother 'Thomas Seymour (*q.v.*), lord high admiral, in whose execution (March 20. 1549) he weakly acquiesced. also impaired his authority. But the main cause of his ruin was the divergence between him and the majority of the council over the questions of constitutional liberty and enclosures of the commons. His efforts to check enclosures were foiled, and the popular revolts which resulted from their failure weakened his position. He was divided in mind between his sympathy with the rebels and his duty to maintain law and order. France seized the opportunity to declare war on Aug. 8; and the outlying forts in the Roulonnais fell into their hands, while the Scots captured Haddington.

These misfortunes gave a handle to Somerset's enemies. Warwick combined on the same temporary platform Catholics who resented the Book of Common Prayer. Protestants who thought Somerset's mildness paltering with God's truth and the wealthy classes as a whole. In September he concerted measures with the former lord chancellor R'riothrsley; and in October, after a vain effort to rouse the masses in his favour, Somerset was deprived of the protectorate and sent to the Tower. But the hostile coalition broke up as soon as it had to frame a constructive policy. Warwick jockeyed the Catholics out of the council and prepared to advance along Protestant lines. He could hardly combine proscription of the Catholics with that of Somerset. and the duke was released in Feb. 1550. For a time the rivals seemed to agree. and Warwick's son married Somerset's daughter. But growing discontent with Warwick made Somerset too dangerous. In Oct. 1551, after Warwick had been created duke of Northumberland. Somerset was sent to the Tower on an exaggerated charge of treason, which broke down at his trial. He was. however. as a sort of compromise, condemned on a charge of felony for having sought to effect a change of government. Few expected that the sentence would be carried out, and apparently Northumberland found it necessary to forge an instruction from Edward VI to that effect. Somerset was executed on Jan. 22, 1552, dying mith exemplary patience and fortitude.

See A. F. Pollard, *England Under Protector Somerset* (London, 1900), also his article in the *Dictioaary of National Biography* and vol. vi of *Political History of England* (London, 1910). (A. F. Po.; R. B. WM.)

SOMERSET, ISABELLA CAROLINE (LADY HENRY SOMERSET) (1851–1921), English philanthropist, was born in London on Aug. 3, 1851, the eldest daughter and coheiress of the 3rd and last Earl Somers. She married in 1873 Lord Henry Somerset. son of the 8th duke of Beaufort. from whom sbe later separated. She was long president of the Nationai British Women's Temperance association. In 1894 she founded the *Woman's Signal* in the interests of women's work, becoming its editor. She died in London on March 12, 1921.

See Kathleen Fitzpatrick, *Lady Henry Somerset; a Memoir* (1923).

SOMERSET, ROBERT CARR (or KER), EARL OF (c. 1590–1645), Scottish politician, youngest son of Sir Thomas Ker of Ferniehurst by his second wife, Janet, sister of Sir Walter Scott of Buccleuch. He may have accompanied James I as page to England, but his early history is obscure. In Dec. 1607 he was knighted and made a gentleman of the bedchamber and thereafter rose rapidly in royal favour. Entirely devoid of all high intellectual qualities. Carr was endowed with good looks. excellent spirits and considerable personal accomplishments. These advantages were sufficient for James. In 1609 the king conferred on Carr Sir

Walter Raleigh's forfeited manor of Sherborne. Carr's influence was already such that in 1610–11 he persuaded the king to dissolve his first parliament. which had shown signs of attacking the Scottish favourites. On March 2j, 1611, he was created Viscount Rochester, and subsequently a privy councilor (April 1612), and on Lord Salisbury's death in 1612 he began in July to act as the king's secretary. On Nov. 3, 1613, he was advanced to the earldom of Somerset, in December was appointed treasurer of Scotland, and in 1614 lord chamberlain. Somerset fell from favour in 161j, when the circumstances of the murder of Sir Thomas Overbury in 1613 were disclosed, and he and his wife. who had secured a divorce from the earl of Essex to marry him, were implicated. For this story *see* SIR THOMAS OVERBURY. Possibly Somerset was no more than an accessory after the event. He was pardoned in 1624, and from that time disappears from history. He died in July 1645.

See the article *by* S. R. Gardiner in the *Dictionary of National Biography,* with authorities there cited; G. E. Cokayne, *Complete Peerage,* xii (London, 1953). (R. B. WM)

SOMERSET, a southwestern county of England. bounded north by the Bristol channel, the Avon river and Gloucestershire, east by Wiltshire, south and west by Dorset and Devon. The geographical area is 1.613 sq.mi. with a population (1951) of 551,453.

Physical Features.— The county consists of a basin surrounded on three sides by hills and limited on the fourth by the sea. The northern hills are the Mendips, composed of Carboniferous Limestone, stretching from Nunney to the sea and appearing again in the islands of Steep Holm and Flat Holm, which link the structure of Somerset with that of south Wales. The summit of the Mendips is a long tableland between 500 and 1,000 ft. in height, but rising in the west to just over the latter figure. To the north they die away gently, as a number of low hills. toward the Avon. There the Limestone is covered in places by Coal Measures, but most of the rocks are Triassic. Southward the Mendip hills drop steeply in an abrupt line broken by many coombes; *e.g.,* the gorge of Cheddar. The basin to the south is composed mainly of Triassic rocks, which, near the sea and along the valleys, are covered by recent alluvium. The basin is usually lower in its western than in its eastern part, which is known generally as Sedgemoor, but has different names in different parts. The large basin is subdivided into those of the Parrett and the Brue by the Polden hills, which run parallel to the Mendips from Lydford to Puriton. To the west of the Parrett rise the Quantock hills, which are outliers of the Devonian moorlands of Exmoor and the Brendon hills. These three hill groups consist almost entirely of Devonian rocks, and their highest points respectively are Will's Neck (1,261 ft.), Dunkery beacon (1,707 ft.) and Lype hill (1,391 ft.). Exmoor (*q.v.*) forest covers the western extremity of Somerset and a large tract of Devon adjoining it. From Crewkerne along the southern and eastern borders of the county as far as the Avon runs a more or less continuous line of low Jurassic hills, while around Chard in the south there is a fair extent of Cretaceous rocks.

History.— In early postglacial times the lowlands were morasses and the claylands forested, and so man, when he came to the district, settled on the open heights—the sterile old rocks of the west, the chalk of the south. the limestone of the Mendips and the oolites on the east—and the caves of Mendip have yielded valuable evidence of early prehistoric cultures. In the Mendips are the Cheddar caves and Wookey hole. Investigations indicated the existence of Mesolithic sites on the moors and in the western hills. Excavations of tumuli and hilltop earthworks produced evidence of occupation during the Bronze and early Iron Ages, but the most remarkable settlement of the pre-Roman period was that of the lake-village at Glastonbury (*q.v.*).

The Romans overran Somerset after the Claudian conquest of A.D. 43, and remains of the period of the Roman occupation are numerous, particularly between the Parrett and the Avon. Bath (Aquae Sulis), which was .probably a settlement in earlier times, became, on account of the medicinal properties of its waters, an important Roman centre where the Fosse way from Cirencester met another road from Silchester. The Fosse way was continued from Bath to near Seaton, Devon, and on it was a station at Ilchester *(Lendiniae?),* where it crossed the Yeo. Remains of about 50 Roman villas or related structures mere discovered in the county. Charterhouse in the Mendips was a centre of the Roman lead-mining industry. In the 6th century Somerset mas the debatable borderland between the Welsh and Saxons, the latter of whom pushed their way slowly westward. By 658 it had been conquered by the West Saxons as far as the Parrett, and there followed a struggle between the kingdoms of Wessex and Mercia, which led to the organization of the lands east of the Parrett as part of the kingdom of Wessex. About this time the monastery of Glastonbury was restored by Ine who completed the conquest of West Somerset. In the 7th century Somerset, as part of the kingdom of Wessex. was included in the diocese of Winchester. The new bishopric of Sherborne, founded in 705, contained the county until 909, when the see was divided into the dioceses of Salisbury, Exeter and Wells, the latter including the whole of Somerset. The diocese was divided into three archdeaconries. Disputes later between the chapters of Bath and Wells as to the election of the bishop led to a compromise in 1245, the election being by the chapters jointly, and the see being known as the bishopric of Bath and Wells.

King Alfred's victory in 878. folloued by the Peace of Wedmore, ended the incursions of the Danes for a time. but 100 years later they were again a great danger, and made frequent raids on the west coast of Somerset. At the Conquest Somerset nas divided into about 700 fiefs, held almost entirely by the Normans; the king's lands were of great extent and importance and the bishop of Winchester owned a vast property of which Taunton was the centre In the 11th century or a little later many Norman castles were built some of which have survived.

The chief families of the county in the middle ages were those of De Mohun, Malet, Revel, De Courcy. Montacute, Beauchamp and Beaufort, who bore the titles of earls or dukes of Somerset from 1396 to 1472. Eduard Seymour was made duke of Somerset in 1547, and in 1660 the title aas restored to the Seymour family, by whom it was still held in modern times. The marquess of Bath is the male representative of the Thynne family, which has long been settled in the county.

Somerset was too distant and isolated to take much share in the early baronial rebellions or the Wars of the Roses. and was really without political history until the end of the middle ages. The attempt of Perkin Warbeck in 1497 received some support, and in 1547 and 1549 there were rebellions against enclosures. Somerset took a considerable part in the Civil War. and with the exception of Taunton uas royalist. the strongholds being garrisoned and held for the king, but they all fell in 1645, and the county was subdued by the parliamentary forces. It nas the theatre of Monmouth's rebellion, and he was proclaimed king at Taunton in 1685. The battle of Sedgemoor on July 6 was followed in the autumn by the "bloody assizes" held by Judge George Jeffreys, in Taunton castle and at Wells.

The county was represented in the parliament of 1290; in 1295 it was represented by two knights, and 12 boroughs returned two burgesses each. It continued to return two members until 1832, when it was divided into Somerset East and Somerset West, each division returning two members. Two additional members were returned after 1867 for a third—the Mid-Somerset—division, until by the act of 1885 the whole county was divided into seven.

Antiquities.— In addition to the numerous prehistoric sites throughout the county, the remains of a unique Roman bathing station are to be seen at Bath. The county museum at Taunton exhibits the results of excavations in all parts of Somerset and particularly the mosaic pavement from the Roman villa at Low Ham.

Examples of medieval ecclesiastical architecture include the cathedral church of Wells, Bath abbey and the ruins of Glastonbury abbey, but Somerset's greatest wealth lies in its parish churches. Of these some have Norman and Early English features, but the most interesting especially for their magnificent towers, are those in the Perpendicular style. of nhich the outstanding examples are at Taunton, Glastonbury, Huish Episcopi, Leigh on Mendip and Kingsbury. Dunster castle, which dates from 1070, has been in the Luttrell family since 1376. Fine examples of domestic architecture of the medieval and Tudor periods are at Lytes Cary, Meare, Martock, Montacute, Barrington and Brympton; the imposing 18th-century architecture of Bath found echoes in simpler but attractive work in other towns in the county.

Agriculture, Industries and Communications. — Somerset has always been an agricultural county. Grain was grown and exported from the 11th to the end of the 18th century. Cider-making has been going on for centuries, and Cheddar gave its name to a famous cheese. Sheep farming was largely carried on after the period of enclosures and the woolen cloth trade flourished in Frome, Bath, Bridgwater, Taunton and many other towns from the 14th to the 19th century.

Somerset is the leading dairying county of England. Permanent grassland predominated in the mid-1950s (554,105 ac. in 1955), especially on the lower grounds, but there are areas where arable farming reaches a very high standard. Market gardening and fruitgrowing flourish in certain favourable districts. Stock raising is mainly concentrated on the hills, Exmoor, the Brendons and Quantocks being known for their calves raised for beef. Sheep breeding is similarly concentrated mainly in the west. On the flat moors of central Somerset more than 1,000 ac. are devoted to withy-growing for the manufacture of baskets, etc. The Forestry commission owned 7,611 ac. of land in Somerset and the National trust (1955) 15,892 ac.; Exmoor became a national park in 1954. Wild deer are still found on Exmoor and the Quantocks and a peculiar breed of ponies, hardy and small. Whitefish, shellfish, salmon and herring are caught in the Bristol channel and Bridgwater bay, part of which is protected for birds. Steep Holm is a native reserve containing rare birds and plants, notably the wild peony. Sharpham moor and Stert Island are also native reserves.

The chief mineral product is limestone from the Mendips. Peat is found in the Glastonbury area, clay (for brickmaking) near Bridgwater and fuller's earth near Bath. There is coal mining in the Radstock area.

Traditional manufactures include gloves at Yeovil and Wincanton, lace at Chard, linen at Crewkerne and silk at Taunton and Shepton Mallet. Many new industries were introduced—shoes at Street, shirts at Taunton, potash at Portishead and cellulose film at Bridgwater.

The holiday and tourist industry is economically important, not only at the seaside towns such as Weston-super-Mare, Burnham-on-Sea and Mir-head, but also inland at Cheddar, Wells, Taunton, on the Quantocks and on Exmoor.

Population and Administration. — The area of the administrative county is 1,603 sq.mi. with a population (1951) of 472,159. The municipal boroughs are Bath, a city and county borough (pop 1951, 79,294); Bridgwater (22,202); Chard (5,219); Taunton, the county town (33,620); Wells, a city (5,833); Weston-super-Mare (40,396); and Yeovil (23,337). There are 13 urban and 16 rural districts. Besides the county borough of Bath there are six parliamentary divisions, each returning one member; the county includes part of the parliamentary borough of Bristol.

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SOMERVELL, BREHON BURKE (1892–1955), U.S. army officer, supply chief during World War II, was born in Little Rock, Ark., May 9, 1892. Graduating from the U.S. Military academy in 1914, he served overseas during and after World War I, winning decorations for combat bravery and administrative ability. During the 1920s Somervell was associated with Walker D. Hines in preparing plans for international use of the Rhine and the Danube, and in 1933–34 he participated in an economic survey of Turkey. Later he acted as federal Works Projects administrator in New York city (1936–40), chief of army construction (1940–41), assistant chief of staff for supply (1941–42) and commanding general of the army service forces (1942–46). He retired in May 1946 and died in Ocala, Fla., Feb. 13, 1955.

As army administrator for supply and service activities, Somervell was known for his energy and drive. He was both praised and criticized for getting work done quickly, at some extra cost and regardless of various interests involved. He held that war conditions demanded action, not extensive consultation and deliberation. Somervell was a strong advocate of military responsibility for the procurement and distribution of military supplies, and of a unified command within the army and the armed forces for handling military supply and service operations.

(J. D. MT.)

SOMERVILE, WILLIAM (1675–1742), English poet. A Warwickshire squire, he showed (in Samuel Johnson's words) "that it is practicable to be at once a skilful sportsman and a man of letters." *The Chase* (1735), a "georgic" in four books, offers sound advice on hunting and the breeding of hounds in blank verse with Miltonic rhythms which give way to a more staccato line at the excitement of a check in the hunt. *Hobbinol, or the Rural Games* (1740), a burlesque, and *Field* Sports (1742), both in blank verse, are less successful. (J. E. BT.)

SOMERVILLE, a city of Middlesex county, Mass., U.S.. on the Mystic river, is surrounded by Boston (Charlestown), Cambridge, Arlington and Medford. The last of the Mystic valley towns to separate from the early Charlestown colony, it was originally known as the Cow Commons and was entirely fenced in until 1685. In the city stands the Old Powder House, from which British Gen. Thomas Gage seized 250 half-barrels of gunpowder in 1774. In 1775 it became the magazine of the American forces besieging Boston. After the American Revolution brick-making grew to be an important industry and the opening of the Middlesex canal (1803) which passed through Somerville added to its desirability as an industrial site. It was incorporated as a town in 1842 and became a city in 1871.

The greatest growth in population and industrial activity occurred aiter 1900, when slaughtering and packing became the principal industries. By mid-20th century Somerville had become a working and middle-class residential suburb of Boston with substantial industrial development and importance as a distribution centre. Pop. (1960) 94.69'7; for comparative population figures *see* table in MASSACHUSETTS: *Population.* (L. G. BA.)

SOMERVILLE, a borough of north central New Jersey, U.S., on the Raritan river, is located 36 mi. S.W. of New York city; the seat of Somerset county. It is a retail-trade centre for a large area of farms, manufacturing plants and housing developments. First settled in the late 17th century by farmers, it became the county seat when the county was established in 1783. It mas incorporated as a town in 1863 and as a borough in 1909. In the 1750s Rev. John Frelinghuysen founded the first seminary of the Dutch Reformed Church in America. From these humble origins came Queen's college, chartered in 1766 and now Rutgers university. the state university of New Jersey *(see* NEW JERSEY: *Education);* and the New Brunswick Theological seminary. The Old Dutch parsonage, where Frelinghuysen lived, is open to the public, as is the Wallace house, used as headquarters by George Washington while his troops were quartered at Camp Middlebrook. The Duke estate, established in 1893 by James B. Duke, the tobacco magnate, is a research and exhibition centre for the New York Horticultural society. For comparative population figures *see* table in NEW JERSEY: *Population.* (E. R. D.)

SOMME, a *département* of France formed in 1790 of a large part of the province of Picardy (comprising Vermandois, Santerre, Amiénois, Ponthieu, Vimeu and Marquenterre) and a small portion of Artois. Pop. (1954) 464,153. Area, 2,424 sq.mi. It is bounded on the north by Pas-de-Calais, east by Aisne, south by Oise and southwest by Seine-Maritime, and its seacoast extends 28 mi. along the English channel. Two streams flowing into the channel — the Authie on the north and the Bresle on the southwest — bound it in these directions. The department is part of the chalk plateau of northwest France, cut by the English channel on the west with the result that it is seamed by well-marked valleys showing a succession of terraces which have become classical ground for the student of geology and of paleolithic man. On the plateau, which rises to about 700 ft. where it approaches the Pays de Bray in the southwest, there are large stretches of *limon,* a fine-grained, porous, fertile material. The Somme is a historic zone of defense of Paris, and the whole district east of Amiens bears the traces of much fighting during World Wars I and II. The river Somme has been made navigable by canalization of stretches. It also supplies considerable power. From Abbeville to the sea its canalized course can take ships of considerable size. From the mouth of the Authie to the Bay of the Somme the coast is lined with sand dunes about 2 mi. broad, behind which is the Marquenterre, a tract of 50,000 ac. reclaimed from the sea by dykes, and traversed by drainage canals. The Bay of the Somme, obstructed by dangerous sandbanks, contains the fishing ports of Le Crotoy, St. Valery, also the chief commercial port, and Le Hourdel. Next come the shingle banks, behind which the low fields of Cayeux (25,000 ac.) have been reclaimed; and then at the hamlet of Ault begin the chalk cliffs, which continue into Normandy. Near Amiens the Somme is joined by the Ancre, the Avre and the Selle. The Bresle is a small river south of the Somme, reaching the sea at Tréport.

The *département*, especially in the northeast, is one of the best cultivated in France. Beetroot for sugar is the staple crop of the Péronne *arrondissement;* cereals, chiefly wheat and barley, sugar beet, fodder and mangel-wurzels, oil plants, colza, flax, hemp and potatoes are grown throughout the *département*. Stock raising of all kinds is successful. The chief towns are Amiens (the capital), Abbeville, Montdidier, Péronne, Doullens, St. Riquier, Crécy and Ham. Albert (pop. [1954] 8,793) is a centre for machine construction; Villers-Bretonneux (3,326), a centre of hosiery manufacture; Corbie was once celebrated for its Benedictine abbey (founded in the 7th century) the church of which (16th–18th century) is still to be seen, though now ruined.

Folleville has a church (15th century) containing the Renaissance tomb of Raoul de Lannoy; Picquigny has the remains of a château of the 14th, 15th and 16th centuries, once one of the chief strongholds of Picardy; Rue has a 15th century chapel; and Tilloloy a Renaissance church.

SOMME, BATTLES OF THE, 1916. This series of battles, or, more strictly, succession of limited engagements, constituted the offensive campaign of the Franco-British armies in 1916. Into it was thrown the entire British effort of the year on the Western Front and such part of the French effort as was available after the exhausting strain of the long defensive "battle" at Verdun *(see* VERDUN, BATTLES *OF)*. The genesis of the Somme offensive is dealt with under WORLD WAR I.

The original intention had been that the French should play the larger part in the attack, but as they were drained of their strength at Verdun so did their share of the Somme plan evaporate. Eventually their front of attack on the Somme shrank from 25 miles to eight and their force from an intended 40 divisions to 16, of which only five assaulted on July 1. From now onward the British were to take up the major burden of the Western Front campaign, and this alone invests the attack of July 1, 1916 with a special significance. Yet the aims of the British commander-in-chief were not reduced in proportion to his resources. His intention was, in the first place, to break the German front between Maricourt and Serre. Secondly, to secure the high ground between Ginchy and Bapaume while the French seized its continuation past Sailly and Rancourt. Next, to wheel to the left and roll up the German flank as far as Arras, so widening the breach. With this aim all available troops, including the cavalry, would drive northwards from the line Bapaume-Miraumont while a converging attack was launched in co-operation against the German front south-west of Arras. Fourthly was to come a general advance towards Cambrai-Douai. If the Higher Command did not visualise quite so rapid a break-through as had been expected in 1915, the conception was of an advance immeasurably swifter and deeper than came about.

Topography. — To understand both the problem and course of the battle a brief description of the ground is necessary, for in few battles did topography have so far-reaching an influence and make so deep an impression on the minds of the combatants. Between Ham and Arras the river Somme runs first from south to north as far as Péronne and then bends sharply to the west, on its way to the sea. From Péronne a low range of hills runs somewhat to the north of west, forming the watershed between the Somme and the basins of the Scarpe and the Schelde. This ridge had fallen into German hands in Oct. 1914 in the course of the operations usually described as "the race to the sea" and the line in this quarter, indeed on the whole front from Arras southward to the Oise, had remained substantially unaltered during 1915, the chief change being that in July 1915 a British III. Army had been formed which relieved the French between the Ancre and the Somme. Subsequently a IV. Army was also formed, and early in 1916 the British had relieved the French X. Army on the Arras front, making their line continuous from Ypres southward. The right boundary between the British and French had varied considerably and in June 1916 was near Maricourt, about 3,000 yd. north of the Somme. Here the Allied line, which southward of this point ran north and south, turned sharply and following the lower slopes of the watershed already described ran west for another 7,000 yd. to make another sharp turn at Fricourt, whence it ran north to and beyond the Ancre, which pierces the ridge between Thiepval and Beaumont Hamel.

German Positions. — The German positions had become extremely formidable. Their defenders had been in undisturbed possession of the high ground for over a year and a half, and since the British had taken over this part of the front the previous autumn, the application of the usual British policy of aggressive trench-warfare had stirred the Germans to strengthen their defences, to develop artificially the advantage of nature. Woods and villages had become fortresses, two elaborate trench systems had been constructed about two to three miles apart, each containing several lines and connected up by intermediate lines or "switches" which greatly complicated the task of the attacker who should penetrate any part of the front. Deep "dug-outs," easy to construct in a chalk country, protected the trench garrisons against bombardment, broad belts of barbed wire obstructed the approaches, the lines bristled with well-placed and protected machine-guns, and every point of tactical importance had been specially fortified. The advantage of the ground for observation lay with the Germans. Masefield in his book "The Old Front Line" expressed the situation aptly: "Almost in every part of this old front our men had to go uphill to attack. . . . The enemy had the look-out posts, with the fine views over France and the scenes of domination. Our men were down below, with no view of anything but stronghold after stronghold, just up above, being made stronger daily."

For an attack on such positions the most elaborate preparations were necessary, both tactical and administrative. Roads and railways had to be made, vast dumps of ammunition and stores formed, gun positions selected and dug, bivouacking and encamping grounds prepared, the water supply expanded. It was not till the end of June that the offensive could be initiated; and it had been practically impossible to conceal from the Germans the scale and nature of the preparations or the intended extent of the attack. Surprise, difficult in face of such commanding positions, was the more difficult because the art of camouflage and of concealing preparation was still immature. Had not the vast preparations given it away, the fact that the bombardment lasted a week would in any case have announced all but the actual day of the attack.

Dispositions. — The British share of the attack was entrusted to Rawlinson's IV. Army of 17 divisions, of which only two, together with 3 cavalry divisions, were in army reserve. In addition a corps of three divisions and the headquarters of a reserve army — under Gough — were placed in the battle area under the hand of the commander-in-chief. Two divisions of the III. Army were to make a subsidiary attack near Gommecourt. The artillery concentration totalled 1,500 guns, averaging one gun to every 20 yards of front, a record at that time, although far eclipsed later. Rawlinson expressed doubts whether it was sufficient but his suggestion that the frontage should be reduced was not acceptable. The bombardment began on June 24, the attack being originally intended for June 29, but subsequently postponed until July 1. This involved not only spreading out the ammunition over a longer period, but a greater strain on the assaulting troops who, after being keyed up for the effort had to remain another 48 hours in cramped trenches, flooded by a torrential downpour, under the din of the bombardment and the enemy's retaliation.

I. THE FIRST STAGE

July 1, however, dawned dry and with the promise of broiling heat. At 7 A.M. the bombardment rose in intensity and at 7.30 A.M. the British infantry advanced in close-packed waves. These 1916 formations were designed to enable the assaulting infantry to swarm into the opposing trenches as soon as their own guns had lifted. But they exacted a heavier penalty in case of any interval or any insufficiency of the bombardment. And they cramped initiative and hindered the infantry taking sensible advantage of cover—for the infantry were taught to advance at a slow walk in strict alignment. Here the penalty was fully exacted by the stout-hearted and skilful German machine-gunners who, sheltering in dug-outs or shell-holes while the bombardment flattened their trenches, dragged out their weapons and opened fire directly it lifted.

Fricourt, on the right centre, was a turning point not only in the front but in the fortune of the day. All to the north was failure, with the heaviest British loss of any day in the war. On the British left the VIII. Corps attacked from Serre to Beaumont Hamel, but though its centre penetrated some way into the German lines north of Beaumont Hamel the flanks were checked and the central division was finally dislodged. Equal ill-success befell the X. Corps and the left division of the III. Corps to the south, in their attacks on the formidable defences of Thiepval and Ovillers. The right division (the 34th) pressed past La Boisselle to Contalmaison but was forced to fall back, its flank being enfiladed from Ovillers. The next corps, the XV., partially achieved its task of pinching out the bastion of Fricourt village and wood. On its north, next the 34th division, the 21st division gained and held a narrow salient, with both its flanks exposed until Fricourt fell next day. On the other side of Fricourt the 7th division and the XIII. corps (18th and 30th divisions) attacking in a northerly direction were all successful, taking Mametz and Montauban. Beyond them, again, the French astride the Somme fared brilliantly, reaching Hardecourt and Curlu north of the river, while south of it they actually penetrated to and captured six miles of the German second line. They took 6,000 prisoners at little cost.

The Germans had not expected a French attack and were less well prepared on the Fricourt-Montauban front than on the line running north from Fricourt, where both their positions and their fortifications were strongest. The success achieved by the British right and by the French went some way towards compensating for the disastrous failure elsewhere. The Germans could justly claim a victory, for with only six divisions available, and roughly a regiment holding each British division's sector of attack, they had yielded only 1,983 prisoners and a small tract of ground. Yet, although a military failure, July 1 had proved the moral quality of the new armies of Britain who, in making their heaviest sacrifice of the war, came through the ordeal with courage unshaken and fortitude established. These quondam civilians had borne a percentage of loss such as no professional army of the past had been deemed capable of suffering without being incapable of continued action. For five months more they were to continue.

For, on the morrow Haig, realizing the formidable nature of the frontage astride the Ancre, concentrated his attention on exploiting the success of the right—refusing to accede to Joffre's wish for a renewal of the attack on Thiepval. In the course of 10 days of hard fighting in which some six fresh divisions were thrown into the struggle, La Boisselle, Contalmaison and Mametz Wood were cleared and the line was advanced on a front of over six miles to within reach of the enemy's second system of defences on the southern crest of the main ridge.

Second Line of Defence Assaulted.—This system, less strong than that stormed on July 1, was formidable enough and the stubborn resistance of the Germans in their front system and intermediate lines had allowed large reserves of men and guns to be brought up and the defence to be reorganized. If Haig had been unduly ambitious and optimistic before July 14, he now perhaps tended to the other extreme. In contrast the IV. Army command held that in bold and rapid measures lay the only chance to forestall the building of freshly fortified systems in the rear. Rawlinson framed a plan to attack and break the second system on a four-mile front between Delville Wood and Bazentin-le-Petit Wood. His right was still three-quarters of a mile distant. If the obvious course was followed and an attack delivered only on the left, the prospects were barren. For the experience of 1915 had shown that an attack on a narrow frontage might gain an initial success, only to be "blown" out of the captured fragment of ground by the concentration of enemy gun-fire thus facilitated. Rawlinson proposed to cross the intervening and exposed area on the right under cover of darkness and then to attack along the whole frontage at dawn, preceded by a hurricane bombardment of only a few minutes duration.

In 1916 the ideas of a night advance and of such a brief bombardment were so unorthodox as to be a shock and appear a gamble to cautious opinion, especially as it would have to be carried out by troops of the new armies. The commander-in-chief preferred a more limited alternative but Rawlinson persisted, his confidence reinforced by that of the actual troop-leaders in their ability to carry out the night operation. He gained his way, but the debate caused a day's delay which had serious consequences. The attack was delivered by the 9th and 3rd divisions of the XIII. corps on the right and by the 7th and 21st divisions of the XV. corps on the left. Cavalry divisions were brought up close and placed under the two corps commanders.

The hazardous and difficult approach march on the right was successfully carried out and at 3.25 A.M. on July 14, five minutes after the barrage fell, the whole line advanced to the assault. Surprise was achieved, originality vindicated. The whole of the German second system was rapidly overrun. On the right the resistance soon hardened and the 9th division only fought its way with difficulty through Longueval and to the outskirts of Delville Wood. On the left, opportunity—and the open country—stretched out its arms. Soon after midday the German resistance was obviously disintegrating in front of High Wood, and an effort was made to exploit the opportunity. But delay occurred and not until after 6 P.M. did the 7th division move forward afresh, with two squadrons of cavalry working on their flank—the first mounted cavalry seen on a British battlefield since 1914. The second advance, however, was less vigorous than the first and although most of High Wood was cleared, the northern corner and the flanking trenches held out. Worst of all the 24 hours' postponement had enabled fresh German reserves to arrive on the battlefield and as their strength steadily swelled, the German hold tightened, the British relaxed. Late on July 15 the Wood was evacuated under pressure of counter-attacks, and two months were to pass before it was regained. On July 14 the British offensive came within reach of open country and within sight of a strategic decision; thenceforward it degenerated into a campaign of attrition. Two months of hard fighting followed during which the British were unable to make more than very gradual progress at disproportionate cost.

Progress was especially slow on the right, where Ginchy, Guillemont and Falfemont Farm formed a barrier against which many attacks were shattered even after Delville Wood had been won. It was important to extend on this side to get touch with the French who were gaining ground north of the Somme: High Wood in the centre, Pozières on the left, were equal obstacles, and behind Pozières were all the formidable defences of which Thiepval was the centre. Division after division was thrown into the fight, fought desperately, lost heavily and apparently achieved little, though Pozières was taken by the Australians before the end of July. The strain was at last beginning to tell heavily on the Germans: they checked the Allied progress but their resources in men, guns and ammunition were, by Ludendorff's admission, severely taxed and they had to relinquish entirely their attacks on Verdun.

II. THE SECOND AND THIRD STAGES

On Sept. 3 a renewed attack astride the Ancre by the V. Army, formed from troops taken out of Rawlinson's IV army and placed under Gough, was unsuccessful, but the IV army on the right at last mastered Guillemont and in the next few days added Falfemont Farm, Ginchy (Sept. 9), Leuze Wood and Bouleaux Wood to its gains, while the French made substantial progress north of the Somme and gained a big success south of it, taking 7,000 prisoners and storming three mi. of the old German front line as far as Chaulnes. These successes removed the main obstacles to the advance of the British centre, freeing it from the menace of being enfiladed.

Haig thereupon planned a big spring forward for Sept. 15, second only in scale and ambition to July 1. The attack was to pivot on the left wing—Gough's army. The object of the main blow, by Rawlinson's IV army, was to break through the Germans' original last line between Morval and Le Sars, in co-operation with a French thrust to the south between Combles and the Somme—"pinching out" Combles. If the opening success warranted the attempt the attack was to be extended on the left to seize Courcelette and Martinpuich. Eight divisions were deployed for the original attack, and two detailed for the "extension." A special feature was the employment for the first time of tanks (*q.v.*), the armoured cross-country machines which had been invented as an antidote to the defensive obstacle of machine guns and barbed wire. In disregard of the opinions of the tank's progenitors, and of their own expressed agreement with these opinions, the British higher command had decided to utilize such machines as were available, to redeem the fading prospects of the Somme offensive. When this decision was taken only 60 of the initial 150 machines had been transported to France. Forty-nine were actually employed, to work in tiny detachments of two or three machines—another breach of the principles laid down by Colonel Ernest Swinton. The rushed preparation combined with the mechanical defects of these early models to reduce the total so that only 32 reached the starting point. Of these, nine pushed ahead with the infantry, nine failed to catch the infantry but helped in clearing the captured ground, nine broke down and five were "ditched" in the craters of the battlefield. The first nine rendered useful aid, especially in capturing Flers, but the greater prize of a great surprise stroke thus lost was a heavy forfeit to pay for redeeming in a limited degree the failure of the Somme offensive.

The attack was launched at dawn on the 15th in a slight mist, and the XV corps in the centre made early and good progress, and by 10 A.M. its left division was beyond Flers. But on the right the XIV corps lost heavily and was held up long before it could reach Morval and Lesboeufs. The III corps, on the left, also fell short of its objectives, although its 47th division finally cleared the long-sought High Wood. On the extreme left the projected "extension" of the attack was carried out and both Martinpuich and Courcelette were taken. As a result of the day the crest of the ridge had been gained, except on the right, and with it the commanding observation which the Germans had so long enjoyed. A fresh attack on Sept. 25, swept over Morval, Lesboeufs and Gueudecourt and by joining up with the French who had again secured substantial successes both north and south of the Somme, compelled the Germans to evacuate Combles (Sept. 26).

Simultaneously with this success operations were resumed by the V army on the British left and Thiepval was at last taken (Sept. 26). This left the Germans with only the scantiest foothold on the main ridge. Thus by the beginning of October the enemy had been driven back to his last completed line of defenses, which ran from Sailly-Saillisel on the right, past Le Transloy and in front of Bapaume: he was busily engaged on fresh lines further in rear but as yet these were unready. On the other hand, these days had proved the continued strength of the German resistance, and the limited success held out little hope of a real breakthrough or its exploitation. The early onset of the autumn rains daily made this hope more slender. Continuous and heavy rain combined with the effects of the bombardments to make the ground a sea of mud, across which guns and transport could hardly be moved, and even lightly equipped men could only struggle slowly forward. Attacks under such conditions were terribly handicapped; that most of them failed was not remarkable, for when a trench was taken the difficulties of consolidating it were greater than ever. Eaucourt l-Abbaye (Oct. 3) and Le Sars (Oct. 7) were taken, though repeated attacks on the Butte de Warlencourt were foiled by the mud. Eventually the weather improved enough for a renewal of the attack on the left and the last important operation in the Somme offensive took the shape of an attack on Beaumont Hamel by seven divisions on Nov. 13. This proved successful on the right and centre, taking Beaumont Hamel itself, and Beaucourt-sur-Ancre with 7,000 prisoners. On the left, however, Serre again proved impregnable. Before the success could be expanded the return of bad weather again put a stop to active operations which were not resumed on any considerable scale until well after the New Year, just before the carefully planned German retreat to the Hindenburg line. The folly of the third phase was that having at last won the crest of the ridge and its commanding observation, the advantage was thrown away, without adequate prospect of compensation, by fighting a way down into the depression beyond. Thereby the British troops were doomed to spend the winter in flooded trenches, and the battles of the Somme closed in an atmosphere of disappointment and with such a drain on the British forces that the coincident strain on the defense was obscured. For the fighting sometimes known as the second battle of the Somme, *see* ST. QUENTIN, BATTLE OF, 1918.

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SOMNAMBULISM or SLEEPWALKING, the condition under which people walk while asleep, apparently unconscious of external impressions, return to bed, and when they awake have no recollection of any of these occurrences. Sometimes the actions performed are of a complicated character and bear relation to the daily life of the sleeper. Frequently somnambulists have gone along dangerous paths, executing delicate movements with precision. Somnambulists may: (1) speak without acting, common in children and not usually considered somnambulistic; (2) act without speaking, the most common type; (3) act and speak, more exceptional and (4) act, speak and have the senses of touch, sight and hearing. The iourth class merges into hypnotism. It should never be forgotten that somnambulism may he an indication of some disorder requiring careful diagnosis and treatment so as to avoid more dangerous maladies. (*See* HYPNOTISM; PSYCHIATKY.)

SOMNATH (PATAN SOMNATH, SOMNATHA-PATAN), an ancient decayed city on the southern coast of Bombay, India, 103 mi. S. of Rajkot. There stood a famous temple of Siva as Soma-natha, "lord of the soma," a sacred intoxicating plant, and, by extension, "lord of the moon." The temple was sacked and its 9-ft. jeweled linga or phallic emblem broken down by Mahmud of Ghazni in A.D. 1025. The existing temple is fundamentally the second reconstruction of 1169, destroyed in the final Moslem invasions of the late 13th century. The last, sixth, rebuilding was in 1951, when Pres. Rajendra Prasad presided over the reinstallation of the Sivlinga or principal idol. PATAN (pop., 1951, 12,056), a port in Sorath district on the old city site, is now overshadowed by the adjacent port oi Veraval (40,378).

SOMNUS, Sleep, the son of Night and the twin brother of Death, with whom he dwells in the darkness of Hades. In Ovid the home of Sleep is placed in a dark grotto in the land of the Cimmerians, where he dwells surrounded by a band of Dreams.

See Homer, *Iliad*, xiv, 231 to xvi, 672; Hesiod, *Theog.*, 212, 758; Pausanias v, 18, 1.

SOMOV, KONSTANTIN ANDREEVICH (1869–1939), Russian decorative artist, the son of A. I. Somov, director of the Hermitage museum, was born in St. Petersburg on Nov. 18, 1869. He studied under the realist painter Ilya Repin at St. Petersburg Academy (of which he was elected academician in 1913) and in Paris, where he settled after the Revolution. He was a founder member of the group centred round Sergei Diaghilev's review *Mir Iskusstva* ("The World of Art," 1899; *see* DIAGHILEV, SERGEI PAVLOVICH), to which Alexandre Benois and Léon Bakst also contributed. Somov, at first an Impressionist. was later markedly influenced by Aubrey Beardsley and—in his paintings of rainbows, fireworks and Italian comedy scenes—by the French 18th-century painters of *fêtes galantes;* his portraiture (often in coloured crayon) owed something to Ingres. His illustrations included those for his own *Le Livre de la marquise* (1919); Goethe's *Journey in Italy;* and Antoine Prévost's *Manon Lescaut.* He also designed theatrical costumes. He died in Paris, May 6, 1939.

SONANCE: *see* VOICE.

SONATA, in music, originally a piece "played" as opposed to "cantata," a piece sung. By the time of Corelli the term had come to mean a group of instrumental movements. (A movement is a piece of music forming or starting as if to form, a complete musical design.) The sonatas of Corelli are classified as *sonata da chiesa* (church sonata) and *sonata da camera* (chamber sonata). Both kinds were usually for one or two violins with *continuo* bass (*see* CHAMBER MUSIC and INSTRUMENTATION). Handel, when a boy, wrote six for two oboes, and in later years several for flute, and also for one oboe.

The *sonata da chiesa* consists typically of a slow introduction, a loosely fugal allegro, a cantabile slow movement and a lively finale in melodic "binary" form (*see* SONATA FORMS). The *sonata da camera* consists mainly of dance-tunes (*see* SUITE). Bach, who uses neither title, keeps the two kinds unmixed in his six sonatas for violin alone, the first, third and fifth being *sonata da chiesa* and the others *partitas.* A fusion of the two styles persisted in Italian violin music almost to the end of the 18th century.

The sonatas of Domenico Scarlatti (*q.v.*) are small harpsichord pieces, of which the best known are extremely brilliant single movements in binary form. The complete collection of 545, published by Longo, shows that Scarlatti experimented audaciously in remote modulations; that he also wrote some orthodox violin sonatas; and that he sometimes followed a lively movement by a slow cantabile, as Paradies did in his sonatas. Clementi's early sonatas are at their best when they resemble a sober and heavy-handed Scarlatti in a first movement which maintains a uniform rush of rapid motion; and Mozart has left a fine example of the kind in the first movement of his F major violin sonata (K 377).

The main classical sense of the term indicates a work for not more than two instruments, containing at least two, and in the complete scheme, four well-contrasted movements, of which the first and last are on the same tonic, and the others in demonstrably related keys (*see* HARMONY); the forms being those dealt with in the following article. (D. F. T.)

SONATA FORMS, in music. The sonata forms (*see* SONATA above) cover the whole ground of instrumental music from C. P. E. Bach to the advent of Schumann's pianoforte lyrics and Liszt's symphonic poems, and are still living forms. Their rise made Gluck's reform of opera possible; for they represent a general change in the language of music which made it a truly dramatic medium. They comprise the largest and most central problems of pure music; and the outward forms must be studied in constant connection with instrumentation, harmony, melody, counterpoint and rhythm (*qq.v.*).

Elements of Form.—Two types of form are externally common to the true dramatic sonata style and the earlier melodic forms used in the suite (*q.v.*). The terms *binary* and *ternary* have been chosen for these; and, as we shall see, badly chosen. A binary melody falls into two portions, of which the first ends away from tonic, and the second ends on the tonic. *Barbara Allen,* quoted in the article MELODY, is an exquisite example on the smallest possible scale. A ternary melody, such as *The Bluebells of Scotland,* has a complete first clause, a second clause not as complete, and a third clause consisting of the first over again; a form conveniently symbolized as ABA.

No view of music can be correct that neglects the fact that it moves in time; though a composer may develop Mozart's capacity for seeing music spatially, *i.e.,* like a picture, all at once. Now, when do we know that a melody is going to be "ternary"? Obviously when its first clause has shown itself to be complete. If the sequel refuses to divide itself according to a "ternary" rule the ear is not going to reverse its judgments merely because we have chosen a bad term of classification. After the first clause, anything may happen. The rest of the tune may be no longer than the first clause. All that we can expect of it is that it will cover a wider ground than the first clause, even if in fewer notes or in less time. But this is not all. Every tune of several clauses lends itself to repeating its sections. Binary tunes repeat their two sections. Does a ternary tune repeat its three sections? Try the experiment on the very typical ternary theme of the variations in Beethoven's Kreutzer sonata. Play the first clause with its repeat and try repeating the second clause before returning to the first. You will hardly have the patience to finish the experiment. It will at once reveal that under the test of repeats our "ternary" melody is not ABA but A, BA.

Ex. 1

Andante

Thus while both these forms divide only into two repeatable portions the one named "binary" has an incomplete first part while the first part of the other is complete. Our pundits would make musical terminology less misleading if they would kindly find Greek or Latin names, not longer than the forms themselves, that should express "form-with-an-incomplete-first-part" on the one hand, and "form-with-a-complete-first-part" on the other. Clearly the distinction is that between higher organizations and lower, or sectional, forms. From the so-called binary form originates the sonata-form *par excellence,* that of the first movement of a sonata. From the so-called ternary form originate all those sectional forms of music that begin with a complete symmetrical melody, however many sections the form may eventually develop. Thus the "ternary" type underlies the *rondo* (*q.v.*).

The Sonata Style.—Sonata form represents a style that is evident in every bar from the outset, however its themes may be distributed. We are told that the binary form of a dance-movement in a suite has a polyphonic texture and a single theme; and that Philipp Emanuel Bach created the true sonata form by inventing the "second subject." Good teachers make sure that their pupils understand that the "subject" of a sonata is not a single theme, like the subject of a fugue; but in spite of all precautions a host of bad musical forms and crooked musical doctrines have grown up from the provincial fact that English musicians have fastened on the terms "first" and "second subject" instead of translating the excellent German terms *Hauptsatz* (principal member) and *Seitensatz* (subordinate member).

Some of Sebastian Bach's most typical gigues have at least two distinct themes, while more than one of Haydn's ripest sonata movements derive everything from their first themes. Accordingly we may illustrate the true distinction of style by examples which refute superficial doctrines.

These two examples are almost exactly the same length, yet

Haydn is beyond Bach's scope in the first eight bars. If Bach could have accepted so trite a theme as Haydn's. he would have postulated that it did not end with a bump: and bars 5–8 would have horrified him, for he would have supposed that a movement that began so vulgarly was condemned to continue in the same style. Bar 8, however, enters on matters that Bach had never known. In it the first bar of a new period overlaps with the last

Ex. 2. Bach. Gigue from 3rd Suite 'for Violoncello

bar of the old; and therewith we are plunged into a polyphony quite lively enough for Bach, and quite unpredictable in rhythm and key, its fourth bar overlapping with the answer in A minor, and the viola and violoncello entering in F major at intervals of two bars. Then, arising from bar 18, there are four bars on the dominant of F, with that merely jingling figure (c). We need not set limits to Bach's intelligence, and we may suppose that such a composition would have convinced him that here was no trivial divertissement, as he called the non-polyphonic sonatas that were becoming fashionable in 1745, but a new art with enormous possibilities.

Bars 23–26 transform the two notes of (a) into rich sustained harmonies. Then figure (b) bursts out in a new type of phrase, built up in 3-bar periods, which the ear need not trouble to recognize as such in the general bustle. The third of these periods abandons the figure and makes a melodious close into 5 bars of cadence on figure (b) with upper notes that merge into (c), nicely phrased. It is idle to say that all this has more than one theme, and worse than idle to deny that Bach's gigue has at least two distinct themes. that of the beginning, and that in bars 29–36. But Bach's relatively uniform texture will tolerate neither interruption nor irregularity of rhythm.

Haydn's exposition groups itself clearly into bars 1–8, the first group (*Hauptsatz*), asserting the tonic and overlapping with bars 8–22, which effect the transition (plus the sustained chords 23–26) to the second group (*Seitensatz*) in F major, bars 27–40, with its cadence-phrase (*Schlussgruppe*) in bars 36–40. These sections could not be more distinct uith any number of themes.

There are no rules whatever for the number or distribution of themes in sonata-form. When critics tell us that Rfendelssohn is weak "in second subjects, where the human element is required," they disqualify themselves by a terminology as useless as that of the friend who did not see where the painter was going to put his brown tree. Any generalized criticism of sonata themes is bound to be nonsense; for themes stand in endless variety of relation to the whole. They are details. which give pleasure in themselves as well as in their relation to the scheme. But it is foolish and vexatious to lay down rules as to what pleasure the details shall give. If you examine frescoes with a microscope or miniatures with a telescope you will not enjoy them; and if you expect Beethoven's "Harp" quartet to show you the purport of its first movement in its themes you might as well try to study foreign poetry through a traveller's phrase-book.

So much, then, for the vital element of drama in the sonata. Historically it originates wholly with Haydn and Mozart; and Philipp Emanuel Bach contributed to it nothing but a romantic rhetoric. His chief pride was in his invention of *Sonaten* mit *veränderten Reprisen;* that is to say sonatas in which the repeats were written out in full in order to control the fashion of altering and amplifying the ornaments on repetition Now, could anything more clearly betray a non-dramatic style? The survival of repeats in the most dramatic works of Beethoven and Brahms shows how powerfully an architectural symmetry can dominate a series of emotional tensions: but imagination boggles at the thought of using these repeats to display a new set of ornaments.

Haydn saw that the only place for C. P. E. Bach's device was in purely lyric slow movements. Even there he never had the patience to plod and pose (as C. P. E. Bach did to the bitter end) through a repetition of both parts. When his second part comes to recapitulate the second group it combines both versions. This form appears for the last time in history in one of Haydn's "London" symphonies, in the wonderful movement of which the theme is quoted in RHYTHM, Ex. 1. Though "binary" it is manifestly lyric, and could no more be applied to active movements than the Spenserian stanza could be applied to drama.

A more important step toward the true sonata style was made by Philipp Emanuel's less romantic brother. Johann Christian, who settled in London, founded the Bach and Abel Concerts, and had a great influence on the boy Mozart. J. C. Bach is the first composer to lay a dramatic emphasis on the transition between his first and his second group. In crude or deliberately formal examples this has been wittily described as "presenting arms" to the new key. Its point is not that there is any difficulty in apprehending the new key, but that the move into it is dramatic and not decorative. Whether the move be made with intellectual music or with common forms makes no difference. Beethoven preferred, in his most characteristic early works, to disguise it cleverly. In later works he acquired the grand formal breadth of Mozart's chamber-music in this transition.

First-movement Form.—The general scheme of the first-mo ement form or, par excellence, sonata form, is as follows. There is a first group in the tonic. followed by a transition to another key, where there is a second group that usually ends with a neat little cadence-theme. These groups constitute the exposition, which may be repeated. Then follows the development, the function of which is to put the previous materials into new

Ex. 3 Exposition in sonata style

lights, regrouping the figures into new types of phrase, modulating freely and settling, if at all, only in new keys. Eventually a return is made to the tonic, and so to the Recapitulation. This recapitulates the exposition, but it gives the second group in the tonic, and so completes the design. The development and recapitulation may be repeated; a coda may follow the recapitulations.

This account has required so many words that the illusion is apt to arise that it conveys more information than, say, the statement that the plan of a cathedral is cruciform and that the arms of the cross are called transepts, and so on. It gives us no means of distinguishing an ambling decorative movement by Boccherini from the first movement of a Beethoven symphony; and the description of the development is the only point which would rule out the sequel of our second example as a specimen of sonata-form. Haydn, Mozart and Beethoven differ widely in their handling of every part of the scheme.

The most regular form is to be found in Mozart, whose transitions are always broad and smooth. The effect of "presenting arms" is evident only in small or perfunctory works; and if it is found at all in larger works it is on such a scale and with such a purpose as Beethoven would give it. The second group contains at least one definite new theme and a number of cadence-phrases in various rhythms. The development is short, consisting of one broad sequential process that leads through a wide range of keys back to the tonic. Sometimes it contains an entirely new theme. Such an episode, which is generally placed at the beginning, by no means always indicates a lighter style and texture. It may be a relief from unusually concentrated figure-work in the exposition; and the developments of two of Mozart's most serious works (the C minor serenade for 8 wind instruments, better known as a string quintet, and the G minor pianoforte quartet) are episodic. The return to the tonic always has the effect of being accurately timed after a delightful period of anticipation.

The recapitulation is full and has' a deceptive appearance of regularity. In reality it is anything but mechanical. It has just that kind of difference by which stereoscopic pictures produce the effect of binocular vision. In the light of the recapitulation the listener finds that points that were superficial in the exposition have now become solid. The composer instinctively conceives his exposition in relation to the question "How will this sound when it returns?" The minimum change happens automatically with the transition to the second group, for this transition must no longer lead to the complementary key of the exposition. One quaint primitive device in the transition is that of making it not leave the tonic at all but simply come to a pause on (but not in) the dominant. This dominant is then taken literally as a key. In such a case the recapitulation need alter nothing; the second group merely follows in the tonic instead of in the dominant. Even this automatic device makes the recapitulation give a more solid impression than the exposition; for the pause on the dominant, treated paradoxically in the exposition, is now treated rationally.

We need not deny that formal devices are apt to become mechanical; but we have no right to, the a *priori* opinion that Mozart is writing unimaginatively every time that he decides that the most familiar course is the wittiest. It is much wiser to regard the most exact recapitulation as the extreme case of delicate balance, and even in the most exact the crucial detail will appear. Here is a case in a difference of a single bar, Mozart's string quartet in E flat (K. 428) has the following clause in the first theme:

In the recapitulation you have this—

The little comment of the second violin is expanded and made to turn the following "added 6th" chord into a momentarily solid supertonic key. Similar points make the recapitulation of the second group also stand out in higher relief. Most interesting of all are the ways in which Mozart in a minor movement translates the second group from the major into the minor mode. It is worth while trying the experiment of literal translation (not always an easy task) and then seeing what Mozart has done in such cases. For codas Mozart either finds a slight expansion in the recapitulation of his second group adequate, or else he adds a neat final paragraph. If the development contained an episode Mozart's coda may allude to it. In the finale of the so-called "Jupiter" symphony he uses the coda for his quintuple counterpoint on all the five themes of the movement. (See COUNTERPOINT.)

Haydn's practice in his later works differs from Mozart's in almost every particular. His second group often contains no new theme until the cadence-group at the end; his development is long and divisible into several stages, often including an illusory early return to the main theme in the tonic followed by a new excursion into remote regions; and as to recapitulation, the term is seldom applicable at all. The first theme, indeed, returns, but it is followed by a brilliant peroration full of new developments and giving the repose of recapitulation only in the fact that it remains firmly in the tonic. If after such a peroration Haydn chooses to end quietly and abruptly with his cadence-theme, the effect is witty. But it does not make him a formalist. He is a master not only of form but of spaciousness in the smallest possible compass. One main theme for both groups gives him more room for expansion than two; and instead of saying that his recapitulations are free we ought to say that he invented the most brilliant type of Beethoven's coda. And these features of his form are not, as has sometimes been alleged, primitive. They are only partially visible in quartets before Op. 50. Then they appear in full vigour, and Haydn's admiration for Mozart only confirms him in his independence.

Mozart's more symmetrical form is a function of two things, a more polyphonic style and a larger scale. We may sum up the relation between Mozart's form and Haydn's thus: that in Haydn we are aware of an expansive freedom which proves, on scrutiny, to have an all-pervading sense of proportion; while in Mozart we are aware of beautiful and symmetrical proportions which prove on scrutiny to be handled with an all-pervading freedom.

Beethoven combined the forms of Haydn and Mozart, writing on a scale large enough to contain Mozart's regular recapitulations together with Haydn's free perorations, and developing a tragic power all his own. Such new power was not to be obtained without a new technique. A pzssage from Haydn and one from Beethoven, may be chosen to show how Beethoven set to work. In the first movement of Haydn's A major quartet (op. 20, No.

6) the second group has been duly ushered in by a highly-organized transition Passage and has already started a new theme. This, however, comes to a pause on the dominant. and then we have the following modulating themes—Ex. 6. The harmonic colour of these keys is delightful, and their mutual relations are of direct importance. The passage is improvisatorial and ruminating. Its modulations are within the local range of its start in E minor, and its windings only confirm the drift towards E major. Without them the passage would lose its freedom: with wider modulations it would lose coherence.

Now take the opening of the second group in the first movement of Beethoven's sonata, Op. 2, no. 2. Here is its skeleton outline—

To analyse the enharmonic modulations and keys (including the unrelated ♭VI) of this passage is, in Kingsley's admirable parable, like making an exhaustive chemical analysis of a plum-pudding and omitting to ascertain that the cook had boiled it in a cloth. The gist of the matter is the steadily rising bass, with its accelerated later steps and the profound psychology of its pause for 8 bars (after the quotation) before plunging into the final codential steps G♯, A and B, in widely different octaves. This is one of the epoch-making passages in musical history. Its importance does not lie in its wonderful enharmonic modulations. These could not in themselves have achieved more than had been already achieved by C. P. E. Bach: for without the rising bass their purpose would be merely to astonish and not to construct. But with the rising bass and similar resources the whole art of tonality expands. This soon enabled Beethoven to choose remoter keys for his second group. (*See* HARMONY.)

Ex. 8 gives the outline of the first movement of Beethoven's "Eroica" symphony. Blank bars indicate the continuance of a harmony. They are often without theme, and are the lungs of the organism. Quaver-bars or other rhythmic indications above the line indicate the prevalent movement in accessory parts, whether contrapuntal or homophonic. Fine detail is not indicated, and short passages marked as repeated may be assumed to be rescored often beyond recognition. The outline, however, gives a comprehensive summary of the structure of this highly significant movement, and by means of it the reader will be enabled to apprehend, almost at a glance, the inexhaustible expansive and contractile power of Beethoven's phrase-rhythm. Nine conductors out of ten overlook the first theme of the second group entirely, but it is the one constant element in all Beethoven's dozens of sketches.

Freedom in a recognizable recapitulation can go no further than the marvellous modulations with which Beethoven transforms the first group; and anybody inclined to cavil at the exact recapitulation of no less than 100 bars comprising the transition and second group, may be surprised to learn that this is, by the clock precisely the same length as Isolde's Liebestod (*vide* RHYTHM) and that in the Liebestod Wagner exactly recapitulates, without transposition, the last movement of the love-duet in a previous act. Recapitulation is as inveterate in musical form as symmetry is in architecture; and nobody understood this better than the first and most uncompromising realist in the application of music to drama.

Other Movements.—A thorough understanding of the style and methods of first movements makes all the rest easy. As to slow movements, the first thing that must be realized is that if a theme conceived in an average quick tempo be played four times as slow it will take four times as long. Some composers, and even some teachers, do not seem to have learnt this remarkable fact. In the music of a master slowness means bigness. The first 16 bars of the slow movement of Beethoven's D minor sonata (Op. 31, no. 2) look like, and are, a single binary sentence closing into the 17th bar. But the all-seeing eye that takes this in at a glance many miss the important fact that that binary sentence takes a whole minute by the clock. Quavers at 96 is a very good metronome-tempo for this movement, and it gives exactly 16 of those bars to a minute. The metronome at 72 to a bar gives a good, moderate tempo for the finale. Now, see how far one minute takes us in the finale. The simple binary first sentence of the adagio takes as long as the two closely-printed pages from the beginning of the finale to the middle of its cadence-theme! Thus in the slow movement of Beethoven's fourth symphony (another case of 16 bars to the minute) the 15 bars beginning in E flat minor and dwelling in G flat (bars 50–64) are a very spacious development; and so are the 7 bars in the middle of the slow movement of the trio in D major, Op. 70, no. 1. Such passages are ample developments if they modulate widely and contain important changes of rhythm, instead of merely dwelling on the dominant before the return of the main theme as in the slow movement of the D minor sonata.

No wonder that in any movement slower than *andante* the full sonata form is unusual and of gigantic effect. The full-sized rondo-form (*see* RONDO) as in the case of the fourth symphony just mentioned, is still more voluminous in a slow tempo. Movements of more normal size may be in A, B, A form, or sonata-form without development (Mozart's favourite form); or may consist of a theme with five or six variations and a short coda. Haydn's form of variations on two alternating major and minor themes is sometimes used by him in slow movements, and sometimes (in small works) as the first movement or as finale. (*See* VARIATIONS.)

The finale is often in first-movement form, but will, in such cases, have a much simpler texture. The last part of a work that moves in time will always relieve the strain on the attention. Hence the large number and importance of rondo-finales; and hence the paradox that both Haydn and Beethoven found the fugue an excellent form for a finale. For the fugue, while continually stimulating and exercising the mind by means of details, makes no claim on the listener's memory over long stretches in a major composition.

The first movement, slow movement and finale have thus an unlimited dramatic scope. A purely lyric or dance movement added to such a scheme would in itself be dramatic by contrast, as a song may be a dramatic element in a play. This justifies the dance-form of the Mozart-Haydn minuet and trio, of which Beethoven accentuated the dance-character when he expanded it to the scherzo (*q.v.*). Haydn's very earliest minuets show an inveterate irregularity of rhythm which stamps them even sooner than his other movements, as dramatic. Mozart's minuets are smoother, but he can pack operas into them without bursting the bounds of melodic forms. The minuet of his E flat quartet, for example (K. 428), has five distinctly expressed themes; and its trio, which in contrast has only one theme, moves, however, in four distinct new keys.

The Sonata as a Whole.—The full scheme of a sonata consists, then, of these four movements, the minuet or scherzo being either second or third. Two movements, suitably contrasted, will make a sonata, even if (as in Beethoven's Op. 54) neither of them is in full first-movement form. But it is exceptional for a mature work to claim the title of sonata on merely lyric forms. And in


Ex. 8
First Group begins
till bar 23
Allegro con brio
a
b
melody
counter-statement
(ab)
(b)
New theme
c
(c)
rise instead of the fall of bar 6
(movement stops)
for 8 bars
third statement; transition
for 10 bars
Dominant preparation for B♭
d
theme continues
(movement stops)
Second Group
etc.
e
New theme
Counter-statement in minor
New theme
E♮ = F♭
(b) diminished


Return to opening
Cadence-phrase
(a)
1ma
145
150
x
2nd
Development begins
x
x
x
themeless
155
160
165
Bars 166–177=bars 45–56 on dominant of C with a new counterpoint
(b)
D♭ minor=C♯ minor
etc.
(e) continued
(a)
178
180
185
(e)
D minor
190
(a) diminished
(a) diminished
(e)
195
Bars 198–208=186–198 Starting from G minor
210
etc.
themeless
(with lively
215
Bars 220–230=186-197 =45-56 on dominant of A♭
232
(d)
235
counterpoint)
C minor
G minor
D minor
240
245
(movement stops)
(d)
(c)
6 similar bars
Ditto
250
255
260
Ditto
simile
265
270
275
280
Episode (new theme)
E minor
(y)
284
285
286
288
289
290
284–290 in A minor
C major
(ab)
(b) developed
298
300
303-306 in C minor
303-306 in E Flat
284-287 in E♭ minor
305
311
320
326
G Flat (y)
(y)
(y)
(ab)
(ab)
(ab)
330
335
♮6 4 3
(c)
continued for 28 bars
340
simile
345
350
355
360

*The allusion is probably intentional as Beethoven had great difficulty with those introductory bars. At all events he found that their proper shape was that of final bars.

the case of quartets, the feeling of the classical masters is that when so many as four players are assembled it is a waste of opportunity to give them less than a four-movement work to play.

Why do the classical sonatas maintain this scheme of self-centred movements with no community of theme? The answer to this lies in the relation between their time-scale and their emotional content. In its early forms the sonata is a new kind of suite, complete in its contrasts. In its later developments the individual movements, while complete as designs, raise emotional issues which each movement is unable to satisfy without the others. The first movement of Beethoven's not inaptly named *Appassionata* sonata (Op. 57) whirls us through an immense tragedy in eight minutes. The movement is irrevocably completed; but our emotional reactions have not more than begun. We need the unutterable calm of the slow movement with its theme rooted to its tonic chord, and its simple and solemn variations in the ancient form of doubles. A foreign chord replaces that of its cadence; the vision is broken and the finale rushes headlong to the end of a tragic fate. The whole emotional scheme is perfect; but for one movement to take up the themes of another would be to tell a twice-told tale. Hence the classics, including Brahms, are not only cautious but cryptic in the few cases where they allow one movement to allude to another. The only occasion for clearness in such allusions is with introductions, which may well foreshadow the following movement, and, in the case of introductions to finales, may dramatically recall the past.

The emotional unity of the sonata is already significant in Mozart and Haydn. Their artistic hypotheses are those of comedy; and even so tragic a note as the last page of Haydn's F sharp minor quartet (Op. 50, no. 4) can be sounded only in the severe form of fugue. One of the most significant gestures in all the history of music is that of the introduction to the finale of Mozart's G minor quintet. The slow movement is one of the profoundest things possible before Beethoven. One is inclined to resent the notion that such music can have limitations. Being perfect it is infinite, and you cannot compare infinities. But you can be clear as to their elements; and the terms of its art forbid this pathetic music to handle tragic action. For tragedy, music needs such resources as are shown in Ex. 7, and these would shatter Mozart's aesthetic system. But after that slow movement even the finale of Mozart's own G minor symphony would sound peevish. So Mozart writes a solemn slow introduction which bids the art of music run away and play, for the rest is too sad for it. And so the bright rondo-finale is another story. Mozart would neither violate his aesthetic system nor anticipate Mendelssohn's naïve way of striking a religious note with a complete unconsciousness of its blasphemy.

The Sonata Since Beethoven. — The sonata-style belongs to the sonata time-scale and to the classical key-system. Music in the Wagnerian time-scale, or in "atonal" or other new harmonic systems, has no more to do with it than Greek prose. Nor do changes in the general outlines of the form mean much in themselves. The classical forms are, even externally, far more varied than those of later sonata-works; and the essentials of the sonata lie much deeper.

Schubert achieved wonderful things in his sonata works, but died before he had perfected his forms. His expositions digress into developments, his developments subside into long twice-repeated lyric episodes, and his recapitulations reveal that recapitulating is the very thing his expositions are not designed to bear. Nevertheless Schubert was on the high road towards genuine new forms.

What these forms were to be was best revealed by Brahms. It is fashionable to deny that Brahms invented new forms; and this is like Humpty-Dumpty's complaint that Alice's features were arranged so exactly like other people's that he could not be expected to recognize her. Forms must be studied in detail from phrase to phrase, and classified afterwards: not classified by guess-work and warped to fit the guess. Brahms has many new ways of phrasing and of developing themes (see MELODY, Ex. 11) ; and no two of his forms are alike. Least of all composers does he resemble Schumann, whom he was at first accused of imitating.

Schumann's sonata works show an interesting artificial system. His ideas were lyric and epigrammatic; and they shaped themselves squarely and with a Macaulayesque habit of antithesis. With this style he contrived to build important sonata works as one might construct a landscape in mosaic. He knew what he was doing, and the result is often delightful. In his D minor symphony he achieved a new continuity of form and theme, retaining the classical group of four main movements, but running them together without break and using transformations of the same themes in all four. Schumann's hard outlines and square rhythms have been copied without his wit in countless later sonata works, especially by those Russian composers who, led by Nicolas Rubinstein, danced upon his grave in derision of these very features.

Mendelssohn handled all sonata forms with an often dangerous facility but sometimes with genius. The opening of his D minor trio is the prototype of those innumerable allegros which are really andantes riding an ambling horse or running up a descending escalator.

The masterly scheme (there is only one) of Spohr is (as Schumann remarked) not so easy to imitate as it looks; but it is the prototype of most pseudo-classical works up to the present day; and many teachers believe it to be the only orthodox form. Against such teaching young artists do well to revolt, but why call it classical?

The quality most conspicuously absent in sonata-work since Brahms is movement. The fundamental mistake of Bruckner (*q.v.*) was in associating his Wagnerian style with sonata forms at all. Sibelius solves Bruckner's problem, and takes and leaves the sonata style as he pleases, and always with clear purpose, whether convincingly or not. Reger's meticulously regular forms are hard to accept as the really proper vessel for his strong chromatic brew; and as for imitating him, one might as well try to write a Meredith novel from one metaphor to the next. The art of movement is the crux of the sonata problem; and the classical solutions of it from Haydn to Brahms are the greatest things in pure music.

(See also SYMPHONY; SONATA; MUSIC; VARIATIONS; RONDO; SCHERZO; and the articles on the various individual composers who have been referred to.) (D. F. T.)

SONDERBORG, a seaport and seaside resort in Aabenraa-Sonderborg, Denmark, on the southnest coast of the island of Als, of which it is the chief town, and 1; mi N E. from Flensburp Pop. (1950) 16.204. The town, which existed in the middle of the 13th century, mas burned down in 1864 during the assault by the Prussians upon the Duppler trenches It then passed into the possession of Germany, but was restored to Denmark by the plebiscite of 1920. It is connected with the mainland by a pontoon bridge, and has a castle with a beautiful chapel.

SONDERSHAUSEN, a town of Germany. in the Land of Thuringia. 37 mi. by rail N. of Erfurt Pop (1939) 11,518 It possesses a castle and manufactures of woollens and bricks Potassium salts are also mined there The town nas formerly the capital of the principality of Schnarzburg-Sondershausen

SONDRIO, a tonn of Lombardy, Italy. capital of the province of Sondrio, in the Valtellina, 1,140 ft. above sea level on the Adda river, 26 mi. E. of Lake Como and 82 mi. N E of Milan by rail. Pop (1951) 14.609 (commune). Sondrio has silkworks. Above the town to the north rise the snow-clad peaks of the Bernina group The railway goes on to Tirano 16 mi farther east. and thence over the Bernina pass into Snitzerland. while the Stelvio road crosses to Spondigna in the upper valley of the Adige (later called the Val Venosta)

SONE (SON). river of northeast central India. 46j mi long, and the chief tributary received by the Ganges from the south. The Sone flows through a deep valley from the Maikala range northwest as far as the Kaimur range. where it is deflected eastward and begins a slow course across the Gangetic plain It collects the drainage of the northern slopes of the Chota Nagpur highlands and enters the Ganges 10 mi. above Patna About 600,000 ac south of the main river between Benares and Patna are irrigated from a weir at Dehri. The scheme is mainly protective because water supplies are low in the spring. (T HER)

SONG is the joint art of words and music. two arts under emotional pressure coalescing into a third. The relation and balance of the two arts is a problem that has to be resolved anew in every song that is composed.

EARLY SONG

Little song survives from the ancient world, except insofar as elements from Jewish cantillation are to be found in plain song, which itself goes back beyond the time of Pope Gregory (590–604), and insofar as folk song. (*q.v.*) which has no history, everywhere preserves elements from its own past. From classical Greece six hymns and some fragments survive which have been deciphered from inscriptions and can be sung with confidence that they are correct. Troubadour song is an inheritance from the middle ages. Like ancient song, plain song and folk song, it is essentially monodic, *i.e.,* single-line melody with no prescribed instrumental accompaniment. In the art of the troubadours the pull of poetry and music against each other. which has to find its reconciliation in every song that is ever composed! is resolved *ab initio*, since the poet and the composer, and perhaps the singer, are one. The melodies are in the church modes in current use. with the Ionian, *i.e.,* our modern major, mode specially favoured, and are notated in the four-line stave used for plain song, of which they are indeed the secular equivalent. Over 300 poems with their melodies survive out of a corpus of 1,000 poems in the Provençal *langue* d'oc. The movement in which aristocratic .musician poets celebrated chivalric love started at the beginning of the 12th century. It spread to northern France where the language used was the *langue d'oïl, i.e.,* early French, and the practitioners of the art were called trouveres. Of their songs 800 survive. It is necessary to distinguish these courtly musicians from the goliards or wandering scholars who composed song, and spread songs in Latin — the *Carmina Burana* is the most famous collection — and from the wandering minstrels or *jongleurs* who practised their art in the market place rather than the castle.

The chief name among the troubadours is that of Bernart de Ventadour (d. 1195) ; among the trouveres, Adam de la Hale, who wrote the dramatic pastoral *Le Jeu de Robin et Marion* and also motets in the contemporary polyphonic style. The German equivalents of these aristocratic minstrels were the *Minnesänger* who flourished at a slightly later date. Of these the best known are the three borrowed by Richard Wagner for *Die Meistersinger* (*Meistersinger* incidentally were the bourgeois successors of the *Minnesänger*) and *Tannhaüser; i.e.,* Walter von der Vogelweide, Wolfram von Eschenbach and Tannhaiiser himself.

Folk song, the other monodic survival along with plain song into the modern world. bears the imprint of the community rather than of individual composition. Various theories have been propounded about its origin—communal composition (the brothers Grimm), individual creation orally transmitted through so many minds as to give it communal character (F. M. Böhme), clerical song come down in the world and become popular. But whatever its origin. its character is unmistakable and its best custodians are illiterate peasants. There are examples of degeneration and corruption occurring through oral transmission, but in general it works the other way, so that what are most typical of a community's songs are also its best specimens. Racial and national characteristics are discernible in the technical features of folk song. such as compass. favourite intervals, phrase lengths and accentuation (which naturally follows that of the language of the song). The 19th century saw a determined effort in all parts of Europe to collect and preserve such national folk song as survived, and the salvage was astonishingly alike in quantity and quality. The United States followed suit in the 20th century and added to the data for study the influence of the African Negro upon the various kinds of European music which immigrants had brought with them.

With the development of instrumental music in the middle ages the impulse to accompany songs made itself felt and has grown stronger with the passing of the centuries. The weak-toned lute. which was the first instrument to be used in the modern manner of an accompaniment. has been transformed into the thunderous symphony orchestra, and plain song and folk song have both submitted to accompaniment on a keyboard instrument.

The Lutanists.—At the close of the 16th century, when the lute was the popular musical instrument of the educated classes, the first really important body of song was produced. in Spain, Italy. France and England. At first it may be described as a small satellite detached from the large planet of the madrigal, which had for about a century held the field as the favourite diversion of musical amateurs. There is little doubt that the idea of solo song arose when in madrigal singing the parts of missing voices were taken by instruments. It is plain that if all the voices but one were missing. the effect of a solo song with instrumental accompaniment was realized. A still nearer approach to artistic solo song was reached when the singer sang his own part of a madrigal, playing the other parts himself, In John Dowland's *First Book of Songs or Airs* in four parts (1597), the principal vocal melody has an alternative accompaniment for three additional voices or the lute. Most English madrigals were published "for voices or viols."

In Italy Giulio Caccini published in 1602 his famous collection of songs for the lute (*Nuove Musiche*). He claimed in his preface to be the first to invent songs "for a single voice to the accompaniment of a single instrument." It is true that his friends in Rome, at whose houses these new compositions were performed, assured him that they had never heard the like before. and that his style exhibited possibilities for the expression of feeling that were excluded when the voice sang merely one part in a contrapuntal work. But about 30 years before Caccini lutanists in France had anticipated his innovation, and composed solo songs with lute accompaniments in which is ,evidenced the struggle, not always successful, to break away from polyphonic traditions. Adrien Le Roy's *Airs de Cour,* published in 1571, may be cited in proof of this statement (*see* Peter Warlock. *French Ayres* [1928]). Of these airs "Je suis amour" is somewhat in the declamatory recitative style of Caccini's *Nuove Musiche*. Generally speaking, it may be said of early French songs that they were longer in shaking off the influence of the past than the songs of the Italians, many tricks of expression, belonging to polyphonic times, surviving both in voice parts and accompaniments.

In England. about the end of the 16th century several volumes of songs to be sung with lute accompaniment made their appearance. It is worth observing that several were of earlier date than the "new music" of Caccini: they were an entirely English product. Some were songs or airs of four parts with tablature for the lute, so made that all the parts together or either of them separately could be sung to the lute, or orpharion; some were published only for a solo voice and lute. John Dowland (1563?–1626) who composed 88 songs. was undoubtedly the greatest of the large band of English lutanists. Even when, as in the first book of airs (1597), his songs could be sung ior four voices, they distinguished themselves from the madrigal by the special melodic interest given to the top part. He was thus really the creator of the modern art song. Though Il'illiam Byrd had (about 1583) composed "My Little Sweet Darling" and a few other songs with string accompaniment he did not, like Dowland, make the new type of song a special study. Dowland's fame. apart from the peculiar charm of his melodies, their expressive character, and their fitness to the words —a point which is characteristic of the work of the early lutanists — rests upon the important part he assigns to the lute. In many songs it contributes more to the expression than the vocal melody itself. Being himself not only a distinguished lutanist but a distinguished singer, he understood what it is that makes a song a joy to sing — as later Franz Schubert, also a singer, understood. It became in fact an art form. "Dowland was the first to specialize in this form and to develop it, and the art songs of Schubert, Robert Schumann and Johannes Brahms with pianoforte accompaniment are lineal descendants of Dowland's songs with lute accompaniment" (E. H. Fellowes). The following songs, "Can she excuse my Wrongs," "Sorrow Stay." "Flow my Tears," "Weep you no more sad Fountains," "In silent Night," "Fine Knacks for Ladies." and "Once Again," may be cited as supporting this statement.

Thomas Campion, Philip Rosseter and Robert Jones are, after

Dowland, the most individual composers in the same field Campion's "There is a Garden in her Face," "Shall I come if I swim?"; Rosseter's "If she forsake me," "When Laura smiles" and "Would you see my Mistress' Face": Jones's "Go to bed sweet Muse" and "Sneet Kate" are good examples of their work. Each of these composers wrote about 100 songs.

Italy.—Meanwhile Italian composers. in spite of the frottole, villote, villanelle. balletti and falalas (arrangements in vocal parts of popular melodies common in Italy and other countries in the last half of the 16th century) seem to have been unaffected in the new song movement by popular influences (we have practically no knowledge of the Italian folk song in mediaeval times); they went straight from the polyphonic to the recitative style (invented by Jacopo Peri and Caccini for their early experiments in opera) and advanced with extraordinary rapidity.

In opera and cantata melody was quickly added to relieve the monotony of recitative. and considerable advance in this direction was made by Pietro Cavalli and Marcantonio Cesti. Claudio Monteverdi, though a greater genius than either of them. was more concerned with dramatic expression than with melody for its own sake, but in the famous lament of Ariadne the two elements find their reconciliation in a passionate aria that, so great was its popularity, is found in three different forms. Giacomo Carissimi and Luigi Rossi in oratorio and cantata (a word which then merely described a piece that was sung. as sonata a piece that was played, consisting generally of alternate recitative and aria) brought the organization of melody to a high degree of elaboration, far beyond anything attempted by Cavalli or Cesti. In their hands the declamatory methods of Monteverdi were made subordinate to larger purposes of design. It was, moreover, inevitable in these early developments of musical style, in which melody played the leading part, that such sacrifices as were necessary in balancing the rival claims of expression and form should be in favour of the latter. rather than the former. But the formal perfection of melody was not the only problem which 17th-century Italian composers had to face. The whole question of instrumental accompaniment had to be worked out, the nature and capacities of instruments had to be explored, the reconciliation of the new art of harmony with the old art of counterpoint to be effected. It speaks volumes for the innate musical sense and technical skill of the early Italian composers that the initial stage of tentative effort passed so quickly, and that at the close of the 17th century we are conscious of breathing an atmosphere not of experimental work, but of mature art.

Alessandro Scarlatti (1659–1725) sums up the period for Italy. That much of his work is dry and uninspired is not surprising when the quantity of it is realized (he composed over 100 operas and 600 vocal cantatas) and also the unfavourable conditions under which operatic composers had to work, but the best of it is singularly noble in conception and perfect in design. The same is true of the best work of Giovanni Legrenzi. Francesco Durante, Leonardo Leo and Antonio Caldara, work which was of incalculable importance for the development of musical. and particularly of vocal art. Carissimi's "Vittoria," Scarlatti's "O cessate" and "Le Violette" are the most notable .survivors of a vast quantity of these 17th-century experiments in determining the relation of words to melody.

The almost universal preference of the Italians in the 17th and 18th centuries for the *da capo* aria involved some sacrifice on the dramatic and emotional side. This becomes clear at once if we think of an opera in which nearly all the songs end by repeating not only the melody of the opening part, but the words attached to it. It is this double repetition which from the point of view of dramatic propriety is the most disturbing. But composers mere too much occupied in exploring the formal possibilities of melody to establish a really intimate connection between music and text, a detailed interpretation of which lay outside their scheme of song. Much repetition of words was not felt as an absurdity so long as the music was broadly in accordance with the atmosphere or situation required.

Before Scarlatti's death in 1725 symptoms of decline had appeared. He was himself often compelled to sacrifice his finer instincts to the fashionable demand for vocal display. A race of singers, of whom the majority were virtuosi rather than artists. dominated the taste of the public, and forced composers to furnish opportunities in each role for a full display of their powers. The growth of virtuosity in all departments of music is a feature of 18th-century musical life. and singers, especially the male sopranos (castrati), were the most richly reuarded of all musicians, so highly was vocal display esteemed.

GERMAN SONG

Early Development. — Themusical genius of Germany. which has created for the world the highest forms as yet known of symphony. oratorio and opera! has also created the *Lied— the* term by which is most easily conveyed the modern conceptions of ideal song. Germany is. moreover, the only country in which the art of song in orderly and progressive development can be traced from the simple mediaeval *Volkslied* to the elaborate productions of Schubert. Schumann and Brahms. If Germany is united to the rest of Europe in its debt to Italy, still its final conception of song belongs to itself alone. And this conception has more profoundly influenced the rest of Europe than any Italian conception ever influenced Germany. The student, therefore. is more profitably employed in studying the phases of song development in Germany than in any other country.

It is not necessary to dwell, except in very general terms, upon German song of the 17th century. It can point to nothing corresponding with the *Airs de cour* of France. or the far more important songs of the English lutanists. The kind of literature necessary for such development was wanting and German art was too deeply affected by the spirit which produced the Reformation to develop freely in secular directions. Even in the domain of the *Volkslied* the sacred songs mere scarcely less numerous than the secular, quantities of secular airs being provided with sacred words in accordance with the spirit of the times. In the 17th century, the work of the Italian monodists was found eventually to stimulate German composers to make songs, but their interest at first lay more in opera and choral-instrumental works, in which solo songs appear. than in song as an independent branch of art. A good general view of such isolated songs as appeared can be obtained from Heinrich Reimann's collections *Das deutsche geistliche Lied* and *Dus deutsche Lied*. In spite of some stiffness and awkwardness, many of these exhibit a touching earnestness and sincerity which mark them as distinct from any work done elsewhere at the same time. On the other hand, they lack the certainty of touch, as well as the melodic and declamatory power, which make Henry Purcell in England stand out pre-eminently as the greatest song composer of the 17th century. But the formal aria established by Scarlatti was adopted by George Frederick Handel and bent to his own style and purposes (which were mainly religious) by Johann Sebastian Bach.

In considering the *Lied* it is necessary to distinguish between that more distinctly popular type of song, known as the *volkstümliches Lied,* in which the same melody served for all the stanzas of a poem (as in the *Volkslied* itself, on which the *volkstümliches Lied* was modelled!, and the *durchcomponiertes Lied,* or song "composed through," in which the music forms a running commentary on a poem. either without respect to its form, or varying the music in some stanzas or in all in accordance with their poetical significance. Generally speaking, the former aims at a wider audience than the latter, the appreciation of which involves some degree of culture and intelligence, inasmuch as it aims at interpreting more complex and difficult kinds of poetry. In the 18th century the simple *volkstümliches Lied* in strophic form was most in favour, and those who care to trace its history in the hands of popular composers such as J. A. Hiller, J. A. P. Schulz, J. F. Reichardt and K. F. Zelter, can easily do so by consulting Härtel's *Liederlexicon* (1867), one of a number of similar publications. Side by side with the outpouring of somewhat obvious and sentimental melodiousness which such volumes reveal, it must be remembered that the attention of greater men to instrumental composition, the growing power of composing for keyed instruments (which began to replace the lute in the middle of the 17th century) and the mechanical improvements through which spinet, clavichord and harpsichord were advancing toward the modern pianoforte. were preparing the way for the modern *Lied,* in which the pianoforte accompaniment was to play an increasingly important part. C. P. E. Bach (1714–1788) alone of his contemporaries gave serious attention to lyrical song. selecting the best poetry he could get. and aspiring to something beyond merely tuneful melody. The real outburst of song had to wait for the inspiration. which came with the poetry of Johann Goethe and Johann Schiller.

Haydn and Mozart.— It is unfortunate that Joseph Haydn (1732–1809) and Wolfgang Amadeus Mozart (1756–1791), endowed with all the gifts that make for beautiful song except that of literary discrimination. should have left so little of real value. There is. indeed. much to admire in some of Haydn's canzonets. of which "My Mother bids me bind my Hair" fully deserves its popularity. while Mozart's "Trennung," "Unglückliche Liebe," and "Komm' lieber Mai," are small treasures which we could not afford to lose. But in only two songs by Mozart, "Abendempfindung" and "Das Veilchen," is the goal to which the art was to advance clearly discerned and in the latter case perfectly attained. Both are *durchcomponiert,* in both the general spirit, as well as each isolated point of beauty in the verses is seized and portrayed with unerring insight. "Abendempfindung" is seriously marred by carelessness in accentuation (still worse examples may be seen in "An Chloe") and by annoying repetition of words, due to the development of the melody into a formal and effective climax, on instrumental, not vocal. lines. In "Das Veilchen," however. where Mozart touched a poem that was worthy of his genius, he produced a masterpiece — rightly regarded as the first perfect specimen of the *durchcomponiertes Lied.* Every incident in the flower's story is minutely followed. with a detailed pictorial and dramatic treatment (involving several changes of key. contrasts between major and minor. variations of rhythm and melody. declamatory or recitative passages), which was quite new to the art.

Beethoven. — With Ludwig van Beethoven (1770–1827), song was suddenly exalted to a place among the highest branches of composition. Taken in hand with the utmost seriousness by the greatest musician of the age and associated by him, for the most part. with lyrical poetry of a high order. it could at last raise its head and, freed from the conventional puerilities of the salon, look a larger world confidently in the face.

It cannot. however, be admitted that Beethoven was an ideal song composer. His genius moved more easily in the field of abstract music. The forms of poetry were to him rather a hindrance than a help. His tendency is to press into his melodies more meaning than the words n-ill bear. The very qualities, in fact. which make his instrumental melodies so inspiring, tell against his songs. Though his stronger critical instinct kept him, as a rule, from the false accentuation which marred some of the work of Haydn and Mozart. yet, like them, he could not free himself from the instrumentalist's point of view. at any rate in the larger song forms. The concluding melody of "Busslied" would be equally effective played as a violin solo, the same is true of the final movements of *Adelaïde* and of the otherwise noble cycle *An die ferne Geliebte* — movements in which the words have to adapt themselves as well as they can to the exigencies of thematic development and to submit to serious displacements and tiresome repetitions. In songs of a solemn or deeply emotional nature. Beethoven is at his best, as in that cycle, to sacred words of C. F. Gellert, of which "Die Ehre Gottes aus der Natur" stands as a lasting monument of simple but expressive grandeur, in "Trocknet nicht." "In questa tomba," "Partenza," in the first of four settings to Goethe's "Nur wer die Sehnsucht kennt," and more than all. in the cycle mentioned above, *An die ferne Geliebte.* We have left behind the pretty artificialities so dear to the 18th century, that play around fictitious shepherds and shepherdesses, and entered the field of deeper human feeling, with the surrounding influences upon it of nature and romance. The new spirit of the age. represented in German poetry by the lyrics of Gottfried Bürger, Johann Voss, Matthias Claudius and Ludwig Hölty, members of the famous Giittinger Hainbund. and more notably by those of Goethe and Schiller, communicates itself in Beethoven to song. It needs no large study of his songs to perceive that the accompaniment has assumed especially in the *Liederkreis,* an importance immeasurably greater than in the songs of any previous composer. It begins to take a real not a perfunctory, part in interpretation providing both a background and a commentary to the poet's verses

Schubert.—The pioneer nork of Schulz Reichardt and Zelter in the setting of Goethe's lyrics—for they did not confine their activities to popular songs — deserves mention as indicating the direction in which composers nere moving A word is also due J R Zumsteeg who in spite of the sometimes childish simplicity of his nork in the use which he made of modulation as a means of lyrical expression had some influence upon the greatest song writer of all ages, Franz Schubert (1797–1828).

Schubert's "Erlkonig" was written a few months before Beethoven's *Liederkreis,* "Gretchen am Spinnrade." about a year before the "Erlkonig." He was 18 when he composed the latter. in 1814. Lyrical song, divorced from all hindering elements and associations, whether of salon or theatre, was here at the threshold of his short career in almost full maturity and plenitude of power. It is sufficiently remarkable that a lad with so little education should have composed such music. It is more astonishing still that he should have penetrated with unerring insight into the innermost secrets of the best poetry. Two of the necessary qualifications for a great song composer were thus at last united. Schubert possessed the third — a knowledge of the human voice, partly intuitive, partly the result of his experience as a chorister. The beauty of his melodies is scarcely more striking than the gratefulness of their purely vocal qualities. The technique of singing had, indeed, been understood for nearly two centuries; but Schubert was the first to divine fully its emotional range, and to dissociate it in lyrical work from the traditions of the schools. From the beginning to the end of his career he never penned a note or a phrase merely because it was vocally effective. What he wrote for the voice to sing was there because for him the poetry could not have it otherwise. This was inherent in his method of working, in which he relied implicitly upon his musical inspiration for a response: usually instantaneous. to the inordinate receptivity of his mind to the impressions of poetry. To read through a poem was for him not only to seize its innermost significance and the salient points of its language and its form, but also to visualize the scheme by which both the whole and the parts could be translated and glorified through the medium of music. As the singer J. M. Vogl, the first of his profession to appreciate him. remarked, "He composed in a state of clairvoyance." It is consequently impossible to summarize in a short space the innovations he introduced: for new poems immediately suggested new types of song. His settings of Goethe's lyrics, that is, the best of 'them, differ as essentially from his settings of those of W. Müller in the cycles *Die schöne Müllerin* and *Die Winterreise,* as these, again, from the settings of the six poems of Heinrich Heine.

Hardly a single development in subsequent phases of the art (except those which eliminate the melodious element) is not foreshadowed in one or other of his songs (about 6j6 in number). Brahms, the greatest of his successors, said that there was something to be learned from every one of Schubert's songs. He was as perfectly at home in the *durchcomponiertes Lied* as in the simple strophic type, or the purely declamatory. "Der Wegweiser," "Haidenroslein," "Der Doppelganger" are familiar but supreme examples of each. Certain features may be selected for emphasis: first, his use of modulation as a means of emotional expression. "Du liebst mich nicht" traverses, in two pages, more keys than would serve most composers for a whole symphony — while the discords on the words "Die Sonne vermissen" and "Was blühen die Narcissen" give a piercingly thrilling effect which is quite modern. The modulations in "Wehmuth" illustrate the subtle atmospheric effects which he loved to produce by sudden contrasts between major and minor harmonies. More familiar instances occur in "Gute Nacht," "Die Rose" and "Rosamunde." Secondly must be noticed his inexhaustible fertility in devising forms of accompaniment which serve to illustrate the pictorial or emotional background of a poem: the galloping horses and the horn in "Die Post," the spinning wheel in "Gretchen," murmuring brooks in many songs from *Die schone Müllerin* and "Liebesbotschaft." the indications of an emotional mood in "Die Stadt" or "Litanei." Occasionally, it is true, the persistence of a particular figure or rhythm induces monotony. as in "Ave Maria" or "Normans Gesang," but generally Schubert had plenty of means at his command to prevent it, such as the presence of an appropriate subsidiary figure making its appearance at intervals, as in "Halt." "Der Einsame," or some enchanting ritornello, by which a phrase of the vocal melody is echoed in the accompaniment. as in "Liebesbotschaft," "An Sylvia." "Standchen" and "Fischerweise," or variations in the accompaniment to the different stanzas, as in "Im Friihling." Thirdly. the sudden entrance of declamatory passages, as in "Der Neugierige," "Am Feierabend." in .'Gretchen" at the famous "Ach, sein Kuss." Fourthly, the realistic touches, by which suggestions in a poem are incorporated into the accompaniment, such as the cock crowing in "Frühlingstraum," the convent bell in "Die junge Nonne," the nightingale's song in "Ganymed," or the falling tears in "Ihr Bild." Finally should be noted the rarity of slips in the matter of the just accentuation of syllables, and this is specially remarkable in a song writer who relies so much upon pure melody as Schubert; for to find and preserve a melodic outline which is felt as a true expression of a poem and yet does no violence to its text is far more difficult than to compose in the declamatory style. But nothing is difficult to Schubert. He is as successful in "Liebesbotschaft" as in "Prometheus."

Loewe, Weber and **Mendelssohn.**—Of his contemporaries, Carl Loewe *(1796–1869)* deserves mention for his singular success in overcoming the difficulties involved in setting long ballads to music. To preserve homogeneity in a form in which simple narration presents perpetually shifting changes of action, of picture, of mood, is a problem which Schubert himself only once triumphantly solved. Loewe's setting of "Der Erlkonig" is not outclassed even by Schubert's. He set scores of ballads of half a dozen European countries. and even some of oriental origin. "Edward" is the best known of a group of English and Scottish popular ballads which he set in Gottfried von Herder's translation. Carl Maria von Weber *(1786–1826)* contributed nothing of permanent value to song outside his operas, beyond a few strophic songs of a popular nature. He disqualified himself for higher work by that singular preference for rapid and trivial verse which so often led Haydn and Mozart astray.

The literary tastes of Felix Mendelssohn (1809–1847) took him often to the best poems but he made but little attempt to penetrate beyond their superficial and obvious import. His own lovable personality is far more clearly revealed in his songs than the spirit of his poets. Differences of literary style affected the style of his music less than that of any other distinguished composer. He attained his highest level in "Auf Flügeln des Gesanges," in the first of the two "Zuleika" songs and in "Nachtlied." It is noteworthy that there is no trace of Schubert's influence. Had he never lived Mendelssohn's songs would have been just the same. Hence, in spite of graceful and flowing melodies, simple in form and instinct with that polished taste and charm of manner which endeared both himself and his works to his own generation. his songs have exercised no permanent influence upon the art. Their immediate influence, it is true. was enormous. It is felt occasionally in Schumann, only too often in Robert Franz, and in the work of many composers of more or less distinction in many countries besides his own, such as Niels Gade. A. F. Lindblad, W. Sterndale Bennett and others who need not be specified.

Schumann.—Of far greater. importance is the work of Robert Schumann (1810–1856), whose polyphonic methods of technique and peculiarly epigrammatic style enabled him to treat complex phases of thought and feeling, which had hardly become prominent in Schubert's time, with extraordinary success. Both by temperament and by choice he identified himself with the so-called Romantic movement. a movement in which both poetry and music tended more and more to become a personal revelation rather than "a criticism of life." With Schubert, who was the very incarnation of romance, the note of universality, that abiding mark of the classical composers, is stronger than the impress of his own personality.

With Schumann the reverse is the case. If the Romantic movement gave a new impetus of vast importance both to music and literature, it had its weaker side in extremes of sensibility which were not always equivalent to strength of feeling. Mendelssohn's songs admittedly err on the side of sentimentality — Schumann, with Franz Liszt, Adolph Jensen, and Robert Franz, frequently betrays the same weakness. His best work appears in the settings of Heine's lyrics (especially the *Dichterliebe*), in the J. von Eichendorff *Liederkreis,* in Adelbert von Chamisso's *Frauenliebe und Leben,* and in a fair number of other songs, such as "Widmung," "Der Nussbaum." "Auftrage," and on the dramatic side in "Der Soldat." "Die Karten-legerin" and "Die beiden Grenadiere," all strong in feeling and full of poetic and imaginative qualities of a high order. He realized that the new poetry called for new methods of treatment. These Schumann, instinctively an experimenter, provided. First, he gave a closer attention to the minutiae of declamation than had hitherto been attempted, and herein syncopation and .suspension provide possibilities unsuspected even by Schubert (in whose work hardly a case of syncopation will be found in the voice part). Secondly, he increased the role of the pianoforte accompaniment — and in this he was helped on the one hand by novel methods of technique, of which himself and Frédéric Chopin were the chief originators. and on the other by his loving study of Bach, which imparted a polyphonic element which was new to modern song. In nearly all Schubert's songs, and in all Mendelssohn's, the melody allotted to the voice is an essential factor. In Schumann the role of interpreter often passes to the accompaniment, while the voice declaims the words, as in "Das ist ein Flöten und Geigen," or "Rosslein," but the notes in which it declaims them are musically important. Consistently with this attitude, he gave increased prominence to the opening and closing instrumental symphonies; these became in his hands no merely formal introductions or conclusions, but an integral part of the whole conception and fabric of the *Lied.* This may be illustrated by many numbers of the *Dichterliebe,* but most remarkable is its final page. in which the pianoforte, after the voice has stopped, sums up the whole cycle. A third point is his fondness for short, interrupted phrases (often repeated at different levels) in place of the developed Schubertian melodies; a practice which has been extended by later composers, but often, as in the case of Franz, without Schumann's tact. On many grounds, then, Schumann may be regarded as having widely extended the conception of the *Lied,* his example has indeed encouraged later composers to regard no lyric poetry as too subtle for musical treatment.

Liszt, Franz, **Jensen** and Cornelius. — A bold experimenter in song was Franz Liszt (1811–1886), whose wayward genius, with its irrepressible bent toward the theatrical and melodramatic, was not at home within the limits of a short lyric. It is true that there is sincerity of feeling, if not of the deepest kind, in "Es muss ein Wunderbares sein" and "Über allen Gipfeln," but concentrated emotion, which involves for its expression highly organized form, was alien to Liszt's genius. which is more truly represented in songs such as "Die Lorelei," "Kennst du das Land" or "Am Rhein," in which are presented a series of pictures loosely connected, giving the impression of clever extemporizations.

The admiration expressed by Liszt and Wagner for the songs of Robert Franz (1815–1892), and the cordial welcome extended by Schumann to those which first made their appearance, have led to an undue estimate of their importance in many quarters. They are characterized by great delicacy both of feeling and of workmanship, but the ingenuity of his counterpoint, which he owed to his intimate knowledge of Bach and Handel. cannot conceal the frequent poverty of inspiration in his melodic phrases, nor the absence of genuine constructive power. To build a song upon one or two phrases repeated at different levels and coloured by changing harmonies to suit the requirements of the poetic text (as in "Fur Musik" and "Du bist elend") is a dangerous substitute for the power to formulate large and expressive melodies. But it is the method which Franz frequently pursued. His songs are mostly short and in the strophic form, some alteration being reserved to give point to the last verse. His tricks of style and procedure quickly become familiar, but the sincerity of his aims, the idealistic and supersensitive purity of his mind (which banished as far as possible even the dramatic element from his lyrics), its receptiveness to the chaste, tender and refined elements in human character provide some compensation for the lack of the larger qualities of style and imagination. His best qualities are represented in the beautiful setting of Nikolaus Lenau's "Stille Sicherheit." Adolf Jensen (1837–1879) is another of the secondary German *Lieder* writers, much influenced by Schumann; he excelled in smaller songs of gay, tender and healthy sentiment. His song cycle *Gaudeamus* contains jovial student songs. Ballads by Sir Walter Scott and lyrics by Robert Burns were set by Jensen, who was himself both a singer and pianist.

A higher value than is usually conceded attaches to the songs of Peter Cornelius (1824–1874), a friend of Liszt and Wagner, but a follower of neither. Before he came under their influence he underwent a severe course of contrapuntal training so that his work, though essentially modern in spirit, has that stability of structure which makes for permanence. He was, moreover, an accomplished linguist, a brilliant essayist and a poet. That intimate fusion between poetry and music which, since Schubert, has been the ideal of German song is realized in an exceptional manner when, as with Cornelius, librettist and musician are one person. Finer declamation is rarely found than in his subtly imaginative "Auftrag," while for beauty of feeling, apart from technical excellencies of a high order, the *Weihnachtslieder,* the *Brautlieder* and much of the sacred cycle *Vater Unser* are hardly surpassed even by Schumann at his best, and point to Cornelius as one of the most beautiful and original spirits of the 19th century.

Brahms and Wolf.—The *Lieder* tradition of the 19th century culminates in the work of Brahms and Hugo Wolf, who adopted opposite solutions of the conflict of literary and musical values inherent in all song writing. Brahms is on the musical line but derives from Schubert; Wolf on the more literary that emerged in Schumann. The songs of Richard Strauss and Gustav Mahler show the tradition in a glorious decline.

The unerring sagacity of Johannes Brahms (1833–1897) discerned that the possibilities of song on the lines set by Schubert were far from being exhausted. A broad melodic outline was for him essential, also a strong contrapuntal bass. In form the majority of his songs are strophic and follow the orthodox ABA or AABA pattern (the letters standing for stanzas), the central portion (B) being so organized as to offer, with the least possible introduction of new material, a heightened contrast with the opening portion through changes of rhythm and tonality, and at the same time to justify itself by producing the mood in which the return to the opening portion is felt as a logical necessity. Chromatic effects in Brahms's scheme of melody are rarely introduced till the middle section, the opening being almost invariably diatonic. It must, however, be admitted that Brahms's formal perfection involves some awkward handling of words, as in the second stanza of "Feldeinsamkeit"; sometimes, as in numbers 3 and 4 of the *Magelone* romances, they are frankly sacrificed to that formal development of material which has already been criticized in the cases of Mozart and Beethoven.

No part of his songs deserves closer study than the few bars of instrumental prelude and conclusion, in them is enshrined the very essence of his conception of a poem. It may almost be said that, since Schumann set the example, the first and last word have passed from the voice to the instrument, from the singer to the accompanist, who is called upon to understand poetry as well as music. Mastery in close organization of form was allied in Brahms not only with the warmth and tenderness of romance but with the imagination and insight of an earnest thinker. Concentration of style and of thought are nowhere else in the history of the *Lied* combined on a plane so high as that which is reached, with all the perfection of melodic and harmonic beauty, in "Schwermuth," "Der Tod, das ist die kühle Nacht," "Mit vierzig Jahren," "Auf den Kirchhof," "O wüsst' ich doch den Weg zurück," and the *Vier ernste Gesänge,* which closed the list of his 197 songs. The alliance to song of so dangerous a companion as philosophy or at any rate of thoughts which are philosophical rather than lyrical, proved no obstacle to Brahms's equal success in the realm of romance. This side of his genius may be illustrated by numerous songs from the *Magelone* cycle (notably "Wie froh und frisch" and "Ruhe, Süssliebchen") and by many others such as "Liebestreu," "Die Mainacht," "Feldeinsamkeit," "Wie rafft' ich mich auf in der Nacht," "Minnelied," "Immer leiset wird mein Schlummer," "Lerchengesang," "Wie Melodien zieht es," "Geheimniss" and "Dein blaues Auge."

It has already been said that Brahms was a student of Schubert. If he had not Schubert's spontaneity of melody, he restored melody to its Schubertian place of supreme importance. In spite of all the tendencies of his age, he never shirked that supreme test of a composer, the power to originate and organize melody, though the long phrases, the wide skips and a certain uncompromising quality make his songs seem austere. But that Brahms is not difficult without reason, or elaborate when he might have been simple, may perhaps be assumed from the preference he felt for his slighter songs in the *Volkstümlich* form and style (*e.g.,* "Abschied," "Sonntag," "Vergebliches Ständchen" and "Wiegenlied"). He was strongly influenced by the *Volkslieder* of his country, the words of which he loved to repeat to himself, as they suggested ideas even for his instrumental compositions. His arrangements of *Volkslieder,* though not uniformly successful, mark an epoch in that field of work. Curiously enough, his love of folk songs did not involve the sense which distinguishes between the genuine and the sham. Of the 49 *Volkslieder* published without opus number in 1894 by far the greater number were imitations which are really quite easy to recognize as such. (*See* Max Friedländer, *Brahms's Lieder*). The value of his arrangements may be tested by comparing them with the small volume containing arrangements by Franz, which are ingeniously done but without inspiration, with those of W. Tappert, which are models of what such things ought not to be, and with the dull, uninviting work of A. Saran. Many of Hugo Reimann's arrangements, however, deserve recognition as both sympathetic and scholarly. One fact emerges from the study of folk song arrangements, in Germany and elsewhere—there are no general principles for success except that they must be done with love and not with a desire to "make something of" the folk song.

The songs of Hugo Wolf (1860–1903) are discussed in the article under his name. They represent the application of the principles of Wagnerian music drama to lyrical song, the piano performing and functions of Wagner's orchestra in illustrating, commenting and enlarging on the text, which is treated with the most scrupulous respect. His songs are therefore something quite new in the relations of the two arts, and he recognized the fact by publishing them as "songs for voice and piano" instead of "songs with piano accompaniment."

The above summary of German song, though necessarily incomplete and confined to the most conspicuous names, may yet provide some points of view from which the songs of other countries may be regarded, especially those in which German conceptions and German methods of technique have been dominant factors. Actual settings of German lyrics figure largely in the works of many non-German composers and can hardly be judged except by German standards. Anton Rubinstein, Peter Tchaikovsky and Edvard Grieg are cases in point, and at a later date Philip Jarnach (b. 1892 in France of Spanish parents).

Later German Lieder.—It remains now to conclude the survey of German song by touching on the work of a few prominent later composers, who may be regarded as having enlarged the scope of the *Lied* without entirely breaking with its past.

Hans Pfitzner (1869–1949), a composer who may be counted among the old romantics, enriched traditional form rather than created new ones. His songs are felt to be individual experiences, they are "original but not at the cost of music" (Oscar Bie), poetical and full of beauty. The charm of "Herbstlied," "Sie haben heut'Abend Gesellschaft," "So fällt ein Stern herunter," does not fade. Others worth quoting are "Das verlass'ne Mägdlein" and "Denk' es, O Seele," which may be compared with Hugo Wolf's settings of the same words, and "Du milchjunger Knabe," of which Brahms's setting is the best known.

Max Reger (1873–1916) composed 225 songs; they are worth exploring on account of the originality of his harmonies, and his extraordinary contrapuntal skill, which he used deliberately with more thought for expression than for beauty. Overweighted with much learning, they make no great appeal to the singer's instincts. With the exception of some of the *Wiegenlieder,* especially "Wiegenlied-Maria," some of the *Schlichte Weisen* (especially "Waldeinsamkeit") and a few of his later songs, such as "Volkslied," "Sterbendes Kind" and "Unvergessen," the bulk of his work in song is not likely to be remembered.

The songs of Richard Strauss (1864–1949) represent a new departure, new, that is to say, to the 19th century, to which the bulk of them belongs. He was, after Hugo Wolf, the most interesting of the modern composers who applied the principles of Wagner to song. Discarding in many cases accepted forms, he found freer play for his exceptional gifts in the matter of pictorial illustration and emotional colour. It is not surprising, therefore, that he originated no great melodies, or indeed, composed many purely melodic songs, apart from such exceptions as "Morgen" and "Du meines Herzens Kronelein," the melodies of which, if not highly organized. are graceful and appropriate. More often the phrase with which a song opens does not develop into a melody; we discover at once that the accompaniment with its rhythmical figure and changing harmonies is really in charge; and that the vocal phraseology, as the song proceeds, adapts itself to it. Though the plan is derived from Wagner, Strauss's music is both in style and feeling his own. "Ruhe, meine Seele," "Spatbot," "Traum durch die Dammerung," one of his most beautiful creations, "Gefunden" and "Schlechtes Wetter" exhibit his best qualities, among them his pouer of depicting a given mood or atmosphere and sustaining it to the end. For brilliance and effectiveness, both for voice and piano, the popular "Standchen" and "Heimliche Aufforderung" may be cited. It is noteworthy that Strauss's name is not associated, as in the case of most of the German song composers, with any particular poet. He composed no cycle unless the *Four Last Songs* with orchestral accompaniment are so regarded. Perhaps his songs came to him too easily. There is nowhere the burning intensity of Schubert or Wolf, and the feeling he had for the potentialities of the soprano voice only found its full expression in his operas.

In the songs of Gustav Mahler (1860–1911) we feel at once the presence of a tempestuous nature, tormented, restless, unsatisfied. He poured his heart into his songs. and his native land (Moravia) and the old German folk song were the inspiration of his music. What they meant to him is revealed in the series of vivid pictures, instinct with life. movement and colour, containing the four *Lieder emes fahrenden Gesellen* (originally for voice and orchestra) and in the three volumes of songs taken from *Des Knaben Wunderhorn* (a famouscollection of old German songs and ballads). They are essentially dramatic songs, even realistic, full of melody of the folk song type and provided with an accompaniment more orchestrally than pianistically conceived. The construction is apt to be loose and diffuse, with rough corners and purple passages; but they are original. alive, refreshing, worth knowing, in spite of blemishes, which are emphasized because they represent a danger to song; they bring it too close to the theatre. It should be added that the later songs composed by Mahler, after he had freed himself from operatic work. are quite different in style. They consist of five songs (not without interest) and the touching and deeply felt group of *Kindertotenlzeder*, the words of all being by Friedrich Ruckert.

There is a long list of composers who, like the above-named, are in touch with the old regime; many have written a number of attractive and well written songs, of which probably the best known are those of Felix Weingartner (1863–1942) and Erich Wolff (*e.g.,* "Du bist so jung." "Alle Dinge haben Sprache," and "Faden"). Those of Joseph Marx (1882–) are at least equally striking, and perhaps more original.

In the 20th century changes took place in the world of music quite as startling and revolutionary as those which, at the beginning of the 17th century. suddenly brought the days of vocal counterpoint and the modal system to an end and substituted harmony for melody as the basis of the "new music." Then, in its turn, the harmonic structure based on key relationship after three centuries of development, was shaken to its very base and the world talked once more of the "new music." Those who would study the "new music" in German song will find it in the later songs of Arnold Schonberg (1874–1951), in those of Anton von Webern (1883–1945), Ernst Krenek (1900–), and in Paul Hindemith's (1895–) *Die junge Magd* (for contralto with flute, clarinet and string quartet) and especially *Das Marienleben* (a cycle for soprano with pianoforte accompaniment). Schönberg's *Pierrot Lunaire* (1912) is a combination of verse and music, though it is not singing but *Sprachgesang.*

NORTHERN EUROPE

In the countries of Northern Europe, Denmark, Norway, Sweden and Finland, the *Lied* produced offshoots in nationally tinged songs, which were frequently provided with German words, to increase their potential appeal or because their composers had studied in Germany or were dependent on German publishers. The title of Niels Gade's *Neun Lieder in Volkston* is significant and Grieg's songs achieved as wide a popularity as his piano concerto. Jean Sibelius (1865–1957) wrote nearly 100 songs, of which the quality is variable, some having the popular touch of his slighter instrumental pieces. There is a classical side to him which produced better songs than these lesser essays in a more romantic vein. "The Tryst," "Jubal" and "A Song of Spring" are examples, and the visionary poetry of his friend A. V. Rydberg produced even stronger songs, such as "The War Song of Tyrtaeus" and "Autumn Evening," of which the original language is Swedish, as is the case with his two settings of Shakespeare. Sibelius's music however with its avoidance of anacrusis shows Finnish characteristics. Another Finnish composer whose reputation is built wholly on his 500 songs is Yrio Kilpinen, who set Finnish, Swedish and German words.

THE LATIN COUNTRIES

France. — The Latin countries have been but little subject to German influences. France especially has always found from age to age, and notably in modern times, solutions of its artistic problems which have proved of deep interest to those who live beyond its borders, they bear emphatically a French hallmark.

Allusion has already been made to the French as pioneers in establishing solo song to lute accompaniment, which there, as in Italy, originated in adaptations of polyphonic compositions. But in France from the first the main influence apart from opera has come from popular sources, the native folk song and the vaudeville, the ditties of country and town. In both that union of grace, simplicity and charm, characteristic of the French nation, tended to produce an art of dainty unpretentious attractiveness. It preserved these characteristics in spite of the artificial atmosphere of the French court, in which it mainly flourished up to the time of the Revolution. In spite, too, of the somewhat different influences derived from opera, the mania for which did not, as in Italy, kill the smaller branch of vocal music. Brunettes, musettes. minuets, vaudevilles, beorgerettes, pastourelles, as the songs were styled according to the nature of the poetry to which they were attached, may be found in Jean Baptiste Weckerlin's *Echos du temps passe,* 3 vol. (1855).

The melodious style of Charles Gounod (1818–1893), whose earlier songs are excellent. is felt as a real influence in the work of Jules Massenet, Benjamin Godard, Camille Saint-Saens. C. P. L. Delibes, Georges Bizet, Edouard Lalo, Cécile Chaminade, Reynaldo Hahn and others, but it yielded to tendencies which corresponded closely with those of the Impressionist movement in French literature and painting. The new movement owed much to the work and inspiration of Cesar Franck (whose contribution to song is small) but more to that of Gabriel Fauré (1845–1924). The style of this master was new and individual. His harmonic conceptions. at first considered strange and revolutionary, were soon justified by the subtle effects of mood which they enabled him to express. as. for example, in "Les Roses d'Ispahan," "Dans les ruines d'une abbaye." "Nell," "Le Secret," "Lydie" and "Les Berceaux." If much of his work in song may be regarded as experimental, this cannot be said of Henri Duparc (1848–1933) whose 1j songs rank among the treasures of French art. They are characterized by an individual warmth, both of feeling and colour. The quietly moving, subtly blending harmonies and the smooth but expressive melodic line, most grateful to sing, are of a kind which it is impossible to associate with any poetry or any language but that of France. When he is dramatic his work is brilliant but without forced effects or violent transitions. Franck was his master. Among Duparc's finest songs are "Extase," "La Vague et la cloche," "Phydyle," "Chanson triste," and "Soupir." To the same school belongs Ernest Chausson (1855–1899), whose songs are the expression of a refined and sensitive nature, remarkable for delicate beauty of detail and form, somewhat after the manner of Duparc but on a smaller scale; *e.g.*, "Le temps de lilas," "Les papillons," "Nanny," "La colibri." With these composers may be associated Pierre De Bréville (1861–1949), Guy Ropartz (1864–1955), composer of the well-known "Berceuse," and Deodat de Séverac (1873–1921).

The startling harmonic innovations of Claude Debussy (1862–1918) exercised a strong influence upon the music and the songs not only of France but of all Europe. He discovered a pathway which had not been trodden before, and explored it so thoroughly that little is left for other seekers within the limits he prescribed for himself. The delicacy and finish of his work, in which the smallest touch tells, is remarkable, as well as the skill with which the notes carrying the words are interwoven into the fabric of the music. The method is Wagner's but the style is Debussy's who makes it seem that it was made for the French language and no other. Only in the early songs and those in *L'Enfant prodigue* is his vocal line melodic. Debussy is certainly the greatest of the Impressionists. The following selection from his 48 songs exhibits the extent of his range and the variety of his style: "Je tremble en voyant son visage," "La Flute de Pan," "Recueillement.," "Clair de lune," "Fantoches," the songs in *Ariettes oubliées*, the three Villon Ballades and the terribly powerful "Noel des enfants qui n'ont plus de maisons," composed in 1915

Maurice Ravel (1875–1937) is a master of clear and effective delineation What he aimed at he achieved. Debussy suggests, Ravel defines, but his definitions are difficult both to play and to sing. His most characteristic songs are the sets *Shéhérazade* and the *Histoires naturelles*, the latter a series of brilliant pictures, full of elaborate and effective detail; of these "Le Paon," "Le Cygne" and "Le Martin-pêcheur" are the best known.

The next generation was for a time dominated by "Les Six," of whom Darius Milhaud (1892–), and Francis Poulenc (1899–) became song composers of serious intentions and achievements. Poulenc wrote a "Le bestiaire" on the times of Ravel's *Histozres naturelles* and many songs for the baritone. Pierre Bernac.

Italy and Spain.—Italy, absorbed in opera, did not contribute much that is likely to have permanent value to 19th-century song, but the finished work of Giovanni Sgambati (1841–1914) is worth knowing. He composed more than 40 songs, of which *Quattro melodie*, Op. 35, and the setting of the old Italian folk song "Separazione" may be cited as characteristic. Ottorino Respighi (1879–1936) studied with Nicolas Rimsky-Korsakov and Max Bruch, but his songs are individual—though not eccentric. Among them are "Nebbie," five charming "Canti all' antica," and the dainty "Stornellatrice." His pupil I. Pizzetti (1880–) in "I pastori," with its fine modal character, effective declamation and cross rhythms composed a remarkable song full of interest for both singer and pianist In Spain the "Trois Mélodies" and particularly the very striking arrangements of seven *Canciones populares* of Manuel de Falla (1876–1946) deserve special mention. Also a collection of 14 old Spanish airs of the 17th and 18th centuries arranged elaborately and with singular insight by Joaquin Nin. The composer includes in each volume a valuable introduction—in French as well as Spanish.

RUSSIA

Russian song deserves more attention than can be given to it here. Since Michael Glinka (1804–1857) released it from Italian influences, and by impregnating it with the spirit and the idiom of the folk song, made it, at least in his own work, national, it has steadily increased in importance. There is a fairly large store of good songs by Russian musicians, but they are only in part Russian, their general conception and to a large extent their technique being derived from the masters of the German *Lied*. They represent a hybrid art which, though full of interest, pales beside the entirely Russian work of one man of genius, Modeste Mussorgsky (1839–1881). Through him, in his songs as much as in his operas, it seems as if the very heart of the strange Russian people nere revealed. His style is sometimes undisciplined, his realistic painting sometimes crude—natural in an art where colour counts for more than line—but there the pictures stand, throbbing with life, memorable. Many a village tragedy is the subject of his song. Death himself appears, terrible but kind, but Mussorgsky can also sing, no one more tenderly, of the cradle and the nursery; there is humour and satire too Of the romantic sentiment, characteristic of Germany, there is no trace In the music of Europe he proved a potent Influence opening the doors of song to admit subjects hitherto thought impossible or unsuitable to set Of his 40 or 50 songs most are definitely melodious; in others the voice part approximates to the rise and fall of the voice in speech, an ideal of song writing nhich he consciously pursued; in all strong rhythm is an outstanding feature In his last years he composed the four *Dances of Death* and the cycle of six songs *No Sun*, ahich rank among the most intensely moving songs ever nritten, tragically sad, but full of beauty. Mussorgsky was one of the four whom Mily Balakirev drew together to form with himself a "nationalist" band of composers The others were Borodin, César Cui and Rimsky-Korsakov. Borodin's "Romance" and "The Sleeping Beauty," Cui's "Hungersong," Rimsky-Korsakov's famous "Song of India," "Believe me not" and Zuleika's song are all good. To this group of composers must be added the names of the more cosmopolitan Tchaikovsky, Sergei Rachmaninov, A. Grechaninov and A. Glazunov. Tchaikovsky's "Nur wer die Sehnsucht kennt" is probably the best of his numerous songs. "The Dreary Steppe" and "Slumber Reigns" are characteristic of Grechaninov Rachmaninov's "To the Children" and "The Harvest of Sorrow" are truly Russian, the one of rare tenderness and beauty, the other heavy with grief.

Nicholas Medtner (1880–1951), a Russian composer of German descent, is in his music both German and Russian. He composed songs in both languages, orthodox in form, but elaborate in texture, difficult to play and, at first, to understand but both on musical grounds and for their serious import well worth unravelling. They are the work of a forceful personality, not making experiments, though he wrote a sonata-vocalise and a suite-vocalise for voice and piano. Among his Russian songs may be cited "Whisp'-ring Nature faintly stirring," "O'er thee I bend," and "I have come to say, Good-morning" Op 24, "The Singer" and "The Muse" (Pushkin) Op. 29, "The Valse" and "To the Dreamer" (Pushkin) Op. 32, "Sleepless Nights" (Tutchevj and the Valse, Op 37; among his settings of Goethe, "Die Sprode," "Die Bekehrte" and "Einsamkeit"; of Nietzsche, "Verzweiflung"; of Eichendorff, "Winternacht," and of Chamisso, "Die Quelle" and "Frisch gesungen."

ENGLISH SONG

Successors of the Lutanists.—The beginnings of English song have already been alluded to in speaking of Dowland, Campion, Rosseter and Jones. The subsequent work of Henry Lawes, and his contemporaries William Lawes, Charles Coleman and John Wilson, was unpretentious and simple. Gems here and there, such as "Gather ye rosebuds" (W. Lawes) and others contained in two small volumes edited by A. Dolmetsch, are the student's reward for a good deal of uninspired and tentative work, in which the main object of composers was to "follow as closely as they could the rhythmical outlines of nonmusical speech: they listened to their poet lriends reciting their own verses and then tried to produce artificially exact imitations in musical notes," (Ernest Walker, *History of Music in England*), producing what was neither good melody nor good declamation. Such work, in spite of John Milton's sonnet to Henry Lawes, could only have a passing vogue, especially with Henry Purcell (1658?–1695) so near at hand to show the world the difference between talent and genius, between amateurish effort and the realized conceptions of a master of his craft. Songs like "Let the Dreadful Engines" and "Mad Bess of Bedlam" reach a level of dramatic intensity and declamatory power, which is not surpassed by the best work of contemporary Italian composers. "I attempt from love's sickness to fly" is so familiar in its quiet beauty. that we are apt to forget that melodies so perfectly proportioned were quite new to English art (though John Blow's "The Self-banished" deserves to stand side by side with it). Monteverdi's "Lament of Ariadne" already has been mentioned, and it is interesting to contrast its emotional force with the equally intense but more sublime pathos of Purcell's "Lament of Dido," in which song a ground bass is used throughout. The "Elegy on the Death of Mr. John Playford" (quoted in full by Walker in his history) exhibits the same feature and the same mastery of treatment. The "Morning Hymn" is scarcely less remarkable, and has likewise a ground bass. Purcell died, aged 37, in 1695; Bach and Handel were then but 10 years old. and Scarlatti, born in 1659, had still 30 years to live—facts of which the significance may be left to speak for itself.

It is among the ironies of musical history that so great a beginning was not followed up. There are echoes of Purcell, stronger ones still of Handel, in the generation that succeeded him, in William Croft, Maurice Greene and William Boyce; but they quickly died away. From the death of Purcell to the Victorian era there is no consistent development of artistic song that is worth recording in detail. Thomas Arne (1710–1778), it is true, composed many fine songs that deserve to be better known. Those which have survived are mostly of the melodious order, still acceptable for an air of freshness and gracefullness that marks them as his own, *e.g.,* "Where the Bee sucks," "Blow, blow thou winter wind" and "Lovely Phyllis." Song writers that followed him, H. R. Bishop, W. Shield. J. Hook, C. Dibdin, S. Storace, C. E. Horn and T. Linley (the elder), were all prolific melodists. who have each left a certain number of popular songs by which their names are remembered, and which are worth hearing occasionally, but there is little attempt to advance, in new directions, no hint that song could have any other mission than to gratify the public taste for tuneful melodies allied to whatever poetry—pastoral, bacchanalian, patriotic, or sentimental—lay readiest to hand A good song appeared now and then, but seldom of serious import.

The 19th-Century Revival.— Who can uonder at the delight with which England welcomed the songs of Mendelssohn? It was in his school of Leipzig that William Sterndale Bennett (1816–1875), the first serious composer of songs in England for nearly a century, received his training. His output and range are small, but the quality of his work is delicate and individual. "To Chloe in Sickness." "Dawn, Gentle Flower," "Gentle Zephyr," struck a note that was new in English song. But he gave to his country a new ideal. Arthur Sullivan (1842–1900), more original, more richly endowed than Bennett, was also trained at Leipzig. Though his reputation has suffered from songs which satisfied the public rather than his own ideals ("The Lost Chord" and "The Sailor's Grave") there are many which have real value, *e g.,* his settings of Shakespeare's lyrics ("O Mistress mine." "Orpheus with his lute." "Where the bee sucks"), of Tennyson's cycle *At the Window* (in which the influence of Schubert is clear), "Tears, idle tears" and "Swallow, Swallow, flying south." and of George Herbert's "Sweet day, so cool." in all of which the touch of genius is unmistakable. It is obvious from songs like these and from the occasional appearance of others, such as John Hatton's "To Xnthea." Charles Salaman's "I arise from dreams of thee," Frederick Clay's "Songs of Araby" and "The Sands of Dee." that new ideals were in the air. In their further realization the increasing familiarity of the musical public with the masterpieces of German song may be reckoned as an important factor.

In the early 1880s, when Hubert Parry (1848–1918) and Charles Villiers Stanford (18 j2–1924), who was also at Leipzig, appeared, it was seen that song was at last taking its proper place in musical art. Parry's early songs are delightfully fresh and melodious, "The Poet's Song," "On a day, alack the day," "Why does azure deck the sky?" The three stirring "Anacreontic" odes mark the transition to that individual style which made the appearance of "Prometheus Unbound" one of the landmarks in England's musical history. He composed about 150 songs in all, the bulk of which are in the 12 volumes of *English·Lyrics.* Breadth, dignity and sincerity, with a nobility of thought and feeling characteristic of the composer. mark the serious numbers, "Through the Ivory Gate," "When we two parted." "Armida's Garden." Equally characteristic are those in which he is boisterous or humorous as in "Crabbed Age and Youth," "The Laird of Cockpen," "Follow a Shadow"; or atmospheric, as in "Dirge in the Woods" and "4 Fairy Town"; or in light and happy vein. as in "Ye Little Birds," and the entirely charming "A Lover's Garland:" With all the good qualities of Parry's songs something is lacking in the majority of them, which may perhaps be described as that intimate lyric note in which heart and voice and instrument sing together. The melodic freshness of his early days grew less in the increasing awkwardness of his piano technique and. perhaps, in the determination at all costs to have his word declamation right. In this he was entirely successful. setting an example which has been of great value to English song.

Stanford composed about 150 songs. If the settings of the poems from George Eliot's *Spanish Gypsy,* Op. *I,* are placed beside the songs of *The Glens of Antrim*, probably the last he composed, it is seen at once that the harmony which adorns the melodies of the former is singularly rich, and that in the latter it is reduced to the barest minimum—and yet it suffices. This gives us the trend of Stanford's work in song—increasing mastery of his resources of technique through the severe principle of economy. not two notes where one will serve. If the expressive colour of "The Radiant Dark." is fine; the astonishing simplicity of "Spring" is perhaps the greater achievement. Between these poles in the long list of Stanford's songs every variety of colour and complexity will be found, but not unduly lavish display. In the work of no composer are the means more perfectly suited to the ends. Arresting songs could be cited in many styles. especially those in *An Irish Idyll* (Moira O'Neill). There, in six pieces of rarest beauty he has portrayed against a background of Irish wind, sky. mountain burn and loch, all that is most lovable and most deep in the Irish character, its wistfullness and its pathos, its sunshine and gloom, its seriousness and humour, with a poetical and imaginative power of a kind which is unique. In these will be seen the sureness and delicacy of his touch not only on the spirit of each song but on the exact words with which it is conveyed. Poetry and music are fused without sacrifice on either side; the unity is complete. in further illustration are the "Corsican Dirge," the remarkable ballads, "La Belle Dame sans Merci" and "The Pilgrimage to Kevlaar," also "Three Cavalier songs" (Browning). "A soft day," "The Pibroch," "The Chapel on the Hill," "Easter Snow," "The Monkey's Carol," "Grandeur," "Daddy-long-legs." No less masterly are his arrangements of Irish folk songs of which there are four volumes.

20th-Century Development.— In the next generation no one composer was so prolific of songs. Arthur Somervell (1863–1937) and Roger Quilter (1877–1953) will survive by virtue of their songs rather than their other work. Somervell produced a body of work characterized by sincere and tender feeling, instinct with a quiet beauty which is individual and charming. Larger qualities appear in the admirable cycle from Tennyson's *Maud,* in *A Shropshire Lad* and *Love in Springtime* (the last named containing the singularly beautiful "Young Love lies sleeping"). "The Shepherd's Cradle Song," "Once at the Angelus," "When I am dead, my dearest," and "Weep ye no more, sad Fountains," deserved to be remembered.' They are real songs. grateful to sing and without pretentiousness or pose. Somervell has arranged many folk songs. in *Songs of the Four Nations* and two volumes of *Welsh Folk-songs,* with notable skill, taste and sympathy.

Quilter's is a muse of charm and delicacy, his German training did not overlay his English sentiment though the sweetness of his harmony owes nothing to Purcell or folk song. Typical in its fragrance and lack of pretension is "Now sleeps the crimson petal" (Tennyson) and he found an affinity with Robert Herrick in his "Julia" songs. Two sets of Shakespearian and Elizabethan lyrics contain more robust examples of his essentially lyrical art.

John Ireland (1879–1962), also a song writer, has other titles to fame. notably his piano music. but his settings of Thomas Hardy and A. E. Housman and John Masefield sound a distinctive note and his "Sea Fever" achieved a well-deserved and enormous popularity. Ivor Gurney (1890–1937) and Peter Warlock (1893–1930), younger men of Ireland's generation, both died in their early maturity. Gurney, a pupil of Standford. set contemporary (Georgian) verse besides Elizabethan poems and was himself a poet in whom the identification of poet and composer thus recalled Campion. In Warlock, whose personality was a divided one. as was Schumann's, the robust songs are influenced by the Elizabethan poets and composers, the more reflective by Frederick Delius (1862–1934), who left about 40 songs to Danish. Norwegian. German, French and English texts. It is not surprising therefore that the general drift of the poem meant more to Gurney than either the claims of exact declamation or of sheer melodic beauty. Warlock was more careful in these matters, and he had a peculiar felicity in providing modern settings to mediaeval carols.

But already before World War I another composer of greater stature had begun to make his presence felt. The music of R. Vaughan Williams (1872–1958) was influenced at its formative stage by the rediscovery of English folk song with its modal melody and rhythmic freedom. An early song, "Linden Lea." is perhaps the only true *Volkstümliche* song in English music. In his youth Yaughan-Williams found inspiration in D. G. Rosetti, of whose sonnets he made settings from which one, "Silent Noon," is a masterpiece. Outgrowing Rosetti he turned to R. L. Stevenson and produced the open air *Songs of Travel* which first made him widely known. He went on to the mystical poets of the 17th century — the *Five Mystical Songs* of George Herbert contain the rapt "The Call" and the triumphant "Antiphon." Williams set Shakespeare intermittently all his long life — there are. for instance, two quite different versions of "Orpheus with his Lute." 30 years apart. Song writing became less during his main symphonic period, but "The Water Mill" is a sort of Theocritan idyll like nothing else in the long tradition of English solo song. His arrangements of folk songs for voice and piano, which run into scores in number. show an extraordinary integration of their communal and idiosyncratic elements. George Butterworth (1885–1916), who was killed in World War I. followed the path opened by Vaughan-Williams in basing his style on folk songs, making excellent settings of them and establishing his independence in a cycle of songs from *A Shropshire Lad*. Arnold Bax and Arthur Bliss both composed songs but only as a relaxation from work in the longer forms. Gerald Finzi of a still younger generation (1901–1956) derived something. though more indirectly. from folk song. He had an affinity with the mystical poets. and with Hardy; in his piano accompaniments he sometimes borrowed from Bach the methods of the figured chorale with fresh and subtle effect. Benjamin Britten (1913–), an enormously prolific composer who by the time he was 35 had composed in every form except Biblical oratorio, and had done more than anyone else to raise hopes for the rise of a British school of opera. reveals an imagination quicker to take fire from words than from purely musical sources. His contributions to the literature of English song are large. though in his youth he had a propensity to choose foreign and even outlandish words for setting. *Les Illuminations* is a cycle to words of Arthur Rimbaud with string orchestra. Another cycle with string orchestra plus a horn is *Serenade* (English words). *Seven Sonnets of Michelangelo, The Holy Sonnets* of John Donne, *A Charm of Lullabies*, and *Winter Words* (Thomas Hardy), are all song-sequences with piano and the individual song is not prominent in Britten's output. Even his settings of folk songs and realizations of Purcell are issued in groups, but he has experimented with two more extended forms of solo vocal music in two Canticles. The long tradition of English solo song going back to the "Agincourt Song" of the 15th century is still very much alive. (*See* also FOLK-SONG.)

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(W. FD.; F. S. H.)

SONG IN THE UNITED STATES

Even in the 17th century. colonial America imported and enjoyed song. Although the *Bay Psalm Book* (1640) acquired no printed tunes until the edition of 1690, and the absence of instrumental support made congregational singing a confused uproar, the Puritan frowning on secular music seems to have been largely official.

From the 1730s, concerts of vocal and instrumental music were presented in Boston, Charleston, S.C., New York, Philadelphia, and Williamsburg, Va. New York city heard Handel's *Messiah* two years earlier than did Germany. The Moravian community of Bethlehem. Pa., imported the symphonies and quartets of Haydn and Mozart. and before the century ended performed Haydn's *Creation* and *The Seasons*. Native composition was religious. the most original contributions being William Billings' "fuguing tunes," which later suggested exhilarating efforts by Henry Cowell. Negro singing impressed Thomas Jefferson in 1784, and mountaineers in the southeastern Appalachians preserved and transformed many traditional English ballads. Francis Hopkinson (1737–1791) and James Lyon (1735–1794) are usually reckoned the first secular composers.

At the beginning of the 19th century, English and German musicians dominated the scene — especially. James Hewitt, first of a long line of musicians, and Gottlieb Graupner, who helped to found the Boston Handel and Haydn society. He also appears to have sung "The Gay Negro Boy" to his own banjo accompaniment, perhaps initiating the trend toward Negro minstrelsy. But the native Lowell Mason (1792–1872) contributed largely to hymnology in the United States (for example. "Nearer, My God to Thee"), and founded the practice of musical instruction in the public schools, which was to become the most comprehensive musical effort in the United States. A few musical institutions destined to survive were established — including the Musical Fund society of Philadelphia (1820) and the Philharmonic Society of New York (1842,) — but the heart of the nation was won by such songs as "Rocked in the Cradle of the Deep." "Woodman, Spare That Tree," and highly sentimental effusions on mother love and disappointed affection.

The only national tune to sprout in United States' soil was the weedy but irrepressible "Yankee Doodle." of revolutionary days. But the Negro Minstrel Show, launched by Dan Emmett in 1843, speedily became. and remained until the end of the 19th century, the most popular entertainment, capturing English audiences as well. And it was Christy's minstrels which made the nation aware of its first authentic genius — Stephen Collins Foster (1826–1864). Foster's musical learning and experience were pitifully meagre. but his gift of melody was as genuine as that of Schubert, and the influence of his best songs on the taste of his countrymen is incalculable.

The European revolutions of 1848 drove many notable musicians to the United States. The Germania society, an orchestra of 25, showed New York city and Boston what finished orchestral performance might be. It disbanded after six years, but scattered its members over the country as excellent teachers. Jenny Lind —an unprecedented success under P. T. Barnum's management, although, as Mendelssohn said: "she sings bad music the best"— offered the nation a perfect example of the singer's art. Germans settled numerously in the Mississippi valley and founded in Cincinnati: St. Louis and Milwaukee strong choral societies which, combined with others in the North American Saengerbund, sponsored huge choral festivals offering valuable opportunities both to singers and composers. No lasting compositions were forthcoming. but the stature of musical art was revealed. largely through song, to a rapidly growing musical public. The Civil War impeded this revelation. It did produce some notable war songs — Emmett's inimitable "Dixie," "Johnny Comes Marching Home." etc.—and the burning question of slavery doubtless intensified the general interest in the Negro spiritual. the United States' truest folk music. But the seepage of German musical thought into the general consciousness gradually bred the soon widespread notion that study in Europe was essential to an American musical career. Both performers and composers underwent the often pedantic discipline of the German tonservatories. The composers were indeed taught to write. But they were also taught *what* to write, and as their ambition soared toward symphonic heights, their thought lost contact with life as lived in the United States.

Returning home, they discovered this disjunction. and often remedied it by founding music departments in colleges, in whose atmosphere their unconscious pedantry could breathe. The growing movement in the public schools was thus continued on the collegiate level—not without benefit. certainly, to the national taste? but also not without danger to its integrity. But. unless in pretentious choral works, song was regarded as a minor endeavour. Even by the best-trained of returning talents, feeble texts on trite themes were preferred to the endless riches of English lyrical poetry. But this indifference was not necessarily due to ignorance of that body of verse, or to insensitiveness to poetic appeal. Neither was it due to the supposed unsingableness of the English language. The German language is no more mellifluous than English; yet the German lyric literature has evoked the richest body of song. And it may be argued that the German lyrists, familiar with music and aware of its peculiar powers of expression, often anticipated the rounding out of their poetic image by the musician, and left it to him to create in tone that atmosphere of sound which was essential to the full embodiment of their poetic image. The English poets of the Romantic era (the song was a product of romanticism) lived in a society far less musical than the German, and anticipated nothing more from the musical composer than a possibly agreeable but (in their view, really superfluous) tonal decoration of their verse. Thus they not only introduced a variety of images quite impossible for the composer to complement in tone (it takes time to develop a musical image. whereas, for a poetic image, a single word may suffice), but contrived an onomatopoetic "atmosphere" so suggestive as to make needless any musical complement or amplification. It is thus quite possible that English lyric poetry is too complete in itself—is, in a sense, too good—to be set to music.

Thus neither J. K. Paine (1839–1906) nor his lesser contemporaries. W. W. Gilchrist. F. G. Gleason, and S. G. Pratt continued to be performed. The next generation. still confronted by growing but inexperienced audiences. also treated the song as a minor form. The salty G. W. Chadwick wrote more than 100 songs, of which only the "Ballad of Trees and the Master" remained impressive. Arthur Foote (1853–1937), without European training, had the vision of a cultured gentleman and within that field his insight was keen and his imagination sensitive. Horatio Parker (1863–1919) was more interested in choral than solo song; but in retrospect even *Hora novissima* seems perfunctory. Edward MacDowell (1861–1908) was at the turn of the 20th century the foremost U.S. composer. About a third of his work is in the song. He found many captivating melodies, but his texts (he wrote several himself) were often banal and his rhythms and repetitions distressingly inept. Mrs. H. H. A. Beach (1867–1944) won wide recognition as an instrumental composer. Three of her 150 songs—"Ah, Love, but a Day," "The Year's at the Spring," and "Ecstasy"—were general favourites. Ethelbert Nevin (1862–1901), whose "Rosary" was anathema to the learned but manna to the million, formed a kind of link between the lower and upper levels.

Opera, in America as in England: was always exotic; but the Metropolitan began in 1910, with Frederick Converse's one-act *Pipe of Desire,* to recognize native production. H. W. Parker's *Mona,* Walter Damrosch's *Cyrano,* and Deems Taylor's *King's Henchman* and *Peter Ibbetson* were largely in the European tradition. Howard Hanson's *Merry Mount* had a New England theme, couched in an idiom derived but often forcefully projected. The greatest operatic successes! however, were in the really native jazz—Louis Gruenburg's *Emperor Jones* and George Gershwin's *Porgy and Bess.* Both Reginald De Koven and Victor Herbert wrote grand operas, produced at the Metropolitan Opera house, but their lighter' pieces were true successes. Musical comedies or shows (the new names for light operas) such as those of Richard Rodgers and Oscar Hammerstein provided the bulk of popular song, but Gian-Carlo Menotti (*The Medium, The Consul,* etc.), Italian by birth but trained in the United States, bid fair to bridge the gap between the popular and the esoteric.

Learned opinion, under the influences just suggested, was inclined to avert a rather shocked gaze from the so-called "popular" music, much of which. being set to words, was undeniably a species of song. But one variety of this species, the Negro spiritual, possessed a vitality that gave rise to a considerable progeny. For not only did the spiritual, as a religious expression. arouse fine interpreters. both Negro and white, to serious effort. The Negro, not ashamed to enact with his own body his religious exaltation, spontaneously invented for its release new and compelling rhythms which American youth turned—quite without thought of their religious origin—to the purpose of secular enjoyment. The first result was the "ragtime" of the 1890s, which the learned of those days contemptuously dismissed as mere syncopation. Newer variants were given such names as "jazz." "swing," "boogie-woogie" (this latter an apparently unconscious adoption of the old passacaglia or "ground bass" principle), and "bebop": all with a deplorable deterioration in the texts, but all—with a similar deterioration in vocal tone—still often presented in the guise of song. Yet this music showed an ingenuity in arrangement and performance which many European composers recognized as America's only original contribution to musical thought, and which they frankly adapted to their own purposes.

Rhythmic interest predominated in this music. Melodic invention became rare. Only a few of the thousands of pieces that rose to prominence on the "hit-parades" proved to possess any enduring melodic interest; but the few that survived; *e.g.,* Hoagy Carmichael's "Star Dust" and Cole Porter's "Begin the Beguine," did possess that interest. And a considerable number of these hits borrowed their melodic lines from Chopin and other classic composers (in common parlance music came to be classified as "classic." "semiclassic" and "popular"). demonstrating once more the truth of Mozart's contention that melody is the essence of music. These melodies, however, were distorted by jazz-rhythmed accompaniments and by re-shaping them into the 4–4 time which was the only measure in which jazz musicians could think; and texts were provided uhich even the "torch singers" probably would have blushed to pronounce merely as words. Once established in popular favour, these pieces often were played as instrumental compositions purely to arouse, the dance-impulse being the evident objective of the performers.

The chief impediments to an early U.S. song literature—the rawness of the general public and the prevalence of European tradition—had been largely removed by the early 20th century. But another and perhaps a greater impediment then arose—a new musical idiom. Obscure rhythms, elusive melodic intervals, and "linear" counterpoint destructive of the old lahdmarks of tonality, yielded music performable on Instruments but difficult for average voices and confusing to average ears. (It should be noted that this idiom originated in Europe.) A new versification. also elusively measured, was likewise adopted by the poets. It cannot be denied that the new music made (but often by back-tracking toward older tradition) impressive headway and threw into high relief the flimsiness of much former conventional thinking. It seemed unfavourable, however, to a generally impressive treatment of the song.

The difficulty of the idiom, rather than indifference to the form, seemed to account for the considerable neglect of song by composers of the 1950s. Music appropriate to their verse was never anticipated by the English poets as it was by the 19th-century Germans. and that compatibility of word and tone uhich marks the masterpieces of a Hugo Wolf nas apparently harder to achieve in the existing than in the older idiom. The first of the "modernists" was Charles T. Griffes (1884–1920) who began with conventional settings, turned for a time to German texts (as did Charles Ives and others), then began to reveal the fertility of his genius—and died. Samuel Barber. at first a timid innovator, set Arnold's *Dover Beach* for voice and strings, and reached his summit with *Knoxville: Summer of 1915,* for soprano and orchestra. Besides a few ventures with surrealist verse, Barber did ten "Hermit Songs" to old Irish poems, and set three pieces from James Joyce's *Chamber Music*. Ross Lee Finney set that whole cycle, interestingly. Charles Ives (1874–1954), really the earliest and most daring of the modernists, was as provocative in song as in other fields, running the gamut from extreme simplicity to vocal conjectures almost impossible to sing, yet undeniably purposeful. Virgil Thomson, stimulated by Gertrude Stein, helped make that strange figure intelligible. Roger Sessions, Henry Cowell, Paul Creston, Aaron Copland, Douglas Moore. Paul Nordoff, Celius Doherty, Marc Blitzstein, Norman Dello Joio and a host of others contributed, in various manners, to the literature of the United States' song; but there was no aspirant to the eminence of a Hugo Wolf.

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SONGBIRD. Besides the application to any bird that sings, the term songbird has a restricted, precise meaning in bird classification. The true songbirds comprise the 53 families of the suborder Passeres or Oscines, which includes most of the great group of perching birds called the Order Passeriformes. They are well represented by many common garden birds such as sparrows, warblers, thrushes and wrens.

General Description and Natural History.—These birds vary in size from tiny kinglets and sunbirds to comparatively large crows. They are land birds which live in a wide variety of situations, from open grassland to forest. While songbirds include some of our best songsters such as thrushes, some have harsh voices like crows, and some do little or no singing. Their main food includes insects, worms, seeds and fruit picked up from the ground or from among vegetation, depending on the species. However, some like the swallows are very capable flyers and catch insects on the wing. Others, as the dippers, seek their food underwater in streams; and shrikes may catch mice and small birds.

In many species the birds pair at nesting time. The nest is most often a cup-shaped structure. However, a hanging nest is made by some species and a tunnel excavated by others. The number of eggs may vary from one, in some tropical species, to as many as a dozen in some titmice. In colour the eggs range, depending on the species, from immaculate chalky white and light tints to deeper tones, and many are speckled and marked. The young hatch with a scant covering of down at most and in a blind, neariy helpless condition. They are cared for in the nest for a time and reach full size and are able to fly well a short time after leaving the nest. Many northern species migrate to a milder climate for the winter. The greatest number of species of songbirds is in the tropics, but they are also well represented in temperate zones. A few live in the arctic, but there are none in the antarctic.

Songbirds are distinguished from the other perching birds by certain anatomical characteristics, especially the more complicated vocal organ or syrinx (*see* below).

Bird Song.—Vocalization in birds includes a wide variety of calls besides the song proper and provides a means of social communication. Man is the only other animal that exceeds birds in the use of voice, and probably no other animals approach birds in this ability. Bird song is best considered the vocalization that is used in courtship and breeding, chiefly by the male, to advertise that he is ready to mate, to attract the female and perhaps stimulate her sexually, to keep the pair together and to inform rival males that he has established a territory from which they will be excluded. The male's calls are also part of a threat display that takes the place of actual combat in repelling intruding rivals. However, similar song is sometimes given spontaneously when there is no obvious use for it. Occasionally females sing, and especially in tropical species pairs may duet, again perhaps a method of reinforcing the bond between the pair. Often the song is delivered from a series of regularly used perches. Some species, especially those that live in grasslands, have flight songs.

In some birds other forms of sound-making have taken the place of vocalization in part at least, as in the woodpeckers which drum out a tattoo by pounding on a dead branch with their bill. Some grouse drum with their wings, others stamp their feet. The winnowing or bleating of the snipe in courtship flight is caused by air passing between the outer tail feathers; peacocks rattle their quills in courtship. (*See* COURTSHIP, ANIMAL.)

Song need not be pleasing to the human ears. The hooting of an owl; the monotonously repeated phrases of the North American whip-poor-will; the crazed repeated whistle of a Malayan cuckoo that has given it the name of the brain-fever bird; and the African tinker bird's repeated notes, which from their resemblance to hammering on metal, have given the bird its name—all must be called songs. While the best songsters are true songbirds, some birds of other groups have pleasing or musical utterances, like the quavering trill of the screech owl and the cheery whistle of the bobwhite quail.

Which birds are the best songsters is a question that is subjective in part. Although national pride and pleasant associations surely have an effect. there is general agreement on certain species. The nightingale of Europe (*Luscinia megarhynchos*), which is a small thrush, perhaps heads the list of famous songsters of literature. Its beautiful brilliant song, full of sweet trills, fluted notes and liquid phrases in surprising variety, is rich and loud. The melody is often enhanced by being delivered at night when all else is still. The European skylark of the poets (*Alaudia arvensis*) soars up, singing as it goes, until it is a mere speck in the sky where it alternately flutters and sails, pouring out its joyful and melodious song. Another outstanding songster is the European blackbird (*Turdus merula*), one of the thrushes.

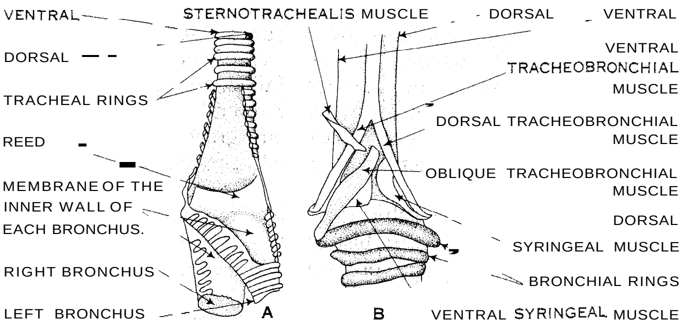
In North America the mockingbird (*Mimus polyglottos*) is a wonderful performer with a rich, melodious, long-continued song. It consists of a great many phrases with notes repeated two or three times. Imitations of other birds are often incorporated into the mockingbird's song, and on moonlit nights the bird may sing almost until dawn. Among the finest songsters are the cardinal (*Richmondena cardinalis*), with its loud clear whistles in crescendo and accelerando; the hermit thrush (*Hylocichla guttata*), with silver bell-like quality to its serene song. Townsend's solitaire (*Myadestes townsendi*) is another thrush, whose superb song consists of clear, brilliant, ringing notes that rise and fall in pitch and volume as the bird warbles and trills.

In Australia the lyre birds, which are not true songbirds, have songs which are superlative in variety and intensity and have a dramatic quality. The pied butcherbird has a richly musical flutelike song. The brown honeyeater has a song remarkably like that of the European nightingale's, and divides his song into proper stanzas.

C. Hartshorne has elaborated the concept of bird song as music. He shows there is a measure of congruity between songbirds' feeling for sound patterns and ours. Birds have in unequal degree an actual musical ability and sensibility, and their song can be considered a primitive form of music, an evolutionary anticipation of human music. Of the approximately 9,000 species of birds perhaps only a third should be considered singing species. Of these perhaps 1,200 might be said to have fairly good songs and only 225 species, scattered over the world, have really outstanding songs. Of the outstanding songsters there are 26 in Europe, 21 in North America and about 20 in Australia. It is possible that there are more outstanding bird songs in the mountains of the tropics than elsewhere.

Music consists predominantly of tones rather than noises, *i.e.*, of relatively pure sounds of a single frequency or with natural harmonies instead of miscellaneous blends of frequencies. While birds produce both noises and tones, the latter are more conspicuous in the better songs. Flutelike notes are common in bird song, though often of higher pitch than flutes. There are truly chime or bell-like, guitarlike or even organlike tones in bird song.

Bird song tends to be high pitched (this is perhaps correlated with birds' high rate of metabolism) and their hearing range somewhat surpasses ours. Notes tend to be very short and arranged in some kind of pattern. It is true that some songs are repeated over and over with slight variation, but almost always there is a pause between songs. The birds may have a shorter attention span



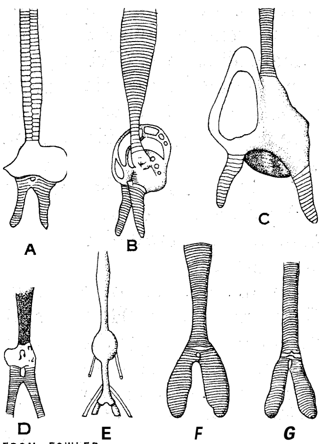
FROM FOWLER SUMMER STUDIES OF BIROS AND BOOKS (MACMILLAN LTD)

FIG. 1.—INTRICATE STRUCTURE OF A SONGBIRD'S VOCAL MECHANISM
(A) Interior view of the syrinx and (B) an exterior side view of the syrinx

and weaker memory than we have, and the monotony of certain of their songs is. therefore, heard by our ears rather than the bird's. It is significant, too, that the birds' songs which rate highest with us have a certain randomness, a quality of unpredictability. Thus the wood thrush (*Hylocichla mustelina*) has, say ten songs. which can follow one another in 90 combinations; the bird improvises scores of different contrasts in a few minutes' singing. According to Hartshorne there exists one radical inferiority in the best bird songs, when compared with human music. and that is their great simplicity in length, shonn by the brief time span of the motifs or musical units. The longest seems to be about ten seconds and only a few extend to six seconds. The average is probably less than three seconds. It is true that some birds have a repertoire that extends through a minute or two of uninterrupted singing, but these repertoires consist of discrete elements each lasting a few seconds at most. Other birds have a single song lasting a minute or longer, but this, like some insect songs, is a relatively patternless prolongation of a single sound, trill or buzz.

As well as having a primary biological function in the breeding season. when bird song reaches its height. some bird vocalizing appears to be secondarily a leisure activity or play. an effusive burst of song out of sheer joy. This is especially evident in such birds as the white-throated sparrow (*Zonotrichia albicollis*) nhich sings on migration, the many species which sing in the autumn; and such birds as the Carolina wren (*Thryothorus ludovicianus*), uhich may sing every day of the year. This off-season singing may be the species' song at its very best.

Bird song shows every elementary rhythmic effect: accelerando (field sparrow, *Spizella pusilla*). ritardando (yellow-billed cuckoo, *Coccyzus americanus*), crescendo (some thrushes), interval inversion, simple harmonic relations, retention of melody nith change in key and theme with variations. Bird song, according to Hartshorne, is always intelligible as simple music. The best singers are those with more variety and complexity in the use of elementary musical devices, and they seem to sing most.



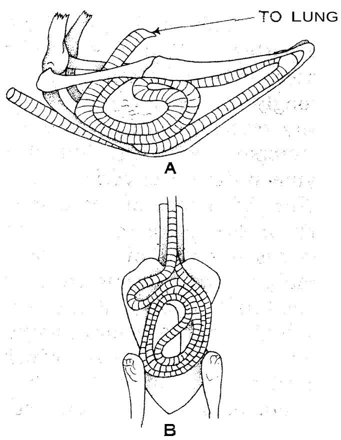
FROM FOWLER SUMMER STUDIES OF BIRDS AND BOOKS (MACMILLAN LTD)

FIG. 2 — SYRINX OF SOME DUCKS HAS AN ENLARGED BONY CHAMBER
As found in (A) mallard, (B) pochard, (C) goosander, (D) steller's eider, (E) velvet scoter, (F) male and (G) female common scoter

Bird songs have been recorded in various ways. by musical notation by graphic notation, by fitting words to the song, by describing it in words and by capturing it on tape or phonograph disc. But a most useful way for analyzing and comparing bird song is the sound spectrograph which turns the song into a visual pattern recorded on paper. One of the important uses of this, by W. H. Thorpe of Cambridge university, was in a study demonstrating that in some birds the song is innate, while in others it is partly innate and partly learned from others of the same species. This learning takes place only in the early part of the bird's life.

Vocal Organs. — The syrinx, as the voice-producing structure or song box is called, is located at the point where the windpipe divides into two bronchial tubes to go to the lungs. (See fig. 1.)

The syrinx is an intricately constructed organ with a firm bony framework and filmlike vibrating internal membranes over which the air, during exhalation, passes rapidly, producing all the many utterances of the bird. A variable number of syringeal muscles and their controlling nerves adjust the tension on the membranes. The song box reaches its greatest complexity in the true songbirds. But it is not a complicated syrinx alone that determines singing ability for some true songbirds hardly sing at all.



FROM PYCRAFT HISTORY OF BIRDS (METHUEN)

FIG 3 —ELONGATED WINDPIPE
(A) Enclosed in the sternum of a crane and (B) elaborately coiled in a manucode, one of the birds of paradise

In certain ducks, especially in the males, the syrinx has an enlarged. bony chamber (see fig. 2). Honever. none of these birds have elaborate voices. though the male's voice may be different from that of the female. Sometimes the windpipe is elongated and elaborately coiled. In some cranes and swans this elongation is enclosed within the breast bone or sternum. In certain of the birds of paradise knonn as manucodes the elongated windpipe is coiled on the breast between the skin and the flesh (*see* fig. 3). Presumably this lengthening of the windpipe gives resonance to the voice.

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SONNEBERG, a town of Germany, in the district of Suhl, situated in a narrow valley of the Thuringian forest. 13 mi by rail N E of Coburg. Pop. (1950) 30,182. It is famous for the manufacture of toys.

SONNET. Like most beginnings the genesis of the sonnet is somewhat obscure. On the whole the most probable account is that it sprang, as the result of endless experiments, from the popular short poems sung, in early medieval times. with or nithout refrain. to musical accompaniment. as the Idyl of Theocritus similarly arose from simple pastoral strains A very early specimen of the sonnet of a tolerably finished kind, is ascribed to Piero delle Vigne (d 1249). the famous chancellor of Frederick II. and this poem, alike by its Sicilian origin and by its formal elaboration, is sufficient to prove that a long period of experimenting must have preceded. Time is required both for the genre to have reached so far south and for the degree of finish shown by this poem to have been attained But nith every allowance for earlier talent we probably do little injustice if. in accord with the majority of critics. we call Guittone of Xrezzo (d 1294) the 'only begetter" of the sonnet as we know it It nas he nho firmly established its laws. From his time it was recognized that there must be an "octave," with rhymes (in an unusual notation), a. b, b. a;. a. b, b a and a "sestet." in which, while some variety is allowed the final couplet is excluded Betneen the octave and the sestet there is a distinct break and, as a rule, the first quatrain of the octave is though less strongly marked off from the second. More important still, in spite of a certain looseness of thought and roughness of style, Guittone established the unitary character of the sonnet.

It was the Guittonian sonnet which, in the hands of Dante and Petrarch, became—certain aberrations notwithstanding—the unquestioned model for later Italian writers. Especially as used by Petrarch, in his immortal Laura-poems, it set a standard which the greatest poets could hardly hope to overpass, and it was imitated bv such poets throughout the whole of western Europe.

The English Form.—Transplanted to England by Wyatt and Surrey (it is remarkable that it does not seem to have attracted Chaucer) the sonnet was made universally known by the very popular *Tottel's Miscellany* of 1557, and almost immediately captured the fancy of every poet, great, indifferent, or contemptible. In France, about the same time, it was cultivated with success by Desportes, de Baïf, Pierre de Brach, du Bellay, Ronsard and other writers, whose influence was very strongly felt in England—how strongly has been well shown by Sidney Lee. But in England, for many reasons (one, perhaps, being merely the scarcity of rhymes as compared with their abundance in the Romance languages), the rhyme-system was varied and simplified in endless ways.

For the names of the many sonneteers of this period any history of literature may be consulted. Most of them tried "sequences'—series of more or less connected sonnets; but while some individual poems are of surpassing beauty, few writers succeeded in composing more than two or three that deserve a place in a high-class anthology. Even Spenser was not wholly successful, though he adopted a form which might seem suited to his genius—the rhyme-system, a, b, a, b; b, c, b, c; c, d, c, d; c, c, which reminds us of the stanza of the Faerie Queene. Others came gradually to adopt uniformly the especially "English" scheme, a, b, a, b; c, d, c, d; e, f, e, f; g, g; a scheme in which it is immediately obvious that the three quatrains and the "clinching" couplet attain an epigrammatic effect foreign to that of the Petrarchan type.

Milton and Wordsworth.—By the date (1609) of the publication of the supreme examples of the Elizabethan type, Shakespeare's sonnets—which had indeed been probably written long before—the vogue of this style had worn itself out, and the 23 English and Italian sonnets of Milton show, as might be expected, a reversion to a stricter model. Though the poet of the "variously drawn-out" verse of Paradise *Lost* was bound to make no attempt to break the sense at the conclusion of the octave, yet in other respects he conforms (in the main) to the Petrarchan system, and is Italian enough to give us one "caudate" sonnet. Apart from questions of relative merit, the tone of these sonnets is thus altogether different from the Elizabethan. Since his time there have been few endeavours to revive the "English" style. Not that, till much later, the rigid rules were observed. Even the scholarly Gray, in his sonnet on the death of West, allows himself extreme licence; and Cowper's on Mrs. Unwin, beautiful as it is, ends with a couplet. Thus, as the merit of a sonnet is usually in proportion to its strictness, it is perhaps as well that it went out of fashion between 1740 (the date of Gray's sonnet) and 1789 (the date of those of Bowles). The importance of Bowles, again, consists hardly at all in intrinsic worth, but almost solely in the influence he exerted upon Coleridge and Wordsworth; nor are Coleridge's sonnets, few as they are, worth the trouble of reading. It is to Wordsworth that we owe the great and enduring popularity of the form, and possibly even the revived appreciation of Shakespeare's sonnets, which, as is well-known, Steevens refused to reprint on the ground that they were unreadable. Wordsworth, not merely by the surpassing beauty of 20 or 30 of his sonnets, but by his "sequences," is the modern founder of the genre. It is true that not many even of his sonnets are quite regular, and that it is not to the "Ecclesiastical Sketches" nor to the "Duddon" series that we look for his best work; but his perception that the form lends itself to the expression of connected thoughts inspired Rossetti in his House of Life, Mrs. Browning in her Sonnets *from* the Portuguese, and Meredith in his Modern Love, which, though not in the sonnet-form, has much of the character. Since Wordsworth there have never been lacking sonneteers, and at least some of their work has been of great excellence. It is noteworthy how often men not of the highest genius have found in the very constriction of the form "not bonds but wings," and have produced, by a flash of inspiration aided by labour, single sonnets not unworthy to be compared with the best even of Shakespeare's or of Milton's. While, as we saw, Coleridge failed, and while the genius of Shelley was cramped in the "narrow room" (he wrote but one good sonnet, and that not a true one), some great poets, like Keats, and others of a lower order, have moved in it with ease and have attained great heights.

The literature of the subject is large, and but a tithe of it can be mentioned here: for history and criticism Capell Lofft, Leigh Hunt, Mark Pattison (preface to Milton), Trench (preface to Wordsworth), Sidney Lee (Life of Shakespeare), Lentzner (down to Milton), Addington Symonds, Ashcroft Noble, Theodore Watts-Dunton and T. W. H. Crosland. Good and comprehensive selections also abound, many of them with critical and historical prefaces and notes. Of these we may choose Lofft, Hunt, William Sharp, Waddington, Hall Caine and Tomkinson. But as new sonnets are constantly being written so new selections are constantly being made. (E. E. K.)

SONNMO, SIDNEY BARON (1847–1922), Italian statesman and financier, was born at Florence on March 11, 1847. Entering the diplomatic service at an early age, he was appointed successively to the legations of Madrid, Vienna, Berlin and, Versailles, but in 1871 returned to Italy, to devote himself to political and social studies. On his own initiative he conducted exhaustive inquiries into the conditions of the Sicilian peasants and of the Tuscan *métayers*, and in 1877 published in co-operation with Signor Leopoldo Franchetti a masterly work on Sicily (La *Sicilia,* Florence, 1877). In 1878 he founded a weekly economic review, La Rassegna Settimanale, which four years later he converted into a political daily journal. Elected deputy in 1880, he distinguished himself by trenchant criticism of Magliani's finance, and upon the fall of Magliani was for some months, in 1889, under-secretary of State for the treasury. In view of the severe monetary crisis of 1893 he was entrusted by Crispi with the portfolio of finance (Dec. 1893), and by energetic measures he averted national bankruptcy, and placed Italian finance upon a sounder basis than at any time since the fall of the Right. Though averse from the policy of unlimited colonial expansion, he provided by a loan for the cost of the Abyssinian War in which the tactics of General Baratieri had involved the Crispi cabinet, but fell with Crispi after the disaster at Adowa (March 1896). Assuming then the leadership of the constitutional opposition, he combated the alliance between the Di Rudini cabinet and the subversive parties, criticized the financial schemes of the treasury minister, Luzzatti, and opposed the "democratic" finance of the first Pelloux administration as likely to endanger financial stability. After the modification of the Pelloux cabinet (May 1899) he became leader of the ministerial majority, and bore the brunt of the struggle against Socialist obstruction in connection with the Public Safety bill. Upon the formation of the Zanardelli cabinet (Feb. 1901) he once more became leader of the constitutional opposition, and in the autumn of the year founded a daily organ, *Il* Giornale *d'Italia,* the better to propagate moderate Liberal ideas. He was prime minister for a few months in 1906.

On Dec. 2, 1909, Sonnino formed his second ministry. But he did not enjoy the favour of the still Giolittian Chamber, and his cabinet was defeated over the new shipping bill. On March 21, 1910, he resigned.

In the autumn of 1914, he became foreign minister in the Salandra cabinet. He was still foreign minister, under Orlando's premiership, during the Peace Conference, which he attended as second Italian delegate from Jan. 18 to June 19, 1919 On the fall of the Orlando cabinet (June 19, 1919) Sonnino retired into private life. He died on Nov. 24, 1922.

SON OF MAN. In the Gospels Jesus often refers to himself as the Son of man in such a way that it becomes clear that this must have been a term that was well known and loaded with meaning before his time. There is no agreement, however, as to the origin of the idea and as to what extent these sayings of Jesus are to be considered as authentic.

In the Synoptic Gospels (Matthew. Mark, Luke) the sayings in which the term Son of man is used fall naturally into three categories:

1. Eschatological sayings in which the Son of man is depicted as the judge who is to come in glory with the clouds of heaven in order to judge the world (*e.g.,* Mark viii, 38, xiii, 26. xiv, 62; Matt. xxiv, 27. 37, 39. 44). In these sayings the Son of man is always referred to in the third person, and there is no clear indication that Jesus is identical with that eschatological figure. Only once (Luke xii, 8 ff.; *cf.* Mark viii, 38) is any relationship established between Jesus and the Son of man: "everyone who acknowledges me before men, the Son of man also will acknowledge before the angels of God."

2. Passages concerned with the suffering, death and resurrection of Jesus (*e.g.,* Mark viii. 31, ix, 31, x, 33 ti.): "the Son of man must suffer many things . . . and be killed, and after three days rise again."

3. A few sayings which refer to various aspects of the activity of Jesus: he "has authority on earth to forgive sins" (Mark ii. 10), he "is lord even of the sabbath" (Mark ii, 28), he is called "a friend of tax collectors and sinners" (Matt. xi, 19) and he is homeless, having "nowhere to lay his head" (Matt. viii, 20; Luke ix. 58).

There is no relation whatsoever among these groups.

The first question that should be asked concerning these passages is that of their authenticity. In some cases it can be observed that parallel passages use a simple "I" instead of the title Son of man. Thus Matt. x, 32 uses "I" to replace the "Son of man" of Mark viii, 38 and Luke xii, 8 ff.; Matthew introduces "Son of man" in xvi, 13, a saying where Mark has "I" (viii, 27). But in most cases tradition is firm on the use of the term. Few scholars question the authenticity of the group 1 sayings. As for group 2, it is necessary to remember that they presuppose the events of Easter and may express the faith of the early church although afterward put into the mouth of Jesus. Other scholars admit the possibility that Jesus uttered these words also, because he must have foreseen the outcome of his conflict with the Jewish authorities. The third group also presents some difficulties, but for the most part the attempts to question the authenticity have not been successful.

As far as the first group is concerned, the implications of the term are comparatively clear on the background of Jewish apocalyptic~. In Dan. vii, 13 there is a reference to "one like a son of man" who was given dominion so that all nations should serve him, and mention is made of a judgment of the evil; later in the same chapter this figure is interpreted as being "the saints of the Most High" (*i.e.,* ideal Israel). It is a matter of dispute whether "son of man" here means just "a man" in general, which would be in accordance with common Aramaic and Hebrew usage, or is already an eschatological term. In later apocalyptics the latter is definitely the case.

The book of Enoch uses the title son of man to denote an eschatological figure who is to come at the end of the present age to judge the world and establish the Kingdom of God. He is referred to as existing before the creation of the world and as being kept hidden with God until his appearance at the consummation of the age. Certain motifs connected with this figure seem to be influenced by the Iranian idea of the First Man, which is also reflected in certain (later) Gnostic speculations. It is a disturbing fact, however, that the son of man passages in the book of Enoch are all in the part of the book commonly referred to as the Similitudes, of which there remain no Greek fragments and which does not seem to be represented among the fragments from the Qumran caves. This suggests to some scholars that these passages may be later, perhaps Christian interpolations. However, II Esdras, which derives from the time immediately after the fall of Jerusalem in A.D. 70, testifies to the existence of the term in Jewish apocalyptics, and it would probably not have been introduced there after the title had been used by Jesus.

In the third group, one or two of the passages might be explained by assuming the meaning of "man" in general. or especially "mortal man," as is the case in a number of passages in Ezekiel, where the prophet is addressed as "son of man." Matt. xi, 19 is associated with the humble state of Jesus and may be connected with the suffering passages.

The idea of the suffering of the Son of man, represented by the second group of sayings. presents the most difficult problem. It is a matter of dispute whether or not the book of Enoch knew the idea of a suffering Son of man. There is no unambiguous evidence, and those scholars who find this idea represented reach their conclusion only on the basis of the fact that the Son of man has several features in common with the Servant of the Lord as described in Isaiah xl–lv (Deutero-Isaiah). But these common features are positive—his election, his function as a lawgiver and as a light to the nations and the hope of the holy ones, etc. The suffering of the Servant is not referred to in connection with the Son of man, and the contemporary Jewish method of biblical interpretation does not favour the assumption that the figure of the Servant was adopted in its totality; therefore, nothing warrants that the glory of the Son of man presupposes his suffering. The mention of "the blood of the righteous one" in Enoch xlvii, 1–4, immediately following a chapter dealing nith the glory of the son of man, is no conclusive evidence, and the text itself is not even certain.

Thus, if Jesus did really use the title "Son of man" in connection with his suffering, it would seem that it was he himself who made the combination of the Son of man of apocalyptics with the suffering Servant of Deutero-Isaiah. He may even not have known the book of Enoch but interpreted his mission in terms of Dan. vii, Isa. liii and perhaps also the suffering righteous of Wisdom ii–v.

It has also been suggested that the term might derive from Ps. viii, 4 and Ixxx, 17 where it is taken to refer to the king; since the messianic hope developed out of the idea of an ideal king, the term therefore from the beginning would have been a "messianic" title. Ps. viii, 4 is quoted in the New Testament as referring to Christ, but there is no evidence that Jesus applied these psalms to himself.

As a title of Christ the term "Son of man" seems to have lost currency rather soon. By far the most instances occur in the Synoptic Gospels. There are a few instances in the Gospel of John, referring to his pre-existence in heaven (iii, 13), his death (iii, 14, viii, 28, xii, 23, 34, etc.) and his function as a judge (v, 27). Paul does not use it. It seems probable that it mas introduced by Jesus himself, but that the early church found other titles more suitable to express its faith in Jesus as the saviour.

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SONORA, a northwest state of Mexico. Pop. (1950) 510,607; (1956 est.) 623,622; area, 70,484 sq.mi. Sonora is bounded north by the United States, east by Chihuahua, south by Sinaloa and west by Lower California and the Gulf of Lower California. Until the 1940s Sonora was primarily a mining area, producing copper. gold and silver. Climatic conditions are generally arid to semiarid and irrigation is necessary to produce winter vegetables, cereals, cotton, tobacco and maize.

The state's population is clustered around Nogales (*q.v.*), at the border. Hermosillo the state capital, a neat and thriving air, highway and rail centre in the midst of a flourishing cotton district, Guaymas, a coastal deep-sea fishing resort, and Ciudad Obregón, in the heart of the Yaqui valley. The latter grew in the 1950s from a barren crossroads town to a booming city of 70,000, with modern architecture, airport and a large number of cotton-enriched farmers. Irrigation provided by the Alvaro Obregón dam (completed in 1952) on the Yaqui river made this expansion possible by supplying water to more than 500,000 ac. of desert land.

The area of Sonora was explored in the 1530s. and later became a famous colonial mining district. The small town of Alamos is a quaint reminder of this colonial past. In 1830 Sonora became a Mexican state, but the unruly Yaqui tribes were not finally subdued until the 20th century. The primitive Seris still follow their old way of life on the offshore island of Tiburón. The state derives its name (sonorous) from its deposits of grayish marble, which when struck emits bell-like sounds. (J. A. Cw.)

SONS OF LIBERTY, the name adopted by clubs of patriots that sprang into existence in Great Britain's North American colonies in opposition to the Stamp act passed by parliament in 1765. These radical, secret and loosely organized clubs, whose members were recruited mainly from the trading classes. served as headquarters for leaders who directed the mobs that resisted British efforts to collect taxes. Men of wealth and status often gave leadership to the clubs. The "Liberty Boys" terrorized stamp masters, burned stamps and mobbed supporters of alleged British tyranny. At times they gathered openly, held parades and dinners, sang liberty songs and stirred up popular sentiment against the British. A network of the societies covered all the colonies, but New York and Massachusetts supported the most spirited chapters. The New York Sons of Liberty appointed the first popular committee of correspondence, adopted the first nonimportation agreement, threatened those who used stamps and protected those who carried on business without stamps. The Sons of Liberty even attempted to create a military alliance of the northern colonies. The radical societies spread the spirit of resistance to British rule, marked the first effective intercolonial union and prepared the way for the later continental congresses and the American Revolution. (A. DE. C.)

SONSONATE, a department in western El Salvador established in 1855, bordering the Pacific ocean. Area 459 sq.mi. Pop. (1950) 120,327; (1955 est.) 141,801. The population is concentrated on southern mountain slopes, the hot coastal lowlands having few people. In the north, Izalco volcano, a black symmetrical cone without vegetation (altitude 6,184 ft.) and the most active in Central America, erupts at fairly regular intervals. The coastal lowlands produce 50% of the nation's balsam used in medicines. Sonsonate is important in the production of cheese, tobacco, coffee, sugar, pineapples and cotton.

Sonsonate city (pop. [1950] 17,949; [1956 est.] 20,736), the departmental capital, was founded in 1524. Interesting features are El Pilar Colonial church, old cathedral with 17 cupolas of all sizes, and nearby the San Antonio colonial shrine visited every year by thousands of pilgrims seeking cures. Sonsonate is 41 mi. W. of San Salvador by highway and 12 mi. by road and railway from Acajutla, an open roadstead port which handles about 20% of the country's foreign trade. (C. F. J.)

SOOCHOW (SU-CHOU, WU-HSIEN), a city in Kiangsu province, China, situated on the Yangtze delta, 36 mi. S. of the river, 55 mi. W. of Shanghai and close to the eastern lake shore of T'ai Hu. It probably dates from about 484 B.C., and like other old towns nearby was located upon onetime hilly coastal islands, which were later joined together by Yangtze silting plus man's diking and draining for at least 3,000 years. The scenic mass of lakes and canals, including the Grand canal, caused Europeans to name it the "Venice of China," while the Chinese esteemed its beautiful gardens and fair women. It was the capital of the Wu Kingdom in the 5th century B.C. The fertile rice and silk country created wealth which over the centuries was poured into the construction of more than 200 private gardens, many restored and maintained for public enjoyment. Water, fertile soil, a mild climate for vegetative growth, nearby eroded lake stone and leisure for scholarly study and aesthetic development raised gardening in Soochow to one of China's great arts. It was a place of official retirement, inspiration to poets and painters and a luxury handicraft centre for jade and ivory carving, silk weaving and embroidery. Under T'ai P'ing control (1860–63) Li Hsiu-ch'eng instituted numerous social and economic measures that, unlike T'ai P'ing programs elsewhere, won the support of the local people and foreshadowed many of the changes of the Chinese People's Republic. It was a treaty port in 1896 and was held by the Japanese (1937–45). In modern times, silk filatures. weaving mills and a sericulture institute were set up. It is the seat of South Kiangsu Technical college. The city is on the Shanghai-Nanking railway and has a spur line south to Chia-hsing, Chekiang, augmented by highways for local traffic; some of the city's streets were widened for motor traffic. Pop. (1953) 474,000. (TE. H.)

SOPHIA (1630–1714), electress of Hanover, 12th child of Frederick V, elector palatine of the Rhine, by his wife Elizabeth, a daughter of the English king James I, was born at The Hague on Oct. 14, 1630. Residing after 1649 at Heidelberg with her brother, the restored elector palatine, Charles Louis, she married in 1658 Ernest Augustus, who became elector of Brunswick-Liineburg (Hanover) in 1692. Her married life was not a happy one. Sophia became a widow in 1698, but before then her name had been mentioned in connection with the English throne. When considering the Bill of Rights in 1689 the house of commons refused to place her in the succession, and the matter rested until 1700 when the state of affairs in England was more serious. William III was ill and childless; William, duke of Gloucester, the only surviving child of the princess Anne, had just died. The electress was the nearest Protestant heir. Accordingly by the Act of Settlement of 1701 the English crown, in default of issue from either William or Anne, was settled upon "the most excellent princess Sophia. electress and duchess-dowager of Hanover" and "the heirs of her body, being Protestant." Sophia watched affairs in England during the reign of Anne with great interest, although her son, the elector George Louis, objected to any interference in that country, and Anne disliked all mention of her successor. An angry letter from Anne possibly hastened Sophia's death, which took place at Herrenhausen on June 8, 1714; less than two months later her son, George Louis, became king of Great Britain and Ireland as George I on the death of Anne.

See *Memoiren der Kurfurstin Sophie von Hannover*, edited by A. Kocher (1879; Eng. trans., 1888) ; *Briefwechsel der Herzogin Sophie von Hannover mit ihrem Bruder*, etc., edited by E. Bodemann (1885, 1888) ; A. W. Ward, *The Electress Sophia and the Hanoverian Succession* (1909) ; O. Klopp, *Der Fall des Hauses Stuart* (1875–88) ; *Correspondance de Leibnitz avec l'électrice Sophie*, edited by O. Klopp (1864–75) ; R. S. Rait, *Five Stuart Princesses* (1902).

SOPHIA ALEKSEYEVNA (1657–1704), tsarevna and regent of Russia, was the third daughter of Tsar Alexius and Maria Miloslavskaya. Educated on semiecclesiastical lines by the learned monk of Kiev, Polotsky, she emancipated herself in a short time from the traditional tyranny of the *terem*, or women's quarters. Setting aside court etiquette, she had nursed her brother Tsar Theodore III in his last illness, and publicly appeared at his obsequies, though it was usual only for the widow of the deceased and his successor to the throne to attend that ceremony. Three days after little Peter, then in his fourth year, had been raised to the throne, she won over the *stryeltsy* (musketeers), who at her instigation burst into the Kreml, murdering everyone they met, including Artamon Matveyev, Peter's chief supporter, and Ivan Naryshkin, the brother of the tsaritsa-regent Natalia, Peter's mother (May 15–17, 1682). When the rebellion was over there was found to be no government. Everyone was panic-stricken and in hiding except Sophia, and to her, as the only visible representative of authority, the court naturally turned for orders. She paid off and pacified the *stryeltsy*, and secretly worked upon them to present (May 29) a petition to the council of state to the effect that her half brother Ivan should be declared senior tsar, while Peter was degraded into the junior tsar. This duumvirate was but a steppingstone to the ambition of Sophia, who thus became the actual ruler of Russia.

By Nov. 6, Sophia's triumph was complete. The conduct of foreign affairs she committed entirely to her paramour, Prince Vasily Golitsuin, while the crafty and experienced clerk of the council, Theodore Shaklovity, looked after domestic affairs and the treasury. Sophia's fondness for Golitsuin induced her to magnify his barely successful campaigns in the Crimea into brilliant triumphs which she richly rewarded, thus disgusting everyone who had the honour of the nation at heart. Most of the malcontents rested their hopes for the future on the young tsar Peter, who was the first to benefit by his sister's growing unpopularity. Sophia took council of Shaklovity, and it was agreed (1687) between them that the stryeltsy should be employed to dethrone Peter. The stryeltsy, hoaever, received the whole project so coldly that it had to be abandoned. A second conspiracy to seize him in his bed (Aug. 1689) was betrayed to Peter. and he fled to the fortress-monastery of Troitsa. All his friends rallied round him. including the bulk of the magnates, half the stryeltsy and all the foreign mercenaries.

From Aug. 12 to Sept. 7 Sophia endeavoured to set up a rival camp in the Kreml; however her professed adherents gradually left her. She was compelled to retire within the Novo-Dyevichy monastery, but without taking the veil.

Nine years later (1698), on suspicion of being concerned in the rebellion of the stryeltsy, she was shorn a nun and imprisoned for life.

See J. E. Zabyelin, *Domestic Conditions of the Russian Princes* (1895); *R.* N. Bain, *The First Romanovs* (1905).

SOPHIA DOROTHEA (1666–1726), nife of George Louis, elector of Hanover (George I of England), only child of George William, duke of Brunswick-Lüneburg-Celle by a Huguenot lady named Eleanore d'Olbreuze (1639–1722), was born on Sept. 15, 1666.

Sophia Dorothea was married. for dynastic reasons, to her cousin George Louis. son of Duke Ernest Augustus, who became elector of Hanover in 1692. This union was a very unhappy one. The electress Sophia hated her daughter-in-law. and this feeling was soon shared by the prince himself Cnder these circumstances Sophia Dorothea made the acquaintance of Count Philipp Christoph von Konigsmark (*q.v.*), who assisted her in one or tno futile attempts to escape from Hanover, and rightly or wrongly was regarded as her lover.

In 1694 the count was assassinated. and the princess was divorced and imprisoned at Xhlden remaining in captivity until her death on Nov 23, 1726 Sophia Dorothea is sometimes referred to as the 'princess of Xhlden." Her tno children were the English king. George II, and Sophia Dorothea. wife of Frederick William I and mother of Frederick the Great

SOPHISM, an unsound argument or fallacious proof especially one in which the fallacy is difficult to detect, or one which is put forward with deliberate intent to deceive. (Ao *C.*)

SOPHISTS, the name given by the Greeks about the middle of the 5th century B.C. to certain teachers of a superior grade who, distinguishing themselves from philosophers on the one hand and from artists and craftsmen on the other, claimed to prepare their pupils, not for any particular study or profession, but for civic life (**σοφιστής**, literally, man of wisdom). For nearly a hundred years the sophists held almost a monopoly of general or liberal education. Yet, within the limits of the profession, there was considerable diversity both of theory and of practice. Four principal varieties are distinguishable, and may be described as the sophistries of culture, of rhetoric, of politics and of "eristic," *i.e.*, disputation. Each of these predominated in its turn, though not to the exclusion of others, the sophistry of culture beginning about 447, and leading to the sophistry of eristic, and the sophistry of rhetoric taking root in central Greece about 427, and merging in the sophistry of politics. Further, since Socrates and the Socratics were educators, they too might be, and in general were, regarded as sophists; but, as they conceived truth—so far as it was attainable—rather than success in life, in the law court, in the assembly or in debate, to be the right end of intellectual effort, they were at variance with their rivals, and are commonly ranked by historians, not with the sophists, who confessedly despaired of knowledge, but with the philosophers, who, however unavailingly, continued to seek it. With the establishment of the great philosophical schools—first, of the Academy, next of the Lyceum—the philosophers took the place of the sophists as the educators of Greece.

The sophistical movement was then, primarily, an attempt to provide a general or liberal education which should supplement the customary instruction in reading, writing, gymnastics and music. But, as the sophists of the first period chose for their instruments grammar, style, literature and oratory, while those of the second and third developments were professed rhetoricians, sophistry exercised an important influence upon literature. Then again, as the movement, taking its rise in the philosophical agnosticism which grew out of the early physical systems, was itself persistently sceptical, sophistry may be regarded as an interlude in the history of philosophy. Finally, the practice of rhetoric and eristic, which presently became prominent in sophistical teaching, had, or at any rate seemed to have, a mischievous effect upon conduct; and the charge of seeking, whether in exposition or in debate, not truth but victory—which charge was impressively urged against the sophists by Plato—grew into an accusation of holding and teaching immoral and unsocial doctrines, and in our own day has been the subject of eager controversy.

Genesis **and** Development of Sophistry.—Sophistry arose out of a crisis in philosophy. The earlier Ionian physicists, Thales, Anaximander and Anaximenes, in their attempts to trace the Multiplicity of things to a single material element, had been troubled by no misgivings about the possibility of knowledge. But, when Heraclitus to the assumption of fire as the single material cause added the doctrine that all things are in perpetual flux, he found himself obliged to admit that. things cannot be known. Thus, though, in so far as he asserted his fundamental doctrine without doubt or qualification, he was a dogmatist, in all else he was a sceptic. Again, the Eleatic Parmenides, deriving from the theologian Xenophanes the distinction between ἐπιήστμη and δόξα, conceived that, whilst the One exists and is the object of knowledge, the Multiplicity of things becomes and is the object of opinion; but, when his successor Zeno provided the system with a logic, the consistent application of that logic resolved the fundamental doctrine into the single proposition "One is One," or, more exactly, into the single identity "One One." Thus Eleaticism, though professedly dogmatic, was inconsistent in its theory of the One and its attributes, and openly sceptical in regard to the world of nature. Lastly, the philosophers of the second physical succession—Empedocles, Anaxagoras, Leucippus—not directly attacking the great mystery of the One and the Many, but in virtue of a scientific instinct approaching it through the investigation of phenomena, were brought by their study of sensation to perceive and to proclaim the inadequacy of the organs of sense. Thus they too. despite their air of dogmatism, were in effect sceptics. In short, from different standpoints, the three philosophical successions had devised systems which were in reality sceptical, though they had none of them recognized the sceptical inference.

Towards the middle of the jth century, however, Protagoras of Abdera, taking account of the teaching of the first, and possibly of the second, of the physical successions, and Gorgias of Leontini, starting from the teaching of the metaphysical succession of Elea, drew that sceptical inference from which the philosophers had shrunk. If, argued Protagoras in a treatise entitled Truth, all things are in flux, so that sensation is subjective, it follows that "Man is the measure of all things, of what is, that it is, and of what is not, that is not"; in other words, there is no such thing as objective truth. Similarly, Gorgias, in a work On Nature, or on the Nonent, maintained (a) that nothing is, (b) that, if anything is, it cannot be known, (c) that, if anything is and can be known, it cannot be expressed in speech; and the summaries which have been preserved by Sextus Empiricus (*Adv.* Math. vii. 65-87) and by the author of the De Melisso, etc. (chs. 5, 6), show that, in defending these propositions, Gorgias availed himself of the arguments which Zeno had used to discredit the popular belief in the existence of the Many; in other words, that Gorgias turned the destructive logic of Zeno against the constructive ontology of Parmenides, thereby not only reducing Eleaticism to nothingness, but also, until such time as a better logic than that of Zeno should be provided, precluding all philosophical inquiry whatsoever. Thus, whereas the representatives of the three successions had continued to regard themselves as philosophers or seekers after truth, Protagoras and Gorgias, plainly acknowledging their defeat, withdrew from the ungrateful struggle.

Meagre as were the results which the earlier thinkers had obtained, the extinction of philosophy just at the time when the liberal arts became more technical and consequently less available as employments of leisure, threatened to leave a blank in Hellenic life. Accordingly Protagoras, while with the one hand he put away philosophy, with the other offered a substitute. Emphasizing the function of the teacher, which with the philosophers had been subordinate, and proclaiming the right end of intellectual endeavour to be, not "truth" (ἀλήθεια) or "wisdom" (σοφία), which was unattainable, but "virtue" or "excellence" (ἀρετή), he sought to communicate, not a theory of the universe, but an aptitude for civic life. "The lesson which I have to teach," Plato makes him say (Prot. 318 E), "is prudence or good counsel, both in respect of domestic matters that the man may manage his household aright, and in respect of public affairs, that he may be thoroughly qualified to take part, both by deed and by word, in the business of the state. In other words, I profess to make men good citizens." As instruments of education Protagoras used grammar, style, poetry and oratory. Thus, whereas hitherto the young Greek, having completed his elementary training in the schools of the γραμματιστής, the κιθαριστής, and the παιδοτρίβης, was left to prepare himself for his life's work as best he might, by philosophical speculation, by artistic practice, or otherwise, one who passed from the elementary schools to the lecture-room of Protagoras received from him a "higher education." The progsamme was exclusively literary, but for the moment it enabled Protagoras to satisfy the demand which he had discovered and evoked. Wherever he went, his lecture-room was crowded with admiring pupils, whose homage filled his purse and enhanced his reputation.

After Protagoras the most prominent of the literary sophists was Prodicus of Ceos. Establishing himself at Athens, he taught "virtue" or "excellence," in the sense attached to the word by Protagoras, partly by means of literary subjects, partly in discourses upon practical ethics. It is plain that Prodicus was an affected pedant; yet his simple conventional morality found favour, and Plato (Rep. 600 C) couples him with Protagoras in his testimony to the popularity of the sophists and their teaching.

At Athens, the centre of the intellectual life of Greece, there was soon to be found a host of sophists; some of them strangers, others citizens; some of them bred under Protagoras and Prodicus, others self-taught. In the teaching of the sophists of this younger generation two points are observable. First, their independence of philosophy and the arts being assured, though they continued to regard "civic excellence" as their aim, it was no longer necessary for them to make the assertion of its claims a principal element in their exposition. Secondly, for the sake of novelty they extended their range, including scientific and technical subjects, but handling them, and teaching their pupils to handle them. in a popular way. In this stage of sophistry then, the sophist, though not a specialist, trenched upon the provinces of specialists; and accordingly Plato (Prot. 318 E) makes Protagoras pointedly refer to sophists who, "when young men have made their escape from the arts, plunge them once more into technical study, and teach them such subjects as arithmetic, astronomy, geometry and music." The sophist of whom the Platonic Protagoras is here thinking was Hippias of Elis, who gave popular lectures, not only upon the four subjects just mentioned, but also upon grammar, mythology, family history, archaeology, Homerology and the education of youth. In this polymath we see at once the degradation of the sophistry of culture and the link which connects Protagoras and Prodicus with the eristics, who at a later period taught, not, like Hippias, all branches of learning, but a universally applicable method of disputation.

Meanwhile, Gorgias of Leontini, who, as has been seen, had studied and rejected the philosophy of western Greece, gave to sophistry a new direction by bringing to the mother country the technical study of rhetoric-especially forensic rhetoric (Plato, *Gorg.* 454 B; *cf.* Aristotle, *Rhet.* 1354, b 26)—which study had begun in Sicily with Corax and Tisias nearly forty years before. Gorgias was already advanced in years and rich in honours when, in 427, he visited Athens as the head of an embassy sent to solicit aid against Syracuse. Received with acclamation, he spent the rest of his long life in central Greece, winning applause by the display of his oratorical gifts and acquiring wealth by the teaching of rhetoric. There is no evidence to show that at any period of his life he called himself a sophist; and, as Plato (Gorg. 449 A) makes him describe himself as a ῥήτωρ, it is reasonable to suppose that he preferred that title. That he should do so was only natural, since his position as a teacher of rhetoric was already secure when Protagoras made his first appearance in the character of a sophist; and, as Protagoras, Prodicus and the rest of the sophists of culture offered a comprehensive education, of which oratory formed only a part, whilst Gorgias made no pretence of teaching "civic excellence" (Plato, *Meno,* 95 C), and found a substitute for philosophy, not in literature generally, but in the professional study of rhetoric alone, it would have been convenient if the distinction between sophistry and rhetoric had been maintained. But though, as will be seen hereafter, these two sorts of education were sometimes distinguished, Gorgias and those who succeeded him as teachers of rhetoric, such as Thrasymachus of Chalcedon and Polus of Agrigentum, were commonly called by the title which Protagoras had assumed and brought into familiar use.

Rhetorical sophistry, as taught by Gorgias with special reference to the requirements of the law courts, led by an easy transition to political sophistry. During the century which had elapsed since the expulsion of the Peisistratids and the establishment of the democracy, the Athenian constitution had developed with a rapidity which produced an oligarchical reaction, and the discussion of constitutional principles and precedents, always familiar to the citizen of Athens, was thus abnormally stimulated. The Peloponnesian War, too, not only added a deeper interest to ordinary questions of policy, but also caused the relations of dissentient parties, of allied and belligerent states, of citizens and aliens, of bond and free, of Greeks and barbarians, to be eagerly debated in the light of present experience. It was only natural then that some of those who professed to prepare young Athenians for public life should give to their teaching a distinctively political direction; and accordingly we find Isocrates recognizing teachers of politics, and discriminating them at once from those earlier sophists who gave popular instruction in the arts and from the contemporary eristics. To this class, that of the political sophists, may be assigned Lycophron, Alcidamas and Isocrates himself. For, though that celebrated personage would have liked to be called, not "sophist" but "political philosopher," and tried to fasten the name of "sophist" upon his opponents the Socratics, it is clear from his own statement that he was commonly ranked with the sophists, and that he had no claim, except on the score of superior popularity and success, to be dissociated from the other teachers of political rhetoric. It is true that he was not a political sophist of the vulgar type, that as a theorist he was honest and patriotic, and that, in addition to his fame as a teacher, he had a distinct reputation as a man of letters; but he was a professor of political rhetoric, and, as such, in the phraseology of the day, a sophist. He had already reached the height of his fame when Plato opened a rival school at the Academy, and pointedly attacked him in the Gorgias, the Phaedrus and the Republic. Thenceforward, there was a perpetual controversy between the rhetorician and the philosopher, and the struggle of educational systems continued until, in the next generation, the philosophers were left in possession of the field.

While the sophistry of rhetoric led to the sophistry of politics, the sophistry of culture led to the sophistry of disputation. It has been seen that the range of subjects recognized by Protagoras and Prodicus gradually extended itself, until Hippias professed himself a teacher of all branches of learning, including in his list subjects taught by artists and professional men, but handling them from a popular or non-professional point of view. The successors of the polymath claimed to possess and to communicate, not the knowledge of all branches of learning, but an aptitude for dealing with all subjects, which aptitude should make the knowledge of any subject superfluous. In other words, they cultivated skill in disputation. Now skill in disputation is plainly a valuable accomplishment; and, as the Aristotelian logic grew out of the regulated discussions of the eristics and their pupils, the disputant sophistry of the 4th century deserves more attention and more respect than it usually receives from historians of Greek thought. But when men set themselves to cultivate skill in disputation, regarding the matter discussed not as a serious issue, but as a thesis upon which to practise their powers of controversy, they learn to pursue, not truth, but victory; and, their criterion of excellence having been thus perverted, they presently prefer ingenious fallacy to solid reasoning and the applause of bystanders to the consciousness of honest effort. Indeed, the sophists generally had a special predisposition to error of this sort, not only because sophistry was from the beginning a substitute for the pursuit of truth, but also because the successful professor, travelling from city to city, or settling abroad, could take no part in public affairs, and thus was not at every step reminded of the importance of the "material" element of exposition and reasoning. Paradox, however, soon becomes stale, and fallacy wearisome. Hence, despite its original popularity, eristical sophistry could not hold its ground. The man of the world who had cultivated it in his youth regarded it in riper years as a foolish pedantry, or at best as a propaedeutic exercise; while the serious student, necessarily preferring that form of disputation which recognized truth as the end of this, as of other intellectual processes, betook himself to one or other of the philosophies of the revival.

In order to complete this sketch of the development of sophistry in the latter half of the 5th century and the earlier half of the 4th, it is necessary next to take account of Socrates and the Socratics. A foe to philosophy and a renegade from art, Socrates took his departure from the same point as Protagoras, and moved in the same direction, that of the education of youth. Finding in the cultivation of "virtue" or "excellence" a substitute for the pursuit of scientific truth, and in disputation the sole means by which "virtue" or "excellence" could be attained, he resembled at once the sophists of culture and the sophists of eristic. But, inasmuch as the "virtue" or "excellence" which he sought was that of the man rather than that of the official, while the disputation which he practised had for its aim, not victory, but the elimination of error, the differences which separated him from the sophists of culture and the sophists of eristic were only less considerable than the resemblances which he bore to both; and further, though his whole time and attention were bestowed upon the education of young Athenians, his theory of the relations of teacher and pupil differed from that of the recognized professors of education, inasmuch as the taking of fees seemed to him to entail a base surrender of the teacher's independence. The principal characteristics of Socrates's theory of education were accepted, *mutatis mutandis,* by the leading Socratics. With these resemblances to the contemporary professors of education, and with these differences, were Socrates and the Socratics sophists or not? To this question there is no simple answer, yes or no It is certain that Socrates's contemporaries regarded him as a sophist; and it was only reasonable that they should so regard him, because in opposition to the physicists of the past and the artists of the present he asserted the claims of higher education. But, though according to the phraseology of the time he was a sophist, he was not a typical sophist—his principle that, while scientific truth is unattainable by man, right opinion is the only basis of right action, clearly differentiating him from all the other professors of "virtue." Again, as the Socratics—Plato himself, when he established himself at the Academy, being no exception—were, like their master, educators rather than philosophers, and in their teaching laid especial stress upon discussion, they, too, were doubtless regarded as sophists, not by Isocrates only, but by their contemporaries in general; and it may be conjectured that the disputatious tendencies of the Megarian school made it all the more difficult for Plato and others to secure a proper appreciation of the difference between dialectic, or discussion with a view to the discovery of truth, and eristic, or discussion with a view to victory. Changing circumstances, however, carry with them changes in the meaning and application of words. Whereas, so long as philosophy was in abeyance Socrates and the Socratics were regarded as sophists of an abnormal sort, as soon as philosophy revived it was dimly perceived that, in so far as Socrates and the Socratics dissented from sophistry, they preserved the philosophical tradition. This being so, it was found convenient to revise the terminology of the past, and to include in the philosophical succession those who, though not philosophers, had cherished the sacred spark. As for Socrates, he ranked himself neither with the philosophers, who professed to know, nor with the sophists, who professed to teach; and, if he sometimes described himself as a *φιλόσοφος* he was careful to indicate that he pretended to no other knowledge than that of his own limitations.

It would seem then, (1) that popular nomenclature included under the term "sophist" all teachers—whether professors, or like Socrates, amateurs—who communicated, not artistic skill, nor philosophica! theory, but a general or liberal education; (2) that, of those who were commonly accounted sophists, some professed culture, some forensic rhetoric,-some political rhetoric, some eristic, some (*i.e.,* the Socratics) dialectic; (3) that the differences between the different groups of sophists were not inconsiderable, and that in particular the teaching of the rhetoricians was distinct in origin, and, in so far as its aim was success in a special walk of life, distinct in character, from the more general teaching of the sophists of culture, the eristics, and the dialecticians, while the teaching of the dialecticians was discriminated from that of the rest, in so far as the aim of the dialecticians was truth, or at least the bettering of opinion; and, consequently, (4) that, in awarding praise and blame to sophistry and its representatives, the distinctive characteristics of the groups above enumerated must be studiously kept in view.

Lapse of time and change of circumstances brought with them not merely changes in the subjects taught, but also changes in the popular estimate of sophistry and sophists. The first and most obvious sentiment which sophistry evoked was an enthusiastic and admiring interest. The sophist seemed to his youthful hearers to open a new field of intellectual activity and thereby to add a fresh zest to existence. But in proportion to the fascination which he exercised upon the young was the distrust which he inspired in their less pliable elders. Not only were they dismayed by the novelty of the sophistical teaching, but also they vaguely perceived that it was subversive of authority, of the authority of the parent over the child as well as of the authority of the state over the citizen. Of the two conflicting sentiments, the favour of the young, gaining as years passed away, naturally prevailed; sophistry ceased to be novel, and attendance in the lecture-rooms of the sophists came to be thought not less necessary for the youth than attendance in the elementary schools for the boy. The lively enthusiasm and the furious opposition which greeted Protagoras had now burnt themselves out, and before long the sophist was treated by the man of the world as a harmless, necessary pedagogue.

Relations of Sophistry to Education, Literature and Philosophy.—If then the sophists, from Protagoras to Isocrates, were before everything educators, it becomes necessary to inquire whether their labours marked or promoted an advance in educational theory and method. At the beginning of the 5th century B C. every young Greek of the better sort already received rudimentary instruction, not only in music and gymnastics, but also in reading and writing. Further, in the colonies, and especially the colonies of the West, philosophy and art had done something for higher education. Thus in Italy the Pythagorean school was, in the fullest sense of the term, an educational institution; and in Sicily the rhetorical teaching of Corax and Tisias was presumably educational in the same sense as the teaching of Gorgias. But in central Greece, where, at any rate down to the Persian Wars, politics, domestic and foreign, were all-engrossing, and left the citizen little leisure for self-cultivation, the need of a higher education had hardly made itself felt. The overthrow of the Persian invaders changed all this. Henceforward the best of Greek art, philosophy and literature gravitated to Athens, and with their concentration and consequent development came a general and growing demand for teaching. As has been seen, it was just at this period that philosophy and art ceased to be available for educational purposes, and accordingly the literary sophists were popular precisely because they offered advanced teaching which was neither philosophical nor artistic. Their recognition of the demand and their attempt to satisfy it are no small claims to distinction. That, whereas before the time of Protagoras there was little higher education in the colonies and less in central Greece, after his time attendance in the lecture-rooms of the sophists was the customary sequel to attendance in the elementary schools, is a fact which speaks for itself.

But this is not all The education provided by the sophists of culture had positive merits. When Protagoras included in his course, grammar, style, interpretation of the poets and oratory, supplementing his own continuous expositions by disputations in which he and his pupils took part, he showed a not inadequate appreciation of the requisites of a literary education; and it may be conjectured that his comprehensive programme, which Prodicus and others extended, had something to do with the development of that versatility which was the most notable element in the Athenian character.

There is less to be said for the teachers of rhetoric, politics and eristic, who, in limiting themselves each to a single subject—the rhetoricians proper or forensic rhetoricians to one branch of oratory, the politicians or political rhetoricians to another, and the eristics to disputation—ceased to be educators and became instructors. Nevertheless, rhetoric and disputation, though at the present day strangely neglected in English schools and universities, are, within their limits, valuable instruments; and, as specialization in teaching does not necessarily imply specialization in learning, many of those who attended the lectures and the classes of a rhetorician or an eristic sought and found other instruction elsewhere. It would seem then that even in its decline sophistry had its educational use. But in any case it may be claimed for its professors that in the course of a century they discovered and turned to account most of the instruments of literary education.

With these considerable merits, normal sophistry had one defect, its indifference to truth. Despairing of philosophy—that is to say, of physical science—the sophists were prepared to go all lengths in scepticism. Accordingly the epideictic sophists in exposition, and the argumentative sophists in debate, one and all, studied, not matter but style, not accuracy but effect, not proof but persuasion. In short, in their hostility to science they refused to handle literature in a scientific spirit. That this defect was serious was dimly apprehended even by those who frequented and admired the lectures of the earlier sophists; that it was fatal was clearly seen by Socrates, who, himself commonly regarded as a sophist, emphatically reprehended, not only the taking of fees, which was after all a mere incident. objectionable because it seemed to preclude independence of thought, but also the fundamental disregard of truth which infected every part and every phase of sophistical teaching. To these contemporary censures' the modern critic cannot refuse his assent.

To literature and to oratory the sophists rendered good service. Themselves of necessity stylists, because their professional success largely depended upon skilful and effective exposition, the sophists both of culture and of rhetoric were professedly teachers of the rules of grammar and the principles of written and spoken discourse. Thus, by example as well as by precept, they not only taught their hearers to value literary and oratorical excellence, but also took the lead in fashioning the style of their time. Their influence in these respects was weighty and important. Whereas, when sophistry began, prose composition was hardly practised in central Greece, the sophists were still the leaders in literature and oratory when Plato wrote the ***Republic,*** and they had hardly lost their position when Demosthenes delivered the ***Philippics.*** In fact, it is not too much to say that it was the sophists who provided those great masters with their consummate instrument, and it detracts but little from the merit of the makers if they were themselves unable to draw from it its finer tones.

The relation of sophistry to philosophy was throughout one of pronounced hostility. From the days of Protagoras, when this hostility was triumphant and contemptuous, to the days of Isocrates, when it was jealous and bitter, the sophists were declared and consistent sceptics. But, although Protagoras and Gorgias had examined the teaching of their predecessors so far as to satisfy themselves of its futility and to draw the sceptical inference, their study of the great problem of tlie day was preliminary to their sophistry rather than a part of it; and, as the overthrow of philosophy was complete and the attractions of sophistry were all-powerful, the question "What is knowledge?" ceased for a time to claim or to receive attention. There is, then, no such thing as a "sophistical theory of knowledge;)' Similarly, the recognition of a "sophistical ethic" is, to say the least, misleading. It may have been that the sophists' preference of seeming to reality, of success to truth, had a mischievous effect upon the morality of the time; but it is clear that they had no common theory of ethics, and there is no warrant for the assumption that a sophist, as such, specially interested himself in ethical questions. When Protagoras asserted "civic excellence" or "virtue" to be the end of education, he neither expressed nor implied a theory of morality. Prodicus in his platitudes reflected the customary morality of the time. Gorgias said plainly that he did not teach "virtue." If Hippias, Polus and Thrasymachus defied conventional morality, they did so independently of one another, and in this, as in other matters, they were disputants maintaining paradoxical theses, rather than thinkers announcing heretical convictions. The morality of Isocrates bore a certain resemblance to that of Socrates. In short, the attitude of the sophists towards inquiry in general precluded them, collectively and individually, from attachment to any particular theory. Yet among the so-called sophists there were two who had philosophical leanings, as appears in their willingness to be called by the title of philosopher. First, Socrates, whilst he conceived that the physicists had mistaken the field of inquiry, absolute truth being unattainable, maintained, as has been seen, that one opinion was better than another, and that consistency of opinion, resulting in consistency of action, was the end which the human intellect properly proposes to itself. Hence, though an agnostic, he was not unwilling to be called a philosopher, in so far as he pursued such truth as was attainable by man. Secondly, when sophistry had begun to fall into contempt, the political rhetorician Isocrates claimed for himself the time-honoured designation of philosopher, "herein," says Plato, "resembling some tinker, bald-pated and short of stature, who, having made money, knocks off his chains, goes to the bath, buys a new suit, and then takes advantage of the poverty and desolation of his master's daughter to urge upon her his odious addresses" (*Rep.* vi. 495 E). It will be seen, however, that neither Socrates nor Isocrates was philosopher in any strict sense of the word, the speculative aims of physicists and metaphysicians being foreign to the practical theories both of the one and of the other.

BIBLIOGRAPHY —On the significance of the sophistical movement, *see* E Zeller, *Philosophie d Griechen,* i, 932–1041, 4th ed (1876); *Presocratic Phzlosophy,* ii, 394–516 (1881); G. Grote, *History of Greece,* ch lxvii (1851); E. M. Cope, "On the Sophists," and "On the Sophistical Rhetoric," in *Journ. Class. and Sacr. Philol.* vol ii, iii (1855–1857), an erudite but inconclusive reply to Grote H. Sidgwick, "The Sophists," in *Journ of Philol,* vol iv, v (1872–1874), a brilliant deiense of Grote; A W Benn, *The Greek Phzlosophers* i, 53–107 (1882) For lists of treatises upon the life and teaching of particular sophists. On the later use of the term sophist, *see* RHETORIC.

(H In.)

SOPHOCLES (497 or 495–406 B.C.), one of the three great Greek tragic poets, was born at Colonus, a village just outside Athens. The only ancient biography is a short anonymous account of unknown date, compiled from earlier biographies, and prefixed to most of the Sophoclean manuscripts—a mixture of bald fact, hypothesis and gossip. It can be supplemented from other ancient sources, but the result is meagre. All give a picture of a dignified, gracious and well-loved citizen who moved in good society and enjoyed the pleasures of life. His father, otherwise unknown, was Sophillus. perhaps a manufacturer of armour. He was wealthy and gave his son a good education: his master in music was Lamprus. the most distinguished musician of the day, and he is said to have studied tragedy (including no doubt musical composition and choreography) under Aeschylus. He was a beautiful boy, a good dancer, lyre player and wrestler. He was selected to lead a chorus of boys which performed a paean in celebration of the victory over the Persians at Salamis (480 B.C.). It is not known when he first competed in the dramatic festival; he gained his first victory in 468, defeating Aeschylus. This began a career of unparalleled success. An inscription of the 3rd century B.C credits him with 18 victories, the Suda lexicon (10th century A.D.) with 24, while the Life, citing a nriter of the 2nd century B.C., says that he won 20 first prizes, many second prizes and was never third. (The lowest of these figures may not have included victories won in the Lesser Dionysia.) Aeschylus won 13—but he died at the age of 68, and Sophocles nas still nriting at 90; Euripides won only three. Sophocles' most famous play Oedipus *Tyrannus* (Oedipzts Rex), brought him only the second prize: the prizes however were awarded not for single plays but for a tetralogy comprising three tragedies and one satyr play, and it may well be that the plays presented with the Oedipus were not first-rate. According to the Suda lexicon he wrote 123 plays—no unlikely number: it would correspond to about 30 trilogies in a productive career of 60 years, and in mere bulk would not much exceed Shakespeare's output. Of his minor poems nothing remains.

Unlike Euripides, he played a distinguished part in the public life of Athens. In 443–442 he was Hellenotamias (president of the board that collected the tribute from Athens' subject-allies in the Delian league; *q.v.*). In 440 he was elected one of the ten strategoi (military and naval commanders) in the war against the revolted Samians; his senior colleague was Pericles. The Argument to the *Antigone* attributed to the scholar Aristophanes of Byzantium says that Sophocles owed his election to the Impression created by the play. The statement can hardly have been more than a surmise; nevertheless it dates the Antigone. A story in Plutarch's Life of *Nicias* implies that Sophocles mas elected strategos a second time. The Life says that he served on embassies to foreign states, which is likely enough; also that he founded the Thiasos ton *Mouson* (which might be rendered "The Royal Society for Music and Literature," except that the patrons were the muses). Outliving Euripides (who was about 12 years his junior) by a fen months, he died just before the disastrous end of the Peloponnesian War. The Life of Euripides says: "Sophocles, hearing that Euripides nas dead, brought on his chorus and actors without their cronns. and himself put on mourning; and the people wept." Euripides had died at the court of Archelaus king of Macedon: Aeschylus also had died abroad (in 456 B.c.), in Sicily; it was gratefully remembered of Sophocles that he had remained in Athens. In 405 Aristophanes produced The Frogs, in which Aeschylus and Euripides contend for the throne of tragedy in Hades. with Sophocles sitting by, ready to take on Euripides if he should win (which he does not); Aeschylus himself had offered the throne to Sophocles, but he had declined it, "courteous in Hades, as he had been on earth."

WORKS

Of Sophocles' works, there remain seven complete tragedies, about 400 lines of a satyr play, the Ickneutai (*Ichneutae,* "The Investigators") discovered in Egypt in 1907 on a papyrus written in the second half of the 2nd century A.D. and several hundred fragments of plays now lost. The fragments vary in length from a single word, cited by a grammarian or a lexicographer, to passages of 12 or 15 verses. The seven complete plays derive from a selection made by a scholar unknown at a date unknown—perhaps in Alexandrian times, and perhaps for school use. All are works of Sophocles' maturity, though (apart from the Antigone, which must have been produced in 441 or 442) only one is dated by documentary evidence: the Philoctetes, 409 B C. Tradition, which there seems no good reason to disturb, makes *Oedipus Coloneus* a work of Sophocles' extreme old age; it is said to have been produced by his grandson. For dating the other plays we must depend on stylistic and metrical evidence—some of which is more hazardous with Sophocles than with, for example. Euripides. Sophocles' dramatic style was much more supple. and in some respects changes from minute to minute rather than from decade to decade. Contemporary allusions are also much rarer and more problematic than in. say, Euripides or Shakespeare. However, it is clear that the Ajax is the earliest of the seven; 447 ± 3 is a date that most scholars would accept. The Trachiniae was tentatively placed by R. C. Jebb between 420 and 410; later stylistic analysis places it much closer to the *Antigone*. For the remaining plays. Oedipus Rex and Electra, dates between 430 and 415 would be reasonable; the Electra seems to be the later of the two. The Ichneutae could be an early work, but the evidence available is not worth much.

Dramatic Style.—Ancient authorities credit Sophocles with dramatic innovations, most of them of minor importance. He invented *skenographia* (certainly not "scene painting." but probably some kind of device applied to the wall of the building at the back of the *orchestra*), and periactoi, which may have been revolving drums giving some indication of locale. The one major innovation—which, however, some authorities ascribe to Aeschylus—was the introduction of a third actor. It had always been permissible for the two actors to "double," but the addition of a third enabled the dramatist to increase the number of his characters, thereby making plot more fluid and situation more complex: Sophocles' finest scenes are those that involve the three actors at once, as for instance the messenger scene in the Electra (see below). Aeschylus in his later plays used the third actor to great effect, but in quite a different way, as when Cassandra is silent, though dramatically powerful, in the scene between Agamemnon and Clytemnestra. The differenceis that the typical Aeschylean plot is linear; the Sophoclean, complexive. In the Ovcsteia, for example. Agamemnon takes vengeance on Paris. Clytemnestra on Agamemnon and on Cassandra. and Aegisthus on Agamemnon; Orestes avenges his father upon Clytemnestra and Aegisthus, and then has to contend with the avenging spirits of his mother. In such a drama characters collide rather than struggle with each other; they destroy, and are destroyed, in accordance with cosmic, and evolving, conceptions of retribution. There is little personal interplay; the characters are impressive in size and power, and therefore are not drawn in detail. The typical Sophoclean tragic action is one that is seen, as it were, not through the telescope but by the natural vision, though a vision that is assisted, and controlled, by the pervasive presence of gods. The chief agent does something involving grave error; this affects others, each of whom reacts in his own way, and thereby. perhaps, causes the chief agent to take another step toward ruin—his own, and that of others as well. The characters do struggle with each other; therefore they must be drawn in more detail. Peripheral figures too become involved in the central issue; plot must be more complex—though Sophocles avoids anything like subplot or decorative additions; the economy and concentration shown by his plays are most remarkable. This more complexive tragedy demanded a third actor. Equally, those who were to suffer from the tragic error were none of them of the next generation; all were present at the time. Therefore Sophocles abandoned the spacious Aeschylean framework of the connected trilogy; all was comprised within the single play. From then on, with very rare exceptions, "trilogy" meant no more than three separate tragedies presented at the same festival.

The development of character and plot naturally increased the histrionic and decreased the lyrical element in drama. Counting by lines, slightly more than one-half of the *Agamemnon* is either sung or chanted; of the Antigone, less than one-third, though this play is by far the most lyrical of the seven. But the chorus is still integral. No one formula can sum up its functions. As Aristotle remarked, in Sophocles the chorus is "a fellow actor"; therefore it will often share the illusions of other actors in the piece. as it does for instance in the Arttigone and *Ajax,* where it takes, more or less, the point of view of Creon and Ajax respectively—that is. the wrong one. Sometimes it becomes the "ideal spectator," making philosophic comment (as in the solemn third ode of Oedipus Rex); sometimes it is a purely lyrical instrument, giving release from the tragic tension through the beauty of its dance and music.

Some of the odes, *e.g.,* the one just mentioned, or the second, third or sixth of the *Antigone,* place Sophocles in the front rank of Greek lyric poets. Of the music that he wrote nothing is known; about the choric dances this much can be inferred from their metres, that they must have been conceived in a very plastic fashion. As for the style of the spoken verse, it is reminiscent of Shakespeare's, responding directly to the dramatic needs of the moment; it is as far as possible from being a standard, uniform style, like Euripides'. It will be weighty or swift. intense or easy-going. highly-wrought or perfectly plain. It is no accident that Aristophanes. who parodied Euripides' and Aeschylus' style. left Sophocles' alone.

His Tragic Thought.—Sophocles has been universally admired for the sympathy and vividness with which he draws characters; especially notable are his tragic women: Electra, Antigone, Deianeira. Tecmessa and others. Also. few dramatists have been able to handle situation and plot with more power and certainty; the frequent references in the Poetics to *Oedipus* Rex show that Aristotle regarded this play as a masterpiece of construction, and few later critics have dissented. Further, he is unsurpassed in his moments of high tragic tension, and in his revealing use of tragic irony. In other respects there has been some tendency to compare him unfavourably with Aeschylus and Euripides: Sophocles. it has been said, was a supreme artist and no more: he grappled neither with religious problems like Aeschylus nor with intellectual and social ones like Euripides; he accepted the gods of Greek religion in a spirit of unreflecting orthodoxy. and contented himself with presenting human characters and human conflicts. Further, two of his plays. Ajax and *The Trachiniae,* have been adversely criticized in precisely that aspect of his art for which, elsewhere, he has been so much admired, namely in their structure: for though the Ajax seems to reach its natural conclusion in the suicide of the hero, the play continues with several scenes that concern the burial of his body; while in The *Trachiniae,* if Deianeira is the central character, she too kills herself two-thirds of the way through and is subsequently hardly mentioned, while if Heracles is taken to be the hero. he does not even appear until his wife is already dead, when he himself also is on the point of death. For the "lack of unity" in the Ajax several inorganic explanations have been offered, the most naïve of which is that Sophocles was running short of material; about The Trachiniae the worst that can be said is that he simply combined two personal tragedies into one play.

The source of these misconceptions is the same. Sophocles did not write tragedies of character about individuals, but tragic drama about Man and the Gods; the religious element in his plays is not orthodoxy, not something added, out of personal piety, to a humanistic drama already complete; it is his presentation of the way in ahich the universe works—and it is worthy of attention. This is the reason why his gods are so stern. sometimes baffling, rarely benevolent; and the reason why he does not criticize them is that there is not much point in grumbling at the universe. Further, he did not, like Aeschylus and Euripides, make statements about his religious ideas: his thought is made implicit in the structure of the plays, and if his most telling strokes are considered only as examples of theatrical virtuosity, naturally the thought disappears.

Electra.—Two scenes from the *Electra* illustrate the fusion of his thought with his art. It is easy to dismiss the messenger scene as being no more than a clever piece of stagecraft. Clytemnestra has been terrified by a dream portending that her son Orestes will return from exile to avenge his father upon her and her accomplice Aegisthus and to reverse their usurpation. She comes out from the palace; she offers prayer and sacrifice to Apollo that he will avert the omen of the dream, divert it upon her enemies (meaning Orestes and Electra her daughter). frustrate them and preserve for her nhat her murder and adultery have won. She has only just finished the sacred rite when there enters, unrecognized, Orestes' old servant with a story—prearranged by Orestes—that Orestes is dead: it is designed to throw Agamemnon's murderers off their guard. The story of his supposed death in a chariot race at Delphi is itself a brilliant narrative; the situation enhances it, for it is being told to the mother who finds her own deliverance through the death of her son, and to the sister who finds in it the ruin of all her life; the messenger's preoccupation is so to deceive Clytemnestra that he may be invited into the palace to make ready for Orestes' coming. But this is by no means all, for an audience that believed in Sophocles' gods—being in any case assured already, through the chorus, that Zeus will bring the avenger home to triumph. and that retribution follows crime—would see in the arrival of the messenger. directly after the blasphemous prayer, the god's devastating answer to it. So it is too with the coup de thkatre in which the play ends. Clytemnestra has summoned Aegisthus from the countryside to hear the glad news. He enters, arrogant, secure at last from any threat of vengeance. He orders those who have brought the body to bring it out and display it publicly. "Here lies one," he says, "struck down by the anger of the gods." He is right; he draws back the shroud. and finds himself looking at the face of his dead wife. Whereupon Orestes drives him in to die on the spot where he had murdered Agamemnon. So do the gods work; crime breeds its onn recoil.

It is the interfusion of divine and human action that gives to Sophocles' character drawing its deep significance. Electra is seen. for example, passing through the whole range of human emotion—from passionate love to cruel hatred, from numb despair to wild joy: the audience sees, in some detail. how her daily life with the murderers has entered like iron into her soul; she can live for nothing but vengeance and liberty. Orestes too, living on charity in exile, needs, and receives, no divine prompting: he asks Apollo not whether to do it but how to do it; however the god, though he approves. does not help. Sophocles is showing not that the gods from afar intervene to punish crime, but that the retribution comes in the natural order of things.

Alztigone and *Trachiniae.*—In the *Antigone* the prophet warns Creon that all the gods are angry at what he has done and that their Avengers are lying in wait for him. What the prophet threatens comes to pass. not through "divine intervention" but through the instinctive reactions against Creon of Xntigone, Haemon his son and Eurydice his wife. It is not the personal conflict between Antigone and Creon. great though it is, that is the deepest conflict in the play, but the conflict between Creon and the gods. He, for what he thought good reasons, ordained that the body of Antigone's traitor brother should not receive burial, the last tribute that humanity pays to humanity, but should be eaten by animals; Antigone rising in total rebellion, obeying all her instincts of love, loyalty and humanity, is indeed obeying "the unwritten and unchanging laws of the gods"; Creon is defying them, and they crush him. Individual characters and personal conflicts are in no way diminished or obscured by being set in this universal framework; on the contrary, they preserve to the full their own particular sharpness, and receive the added significance of being made universals.

The *Trachiniae* becomes unintelligible in structure only when we reduce it (perhaps under the influence of Aristotle) to personal dimensions Sophocles makes it quite clear what the scope of the play is. At the beginning, Heracles' patient and understanding wife is distracted with anxiety at the ominously long absence of her husband. Reassuring her, the chorus observes that in human life joy and sorrow alternate like day and night; they follow the same universal rhythm. Therefore, having known little but sorrow, she may now expect joy. Moreover, Heracles is a son of Zeus, and Zeus does not neglect his offspring. But at the end of the play. she is dead and he is dying—ravaged by the "shirt of Nessus" that she had innocently sent him, to charm back his love—and their son Hyllus cries out upon the cruelty of the gods. who have brought this to pass. But the play has made it clear why, in this case, the universal rhythm broke down: to get a young girl for his mistress, in utter disregard of his wife. Heracles has destroyed a city. killing all the men and enslaving the women. This hubris is followed by a second, when he sends the girl to live in Deianeira's house. Deianeira was certainly simple-minded in trusting to a supposed love charm given her by an enemy of Heracles; Sophocles' point however is that ignorance is an inescapable part of the human condition: later, he makes Hyllus curse his mother, in his ignorance, for a vindictive murderess, and then repent bitterly nhen he learns the truth. Life at its best is a precarious affair, but it was the reckless violence of Heracles, acting within this precarious framework, not the cruelty of the gods, that brought all down in ruin.

Ajax and Oedipus Rex.—The hero of the Ajax is like Shakespeare's *Coriolanus:* he is a magnificent fighting man, a great bulwark of the commonwealth, who yet ruins all through an insensate pride that drives him into treachery and crime, and so to suicide. If this were all, there would be no need of the final scenes; but in these, too. Sophocles draws attention to the human condition and the demands it makes. Twice already has the arrogance of Ajax affronted the gods; now, when the prize of valour has been adjudged not to himself but to his enemy Odysseus, his instant response is to murder the judges, his commanders. In this he is frustrated by Athena, who visits him with an attack of madness. so that he kills sheep instead. Athena—no gracious Madonna—points to the humiliated Ajax and invites Odysseus to exult over him: "You see how strong the gods are!" But he, unlike Menelaus later, will do no such thing: "I pity him in his ruin, for I see that Man is nothing but an empty shadow. Therefore" says Athena "shun pride; it is the prudent that the gods cherish." Nemesis comes to the great Ajax when he falls on his own sword: has lacked understanding of the way in which Man must live. also do the two kings, when they order that his body shall be g out to the animals—Menelaus, out of mean vindictiveness; memnon, to vindicate discipline. But this is no way in which ma should treat man. Once more it is Odysseus who shows understanding: no man, he says to Agamemnon, is always loyal and good; we must remember benefits and forget injuries. Any man may some time stand in need of forgiveness. Death is the common lot, and it must be respected. Agamemnon yields. but only as a favour to Odysseus, and Ajax's brother will not allow Odysseus to have any share in the funeral rite, fearing the anger of Ajax's spirit; so that Odysseus reluctantly departs. the only one in the play who understands the human condition and shows true reverence towards the gods.

In the *Oedipus Rex,* the most famous of the seven plays, the scene of discovery, between Oedipus and the two shepherds—only 86 verses long—is surely among the most tense in all dramatic literature. The play is sometimes described as a tragedy of blind, inexorable Fate before which human efforts. even human virtue, are of no avail. This interpretation, would, however, contradict the whole trend of Sophocles' work, and in particular the third ode in this play. Sophocles insists always on the necessity for reverence, purity, moderation—though, being a tragic poet, he never pretends that these virtues mill ensure security. One of the many tragic moments in the play is when Jocasta. jubilant before she learns the truth. proclaims that since life is random it is best to abandon principle and live from hand to mouth. The unifying thought in the play seems to be that since not even the greatest and most intelligent of us can control things, we should avoid the self-confidence that disregards religious restraints and leads straight to disaster.

Philoctetes and Oedipus Coloneus.—The *Philoctetes* concerns Neoptolemus the honourable but inexperienced son of Achilles who, on a clever plea of harsh political necessity, reluctantly undertakes a repulsive crime, only to find that it is much more repulsive than he had foreseen and also completely useless. The shifting relationship between him and his intended victim and Odysseus (who in this play is a plausible rogue) is presented with the utmost delicacy and vividness; also, in the background is the suggestion that the Greek commanders themselves, by their past inhumanity toward Philoctetes. have caused their present frustration, from which they are trying to escape by even worse inhumanity.

The last play. *Oedipus Coloneus,* is also the most imaginative, and is surpassed by none in the power and beauty of its poetry. Oedipus, now old, blind, an outcast, his very name a source of horror, is summoned by the god to his final resting place at Colonus, and becomes, in his death, a mysterious source of defense to the land that has given him refuge.

The Satyr Play.—The *Ichneutae* is based on two stories about the miraculous birth of the god Hermes: that the infant, growing to maturity in a few days, stole cattle from Apollo, baffling discovery by reversing the animals' hoof marks, and that he invented the lyre by fitting strings to a tortoise shell. In this incompletely recovered play the investigators are the chorus of Satyrs, who are looking for the cattle; they are amusingly dumbfounded at the sound of the new instrument. Enough of the play survives to give an impression of its style: it is a genial, uncomplicated travesty of the tragic manner; the antics of the chorus were apparently the chief source of fun. It escapes from the intensity of tragedy into a world in which myth is taken quite literally, for the sake of relaxation and amusement—a very suitable conclusion to a day in the theatre, most of which had been occupied by the strenuousness of three tragedies.

Bibliography.—On the manuscripts the standard work is A. Turyn, *Studies in the Manuscript Tradition of the Tragedies of Sophocles* (1952). The text of the seven plays was edited by R. C. Jebb (1897) and by A. C. Pearson, Oxford classical texts (1924). Of the commentaries, the best and fullest are those of R. C. Jebb, 7 vol. (1889–1914), each giving with the text an introduction, commentary and translation, supplemented by A. C. Pearson's three similar volumes on the fragments (1917). Jebb's translations, though archaic in style, are iaithful. The Budé text is edited, with introductions, by A. Dain, with French translation by P. Mazon (1950–). *Oedipus Tyrannus* has been edited by J. T. Sheppard with explanation and translation (1920). *See* also J. C. Kamerbeek, *Plays of Sophocles* (1953–1959).

For interpretative criticism *see:* the relevant chapters in M. Pohlenz, *Die griechische Tragodie,* 2nd ed. (1954); Gilbert Norwood, *Greek Tragedy,* 4th ed. (1948; reprinted with corrections, 1953); H. D. F. Kitto, *Greek Tragedy,* 2nd ed. (1954) and *Form and Meaning in Drama* (1956); K. Reinhardt, *Sophokles* (1933); T. B. L. Webster, *Introduction to Sophocles* (1936); C. M. Bowra, *Sophoclean Tragedy* (1944); F. R. Earp, *The Style of Sophocles* (1944); R. F. Goheen, *Imagery oj Sophocles' Antigone* (1951); C. H. Whitman, *Sophocles: a Study of Heroic Humanism* (1951); F. J. H. Letters. *The Life and Work of Sophocles* (1953); G. M. Kirkwood, *A Study of Sophoclean Drama* (1958); H. D. F. Kitto, *Sophocles, Dramatist and Philosopher* (1958). (H. D. F. K.)

SOPHRQN of Syracuse (fl. c. 430 B.C.), was the author of rhythmical prose mimes in the Doric dialect. Although the mimes survive mostly in fragments of only a few words, it can be seen from their titles, *e.g., The Tunny-fisher, The Sempstress,* etc., that they depicted scenes from daily life. One longer fragment deals with a magical ceremony. Plato thought highly of Sophron, who had some influence on Theocritus and also on Herodas.

For fragments *see* G. Kaibel (ed.), *Comicorum Graecorum fragmenta,* pp. 152–181 (1899); and for the longer fragment *see* D. L. Page (ed.), *Greek Literary Papyri,* "Loeb Series," 2nd ed., vol. 1, pp. 328–331 (1942). (E. A. B.)

SOPRANO (a variant of Ital. *sovrano,* supreme, sovereign), in music, the highest human voice, the term being often restricted to that range in the female voice, "treble" being used of a boy's voice. Male *soprani,* either natural or artificially produced, as formerly in the *castrati* of the papal choirs (*see* Eunuch), are also found.

SOPRON (German *Ödenburg*), a town of Gyor-Sopron, Hungary, on an important route from Transdanubia to Vienna through the so-called "Odenburg Gate" between the Leitha and Rosalien mountains. Through this gap German forms of culture penetrated and Sopron has in part the appearance of a west European town. The critical site has been continuously occupied since pre-Roman times, a Roman colony, *Scarabantia,* having existed there, and has a wealth of old buildings, notably the 13th-century Benedictine church, the 15th-century church of St. Michael in Gothic style and the 17th-century Dominican church. Pop. (1930) 35,895, about 50% German; (1957 est.) mun., 37,000.

SOPWITH, SIR THOMAS OCTAVE MURDOCH (1888–), British aircraft designer and well-known yachtsman. was born in London, Jan. 18, 1888. He taught himself to fly in 1910 and in that year won the de Forest prize for the longest flight to the continent. In 1912 he founded Sopwith Aviation Co., Ltd.. at Kingston-on-Thames and, flying a Blériot monoplane. won the first aerial Derby. In 1914 he designed and built the seaplane that won the Schneider trophy. During World War I his firm produced many military aircraft, including the "Pup," "Camel," "1½-strutter" and "triplane." Sopwith was chairman of the Society of British Aircraft Constructors, 1925–27. In 1935 he became chairman of the Hawker Siddeley Group, Ltd., which during World War II built the Hurricane fighter and the Lancaster bomber. They also built the first British jet aircraft, the Gloster E 28139, powered by the Whittle engine (see Whittle, SIR FRANK). Between the wars Sopwith raced such yachts as "Shamrock V" and "Endeavour II." (D. CR.)

SORACTE, a mountain in the province of Roma, Italy. It is a narrow, isolated limestone ridge, about 5 mi. S.E. of Civita Castellana, and $3\frac{1}{2}$ mi. in length. The highest summit is 2,267 ft. above sea level; just below is a monastery originally founded about 748 by Carloman, son of Charles Martel (the altar has fragments of sculptures of this period).

Owing to the isolated position of the mountain the view is magnificent, and Soracte is a conspicuous object in the landscape, being visible from Rome.

SORANUS (fl. 2nd century A.D.), Greek physician, born at Ephesus, lived during the reigns of Trajan and Hadrian. According to Suidas, he practised in Alexandria and subsequently in Rome. He was the chief representative of the school of physicians known as "methodists." Two treatises by him are extant: *On Fractures* (in J. L. Ideler. *Physici et medici minores,* i, 1841) and On *Midwifery and the Diseases of Women* (first printed in 1838, later by V. Rose in 1882, with a 6th-century Latin translation by Moschio). The uork of Soranus on midwifery was the source of many works on obstetrics; the book also contains a chapter on the care and feeding of infants. Of Soranus' most important work, *On Acute and Chronic Diseases,* only a few fragments in Greek remain, but there exists a complete 5th-century Latin translation by Caelius Aurelianus. The *Life of Hippocrates* (in the work cited, by Ideler) probably formed one of the collection of medical biographies by Soranus referred to by Suidas, and is valuable as the only authority for the life of the great physician, with the exception of articles in Suidas and Stephanus of Byzantium.

SORANUS, an underworld deity worshiped in antiquity on Mt. Soracte, in Etruria north of Rome. Traditionally the Hirpini (*q.v.*) got their name from the fact that once as they worshiped Soranus, wolves (*hirpi*) carried off the sacrificial entrails (Servius, *ad Aenezd,* xi. 785). As priests the *hirpi* (or *hirpini*) *Sorani* celebrated a rite in uhich they marched over burning coals barefooted (Pliny, *Natural Hzstory,* vii, 2, 19). Soranus mas identified with Dis and Apollo (*q.v.*) and had a female partner. Feronia. (R. B. LD.)

SORBONNE: *see* PARIS UNIVERSITY.

SORBS or LUSATIAN SERBS, a Slavonic-language-speaking people in eastern Germany. in Upper and Lower Lusatia (Lausitz), with the towns of Bautzen (Budysin) and Kottbuss (Chocebuz) respectively as their main cultural centres. They occupy roughly an area between Dresden in the west, the Polish frontier in the east. Czechoslovakia in the south and Liibben in the north. The Germans call them *Wenden* or *Sorben;* they call themselves *Srbi* (plural of *Srb*). There are about 150,000 Sorbs (1952 est.), *i.e.,* 20% of the present population in mixed German-Lusatian districts. They speak Lusatian, also known as Wendish and Sorbic, a west Slavonic language going through a process of consolidation and fusion of its two main forms, of which Lower Lusatian is nearer to Polish and Upper Lusatian to Czech. The religion of 90% is Lutheran.

See also LUSATIA.

See: E. Muka, *Slownik dolnjoserbskeje rěcy a jěje narecow* (1911–26), a vocabulary of Lower Lusatian language and its dialects; J. Jatzwauk, *Wendische (Sorbische) Bibliographie* (1952). (E. HL.)

SORBUS, a genus of the rose family consisting of ornamental woody plants, commonly known as mountain ash, grown for their attractive foliage, showy white flowers and handsome clustered unusually red fruit. By some authors the genus is treated as subgenus under *Pyrus*. *See* MOUNTAIN ASH. (J. M. BL.)

SORBY, HENRY CLIFTON (1826–1908), English pioneer petrographer and microscopist, was born at Woodbourne near Sheffield, on May 10, 1826. His first paper, on sulfur and phosphorus in agricultural crops. was published in 1847. An early paper dealing with the origin of valleys in Yorkshire was followed by others on the physical geography of geological periods, rock denudation and deposition and the formation of river terraces.

In 1849 Sorby began to prepare thin sections of rocks for study under the microscope, thus founding the science of petrography. In 1857 he proved that slaty cleavage was produced by lateral pressure which caused the rearrangement of particles in shaly rocks. His memoir "On the Microscopical Structure of Crystals," published in 1858 in the *Quarterly Journal of the Geological Soczety of London,* made a strong plea for the adoption of microscopic methods in geology and illustrated their value.

In 1865 Sorby announced a new type of spectrum microscope to be used in study of organic pigments, and especially in determination of minute bloodstains. He studied the metallography of iron and steel, concluding that the latter was a crystallized igneous rock, and did related aork of industrial value. His later geologic studies dealt with, among other subjects, the origin of limestones and other stratified rocks, and weathering. His publications in these various fields number 240. He died in Sheffield on March 9. 1908. (C. L. FE.; M. A. F.)

SORCERY: see MAGIC; DIVINATION; WITCHCRAFT.

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